Setting a Benchmark: How Developed Countries Might Equitably Contribute Towards a 450 ppm Pathway

Briefing paper, September 2009

project catalyst

ClimateWorks
REAL-WORLD SOLUTIONS

European Climate Foundation

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About Project Catalyst

Project Catalyst is an initiative of the ClimateWorks Foundation. ClimateWorks is a global, non-profit philanthropic foundation headquartered in San Francisco, California with a network of affiliated foundations in China, India, the US and the European Union. The ClimateWorks family of organisations focus on enacting policies that reduce greenhouse gas emissions through three general policy areas: energy efficiency standards, low-carbon energy supply, and forest conservation/agriculture (see www.climateworks.org).

Project Catalyst was launched in May 2008 to provide analytical and policy support for the United Nations Framework Convention on Climate Change (UNFCCC) negotiations on a post-Kyoto international climate agreement, and related stakeholders. Project Catalyst members have been organised into working groups: abatement, adaptation, technology, forestry, climate-compatible growth plans, and finance. Each working group has received analytical support from the international consulting firm, McKinsey & Company. Working group members include a total of about 150 climate negotiators, senior government officials, representatives of multilateral institutions, business executives, and leading experts from over 30 countries.

Project Catalyst and its working groups provide a forum where key participants in the global discussions can informally interact, conduct analyses, jointly problem solve, and contribute ideas and proposals to the formal UNFCCC process. This paper summarises output from Project Catalyst, but the views expressed in this paper have not necessarily been endorsed by all of the members of Project Catalyst nor their governments or organisations. The ClimateWorks Foundation takes sole responsibility for the content of this paper.

Executive summary

At the G8 and Major Economies Forum meetings in L'Aquila in July 2008, leaders of nations representing 88 percent of global economic output and 77 percent of greenhouse gas emissions endorsed an objective of containing average warming to 2 degrees Celsius above preindustrial levels. To have even a moderate probability (40–60 percent) of achieving this objective, it is necessary to stabilise greenhouse gas concentrations in the atmosphere at no more than 450 parts per million (ppm) of carbon dioxide equivalents (CO_2e).

Consistent with a 450 ppm path, the G8 leaders further committed to 80 percent reductions by 2050. This is the lower end of the 80-95 percent range versus 1990 identified by the IPCC[1]. While these commitments represent progress, the discussions then stalled on the critical point of mid-term targets. Developing countries were unwilling to commit to a global target (e.g., more than a 50 percent reduction by 2050) until developed countries commit to mid-term targets. The IPCC identified developed country mid-term reductions of 25-40 percent below 1990 by 2020 as equitable and consistent with a 450 ppm path. The G77 developing country position is that developed countries should commit to 40 percent, the upper end of this range. Yet developed country proposals on the table are collectively below this range and there are disagreements between developed countries on the comparability and equity of their individual commitments.

Re-framing the debate on mid-term targets

Underlying this gap in negotiating positions is a tension between top-down target setting advocated by developing and some developed countries based on historic responsibility for emissions and ability to take action, versus other developed country setting bottom-up targets informed by concerns over the achievability of targets and their economic impact.
This paper attempts to re-frame the debate over developed country mid-term targets by creating a benchmark model that integrates equity, achievability and cost considerations. It also enables comparisons of different developed country commitments, taking into account the full package of their commitments and without advocating a specific base year that may flatter some countries while penalising others.

The model begins by accepting the IPCC 25-40 percent range as a guideline for an aggregate developed country reduction target, which would need to be complemented by funding support for developing country mitigation and adaptation actions. However, in order to recognise differing economic and domestic political considerations, the model provides flexibility as to how countries might individually meet their responsibilities across a three-part package of commitments containing the following: 1) commitments to domestic abatement, 2) commitments to purchase international offsets over and above domestic abatement and 3) commitments to provide funding to support developing country mitigation and adaptation.

A three-part benchmark model

Project Catalyst has developed a benchmark for comparing such three-part packages on an equitable basis. The benchmark is based on three simple principles:

1. **Equal effort on domestic mitigation according to abatement potential** – Each developed country should abate as much at home as technically feasible at a reasonable economic cost. Given different starting points and economic conditions, the amount of feasible, economic abatement will differ significantly by country. But each country should make an equal level of effort. As described in the body of this report, this principle of equality of effort can be made operational by committing to abatement up to an equal level of marginal cost (e.g., €60 per tonne of CO_2e emissions avoided).

2. **Fair share of offset purchases** – Our analysis indicates that developed countries collectively do not have sufficient levels of economic abatement potential available domestically to meet the 25-40 percent IPCC equity range. However, they could "top-up" their domestic abatement with purchases of offset credits from developing countries so their total international target commitment meets the IPCC range. The offset purchases required can be fairly allocated amongst developed countries according to "ability to pay" (e.g., based on GDP) and "polluter pays" (e.g., based on emissions) principles. Funding through carbon market mechanisms will come from both public and private sources; private companies will buy international offsets directly through ETS systems, while governments will purchase additional international offsets to meet national emissions caps,

3. **Fair share of international financial support** – Even with significant offset purchases, meeting a 450 ppm pathway will require large-scale abatement in developing countries. Under the Convention and Bali Action Plan, developed countries have committed to provide financial support for the incremental cost of such abatement (in addition to support for adaptation).

This financial support can likewise be fairly allocated amongst developed countries according to 'ability to pay' (e.g., GDP) and 'polluter pays' (e.g., emissions) principles, as in the case of offset purchases. While developed countries would provide support for incremental cost, the benchmark assumes developing countries will largely self-fund abatement actions that are profitable due to energy savings, though developed countries might provide loan and capability building assistance to support such actions.

One can apply this three-part benchmark model to a scenario consistent with a 450 ppm pathway and calculate the resulting commitments for individual developed countries and then compare those results with current proposals. This can be done for a 2020 mid-term target or any other target year. It is important to note that while the benchmark has a link to the IPCC equity range, the calculations do not depend on the use of any particular base year (e.g., 1990 or 2005) as the benchmark utilises forward looking mitigation potential measured in tonnes and financial contributions measured in Euros.

Countries need to stretch in different ways

The overall result of applying the model to current proposals is that Japan is the only country to meet the benchmark for an aggregate 25% reduction below 1990 by 2020. The benchmark for aggregate 40% seems even more ambitious. But interestingly, each country misses the 25% benchmark in somewhat different ways reflecting the strengths and weaknesses of their current proposals and the model shows what each country would need to do to meet this benchmark level of commitment. For example:

- **European Union** – The EU meets or exceeds the 25% benchmark for domestic abatement with its target of 20 percent versus 1990, but does not include many offsets. If its target were extended to 30 percent it would come close to meeting the combined target of domestic abatement plus offset purchases. If the EU were to add 0.3-1.2 Gt of offset purchases to a 30 percent target and €13-29 billion in financing commitments (average per year 2010-2020) it would meet the benchmark for the total package.

- **United States** – The House version of the American Clean Energy and Security Act (ACES) is within the benchmark range for offset purchases and potentially provides a portion of the financing required but falls short on domestic abatement. A combination of limiting offsetting under the cap - 0.7-1.2 Gt of further international abatement from an increased set aside in the ACES act - and Federal or state regulation outside of the capped sectors, plus financial commitments totalling €15-33 billion annually, could bring the US package to the 2020 benchmark.

- **Japan** – Japan's original proposal of 15% (not including offsets) below 2005 was ambitious relative to the benchmark level of domestic abatement. The new target of 25% below 1990 meets Japan's fair share (as defined in this paper) of a collective emissions cap of 25% below 1990. Japan has not yet made a public finance commitment

More detail and analyses of these and more countries appear in the body of the report. The ranges in the figures depend on assumptions as to how proposals are interpreted and which end of the 25-40 percent IPCC equity range is selected. In the body of the paper we also look at a scenario where the public financing portion of the commitment package is allocated according to a revised version the Mexico "Green Fund" proposal with all countries contributing according to capacity and responsibility. This spreads incremental cost financing across a greater number of countries and reduces the financial contribution portion of the three-part developed country commitment by approximately 21-22 percent overall.

We have also analysed current proposals against a 2030 benchmark. This requires more assumptions as, apart from the US, few countries have proposals extending to this time frame. With some simple assumptions about the likely continued trajectory of reductions after 2020, it is likely that the US, EU, and Japan could meet or come close to the lower end of the 2030 benchmark measure in terms of domestic reductions plus offset purchases.

Ultimately, targets will be set by political negotiation rather than through an analytical exercise. The Catalyst benchmark model can help inform those discussions by integrating views on equity with views on achievability and cost. The model can also help negotiators avoid unproductive debates over base years and look more holistically at packages of commitments over multiple time periods.

