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Comparing the Copenhagen emissions targets

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Abstract

Following the Copenhagen climate Accord, developed and developing countries have pledged to cut their greenhouse gas emissions, emissions intensity or emissions relative to baseline. This analysis puts the targets for the major countries on a common footing, and compares them across different metrics. Targeted changes in absolute emissions differ markedly between countries, with continued strong increases in some developing countries but significant decreases in others including Indonesia, Brazil and South Africa, provided reasonable baseline projections are used. Differences are smaller when emissions are expressed in per capita terms. Reductions in emissions intensity of economies implicit in the targets are remarkably similar across developed and developing countries, with China's emissions intensity target spanning almost the same range as the implicit intensity reductions in the United States, EU, Japan, Australia and Canada. Targeted deviations from business-as-usual are also remarkably similar across countries, and the majority of total global reductions relative to baselines may originate from China and other developing countries. The findings suggest that targets for most major countries are broadly compatible in important metrics, and that while the overall global ambition falls short of a two degree trajectory, the targets by key developing countries including China can be considered commensurate in the context of what developed countries have pledged.

Keywords: Copenhagen Accord, emissions targets, emissions intensity, business-as-usual, cross-country comparison.

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1 Introduction

The Copenhagen Accord (UNFCCC 2009), reached at the UN climate conference in December 2009, has been widely portrayed as a disappointment because of the lack of progress toward a binding global climate treaty – in the words of Schellnhuber (2010), a 'reality shock' not just a reality check. However, the large majority of countries have formally acceded to the Accord, and many, including all of the world's largest greenhouse gas emitting nations, have submitted quantified economy-wide emissions targets for the year 2020 (UNFCCC 2010). Crucially, not just developed countries have made quantitative pledges, but also the largest emitters among developing and industrializing countries. Although the targets have no legally binding status, they can be seen as an indication of the extent of mitigation action that countries are aiming for.

Whether these pledges can be a solid basis for global climate change mitigation policy and whether countries follow through with their pledges will depend to a significant extent on whether the pledges made by key countries are considered adequate, given their circumstances.

In order to form judgments about the Copenhagen pledges, it is necessary to compare emissions targets across the various metrics that different countries have framed their targets in. Developed countries are targeting absolute reductions relative to different base years; China and India have pledged to reduce the emissions intensity of their economies over time; while most other developing countries have defined their targets as reductions below a business-as-usual (BAU) trajectory. Taking these different perspectives on all key countries' targets is an important step in establishing comparability.

This paper puts the targets for thirteen of the largest carbon emitting countries on a common footing, and compares them across four different metrics: changes in absolute emissions, changes in per capita emissions, changes in emissions intensity, and deviations from business-as-usual. Within the emerging literature assessing the Copenhagen targets[1], the specific contribution in the present paper is a consistent estimation for both developed and developing countries across the full range of metrics chosen by countries, coupled with analysis of the adequacy of individual countries' targets in the context of others' pledges.

The paper is organised as follows. Section 2 sets out the methodology and data. Section 3 provides estimates of changes in absolute emissions levels, and Section 4 discusses per-capita measures. Section 5 provides comparisons of implied reductions in emissions

[1] Examples include den Elzen et al (2010), Houser (2010), Levin and Bradley (2010), McKibbin et al (2010), Schleich et al (2010), Vazhayil (2010). Most of these studies look at only a subset of countries or metrics included in the present paper.

intensity, and Section 6 assesses targets against possible business-as-usual scenarios. Section 7 concludes.

2 Methodology and data

2.1 The targets

This analysis comprises thirteen large countries that have submitted quantitative emissions targets for 2020, as part of the Copenhagen Accord process (Table 1). They are six Annex I (mostly developed) countries and country groups (United States, European Union, Japan, Russian Federation, Canada, Australia) and seven non-Annex I (developing and industrializing countries – China, India, Indonesia, Brazil, Mexico, South Korea, South Africa).

Together, these thirteen countries accounted for just over two thirds of global greenhouse gas emissions in 2005, about one third of the total from the six Annex I countries and regions in the sample and another third from the seven non-Annex I countries.[2]

[Table 1 here]

The bottom-up nature of the Accord – in contrast to an international treaty such as the Kyoto Protocol – allows countries' pledges to be framed in very different ways. This extends not just to different forms of targets (absolute, intensity or relative to BAU) and baselines as shown in Table 1, but also to different scopes of emissions accounting[3] and potentially different modes of using international trading in emissions allowances or emissions offsets[4].

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[2] The data source for countries' historical emissions levels is the WRI (2010) CAIT database, using all emissions and sources including land-use change and forestry. For Australia, official national greenhouse gas inventory numbers were used. There are divergences between this dataset and official national greenhouse gas inventories, in particular for emissions from land-use change and forestry and due to the different treatment of different land-based emissions sources and sinks. However, for most countries these divergences are not large, and for some developing countries (in particular Indonesia) consistent official national data are not yet available. Data on levels and growth rates of GDP and population were also taken from the CAIT database.

[3] For example, it is understood that Indonesia's reduction commitment will include emissions from peat fires (Ministry of Finance Indonesia 2009), which is a significant issue practically only in Indonesia. Many other countries meanwhile are expected to exclude the carbon balance from forest management and soils.

[4] The Copenhagen Accord makes no determinations as to the nature and extent of international emissions trading. The UNFCCC has standards in place for offset credits under the Clean Development Mechanism and may define further standards for example for REDD (reducing emissions from deforestation and forest degradation). However in the absence of a

2.2 Computations and assumptions

To compare the targets on a common footing, all countries' targets are converted into

- absolute change in emissions from 2005 (and other base years) to 2020;
- change in emissions per capita from 2005 to 2020;
- change in emissions intensity (emissions per unit of GDP) from 2005 to 2020;
- change in emissions relative to a business-as-usual (BAU) scenario at 2020.

The calculations require assumptions about future growth rates of GDP (from EIA 2010); population projections (United Nations 2009), as well as assumptions about BAU emissions scenarios (for sources and assumptions see Tables 2 and 3).

Each of the comparisons involves *expected* emissions reductions, for the subset of countries that have framed their target in a different metric to the metric under consideration. An overview of the calculations required for the comparison exercise is given in Table 2, and numerical assumptions are shown in detail in Table 3. These assumptions are further discussed in the relevant sections below.

[Table 2 here]

[Table 3 here]

2.3 Comparability, complexity and contestability

The different dimensions over which targets can be compared bring with them different levels of complexity of assumptions and analysis, and more complex metrics are more uncertain and contestable. Within the metrics assessed here, complexity increases from absolute targets (which require only data on emissions levels through time) to per capita and intensity targets (which require data and assumptions about growth in population and GDP respectively) to changes relative to business-as-usual (which requires baseline projections of emissions levels). The latter necessarily relies on a range of assumptions that can be contested.

More complex analyses still attempt to translate an emissions target into a shadow price on carbon emissions, or the economic cost that would be incurred meeting the target. There is a tradition of such analyses using global computable general equilibrium models (eg Weyant et al 2006, McKibbin et al 2010). Such modelling can provide important insights, however the quantitative results are sensitive to assumptions about growth and structural change, substitution elasticities, and technological change. Different models and sets of assumptions will yield different results, and the conclusions are necessarily contestable. The present paper does not quantify economic costs of meeting targets.

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comprehensive international agreement, individual countries might define and operate their own schemes for cross-border investment in mitigation and exchange of emissions reduction units, including on bilateral basis.

3 Absolute emissions

The analysis here converts developed countries' absolute emissions targets to a common base year, and converts non-Annex I countries' targets to an expected change in absolute emissions from the common base year to 2020. Comparisons for different base years are given, and the likely global effect of countries' Copenhagen pledges are discussed.

3.1 Targeted change in absolute emissions

The targeted change in absolute emissions from 2005-2020 explicit or implicit in each country's Copenhagen target is shown in Figure 1 and (with sensitivity analysis) in Table 4.[5]

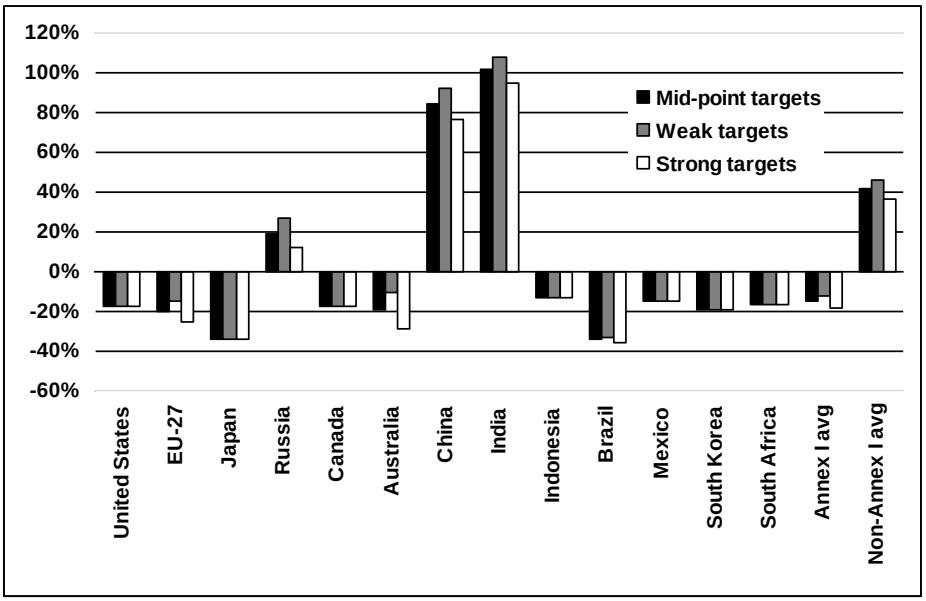
The common base year here is 2005. The targets for the EU, Russia and Japan are converted from their 1990 base, and Australia's from its 2000 base. Comparisons for a 1990 and 2000 base are below. 2005 is chosen because it is the base year nominated by the largest countries (United States, China and India), and because it includes the shortest period of 'historical' emissions growth – this provides a reasonable basis for comparison as only future changes in emissions levels are of direct relevance for the assessment of effort implicit in the Copenhagen targets.

[Table 4 here]

Among the Annex I countries and groups examined here, Japan is targeting the largest percentage reduction between 2005 and 2020. Australia and the EU follow as the second and third largest absolute reductions for the high end of their respective target ranges, but are at or below the average for the low end of their ranges. The absolute reductions pledged by the United States and Canada are closer to the average for Annex I countries, which is a 15 per cent below 2005 levels for the mid-point of target ranges, and between 12% and 18% for the full range of targets. Russia is the outlier, as its target (framed as a reduction relative to 1990 levels) implies an increase over 2005 levels, because a large drop in emissions between 1990 and 2005.

[5] Annex I countries' targets are framed as percentage reductions in total emissions at 2020 relative to a base year, and hence only need converting to a common base year to allow direct comparison. Targets for non-Annex I countries are converted to (expected) absolute reductions by way of assumptions about future GDP growth rates (China and India) and future emissions growth under BAU (other non-Annex I countries). For non-Annex I countries, the central scenario is complemented by 'high' and 'low' growth assumptions, resulting in a range of expected absolute reductions (Table 4).

Figure 1 Absolute targets (targeted change in absolute emissions, 2005 to 2020, central scenario)



Details and sources: see Table 4.

For non-Annex I countries, differences in targeted rates between countries are stark, reflecting strongly differing underlying trends in economic growth, as well as differences in structure of economies and emissions profiles. China's and India's total emissions would continue to rise strongly – though as shown in Section 6 below, China's pledge implies significantly slower growth than might otherwise be the case.

The targets for other non-Annex I countries in the sample all imply reductions relative to 2005 levels, on the basis of business-as-usual emissions growth scenarios as laid out in Section 6 below. In other words, these countries have implicitly pledged to a peak in their national emissions during the next decade. This is principally because underlying growth in these countries is much slower than in China and India, and because the pledged reductions below business-as-usual are substantial. The targets by Mexico, South Korea and South Africa imply reductions between 15 and 20% under our central assumptions.

Indonesia and Brazil are special cases in that their emissions profile is dominated by carbon from deforestation and other land-based sources. These have been broadly stagnant over recent years, and in some cases might fall even without specific climate policy interventions, resulting in only small increases in overall national greenhouse gas emissions under our central BAU scenarios in this paper. On these assumptions, Indonesia's and Brazil's targets imply absolute reductions of 13% and 34% respectively, but with a wide margin of possible variation around these estimates if different assumptions on BAU growth are made.

It is important to note that for most developing countries that have made such pledges, the level of BAU emissions against which 2020 emissions are to be evaluated has not yet been determined. Countries may be tempted to put forth relatively high (or even inflated) BAU trajectories, so that the pledged reductions against that baseline are easier to achieve. This would result in lesser reductions or greater increases in absolute terms.

The definition of BAU emissions trajectories is thus an important factor for the actual stringency and effectiveness of developing countries' Copenhagen pledges, and may rightfully become the subject of intense scrutiny once numbers are proposed.[6]

3.2 Different base years

A comparison of targeted percentage changes in emissions at 2020 relative to different base years (1990, 2000 and 2005) shows large differences for individual countries, because of different rates of growth in the past (Table 5). For example, if the US target were framed with a 1990 base year, the percentage reduction drops from 17% to 3%, because US emissions grew significantly between 1990 and 2005. The opposite effect occurs for Russia, where emissions fell.

[Table 5 here]

The majority of developed countries has chosen base years that result in the largest possible percentage reduction for the same absolute emissions level in 2020.[7] This appears consistent with empirical findings that views about what is fair and proper in international climate policy are strongly correlated with national self-interest (Lange et al 2010).

The choice of base year makes an even greater difference for most non-Annex I countries, which typically have experienced strong emissions growth between 1990 and 2005 – for example in China and South Korea, annual emissions almost doubled during that period. It seems out of the question that developing countries would frame emissions targets as absolute changes relative to a past point in time like 1990, as it would only serve to highlight the rapid growth in their past emissions.

From this perspective, 2005 is an appropriate choice of base year for developing countries. Developing countries might even argue that 2010 should be used as a base year for comparison, once data are available. This would focus comparisons on the period during which the pledges for mitigation actions apply.

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[6] China and India are not in this situation, as their intensity targets are influenced only by the level of reported GDP.

[7] The exceptions in this sample are Japan, where there is a particularly strong affinity to the Kyoto Protocol which had 1990 as a base year; and Australia, where 2000 was postulated as base year in a government-commissioned national climate policy review (Garnaut 2008).

3.3 Global effort

This paper is concerned with the relative contribution by different countries to the overall mitigation effort, rather than the magnitude of the global effort. Nevertheless, two aspects on the global effort are important in assessing individual countries' commitments: conditionality of targets on the level of global effort, and international emissions trading.

Some countries have made their pledges conditional on commitments made by other countries, or the overall global level of ambition. One example is the EU target range, with an unconditional 20% absolute reduction relative to 1990 and a 30% reduction conditional on other countries' commitments. Another is Australia, with an unconditional target of a 5% absolute reduction relative to 2000, a reduction of 25% ""if the world agrees to an ambitious global deal capable of stabilising [...] at 450 ppm CO_2-equivalent or lower", and a reduction up to 15% if a global agreement falls short of the 450 stabilization goal but "under which major developing countries commit to substantially restrain emissions and advanced economies take on commitments comparable to Australia's" (UNFCCC 2010).

A fundamental point to keep in mind in this respect is that targeted near-term emissions levels do not define whether particular long-run concentration or temperature targets can be met. Too much depends on emissions trajectories after 2020. However, the aggregate 2020 targeted emissions levels can be compared to the early segments of plausible longer-term global emissions trajectories for atmospheric concentrations and expected temperatures. Such analyses have tended to show that the Copenhagen targets are roughly on track to a 550ppm or 3 degrees scenario (for example den Elzen et al 2010, Macintosh 2010, Project Catalyst 2010, Rogelj et al 2010).

Secondly, it is likely that some countries will use international trading of emissions reductions to comply with their commitments, possibly to a much greater extent than under the Kyoto Protocol. Specifically, developing countries may sell emission reductions to developed countries, possibly at large scale, in return for payments and investments in mitigation measures. The appropriate accounting then requires that traded emissions reductions are accounted for only in the 'buying' country, not in the selling country.