Overall, the results show that a combination of stretching by individual countries from current negotiating positions to meet the benchmark level of commitment, plus an effort sharing formula on finance, could provide a way forward in the negotiations. While such an approach will not end the debates over mid-term targets, it could potentially help ground them in a common fact-base and shared equity framework.

Introduction

The risks from climate change are large and growing, but they can be contained. If the world can stabilise the long-term concentration of greenhouse gases in the atmosphere at below 450 parts per million (ppm) carbon dioxide equivalent (CO_2e), there is an approximately 40–60 percent chance of restricting global warming to 2 degrees Celsius above preindustrial levels. Above this level, irreversible and very harmful changes to natural and socio-economic systems become much more likely. To contain climate risk, the world must act now, peaking global emissions within the next decade. If it does not, atmospheric concentrations are on a trajectory to surpass 550 ppm within a decade.

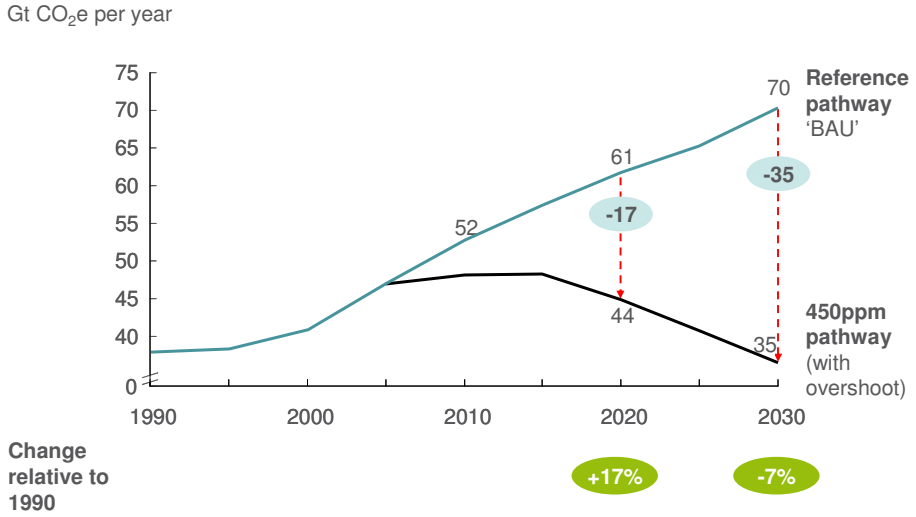
While the mathematics of achieving a 450 ppm path means that all countries must act, developed countries, with their historic responsibility for the bulk of emissions currently in the atmosphere, their high current per capita emissions and greater capacity to act, must take the lead. Consistent with the Bali Roadmap, this leadership must include both quantified emissions reductions and financial support for developing country mitigation actions and adaptation.

In the negotiations leading up to Copenhagen in December 2009, critical questions have emerged as to how that leadership should be divided amongst developed countries and what might constitute comparable and equitable commitments, particularly for mid-term reduction targets (e.g., 2020). This paper is intended to help inform and frame these discussions. While there is a large existing literature on mitigation equity and effort sharing, less work has been done to integrate these principles-driven approaches with data on mitigation potential and costs. Project Catalyst has developed a benchmark model for developed country effort sharing that integrates both a top-down view on equity with a bottom-up view of what each individual country can economically achieve in terms of abatement. The model further allows flexibility as to how commitments are made across a package of domestic mitigation action, offset purchases and financial contributions. The model also does not require the selection of any particular base year. These features recognise the differing domestic political and economic circumstances of each developed country and may provide greater scope for common ground to be found.

1. The scale of the challenge

To stabilise the long term atmospheric concentration of CO_2e at 450 ppm, the world needs to reduce greenhouse gas emissions so that by 2020 emissions are 17 billion tonnes (gigatonnes or Gt) below what they would have been under 'business as usual'[2] and 35 Gt by 2030.

Exhibit 1 – Global GHG emissions

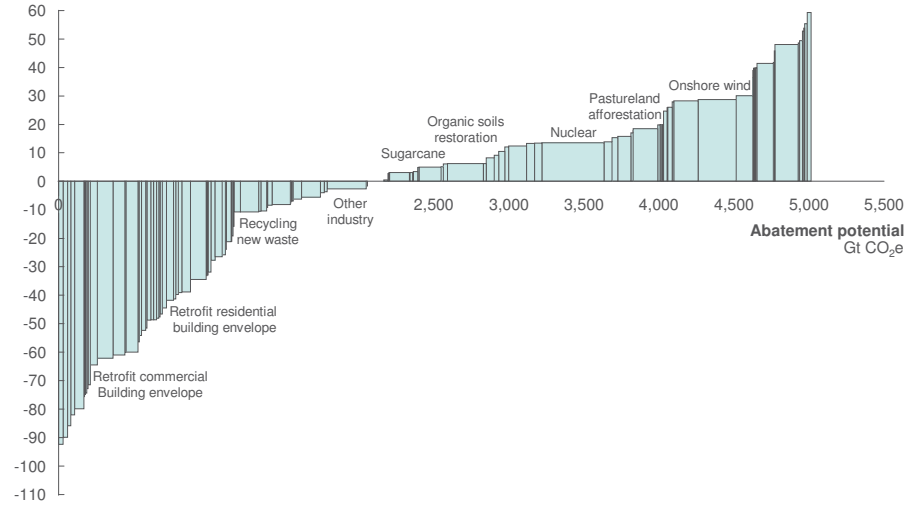


Source: McKinsey Global GHG Abatement Cost Curve v2.0; Houghton; IEA; US EPA; den Elzen, van Vuuren; Project Catalyst analysis

Detailed bottom-up analysis by McKinsey & Company in its Global Greenhouse Gas Abatement Cost Curve (version 2.0)[3] shows that it is economically feasible to achieve approximately 5 Gt of abatement in developed countries at a marginal cost of abatement of less than €60 per tonne (Exhibit 2)[4]. Above €60 per tonne, costs rise sharply and technological risks increase significantly. Other bottom-up assessments show similar or somewhat higher results for developed country potential as the McKinsey work[5] The McKinsey analysis further shows that there is 14 Gt of abatement available in developing countries for under €60 per tonne, including 9 Gt of forestry and agricultural abatement. If there is 5 Gt in the developed world, that implies a need to capture 12 out of the 14 Gt available in the developing world in order to to meet the 17 Gt target.

Exhibit 2 – Developed country cost curve

2020 (up to costs of €60/t, excluding transaction costs, 4% discount rate)



Source: McKinsey Global GHG Abatement Cost Curve v2.0

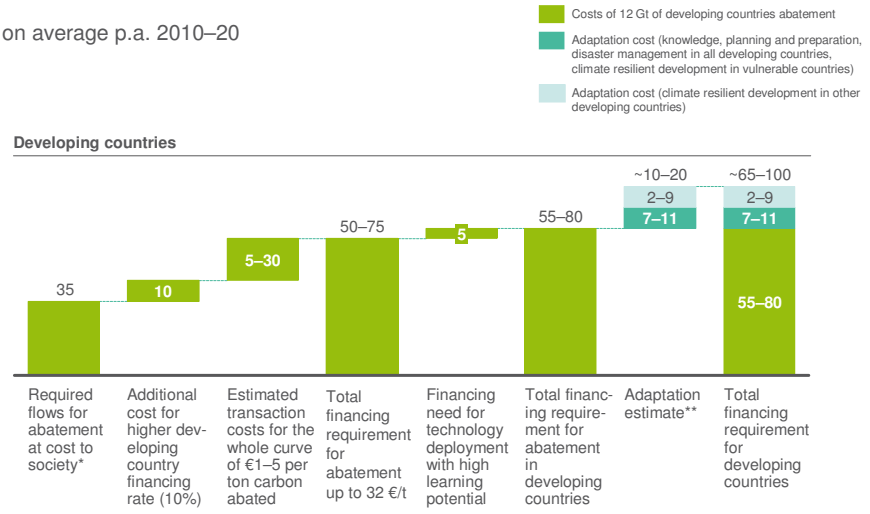
It is possible that the 5 Gt of developed world abatement could be extended through undertaking higher cost, technically riskier actions, behavioural change, or faster technical change. However, it is very unlikely that this could be stretched to reach to the 17 Gt required. Thus significant financing and technology support will be required to support nationally appropriate mitigation actions in the developing world to achieve the circa 12 Gt of abatement by 2020 that the world needs.

The principle that developed countries have agreed to in the Convention (article 4.3) is to provide support for the incremental cost of developing country mitigation actions. Of the 12 Gt of developing country abatement required, we estimate that 9 Gt has positive incremental costs requiring support (i.e., NPV negative). The remaining 3 Gt is profitable over time (i.e., NPV positive) due to energy cost savings and would likely be self-funded by developing countries. Developed country support for capacity building and transaction costs and the provision of low-interest loans to aid capital access would significantly increase the likelihood of successful capture of these profitable abatement opportunities.

Separate analysis by Project Catalyst (see working paper 'Financing Global Action on Climate Change') estimates the incremental cost of supporting the 9 Gt of positive cost abatement at €35 billion per year on average from 2010-2020 Exhibit 3). Including higher finance costs faced by developing countries (10 percent average financing cost), transaction costs of 1–5 €/t and an additional €5 billion investment in technologies specifically for developing countries, the total funding need for mitigation in developing countries in 2010–20 is estimated at €55–80 billion per year. Adaptation will add a further €10–20 billion, bringing the total annual funding needed to €65–100 billion.

Exhibit 3 – Annual financing flows requirements

€b on average p.a. 2010–20



* Assumes all abatement delivered at average cost; 4% discount rate
** Based on increased financing for global public goods (incl. research), expected funding required priority investments for vulnerable countries (based on NAPA cost estimates), and provision of improved disaster support instruments (based on MCII work)
Source: McKinsey Global GHG Abatement Cost Curve v2.0; 'Bosetti; Carraro; Massetti; Tavoni'; UNFCCC; Project Catalyst analysis

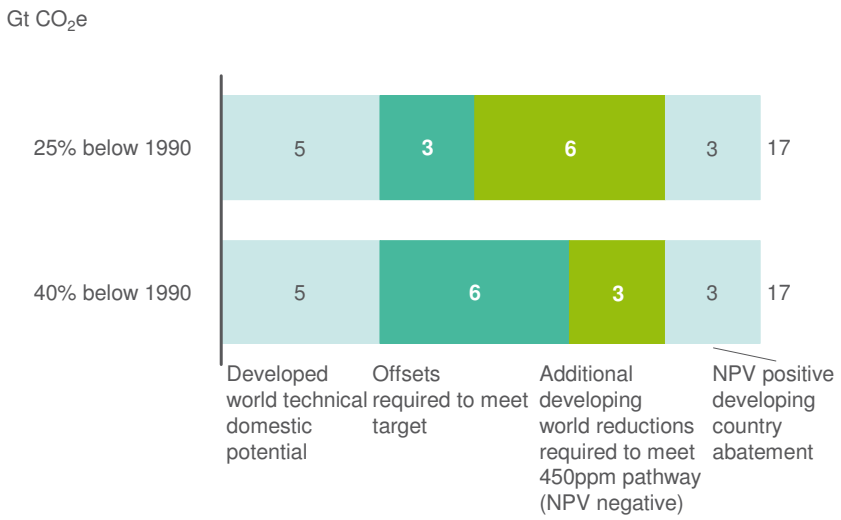
2. Supporting developing world abatement with both carbon market finance and public finance

Developing country mitigation will likely be funded through both carbon market finance mechanisms (i.e., international offsets) and public finance (e.g., through sources such as direct government transfers, AAU auctions, or levies on international shipping and aviation emissions). Funding through carbon market mechanisms will come from both public and private sources; private companies will buy international offsets directly through ETS systems, while governments will purchase additional international offsets to meet national emissions caps, Separate analysis by Project Catalyst (see working paper 'Financing Global Action on Climate Change') shows that there is no 'silver bullet' answer to climate finance and that given the scale of funding required, significant flows will be required from both carbon market and public funding sources.

The IPCC's review of the literature on emissions paths and effort-sharing provided a benchmark target of 25-40 percent below 1990 by 2020 for developed country reductions. This range has provided a point of debate in the negotiations with the G77 proposing developed countries accept the upper end of this range at 40 percent. Developed country proposals thus far add up to well below the bottom-end 25 percent.

At the low end, to meet an aggregate 25 percent target, developed country abatement of 8 Gt below business-as-usual (BAU) would be needed. As the IPCC range refers to responsibility rather than strictly domestic abatement, this could potentially be met by developed countries accepting an aggregate 25 percent target and then meeting that target through the 5 Gt of available of economic domestic abatement and 3 Gt of offset purchases from developing countries (Exhibit 4). Using the average cost of positive-cost abatement, demand for offsets of 3 Gt would cover around €15–20 billion per year of the incremental cost of developing country abatement needed from 2010-2020. Likewise, if developed countries were to accept an aggregate 40 percent target, that would imply 11 Gt below BAU which could be met through the 5 Gt of available domestic abatement and 6 Gt of offset purchases from developing countries covering €30–40 billion of the total finance need.

Exhibit 4 – Required abatement to 450ppm



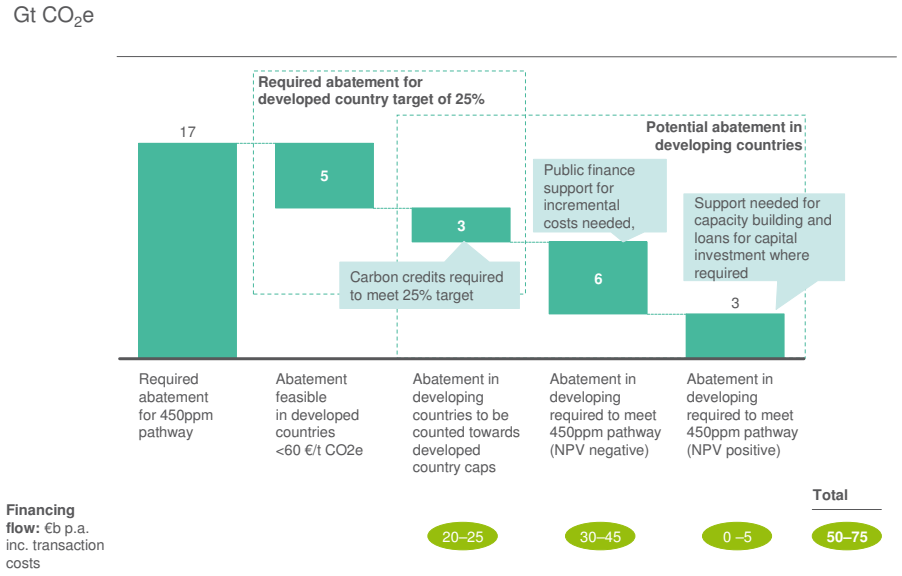
Source: McKinsey Global GHG Abatement Cost Curve v2.0, team analysis

Public finance would then be required to cover the remaining effort. An aggregate target of 25 percent below 1990[6] would leave 6 Gt of developing country abatement (out of a total of 9 Gt) that would need to be financed through public finance of some form, at a cost of €30–45 billion per year, as shown in Exhibit 5.

Public finance would also need to cover the €5 billion required for investment in technologies for developing countries with high learning potential, €0-5 billion for transaction costs for NPV positive developing country abatement and €10–20 billion for adaptation (as shown in Exhibit 3). This gives a total public finance component of €50–80 billion per year for a 25 percent below 1990 target, or €35–60 billion per year for a 40 percent below 1990 target.

It is important to note that the public finance component is lower in the 40 percent case because a greater proportion of the needed financing would flow through offset purchases (see again Exhibit 4 and Exhibit 5). Thus if developed countries were to commit to abate up to €60 per tonne domestically and then provide incremental cost support for the developing world abatement needed for a 450 ppm path, then the choice of 25 to 40 percent becomes a choice as to how much developing world abatement is financed via carbon markets versus public finance. Selecting a 25 percent target means more is done by public finance (€50-80 billion) versus carbon market (€15-20 billion), while selecting a 40 percent target would require more carbon market flows (€30-40 billion) and less money from public finance (€35-60 billion).
Further analysis by Project Catalyst indicates that the international offset price will likely be higher than the actual incremental cost for most of the abatement funded through carbon market finance. Some of this difference could be captured (by intervention in the form of market intermediation, taxes, discount factors or baseline setting) and reinvested as part of the public finance component, thus reducing the amount of public finance needed from other sources. With a 25 percent target for developed countries, this difference could be up to €5–20 billion. (For more details see Project Catalyst's paper, 'Financing Global Action on Climate Change'.)