At this stage it is unclear, in particular for non-Annex I countries, whether the Copenhagen targets put forth would in fact be net of trading. Many developing countries have made it clear that their mitigation actions depend on financing from developed countries, but not how they intend to account for emissions reductions financed by other countries.[8] To the extent that any double counting takes place, this would reduce the overall global effort, and also the effort of the countries involved relative to other countries.

[8] An exception is Indonesia, which has a target of 26 per cent below BAU, and up to 41 per cent with international assistance. It can be inferred that the 26% target is a purely unilateral target, and only reductions beyond 26% would be 'sold' to other countries.

4 Per capita emissions

Emissions levels per capita have for a long time figured prominently in the debate about equity and climate policy. The notion of equal per capita entitlements to emissions are the underpinning of proposals such as ‘contraction and convergence’ (Meyer 2000). A gradual transition towards equal per capita emissions allocations has been seen described as the only ultimately viable climate equity principle (Garnaut 2008) or as essentially inevitable under strong global mitigation (Stern 2008).

A related aspect is the rates of change in emissions per person over time. Expressing emissions targets as change in per capita emissions over time takes out population growth as a variable affecting emissions growth. While population is an important long-term driver of emissions trajectories, but most countries would not consider population policy as a means to achieve short to medium term greenhouse gas emissions commitments. Hence per capita emissions growth over time is a relevant metric, especially if considered in conjunction with levels of per capita emissions.

4.1 Per capita emissions growth

There are stark differences in absolute and per capita targets for countries where population is expected to grow or shrink during 2005 to 2020 (Table 6, Figure 2).

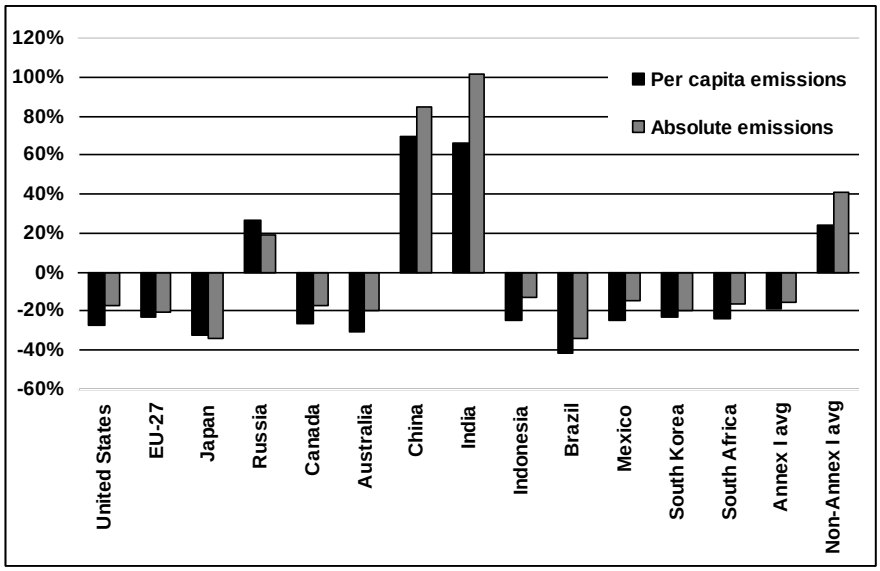
[Table 6 here]

For Australia, Canada and the United States, which have significant immigration as well as relatively high birth rates in comparison to other developed countries, the implied cuts in emissions per person, based on UN (2010) population projections, are around ten percentage points greater than the pledged absolute reductions. By contrast, populations in Europe and Japan are approximately stable, making a given absolute target relatively less ambitious in per capita terms. For example, the mid-point of the EU target range implies are lesser reduction in per capita emissions than the US, Australian and Canadian targets.

The differences between absolute and per capita measures are even starker for most developing countries. On central assumptions, the reductions in per capita emissions pledged by Indonesia, Brazil, Mexico, South Africa and South Korea are all greater than 20%, and are on par with those by the main developed countries. For China and India, the implicit increases in per capita emissions are significantly smaller than in absolute terms.

On average for the sample of countries in this analysis (accounting for around two thirds of global emissions), the Copenhagen targets imply that per capita emissions would remain roughly constant from 2005 to 2020.

Figure 2 Per capita targets compared to absolute targets (targeted change, 2005 to 2020, central scenario, mid-points of target ranges)



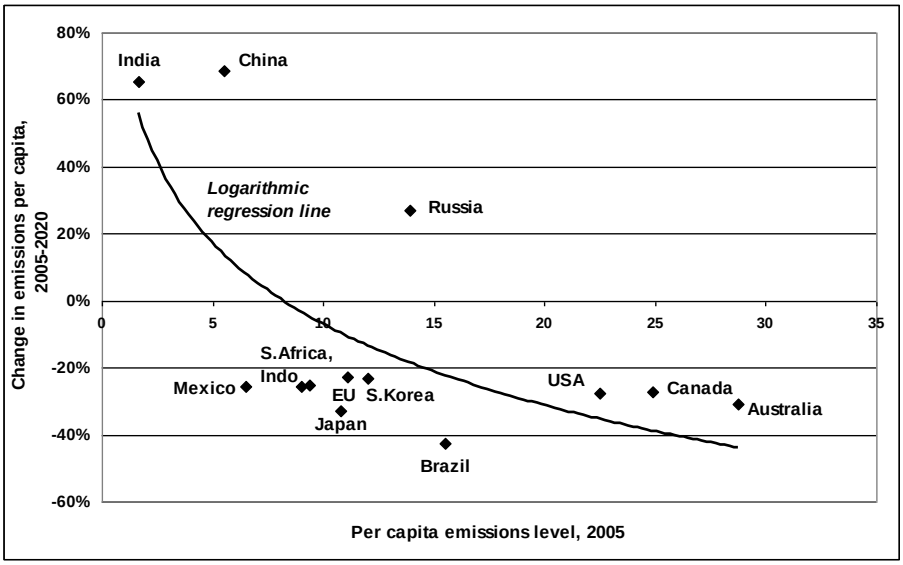
Details and sources: see Table 6.

4.2 Per capita emissions levels

Per capita emissions levels differ starkly between countries, reflecting principally differences in the stage of development between countries, but also differences in resource bases and economic structure. If Copenhagen targets incorporated the principle of convergence towards similar per capita emissions levels over time, then a clear correlation would be evident between the level of per capita emissions and the targeted change in emissions per capita.

The Copenhagen targets for our sample of countries show such correlation only in a very limited sense (Figure 3). For nine of the thirteen countries, targeted per capita emissions reductions are in a narrow band between 23% and 33%, with no correlation to income. Convergence, in broad terms, is evident only if considering a group of countries that has relatively high emissions levels or growth rates: India and China with relatively low per capita emissions levels and high anticipated growth rates; United States, Canada and Australia at the other end of the spectrum; and Russia in-between. The other countries in the sample, comprising both developed and developing countries, have relatively strong reduction targets at moderate levels of per capita emissions.

Figure 3 Targeted change in emissions per capita versus level of per capita emissions



Details and sources: see Table 6.

5 Emissions intensity

China and India have expressed their Copenhagen pledges as emissions intensity targets, reducing the ratio of economy-wide greenhouse gas emissions per unit of GDP. Emissions intensity gets to the heart of the global mitigation challenge and its translation into policy, as the realistic public policy objective is to decarbonize economic activity, not to slow economic development and growth.

Emissions intensity targets were proposed earlier as a means for making it easier for developing countries to take on quantitative emissions commitments (eg Baumert 2009), and have been shown to have advantages in managing uncertainty about future underlying emissions growth (Jotzo and Pezzey 2007). A target expressed in terms of emissions intensity also results in a 'smaller number' in terms of percentage change over time, as it factors out GDP growth.

5.1 Targeted changes in emissions intensity

Any absolute target (or implicit change in absolute emissions) can be expressed in intensity terms, by making assumptions about future GDP growth. The variations in intensity targets is much smaller than for absolute or per capita targets: all countries in the sample have pledged reductions, and seven of the thirteen countries are in a narrow band of targeted reductions between 38% and 46%, for mid-points of targets under central assumptions (Table 7, Figure 4).