Exhibit 5 – Required abatement in 2020



Source: McKinsey Global GHG Abatement Cost Curve v2.0, team analysis

3. Sharing the effort between developed countries

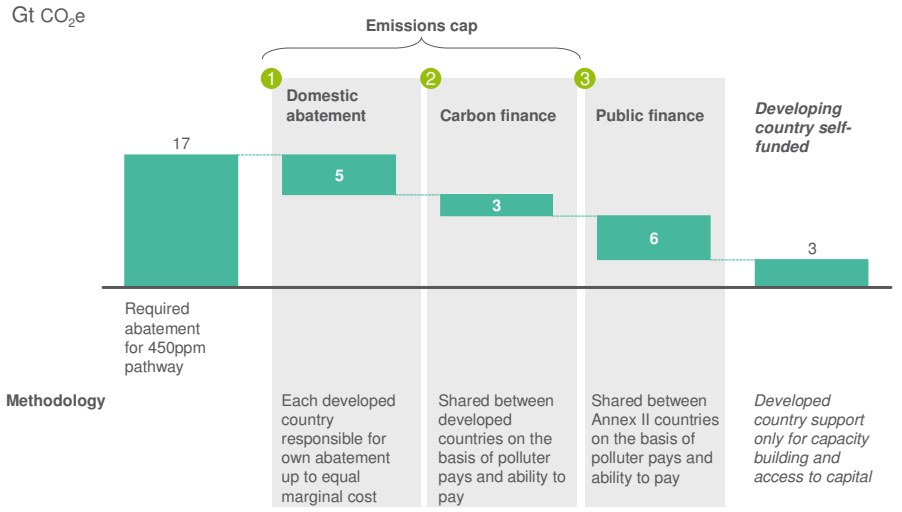
Responsibility for emissions reductions, offset purchases and public financing needs to be divided between developed countries in an equitable and comparable way. Developing countries would be responsible for delivery of the abatement financed, through their 'Nationally Appropriate Mitigation Actions' (NAMAs). There is a broad literature on equity and effort sharing, much of which was reviewed by the IPCC[7] . There are also a number of proposals that have been put forth in the negotiations (see Appendix I). Most of these are based on a combination of two principles; 'polluter pays' and 'ability to pay'.

However, most of these proposals are either based on top-down principles or exclusively on bottom-up estimates of economic mitigation potential in developed countries. They do not typically integrate commitments on domestic mitigation, international offset purchases and commitments for financing support into a combined package. Finally, many proposals, including the IPCC 25-40 percent range, are also linked to a particular base year for measuring emissions. The selection of base year has become a politically contentious issue in the negotiations as the choice of a particular year may make one country look better or worse than another versus an alternative choice of base year.

Drawing on the common principles of existing proposals - in particular "ability to pay" and "polluter pays" principles - and based on a fact-base about where and how expensive the abatement opportunities are, Project Catalyst has defined a benchmark for effort-sharing which is structured according to the three potential contributions: domestic reductions, reductions paid for through the international carbon market and financial support through public finance

This benchmark is intended to contribute to the debate in two ways. First, it aims to help countries understand what their likely share might be of the effort needed for a 450 ppm pathway. Second, it presents a yardstick for discussions of how current national proposals compare with each other.

Exhibit 6 – Required abatement in 2020



Source: McKinsey Global GHG Abatement Cost Curve v2.0, team analysis

The benchmark has three components: domestic abatement, carbon market finance and public finance. The domestic abatement and carbon market finance components combine to give the total included in the emissions cap or quantified emissions limitation and reduction objective (QUELRO), with flexibility on how countries are going to meet this cap .

The three components are as follows:

1. Developed countries are expected to achieve their full domestic abatement potential an equal marginal cost level of €60/tonne CO_2e .
2. The carbon market finance component is sized based on an agreed collective target, somewhere in the IPCC range. (If the aggregate target is 25 percent below 1990 this is 3 Gt, if the target is 40 percent below 1990, it is 6 Gt.) This total is shared between developed countries according to the principles of 'ability to pay' and 'polluter pays'.
3. The public finance component is the amount needed to fund the incremental costs of the remaining required developing country mitigation and adaptation actions. Annex II countries will share this responsibility according to the principles of 'ability to pay' and 'polluter pays'. (The Annex II countries are those that committed to funding the full incremental cost of mitigation and adaptation in developing countries under Article 4 of the Kyoto Protocol, which is why the public finance commitment is split between those countries only.) The amount would be €50-80 billion per year for a target of 25 percent below 1990, or €35-60 billion for the 40 percent case.

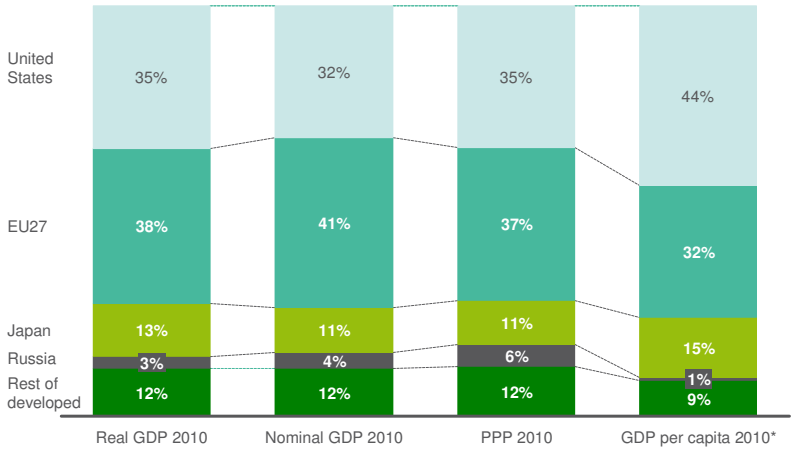
Under this methodology, the metrics used to measure domestic abatement potential, 'polluter pays' and 'ability to pay' determine the relative shares of individual countries. It will be a political decision to decide upon the appropriate weighting of the latter two principles. For the time being, we are using a 50/50 weighting.

- Domestic abatement potential is defined by Catalyst as the abatement up to a marginal abatement cost of €60 per tonne CO_2e, using the McKinsey Global Abatement Cost Curve v2.0. The cost parameter of €60/t is supported by the fact that the cost curve shows only 19 Gt of abatement potential globally below €60/t, and 17 are needed to achieve a 450 ppm pathway. Unless developed countries deliver at least their domestic potential below €60/t CO_2e, it is unlikely that a 450 ppm pathway can be met; there is little 'spare capacity' to make up the shortfall. Likewise, the cost curve shows that above €60/t CO_2e, costs and technological uncertainty increase significantly for most developed countries. While the results shown are based on equal marginal cost of abatement as a proxy for 'equality of effort', other formulations are possible such as equal total cost of abatement as a percentage of GDP.

- For 'ability to pay', typical metrics could be absolute GDP or a function of GDP per capita, either in real, nominal or PPP adjusted numbers. Certain proposals exempt per capita income below a defined threshold, like 'zero tax brackets' in national tax systems. The shares for each developed country are fairly similar for each metric measuring 'ability to pay'. For simplicity we have chosen to use real GDP 2010 as a representative measure. (Exhibit 7)

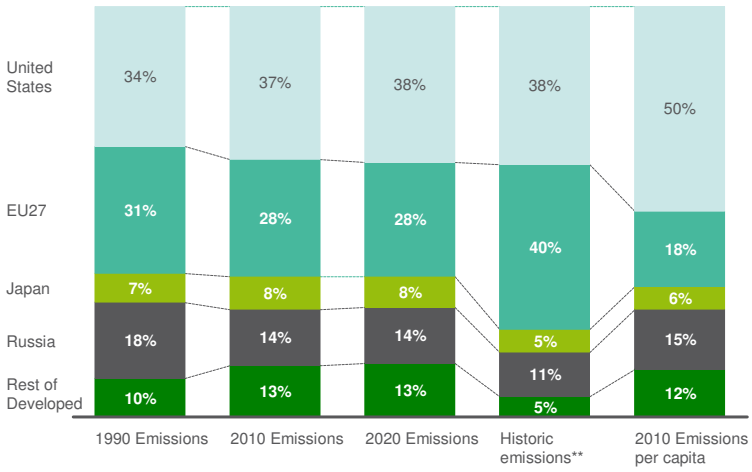
- For 'polluter pays', typical metrics are historic emissions, current emissions and functions of emissions per capita. For 'polluter pays' metrics, the year chosen for 'current emissions' does not have much impact on relative share between countries. Using historic emissions increases the share of the EU, keeps the US approximately constant and decreases the share of the other developed countries, while using an emissions per capita based measure decreases the EU share while increasing the US. Using emissions intensity (emissions divided by GDP), as suggested as one of a combination of metrics in the Mexico Green Fund proposal, places an unduly high burden on poor countries and therefore is not recommended. For simplicity, Project Catalyst has chosen to use 2010 emissions as a representative measure. (Exhibit 8)

Exhibit 7 – Comparison of metrics: ability to pay



* GDP per capita has been scaled up by GDP to be comparable to other metrics
Source: Global Insight, UN