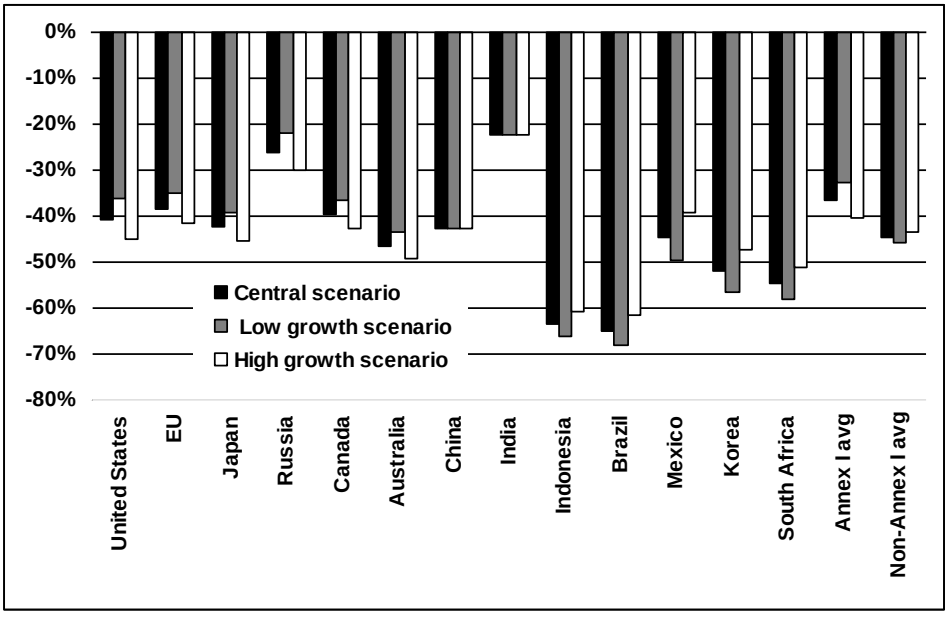
Importantly, China's target range of reducing emissions intensity by 40-45% from 2005 to 2020 spans almost the same range as the implied targeted emissions intensity reductions in the United States, EU, Japan, Canada and Australia. This is a potent comparison that could receive significant attention in the policy debate in years to come.

India's and Russia's targets are less ambitious than the 40-45% range, while the targets by the other developing and industrializing countries are more ambitious. The pledges by Brazil and Indonesia imply reductions in emissions intensity by almost two thirds, again due to the dominance of land-use change related emissions in these countries and their goal to substantially reduce these.

Variations around these estimates under assumptions of higher or lower growth are relatively small (Table 7). For developed countries (with absolute emissions targets), this is because the uncertainty about GDP growth rates is relatively small compared to the targeted rates of reduction in emissions intensity. For countries with targets framed relative to BAU scenarios (principally developing countries), this is because in this analysis it is assumed that higher GDP growth are associated with higher BAU emissions scenarios, with offsetting effects on emissions intensity. For China and India, the reduction in emissions intensity is independent of the GDP growth rate.

[Table 7 here]

Figure 4 Intensity targets (targeted change in emissions intensity, 2005 to 2020, mid-points of target ranges)



Details and sources: see Table 7.

Other recent studies show comparable estimates of implied emissions intensity reductions for Annex I countries (eg Levin and Bradley 2010, McKibbin 2010).

5.2 Emissions intensity targets in context

Emissions intensity tends to decline over time and with increasing incomes, because of technological progress and change in economic structure towards services, and also because the power sector tends to shift toward lower-carbon energy sources as incomes rise (Burke 2010). Globally, emissions intensity decreased by 1.6% per year on average during 1997-2007, and by 2.0% per year from 1971-2007 (IEA 2010). The annual average targeted reduction from 2005-2020 is 3.1% on average for the thirteen countries in this analysis.

The *level* of emissions intensity in a particular country is a function of a host of structural factors including endowment of energy and other resources, geographical factors and relative contribution of different sectors to overall economic activity. For example, emissions intensity can be expected to be higher in countries that have cheap and abundant coal, or that have large energy intensive industries. Similarly, the underlying rate of change in emissions intensity depends on economic structure and the nature of energy systems.

Nevertheless, two aggregate relationships can also be hypothesized.

Firstly, countries with higher levels of emissions intensity might on average pledge greater rates of reductions, because they have greater options to achieve cuts – be it through changes in the fuel mix, improvements in energy efficiency or shifting toward less emissions intensive economics activities.

Secondly, countries with higher rates of economic growth might find it easier to achieve a given reduction in emissions intensity. This is because these economies have a higher rate of new additions in capital stock, and hence greater opportunity to influence the overall emissions intensity solely through cleaner new investments rather than by upgrading or retiring existing equipment.

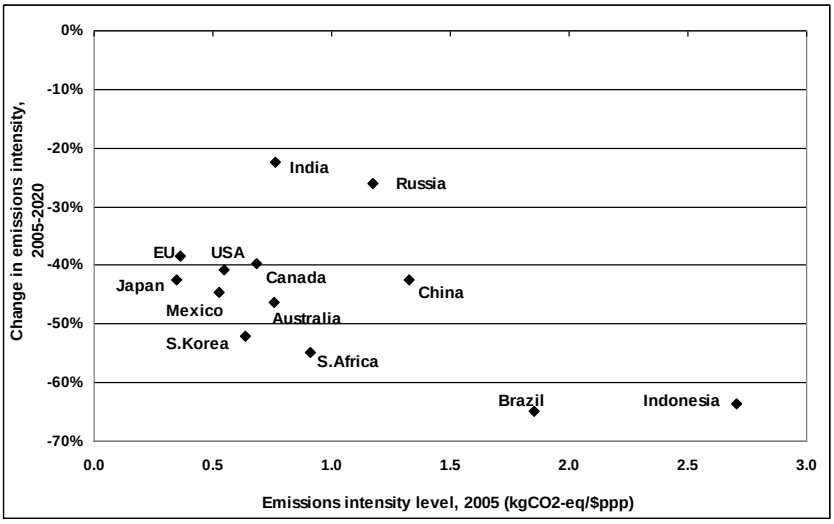
The empirical data do indeed show both these relationships, though there is large dispersion in the sample and clear correlation is evident only for subsets of countries (Figures 5 and 6). The notable outliers are India and Russia with weak reduction targets.

The existence of a negative correlation between levels and targeted rates of change in emissions intensity (Figure 3) implies convergence of emissions intensity levels between countries over time. In the comparative analysis of emissions targets, this relationship could be a useful complement to the concept of convergence of per capita emissions levels.

Fast-growing countries tend to have deeper pledged cuts in emissions intensity (Figure 4). In this relationship, China is an outlier of sorts, as its rate of targeted emissions intensity reductions is similar to those of other key countries, but its GDP growth rate is extraordinarily high. However, China’s target represents a significant degree of ambition

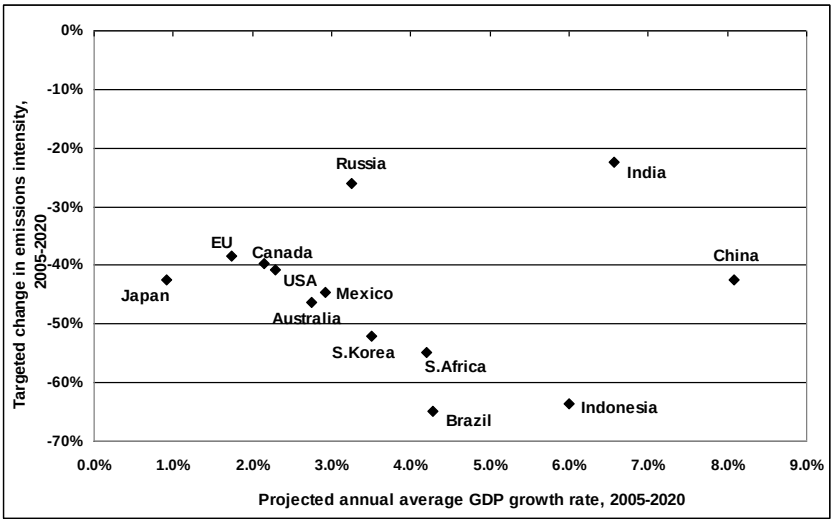
when assessed against likely underlying growth, in contrast to India's and Russia's targets (see Section 6 below).[9]

Figure 5 Targeted change in emissions intensity, versus level of emissions intensity



Details and sources: see Table 7.

Figure 6 Targeted change in emissions intensity, versus GDP growth rate



Details and sources: see Tables 7 and 3.

[9] The data for Indonesia and Brazil are difficult to interpret in this metric, as their pledged reductions in emissions intensity are attributable in large part to reductions in emissions from deforestation, for which the argument about turnover of capital stock applies only in very limited ways.

6 Reductions relative to business-as-usual

Comparing targeted emissions to scenarios of business-as-usual (BAU) gives a direct measure of the actual emissions impact of the pledges. It is the crucial measure for assessing the effectiveness of targets, and it is an important dimension in the comparison of effort.

However, estimates of reductions relative to BAU are much more difficult to conceptualize and to quantify than changes in absolute emissions or emissions per person or per unit of output. BAU is a concept open to different interpretations both in principle, and in its practical application. BAU is also not verifiable ex-post, as it typically refers to a counterfactual scenario.

The contestability of estimates of BAU applies whether or not a country has framed its target in terms of reductions relative to BAU. Where targets are framed in reductions relative to BAU emissions, the (contestable) quantification of BAU emissions levels determines the implicit actual emissions target and hence the effort required; while for countries with absolute or intensity targets, (contestable) estimates of BAU levels need to be made in order to assess what the targeted reduction amounts to relative to BAU.

Different implementations of the BAU concept can lead to substantially different quantitative estimates. Reference case scenarios by agencies such as the International Energy Agency and Energy Information Administration (eg IEA 2009, EIA 2010) typically aim to reflect existing policies and their continuation into the future, but exclude possible or potential future policies (eg IEA 2010, p. 55). This then is not a measure of what emissions (or energy use) would have been in the absence of climate change policy action.

If such reference case scenarios are interpreted as BAU, this means that all continuing current policies are treated as occurring ‘anyway’, even if their purpose is to cut carbon emissions or energy use. It also means assuming that existing policies are fully implemented, even if in practice implementation is incomplete, and that such implementation again is part of BAU. Consequently, using reference scenarios such as that from IEA tends to yield (often significantly) lower estimates of future BAU emission levels than alternative approaches that attempt to net out policy efforts aimed at reducing emissions.

In the present analysis, BAU emissions levels for each country are produced by using projections of emissions intensity at 2020 under the reference case of a general equilibrium modelling study by the Australian Treasury (2008), coupled with the GDP projections used elsewhere in this analysis, and supplemented with data on emissions from deforestation where this is significant (Indonesia and Brazil) – details are listed in Table 3. Sensitivity analysis around the central assumptions on BAU emissions growth, shown below, is a vital component of the analysis.

Estimates of the economic cost incurred in meeting the target are not pursued here (see discussion in Section 2).

6.1 Targeted changes relative to BAU emissions

The resulting estimates show targeted emissions levels significantly below BAU for all countries in the sample except India and Russia (Figure 7 and Table 8). The aggregate reductions for developed and developing countries as groups are almost exactly the same at around a quarter below BAU, under our assumptions. Targeted reductions vary between countries, but without a consistent pattern.

[Table 8 here]

The US and EU targets are both around 25% below BAU, while the targets by Japan, Australia and Canada imply reductions of more than 30% below BAU (for the mid-point of target ranges). Assuming higher and lower BAU emissions growth (as per Table 3) increases or decreases the estimates by around 10 percentage points. Russia's emissions target is just above BAU levels in the central and low-growth scenario, implying that under these assumptions no new policies would be needed to achieve Russia's Copenhagen target.

China's intensity target implies a reduction of just over a quarter below BAU emissions, with a range from 20% to 33% below BAU, for the mid-point of China's target range – around the same reductions as the United States and the overall average. This is an important result in evaluating China's pledged contribution to global climate change mitigation, and is discussed in detail below.

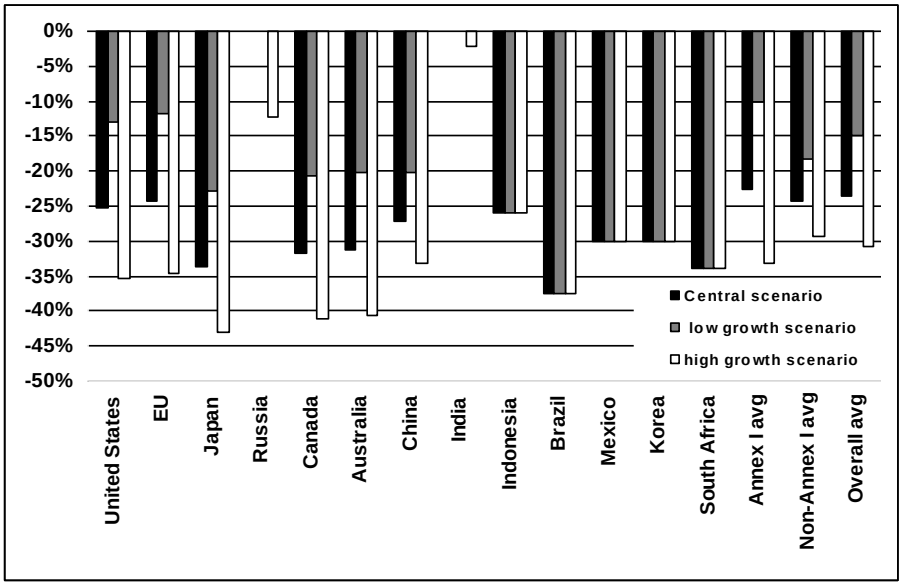
India's intensity target by contrast is above the likely BAU emissions trajectory. Only under the high-growth scenario would a slight reduction below BAU emissions levels occur.

For the developing countries other than China and India in this sample, pledged reductions from BAU emissions range between 26% and 39%. What amount of emissions reductions these pledges amount to in the end depends on what is defined as BAU emission levels by each country.

Estimation of reductions relative to BAU also allows an assessment of the possible contributions by countries to the overall amount of greenhouse gas abatement. On central assumptions, non-Annex I countries would collectively contribute almost two thirds of global abatement pledged for 2020 (Table 9). The share is over 70% in the low growth scenario, and just below 60% in the high growth scenario.[10]

[10] The reason for the changing share is that the amount of abatement implicit in absolute targets, which apply in developed countries, varies much more as a result of higher or lower growth in GDP and BAU emissions than the amount of abatement implicit in developing countries' targets, which are framed relative to growth trajectories.

Figure 7 BAU targets (targeted emissions relative to BAU levels, at 2020, for mid-points of target ranges)



Details and sources: see Table 8.

This does, however, presume that developing countries with BAU targets apply reasonable BAU projections as a basis for their announced percentage reductions. If and where that is not the case and inflated BAU numbers were used, then the amount of emissions reductions would be lower.

China would contribute over 40% of total abatement by the countries in this sample, more than the total abatement by all developed countries combined, and more than 2.5 times the amount of abatement undertaken by the United States. Even when a 'low growth' scenario for China were combined with the 'low growth' scenario for the United States, China still provides more abatement in absolute terms.

[Table 9 here]

6.2 China's emissions intensity trajectory and policies

By 2020, China will be the largest global greenhouse gas emitter by far, and is expected to have among the highest economic growth rate in the world for some years to come (Garnaut et al 2008). Coupled with its increasing geopolitical importance, this means that China's mitigation pledges and policy actions are a crucial factor for other countries' decisions, and for the success of global climate policy overall.

Following China's emissions intensity reduction pledge, some observers noted that significant policy effort would be necessary (Qiu 2009, Chandler and Wang 2009), while others claimed that the intensity target amounts to little more than business-as-usual (eg Houser 2010, Levi 2009). Such judgements have typically been based on reference case

projections by the International Energy Agency, or in some cases the US Energy Information Administration. As discussed above, it is problematic to brand these projections as BAU scenarios, as they assume that all existing policies are continued and fully implemented as part of BAU.[11]

In the case of China, projections include a host of policies and programmes that will result in lower energy use and lower carbon intensity of energy use. Examples are policy support for renewable and nuclear power generation, and large-scale programmes to shut down inefficient industrial plants (NDRC 2008). Subsuming these under BAU yields an inaccurate picture of what Chinese emissions would be like without dedicated policy action.