Exhibit 8 – Comparison of metrics: polluter pays



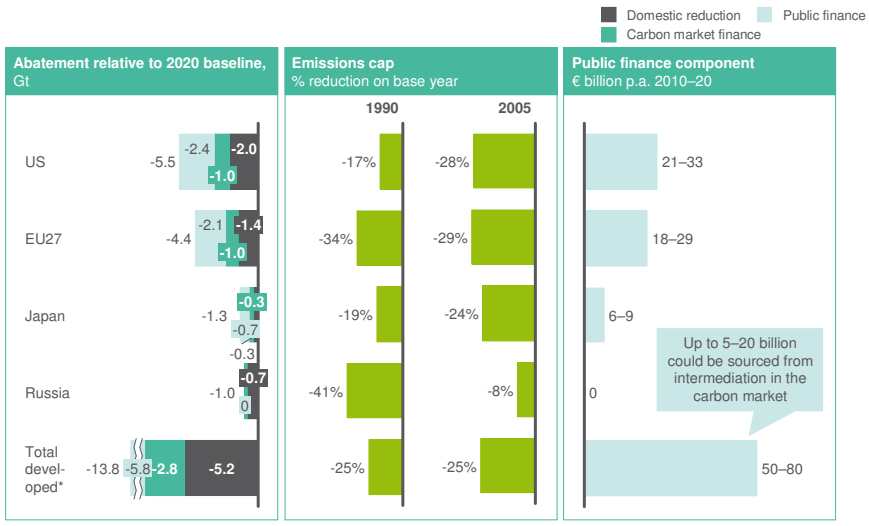
* Emissions per capita and emissions intensity have been scaled up by emissions to make it comparable to other metrics
** Historic CO2 emissions 1850-2005 from WRI
Source: UNFCCC, McKinsey Global Abatement cost curve v2.0, Global Insight, WRI

4. Results of the Catalyst benchmark

The results of the Catalyst benchmark calculations are shown in Exhibit 9 for the 25 percent below 1990 aggregate target, and in Exhibit 10 for the 40 percent below 1990 aggregate target.

How to read Exhibits 9 and 10
The left hand column shows each component of the three-part commitment assigned to each country. The domestic reduction and carbon market finance component combine to set the international emissions cap, which is shown in the centre column relative to 1990 and 2005 base years. The public finance component, in billions of Euros, is shown in the right-hand box

Exhibit 9 – 25% aggregate reduction vs. 1990

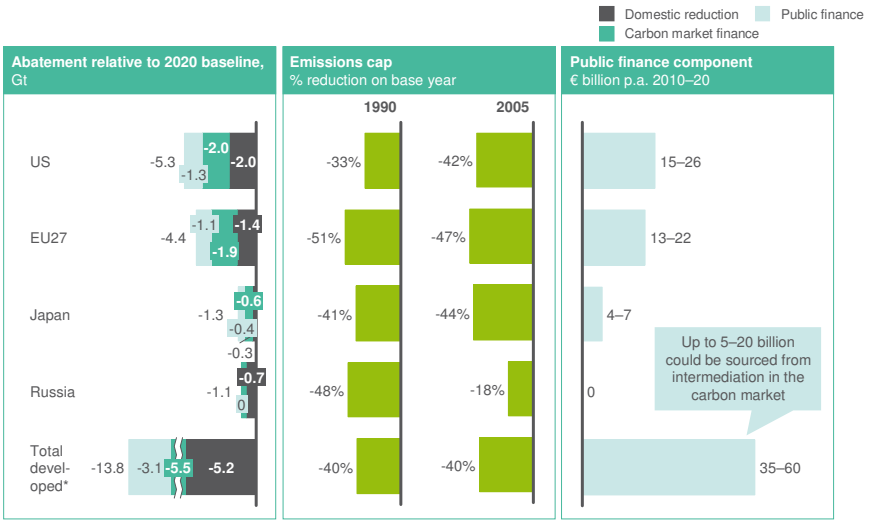


* Includes Canada, OECD Pacific, OECD Europe (Annex I countries; Belarus, Ukraine and Croatia not inc. in total due to cost curve regional groupings)
** Total developed cap is same in 1990 and 2005 as total emissions were the same in both years (18 Gt) due to reductions in Russia and Eastern Europe
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Under the 25 percent aggregate reduction scenario the US would have the largest commitment in terms of total gigatonnes of responsibility, abating 2 Gt domestically, acquiring 1 Gt in offsets international and funding an additional 2.4 Gt of developing country abatement (€21-33 billion per year) for a total responsibility of 6.5 Gt out of 13.8 Gt total (which equals the 17 Gt required to get to 450 ppm less 3.2 Gt of self-funded profitable abatement in developing countries). The combination of domestic abatement and offset purchases would then translate to a 17 percent reduction versus 1990 levels or 28 percent reduction versus 2005.

The benchmark calculations highlight why the base year issue is so contentious. While the benchmark responsibility is the same for the US (5.3 Gt) and EU (4.4 Gt) regardless of base year selected, the US looks low compared to the EU if measured on a 1990 base year or roughly equal if compared on a 2005 base year. Likewise, Russia's responsibility under the benchmark (1.1 Gt) looks high on a 1990 base year and low on a 2005 base year. By portraying commitments as a share of responsibility towards a common goal, the benchmark model removes the need for agreement on a common base year. Another way to view the results is that the US would be assuming a 38 percent share of the common developed country responsibility (5.3 Gt of 13.8 Gt of abatement versus business-as-usual by 2020), the EU assuming 32 percent, Japan 9 percent, Russia 8 percent, and so on (more detailed country-level tables are provided in Appendix III).

Exhibit 10 – 40% aggregate reduction vs. 1990



* Includes Canada, OECD Pacific, OECD Europe (Annex I countries; Belarus, Ukraine and Croatia not inc. in total due to cost curve regional groupings)
** Total developed cap is same in 1990 and 2005 as total emissions were the same in both years (18 Gt) due to reductions in Russia and Eastern Europe
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

The results for the 40 percent versus 1990 scenario (Exhibit 10) preserve the same distribution of responsibility for the 13.8 Gt as the 25 percent scenario[8] . What changes, per the discussion in Section 2, is the mix between offset financing and public financing provided by each country. For example, the total gigatonnes of responsibility for the US is the same (5.3 Gt out of the total developed country responsibility of 13.8 Gt or 38 percent). However, the form of the commitment to financial support for developing country abatement is more heavily weighted towards offset purchases (2 Gt for the US in the 40 percent scenario versus 1 Gt in the 25 percent scenario) rather than public finance (1.3 Gt or €15-26 billion for the US in the 40 percent scenario versus 2.4 Gt or €21-33 billion in the 25 percent scenario).

Thus if the overall principles for dividing up responsibility for the 13.8 Gt amongst developed countries are agreed (equal domestic effort, international offset purchases and financing based on ability to pay and polluter pays), then the choice of base year no longer matters and the decision on 25-40 percent becomes a decision on how much of the funding to developing countries is provided via offsets versus public finance.

5. Variation on the benchmark – including contributions from developing countries

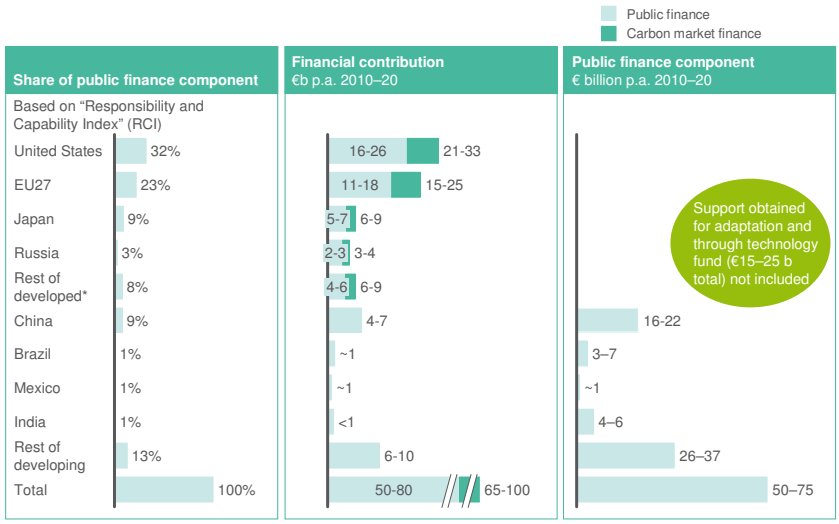
The Catalyst benchmark as described is based on the principle that developed countries should pay for the agreed incremental costs of mitigation in developing countries, as committed in Article 4 of the UNFCCC. However some recent proposals, such as the Mexico Green Fund, have suggested that developing countries might also make some contribution, as they do to fund the United Nations. Based on this, the Catalyst benchmark could be varied to include developing country contributions to the public finance component.