China's modernisation and reforms of the 1980s and 1990s resulted in strong improvements in energy efficiency throughout the economy (Fisher-Vanden et al 2004), and which were followed by increases in energy intensity and emissions intensity during the early 2000s (Garnaut, Jotzo and Howes 2008). Achieving the 2020 target will require annual reductions in emissions intensity of three to four per cent, much closer to the rapid improvements seen during the 1990s than the developments in the early 2000s (Figure 8 and Table 10).

The reference scenarios by IEA and EIA imply that emissions intensity improvements of around three and five per cent respectively will be achieved until 2020. By contrast, studies that explicitly construct a business-as-usual scenario for carbon emissions arrive at significantly lower reduction rates in emissions intensity. For example, the general equilibrium modelling exercise by McKibbin et al (2010) and the econometric analysis by Stern and Jotzo (2010) both project BAU reductions in China's emissions intensity of around two per cent per year respectively.

China has experiences great difficulty in achieving its goal to reduce energy intensity (amount of primary energy consumption per unit of GDP) by 20 per cent over the period 2005-2010 (Howes 2010). In an attempt to achieve the target, the Chinese government in 2010 has resorted to ad-hoc measures including closures of industrial plants and rationing of electricity supply, in a policy dubbed the 'iron hand' (Fielding 2010).

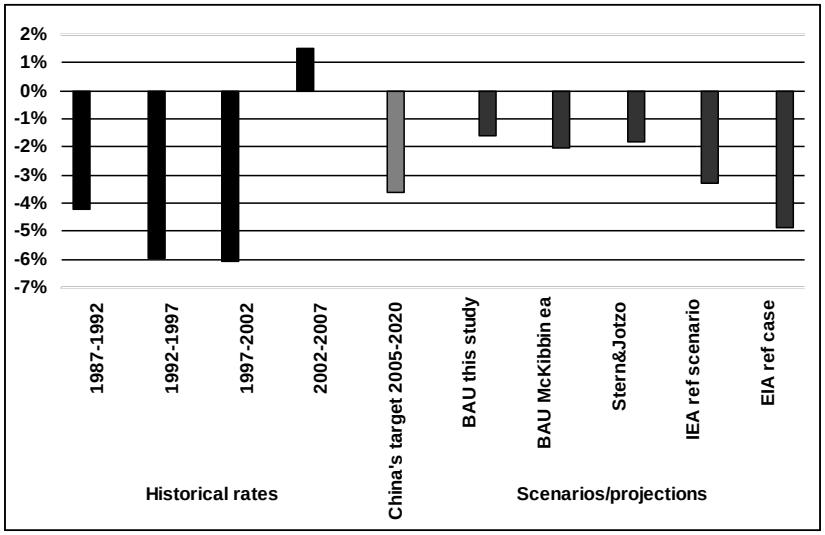
It is reasonable to assume that China would equally be prepared to follow through with implementation of a 2020 target, and that with a longer lead time, policy measures would be more sophisticated than the current ad-hoc approach. In implementing policies that curb carbon emissions, China is not primarily responding to international pressures, but in large part driven by domestic considerations (Pan 2010). This again bodes well for China following through with its Copenhagen target. However, China at the same time is calling for stronger mitigation action from developed countries (Pan 2009), and appears

[11] The underlying approach in studies that find little ambition in China's pledge is summarized by Höhne et al (2010, p.18): "So far, this target seems to be less ambitious than the reduction effort of current policies, if these were to be fully implemented."

highly unlikely to turn its pledge into a binding commitment, especially in the absence of a binding commitment from the United States.

[Table 10 here]

Figure 8 China's emissions intensity: history, target and scenarios/projections, annual average percentage change



Details and sources: see Table 10.

7 Conclusions

This paper compares the Copenhagen climate targets by the major countries on equal footing and across a range of metrics. The analysis shows that the targets by major countries imply significant effort, and that they are comparable in key metrics. Pledges by major developing countries including China match the targets put forth by developed countries including the United States and Europe in terms of emissions intensity and likely reduction relative to business-as-usual.

While the overall ambition of the pledges under the Copenhagen Accord falls short of trajectories that are seen as compatible with limiting warming to two degrees, the comparative analysis across countries allows a cautiously optimistic assessment of the prospect for countries actually following through with their pledges.

The targeted reduction or growth in absolute emissions between 2005 and 2020 differs substantially between countries, in line with differing prospects for economic growth and structural change, differing levels of development, as well as differing emissions profiles. And while China's and India's targets imply strong continued growth in national emissions, the pledges by a number of other developing countries – including Indonesia, Brazil, South Africa and Mexico – imply reductions in their absolute emissions levels.

Achieving strong reductions in developing countries that have framed their target as percentage reductions from business-as-usual requires that reasonable baseline projections are applied by national governments. This is an issue that is predestined to attract scrutiny and debate as countries move toward fully defining their targets.

Computing targets as changes in per capita emissions shows significantly smaller differences than on absolute measures, and reveals that a number of countries with relatively low per capita emissions aim for similar reduction rates as very high per capita emitters.

In terms of emissions intensity, the targets imply remarkably similar reductions across countries. On average, the major developing countries are targeting stronger reductions in emissions intensity than the major developed countries. China's target of cutting emissions intensity by 40 to 45 per cent over 15 years is very similar to the reductions in emissions intensity implicit in the targets by the large developed countries.

Estimates of reductions relative to business-as-usual again show remarkably similar targets across countries. Bar two exceptions, the major countries are all targeting significant reductions compared to what emissions levels might be otherwise. And developing country ambitions are strong: the average targeted reduction for the major developing countries is the same as the major developed country average, around one quarter below business-as-usual at 2020. Developing countries account for almost two thirds of the overall pledged reductions, under our central assumptions.

While estimates of reductions relative to business-as-usual are by nature contestable, the emissions intensity metric is robust. And it is relevant for comparison as it goes to the heart of the global mitigation challenge: the de-carbonization of economic activity. The Chinese and Indian emissions intensity targets (notwithstanding the apparent lack of ambition in India's target) could become a model for other developing countries that wish to define their targets more concretely.

For countries that have submitted a target range under the Copenhagen Accord, comparisons such as presented in this paper can help guide the decision about which precise target to choose. For the European Union, the analysis here suggests that in order to retain a role as one of the leaders in global climate change mitigation, the ambitious end of the range (30 per cent absolute reduction relative to 1990) may need to be chosen. For Australia, the middle of the target range (5 to 25 per cent absolute reduction relative to 2000) would be adequate in the context of other countries' targets and taking into account Australia's characteristics and stated conditions.

The comparisons presented here have important implications for the viability of the global climate policy regime. Almost a year after the Copenhagen climate conference, there is little prospect for a global climate treaty with binding commitments. But the pledges for most of the large countries are meaningful ones, and while analysis of domestic policy action toward the 2020 targets is not part of this paper, it would appear that governments on the whole are standing by their pledges.

The lack of legal obligations under the Copenhagen Accord is an obvious and possibly strong drawback in the quest for strong global mitigation action. But on the flipside, the pledges are probably much more significant than what would have been possible if a binding agreement had been negotiated – precisely because there is no threat of being in breach of a treaty if a unilateral pledge were to be broken, and also because of the greater flexibility that a 'bottom-up' approach provides in how national targets can be defined and complied with.

In order to follow through with their pledges, often in the face of strong domestic political and economic pressures, both developed and developing countries need reassurance that their chosen ambition is adequate in the context of other countries' targets. The analysis here indicates that the targets for the majority of major countries can in fact be considered broadly compatible. Crucially, the targets by key developing countries including China can be considered adequate in the context of what developed countries have pledged. If these pledges are acted on in good faith, then there will be significant mitigation action in developing countries, and little excuse to hold back on mitigation policies in developed countries.

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Table 1 List of selected countries' Copenhagen commitments

Country	Type of emissions target	Quantita-tive target for 2020	Base year / nature of target	Summary of target pledge	Share of global emissions in 2005
United States	Absolute reduction	-17%	2005	In the range of 17%, in conformity with anticipated U.S. energy and climate legislation, recognizing that the final target will be reported to the Secretariat in light of enacted legislation.	14.3%
EU	Absolute reduction	-20% to -30%	1990	As part of a global and comprehensive agreement for the period beyond 2012, the EU reiterates its conditional offer to move to a 30% reduction by 2020 compared to 1990 levels, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.	10.6%
Japan	Absolute reduction	-25%	1990	25% reduction, which is premised on the establishment of a fair and effective international framework in which all major economies participate and on agreement by those economies on ambitious targets.	2.8%
Russia	Absolute reduction	-15% to -25%	1990	The range of the GHG emission reductions will depend on the following conditions: Appropriate accounting of the potential of Russia's forestry in frame of contribution in meeting the obligations of the anthropogenic emissions reduction; undertaking by all major emitters the legally binding obligations to reduce anthropogenic GHG emissions.	4.2%
Canada	Absolute reduction	-17%	2005	17%, to be aligned with the final economy-wide emissions target of the United States in enacted legislation.	1.7%
Australia	Absolute reduction	-5% to -25%	2000	Australia will reduce its greenhouse gas emissions by 25% on 2000 levels by 2020 if the world agrees to an ambitious global deal capable of stabilising levels of greenhouse gases in the atmosphere at 450 ppm CO2-eq or lower. Australia will unconditionally reduce our emissions by 5% below 2000 levels by 2020, and by up to 15% by 2020 if there is a global agreement which falls short of securing atmospheric stabilisation at 450 ppm CO2-eq and under which major developing economies commit to substantially restrain emissions and advanced economies take on commitments comparable to Australia's.	1.2%
China	Intensity reduction	-40% to -45%	Emissions intensity change 2005-2020	China will endeavor to lower its carbon dioxide emissions per unit of GDP by 40-45% by 2020 compared to the 2005 level, increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020 and increase forest coverage by 40 million hectares and forest stock volume by 1.3 billion cubic meters by 2020 from the 2005 levels.	15.1%
India	Intensity reduction	-20% to -25%	Emissions intensity change 2005-2020	India will endeavour to reduce the emissions intensity of its GDP by 20-25% by 2020 in comparison to the 2005 level.	3.9%
Indonesia	Reduction below BAU	-26%	Reduction below BAU at 2020	26% reduction relative to BAU unilaterally, up to 41% reduction with international assistance. (In the quantitative analysis, only the 26% target is considered, as reductions above that appear to be credited toward credit buying countries.)	4.3%
Brazil	Reduction below BAU	-36% to -39%	Reduction below BAU at 2020	Anticipation that reductions in deforestation and other sectors of the economy will lead to reductions of 36.1% to 38.9% relative to projected emissions at 2020.	6.0%
Mexico	Reduction below BAU	-30%	Reduction below BAU at 2020	Mexico aims at reducing its GHG emissions up to 30% with respect to the business as usual scenario by 2020, provided the provision of adequate financial and technological support from developed countries as part of a global agreement.	1.4%
South Korea	Reduction below BAU	-30%	Reduction below BAU at 2020	To reduce national greenhouse gas emissions by 30% from business-as-usual emissions at 2020.	1.2%
South Africa	Reduction below BAU	-34%	Reduction below BAU at 2020	A 34% deviation below the BAU emissions growth trajectory by 2020.	0.9%

Sources: Individual countries' submissions and UNFCCC summaries of country submissions, at http://unfccc.int/home/items/5262.php.
See text for data sources on share of global emissions.

Table 2 Methodology: assumptions for comparison exercise

Form of country target: / Metric for comparison:	Absolute emissions target	Emissions intensity target	Target relative to BAU
Absolute change in emissions	(no assumptions needed, as target framed in this metric – only conversion to common base year necessary)	Assume GDP growth rate	Assume BAU emissions trajectory
Change in per-capita emissions	Assume population growth rate, apply to absolute change in emissions		
Change in emissions intensity	Assume GDP growth rate	(no assumptions needed, as target framed in this metric)	Assume BAU emissions trajectory and GDP growth rate
Reduction in emissions relative to BAU	Assume BAU emissions trajectory	Assume BAU emissions trajectory and GDP growth rate	(no assumptions needed, as target framed in this metric)

Table 3 Assumptions on future growth rates of GDP, population and BAU emissions

	GDP			Population			BAU emissions		
	Average annual growth 2005-2020								
	Central scenario	low growth scenario	high growth scenario	Central scenario	low growth scenario	high growth scenario	Central scenario	low growth scenario	high growth scenario
Source for data/assumptions	EIA (2010) reference case	EIA low/high growth scenario		United Nations (2009) populations projections, central scenario			See footnote to this table		
United States	2.3%	1.8%	2.8%	0.9%	(same as for central scenario)		0.7%	-0.3%	1.7%
EU-27	1.7%	1.4%	2.1%	0.2%			0.3%	-0.7%	1.3%
Japan	0.9%	0.5%	1.3%	-0.1%			0.0%	-1.0%	1.0%
Russia	3.2%	2.9%	3.6%	-0.4%			1.1%	0.1%	2.1%
Canada	2.2%	1.8%	2.5%	0.9%			1.3%	0.3%	2.3%
Australia	2.7%	2.4%	3.1%	1.0%			1.0%	0.0%	2.0%
China	8.1%	7.7%	8.5%	0.6%			6.4%	5.4%	7.4%
India	6.6%	6.2%	6.9%	1.3%			4.3%	3.3%	5.3%
Indonesia	6.0%	5.5%	6.5%	1.0%			1.1%	0.1%	2.1%
Brazil	4.3%	3.9%	4.6%	0.9%			0.3%	-0.7%	1.3%
Mexico	2.9%	2.6%	3.3%	0.9%			1.3%	0.3%	2.3%
South Korea	3.5%	3.1%	3.9%	0.3%			0.9%	-0.1%	1.9%
South Africa	4.2%	3.7%	4.7%	0.8%			1.6%	0.6%	2.6%
Average of Annex I countries in sample	2.0%	1.6%	2.4%	0.3%			0.6%	-0.4%	1.6%
Average of non-Annex I countries in sample	6.5%	6.1%	6.8%	0.9%			4.2%	3.2%	5.2%

Sources: GDP: EIA (2010). Indonesia: author's assumptions with reference to Garnaut et al (2008). Population: United Nations (2009).
BAU emissions: BAU emissions intensity from Australian Treasury (2008), combined with reference case GDP from EIA (2009). *Exceptions:* China and India – BAU emissions intensity from Garnaut et al (2008). Mexico and South Korea – EIA (2010) emissions reference case. Brazil: fossil fuel emissions from EIA (2009), forest and land-use change emissions trend extrapolation. Indonesia: trend extrapolation, with reference to Ministry of Finance (2009).

High/low BAU emissions assumptions: +/- 1% pa.

Table 4 Absolute targets: targeted change in absolute emissions, 2005 to 2020

	Single target or mid-point of target range			Low end of target range			High end of target range			Assumptions
	Central scenario	low growth scenario	high growth scenario	Central scenario	low growth scenario	high growth scenario	Central scenario	low growth scenario	high growth scenario	
United States	**-17%**			n.a.			n.a.			No assumptions needed (targets are framed as absolute reductions)
EU-27	**-20%**			-15%			-25%			
Japan	**-34%**		n.a.	n.a.		n.a.	n.a.		n.a.	
Russia	**19%**			27%			12%			
Canada	**-17%**			n.a.			n.a.			
Australia	**-20%**			-10%			-29%			
China	**85%**	75%	94%	93%	83%	103%	76%	68%	86%	GDP growth assumptions from EIA (2009) as per Table 3.
India	**101%**	91%	112%	108%	97%	119%	95%	85%	105%	
Indonesia	**-13%**	-25%	1%						n.a.	BAU emissions growth assumptions as per Table 3.
Brazil	**-34%**	-43%	-24%	-33%	-42%	-22%	-36%	-45%	-26%	
Mexico	**-15%**	-27%	-1%							
South Korea	**-20%**	-31%	-7%						n.a.	
South Africa	**-16%**	-28%	-3%							
Average of Annex I countries in sample	**-15%**	-15%	-15%	-12%	-12%	-12%	-18%	-18%	-18%	
Average of non-Annex I countries in sample	**41%**	31%	52%	46%	36%	57%	37%	27%	47%	

Author's calculations. Data sources: see Section 2. Assumptions: see Table 3. Low growth scenarios assume low growth for both GDP and BAU emissions.