The share between countries would still be based on 'ability to pay' and 'polluter pays'. However it is no longer appropriate to use a flat share of GDP or emissions as a metric for contributions, due to the great variation in starting circumstance between developed and developing countries. The Greenhouse Development Rights framework has developed a 'responsibility and capacity index (RCI)', which is based on per capita GDP and emissions since 1990, but exempts the population below a certain income threshold from obligations to pay, similar to thresholds for income tax in most countries. For this example the public finance component is shared according to the RCI, set at an income threshold of $5000 per year.

The result would be a share in which developing countries contribute 25 percent of the public finance fund. All developing countries would receive more funding for mitigation actions than they contribute. For example China would contribute €4-7 billion but would receive €16–22 billion for mitigation, resulting in a net gain of €12–15 billion plus its fair share of adaptation and technology funding.

Developed countries would see a 25 percent reduction in their public finance contribution compared to the benchmark for the 25 percent below 1990 scenario, but would still need to make the same contribution through carbon market finance as before. Overall they would see a reduction of financial contributions of 21-22 percent. Such a variation might be perceived as more equitable as all but the poorest countries would contribute to the public finance component of the mitigation needed to reach 450 ppm. Developed countries would still take the lead with caps in the 25-40 percent range versus 1990 (again including both domestic commitments plus offset purchases), but the level of public financing commitments might be more realistic given budget constraints.

Exhibit 11 – Variation of benchmark based on Mexico proposal



* Includes Canada, OECD Pacific, OECD Europe (Annex I countries Belarus, Ukraine and Croatia not inc. in total due to cost curve regional groupings)
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

6. Proposed contributions to the global effort to date

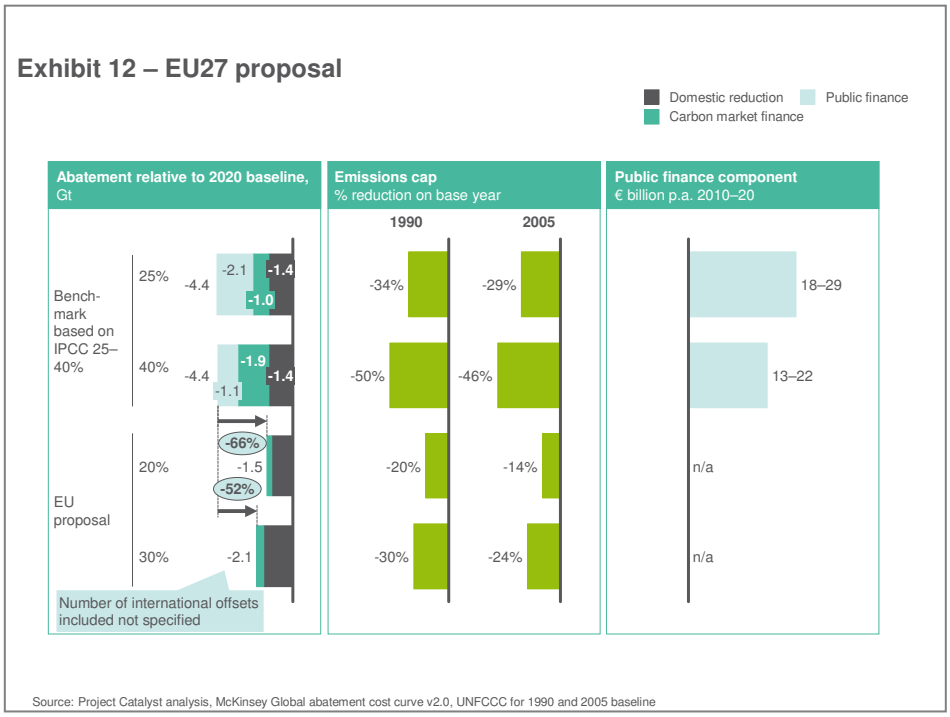
Many countries have put proposals on the table for their contribution to the total reduction required. This section examines proposals from the three largest developed country contributors – the US, EU and Japan. They are quite different in nature and therefore difficult to compare using traditional metrics. For example, while until recently Japan announced domestic reductions only, the EU has focused on an emissions cap, including both domestic reductions and international offsets. Meanwhile in the US, in the climate and energy bill currently under discussion in the US Congress, a public finance component is mentioned too.

The key message of this analysis is that no major country or region meets the benchmark yet with its current proposals. Each would need to stretch in different ways to get there – the EU would need to increase offset purchases and commit financial support, the US would need to increase domestic abatement and financial support, and Japan would need to add commitments to offsets and financial support to its proposal. While the amount of stretch is significant, it does not appear to be in the realm of the impossible, and the fact that each party would need to stretch might potentially make the political dynamics easier versus a formulation where most of the stretch fell on one or two parties.

6.1 EU: 30 percent cap is close to benchmark level of commitment but public finance contribution is not yet defined

The EU has committed in law to a 20 percent reduction on 1990 emissions by 2020. This covers the entire economy, including the sectors in the emissions trading scheme (ETS) as well as those outside it. Within the ETS, 1.6 Gt of international carbon credits are allowed over the period 2008–2020. Outside the ETS a significant number of international offsets are expected to be purchased, although no firm commitment has been made.

The EU has announced a possible further reduction to 30 percent below 1990 by 2020 depending on commitments of other countries in Copenhagen. With the 30 percent target, the EU comes close to meeting the lower end of the benchmark emissions cap for a 25 percent below 1990 aggregate target for developed countries, however it is significantly short of a 40 percent aggregate target (EU contribution would be a 50 percent cap). To meet the 25% benchmark share in full, an additional 0.3 Gt of international offsets would be needed, alongside a public finance commitment of €18-29 billion per year.



Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

6.2 US: The American Clean Energy and Security Act includes a large number of international offsets, but limited domestic abatement

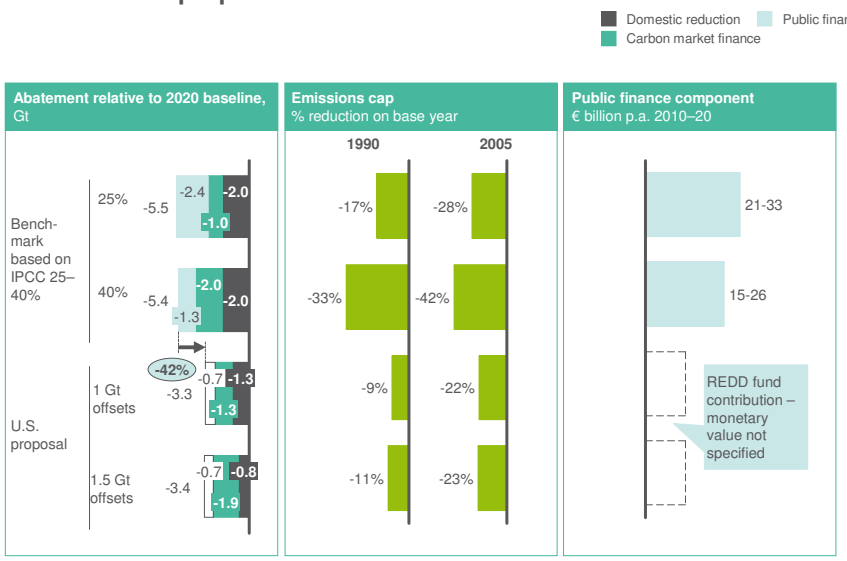
In the US, the House of Representatives passed the American Clean Energy and Security Act. The Senate is beginning its debate. The ACES act includes an emissions trading scheme covering 86 percent of emissions, with a cap set at 17 percent below 2005 by 2020. The emissions trading scheme includes 2 Gt of offsets (1 Gt domestic and 1 Gt international) with the potential to increase the international share to 1.5 Gt if not enough offsets are available domestically. From 2019 there will be a scale factor applied to offset purchases, requiring 5 tonnes of offsets to be purchased from developing countries for every 4 tonnes of US emissions they replace. This would turn the 1–1.5 Gt of offsets in the US ETS into 1.3–1.8 Gt of developing country abatement in 2020.

The bill also includes a number of domestic energy efficiency measures, which are expected to reduce total emissions further (estimated increase in reduction from 17 percent below 2005 to 23 percent including offsets)[9]. It also includes a set aside of domestic credits whose auctioning is expected to pay for 0.7 Gt of forestry abatement internationally. A rough estimate indicates that this amounts to about €3 billion of public finance.

The key differences between the ACES act and the Catalyst benchmark are in domestic abatement and public finance. If all the offset provisions are fully used, Waxman Markey is expected to achieve only half of the US domestic abatement potential. To reach the benchmark, an additional 0.7-1.2 Gt of domestic abatement is needed, alongside a public finance commitment of €15-33 billion.