Table 5 Absolute targets for different base years

	Change in absolute emissions, from different base years to 2020, for mid-point targets under central scenario		
Country	**2005 to 2020 (same as 1st column in Table 4)**	**2000 to 2020**	**1990 to 2020**
United States	-17%	-16%	-3%
EU-27	-20%	-18%	-25%
Japan	-34%	-33%	-25%
Russia	19%	22%	-20%
Canada	-17%	-13%	0%
Australia	-20%	-15%	-15%
China	85%	178%	247%
India	101%	135%	240%
Indonesia	-13%	-9%	0%
Brazil	-34%	-33%	-26%
Mexico	-15%	-5%	17%
South Korea	-20%	-12%	48%
South Africa	-16%	-8%	6%
Average of Annex I countries in sample	-15%	-13%	-15%
Average of non-Annex I countries in sample	41%	75%	113%

Author's calculations. Data sources: see Section 2.

Table 6 Per capita versus absolute emissions: targeted change in emissions, 2005 to 2020 (mid-points of target ranges, central scenario)

Country	**Targeted change in per capita emissions**	**Comparison: Targeted change in absolute emissions** (as per Table 4)	**Per capita emissions levels, tCO_2-eq/person**	
	2005-2020, for mid-points of target ranges, central scenario		**2005**	**Targeted 2020**
United States	**-27%**	-17%	22.5	16.3
EU-27	**-23%**	-20%	11.1	9.1
Japan	**-32%**	-34%	10.8	7.2
Russia	**26%**	19%	13.9	18.7
Canada	**-27%**	-17%	24.9	18.2
Australia	**-31%**	-20%	28.8	22.2
China	**69%**	85%	5.5	9.7
India	**67%**	101%	1.7	2.8
Indonesia	**-25%**	-13%	9.4	7.0
Brazil	**-41%**	-34%	15.5	9.1
Mexico	**-25%**	-15%	6.5	4.9
South Korea	**-23%**	-20%	12.0	9.2
South Africa	**-23%**	-16%	9.0	6.7
Average of Annex I countries in sample	**-19%**	-15%	15.4	12.8
Average of non-Annex I countries in sample	**24%**	41%	5.1	6.5

Author's calculations. Data sources: see Section 2.

Table 7 Intensity targets: targeted change in emissions intensity (emissions/GDP), 2005 to 2020

	Single target or mid-point of target range			Low end of target range			High end of target range			Assumptions
	Central scenario	low growth scenario	high growth scenario	Central scenario	low growth scenario	high growth scenario	Central scenario	low growth scenario	high growth scenario	
United States	**-41%**	-36%	-45%	-41%	-36%	-45%	-41%	-36%	-45%	GDP growth as per Table 3.
EU-27	**-38%**	-35%	-42%	-34%	-31%	-38%	-42%	-39%	-45%	
Japan	**-42%**	-39%	-46%	-42%	-39%	-46%	-42%	-39%	-46%	
Russia	**-26%**	-22%	-30%	-21%	-17%	-26%	-31%	-27%	-34%	
Canada	**-40%**	-36%	-43%	-40%	-36%	-43%	-40%	-36%	-43%	
Australia	**-46%**	-43%	-49%	-40%	-37%	-43%	-53%	-50%	-55%	
China	**-42.5%**	n.a.		-40%	n.a.		-45%	n.a.		No assumptions needed
India	**-22.5%**			-20%			-25%			
Indonesia	-64%	-66%	-61%	-64%	-66%	-61%	-64%	-66%	-61%	BAU emissions growth and GDP growth as per Table 3.
Brazil	-65%	-68%	-61%	-64%	-67%	-60%	-66%	-69%	-62%	
Mexico	-45%	-50%	-39%	-45%	-50%	-39%	-45%	-50%	-39%	
Korea	-52%	-56%	-47%	-52%	-56%	-47%	-52%	-56%	-47%	
South Africa	-55%	-58%	-51%	-55%	-58%	-51%	-55%	-58%	-51%	
Average of Annex I countries in sample	-37%	-33%	-40%	-35%	-30%	-38%	-39%	-35%	-42%	
Average of non-Annex I countries in sample	-45%	-46%	-44%	-43%	-44%	-42%	-47%	-48%	-45%	

Author's calculations. Data sources: see Section 2. Assumptions: see Table 3. Low/high growth scenarios assume low/high growth for GDP and for BAU emissions simultaneously.

Table 8 BAU targets: targeted emissions reductions relative to business-as-usual at 2020

	Single target or mid-point of target range			Low end of target range			High end of target range			Assumptions
	Central scenario	low growth scenario	high growth scenario	Central scenario	low growth scenario	high growth scenario	Central scenario	low growth scenario	high growth scenario	
United States	**-25%**	-13%	-35%	-25%	-13%	-35%	-25%	-13%	-35%	BAU emissions intensity change: Treasury (2008) reference case, GDP growth: EIA (2010)
EU-27	**-24%**	-12%	-35%	-19%	-6%	-30%	-29%	-18%	-39%	
Japan	**-34%**	-23%	-43%	-34%	-23%	-43%	-34%	-23%	-43%	
Russia	***2%***	*18%*	-12%	*8%*	*26%*	-7%	-5%	*11%*	-18%	
Canada	**-32%**	-21%	-41%	-32%	-21%	-41%	-32%	-21%	-41%	
Australia	**-31%**	-20%	-41%	-23%	-11%	-34%	-39%	-29%	-48%	
China	**-27%**	-20%	-33%	-24%	-17%	-30%	-30%	-24%	-36%	BAU emissions intensity change: Garnaut et al (2008), GDP growth: EIA (2010)
India	***7%***	*18%*	-2%	*11%*	*21%*	*1%*	*4%*	*14%*	-5%	
Indonesia	**-26%**	-26%	-26%	-26%	-26%	-26%	-26%	-26%	-26%	No assumptions needed
Brazil	**-37.5%**	-37.5%	-37.5%	-36%	-36%	-36%	-39%	-39%	-39%	
Mexico	**-30%**	-30%	-30%	-30%	-30%	-30%	-30%	-30%	-30%	
Korea	**-30%**	-30%	-30%	-30%	-30%	-30%	-30%	-30%	-30%	
South Africa	**-34%**	-34%	-34%	-34%	-34%	-34%	-34%	-34%	-34%	
Average of Annex I countries in sample	**-23%**	-10%	-33%	-20%	-7%	-31%	-25%	-13%	-36%	
Average of non-Annex I countries in sample	**-24%**	-18%	-29%	-22%	-15%	-27%	-27%	-21%	-32%	

Author's calculations. Data sources: see Section 2. Assumptions: see Table 3. Low/high growth scenarios assume low/high growth for GDP and for BAU emissions simultaneously. Positive numbers (in italics) indicate that targets are above the BAU scenario.

Table 9 BAU targets: targeted absolute amounts of abatement relative to business-as-usual at 2020

	Central scenario	low growth scenario	high growth scenario
	GtCO2-eq at 2020		
United States	1.9	0.8	3.1
EU-27	1.3	0.5	2.1
Japan	0.5	0.3	0.7
Russia	-	-	0.3
Canada	0.3	0.2	0.5
Australia	0.2	0.1	0.3
China	4.9	3.2	7.0
India	-	-	0.1
Indonesia	0.6	0.5	0.7
Brazil	1.1	1.0	1.3
Mexico	0.2	0.2	0.3
South Korea	0.2	0.1	0.3
South Africa	0.2	0.1	0.2
Average of Annex I countries in sample	4.2	1.9	7.0
Average of non-Annex I countries in sample	7.3	5.1	9.9

Author's calculations, based on results in Table 9 combined with estimates of 2020 emissions levels (for data sources and assumptions see Section 2).

Table 10 China's emissions intensity: history, target and scenarios/projections, annual average percentage change

	Annual average change in emissions intensity
Historical data	
1987-1992	-4.2%
1992-1997	-5.9%
1997-2002	-6.1%
2002-2007	+1.5%
China's target	
2005-2020	range -3.1% to -3.9%, mid-point -3.6%,
Scenarios/projections	
BAU this study	-1.6%
BAU McKibbin ea	-2.0%
Stern&Jotzo	-1.8%
IEA reference case	-3.3%
EIA reference case	-4.9%

Sources: Historical data: IEA (2010); target: mid-point of China's target (42.5% reduction from 2005-2020); McKibbin et al 2010 reference case; Stern and Jotzo (2010) "preferred scenario"; IEA (2009) World Energy Outlook reference scenario ; EIA (2010) International Energy Outlook reference case.