Domestic abatement could be increased by limiting offsetting under the cap (while maintaining the carbon market finance component by increasing the set aside in the US ETS for international abatement) and by Federal or state regulation outside of the capped sectors. The addition of financial commitments totalling €15-33 billion annually could bring the US package to the lower end of the benchmark level of contribution in 2020 (collective 25% below 1990).

Exhibit 13 – U.S. proposal



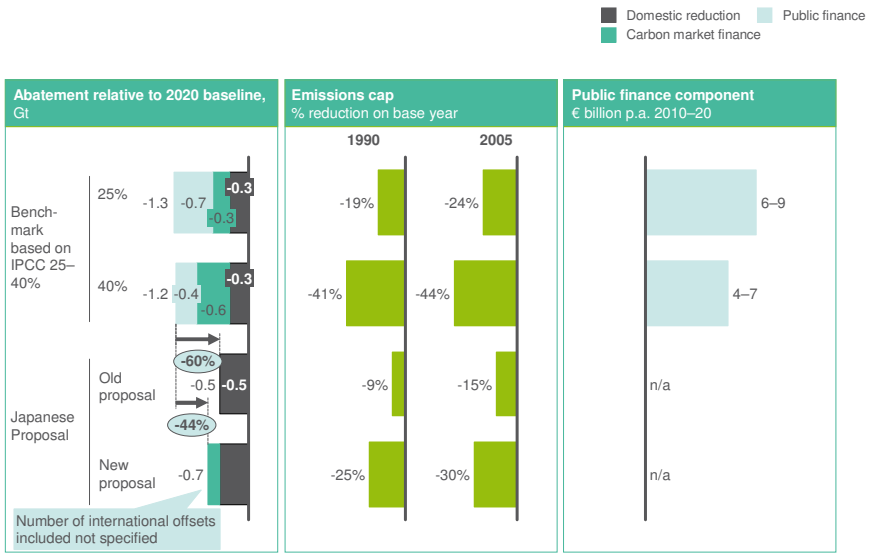
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

6.3 Japan: 15 percent reduction below 2005 is an aggressive domestic target; 25% below 1990 would put the country in a leadership position

Japan has so far announced a domestic abatement target of 15 percent below 2005. This did not include provisions for any international offsets. The newly elected Prime Minister has now announced the Japan's willingness to enhance its ambition up to 25 percent vs. 1990 under certain conditions, plus financial and technological support to developing nations. It is unclear whether the new targets would include offsets.

Already the domestic abatement commitment of 15 percent vs 1990 was aggressive compared to Japan's technical domestic potential; this is particularly impressive given the high cost per tonne of abatement in Japan (as Japan is already a very energy efficient country). The new target would bring Japan's cap towards its fair share in the middle of the IPCC range, and would require only limited additional public finance of €5-8 billion to meet the full benchmark.

Exhibit 14 – Japan's proposal



Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

7. View to 2030

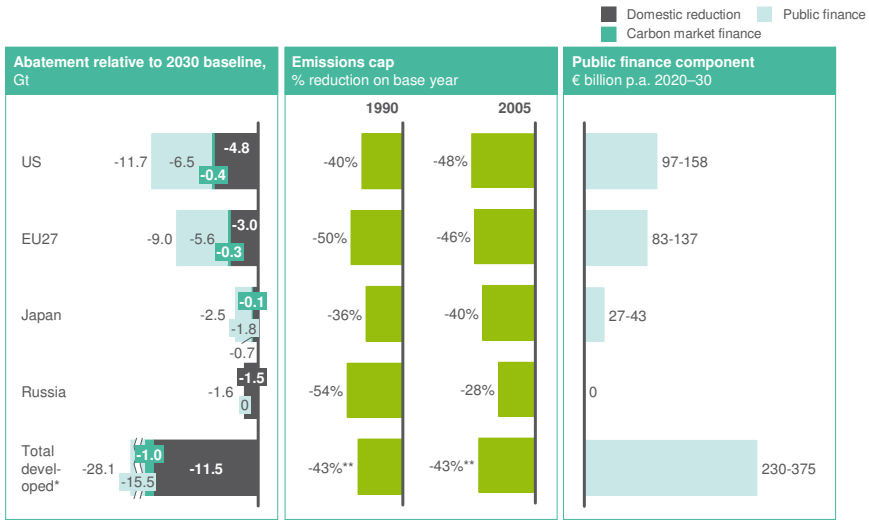
The same methodology can be applied to produce a benchmark for 2030. To remain on the pathway to 450ppm, 35 Gt of abatement versus the reference case is needed by 2030. Of this, the McKinsey Global Abatement Cost Curve shows that 12 Gt can be done in developed countries (up to a marginal abatement cost of €60 per tonne CO_2e). Of the remaining 23 Gt, which will need to be located in developing countries, 7 Gt can be done at positive NPV and can therefore be mostly self financed, leaving 16 Gt to be funded by developed countries.

The total funding required for mitigation in developing countries is €230 – 330 billion on average per annum between 2020-30 (including transaction costs), with an additional €20-60 billion needed for adaptation, bringing the total to €250 – 390 billion.

Although no collective target has been suggested for 2030, a linear trend between targets for 2020 and 2050 would give an aggregate 43-58 percent reduction below 1990 in 2030 (based on collective target 25-40 percent below 1990 in 2020 and the IPCC range 80[10] -95 percent reduction below 1990 by 2050).

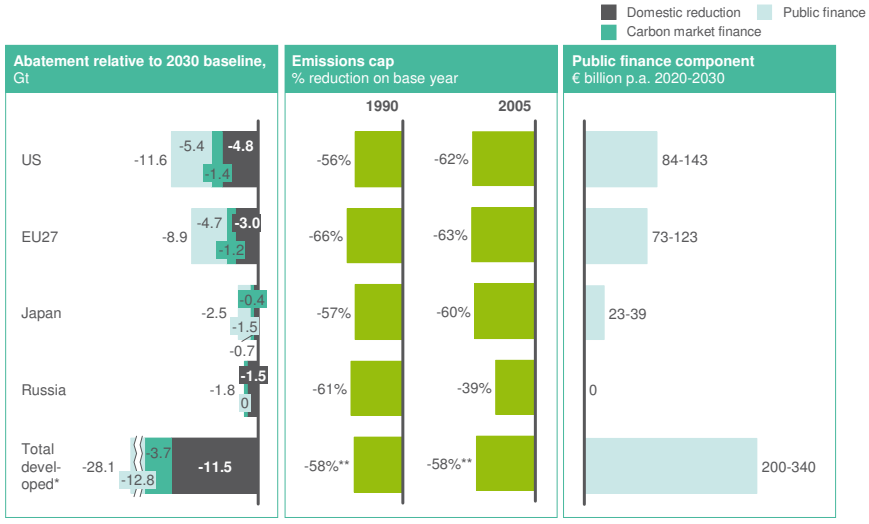
A 43-58 percent target below 1990 would require 13-15 Gt of abatement to be done under the collective developed country cap. 12 Gt of this could be done domestically, leaving only 1-4 Gt of demand for offsets that would generate carbon market finance. This would require the majority (80-95%) of the €250 – 390 billion to be funded through public finance (Exhibit 15).

Exhibit 15 – 2030 benchmark (with 43% target)



* Includes Canada, OECD Pacific, OECD Europe (Annex I countries Belarus, Ukraine and Croatia not inc. in total due to cost curve regional groupings)
** Total developed cap is same in 1990 and 2005 as total emissions were the same in both years (18 Gt) due to reductions in Russia and Eastern Europe
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

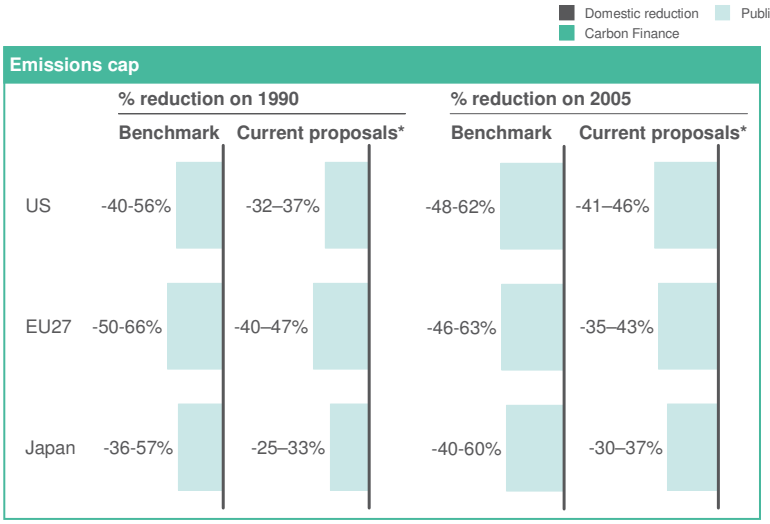
Exhibit 16 – 2030 benchmark (with 58% target)



* Includes Canada, OECD Pacific, OECD Europe (Annex I countries Belarus, Ukraine and Croatia not inc. in total due to cost curve regional groupings)
** Total developed cap is same in 1990 and 2005 as total emissions were the same in both years (18 Gt) due to reductions in Russia and Eastern Europe
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Although only the US proposal has explicit targets for 2030, using some simple extrapolation, the three major economies, US, EU and Japan, could all come close to the lower end of the 2030 benchmark emissions cap (Exhibit 17). However, no country has made any public finance commitment for that timeframe.

Exhibit 17 – Proposals for 2030 vs. emissions caps suggested by the Catalyst benchmark



* 2030 targets calculated by extrapolating to 2050 targets: US: 80% below 1990 by 2050. EU27: 80% below 1990 by 2050. Japan: 80% below 1990 by 2050

Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

While evaluating the benchmark for 2030 targets is an inherently speculative exercise, the analysis shows that developed world abatement trajectories would potentially come close to the benchmark levels, and with the addition of significant finance commitments, the benchmark could be met for the 2030 as well as the 2020 timeframe.

Conclusion

Developed country commitments to mid-term targets and financial support for developing countries are critical to a successful outcome in Copenhagen. If such commitments show leadership by the developed world and credibly set the world on a path to 450 ppm, then the likelihood of a developing country response that also supports a 450 ppm path increases significantly.

Any commitments will ultimately be the result of political negotiation and leadership, not an analytic exercise. However, an analytic benchmark, such as the one described here, can help frame, inform, and ground those discussions. The Catalyst benchmark has five features that may be of particular help to the negotiations:

1. It is based on simple and well accepted equity principles – equality of effort, ability to pay, and polluter pays;

2. It integrates a top-down equity perspective with a bottom-up perspective of abatement potentials and cost;

3. Its results do not depend on agreement on a particular base year;

4. It reframes the 25-40 percent debate from a discussion of whether developed countries take leadership responsibility to a discussion on the form their responsibility takes; and

5. It evaluates developed country proposals as a complete package (domestic abatement, offsets, funding) and puts them on a comparable footing.

The fact that the benchmark shows gaps for all of the major developed countries highlights the political challenge of committing seriously to a 450 ppm path, but also shows that all countries will need to stretch in roughly equal measure to meet that challenge.

Appendix I – Existing equity proposals

- Mexico's 'Green Fund' proposal shares contributions based on a combination of six indicators including current and historical emissions, emissions per capita and the carbon intensity of the economy. Both developed and developing countries would contribute to the fund, although developing country contributions would be limited to significantly less than they receive in support. Relative weightings of the indicators have not been determined.

- The Greenhouse Development Rights 'Responsibility and Capacity Index' defines a share based on 'responsibility', defined by emissions since 1990, and 'capacity', defined as the GDP of the proportion of the population with incomes above $5000 per year (defined as the development threshold). The aim is to ensure that the relatively wealthy people in developing countries make a fair contribution while exempting the poor from undue burdens.

- The European Commission's proposal is based on a weighted combination of GDP per capita, carbon intensity, trends in GHG emissions 1990-2005 and trends in population 1990-2005.

- Oxfam's Adaptation Financing Index is focused on 'polluter pays' and 'ability to pay'; here the 'ability to pay' is measured using the human development index, with the top 24 countries contributing 95 percent of the total.

- The principle of 'contraction and convergence' is based on the concept that every country converges to 2 Gt emissions per capita, using offsets to make up the difference where it is not technically possible to reach this level. This is a focus on the principle of 'polluter pays' rather than 'ability to pay', measured entirely by current emissions.

- The 'Brazilian proposal' bases reduction targets on countries' contribution to temperature increase, with participation in emissions reductions based on a per capita income threshold.

- Academic literature generally focuses on the implications of 'common but differentiated responsibilities', with developed countries accepting responsibility for their historic emissions. It converges on variations of the 'polluter pays' and 'ability to pay' principles.

Appendix II – Relative cost to each country

On average across developed countries, the total cost of domestic action amounts to around 0.1-0.2 percent, while the international contribution needs to be around 0.2-0.3 percent GDP. (Exhibit 18).

For most of the main countries, relative cost is fairly similar, with cost of domestic abatement in Russia being the only significant exception. Russia has a particularly emissions intensive economy (i.e., high emissions per GDP), mainly due to a legacy of emissions intensive industrial and power plants, leaving it with a large domestic abatement opportunity. This also means that its contribution to the carbon market finance component is on the high side (according to the polluter pays principle). However, as it does not contribute to the public finance component (as it is not in Annex II), its overall international contribution is in line with other developed countries.

Exhibit 18 – Relative cost to each country

	Cost as percentage of GDP					
	Domestic		International		Total	
	Low	High	Low	High	Low	High
United States	0.1	0.2	0.2	0.3	0.4	0.5
EU27	0.1	0.1	0.2	0.3	0.3	0.4
Japan	0.2	0.2	0.2	0.3	0.4	0.5
Russia	0.4	0.6	0.2	0.2	0.6	0.8
Canada	0.1	0.2	0.2	0.4	0.4	0.5
Rest of OECD Europe	0.1	0.1	0.2	0.2	0.2	0.3
Rest of OECD Pacific	0.3	0.3	0.2	0.2	0.4	0.5

* Numbers may not add due to rounding
Source:Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Appendix III – Data tables

Backup – 25% aggregate reduction vs. 1990

	Abatement relative to 2020 baseline, Gt				Emissions cap % reduction on base year		Public finance component, €b p.a. 2010–20	
	Domestic	Carbon market finance	Public finance	Total	1990	2005	Low	High
United States	2.0	1.0	2.4	5.5	-17	-28	21	33
EU27	1.4	1.0	2.1	4.4	-34	-29	18	29
Japan	0.3	0.3	0.7	1.3	-19	-24	6	9
Russia	0.7	0.2	0.0	1.0	-41	-8	0	0
Canada	0.2	0.1	0.2	0.5	1	-19	2	3
Rest of OECD Europe	0.1	0.1	0.2	0.4	35	-12	1	2
Rest of OECD Pacific	0.4	0.2	0.2	0.7	-4	-24	2	3
Total developed*	5.2	2.8	5.8	13.8	-25**	-25**	49	80

* Excluding Annex I countries; Belarus, Ukraine and Croatia due to cost curve regional groupings
** Total developed cap is same in 1990 and 2005 as total emissions were the same in both years (18 Gt) due to reductions in Russia and Eastern Europe
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Backup – 40% aggregate reduction vs. 1990

	Abatement relative to 2020 baseline, Gt				Emissions cap % reduction on base year		Public finance component, €b p.a. 2010–20	
	Domestic	Carbon market finance	Public finance	Total	1990	2005	Low	High
United States	2.0	2.0	1.3	5.4	-33	-42	15	26
EU27	1.4	1.9	1.1	4.4	-51	-47	13	22
Japan	0.3	0.6	0.4	1.2	-41	-44	4	7
Russia	0.7	0.4	0.0	1.2	-48	-18	0	0
Canada	0.2	0.2	0.1	0.5	-15	-32	1	3
Rest of OECD Europe	0.1	0.2	0.1	0.4	6	-31	1	2
Rest of OECD Pacific	0.4	0.3	0.1	0.8	-22	-38	1	2
Total developed	5.2	5.5	3.1	13.8	-40**	-40**	36	61

* Excludes Annex I countries; Belarus, Ukraine and Croatia due to cost curve regional groupings)
** Total developed cap is same in 1990 and 2005 as total emissions were the same in both years (18 Gt) due to reductions in Russia and Eastern Europe
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Backup – Abatement relative to 2030 baseline (43% below 1990)

	Abatement relative to 2030 baseline, Gt				Emissions cap % reduction on base year		Public finance component, €b p.a. 2020–30	
	Domestic	Carbon market finance	Public finance	Total	1990	2005	Low	High
United States	4.8	0.4	6.5	11.7	-40	-48	97	158
EU27	3.0	0.3	5.6	9.0	-50	-46	83	137
Japan	0.7	0.1	1.8	2.5	-36	-40	27	43
Russia	1.5	0.1	0.0	1.6	-54	-28	0	0
Canada	0.4	0.0	0.6	1.1	-10	-28	10	61
Rest of OECD Europe	0.3	0.0	0.4	0.7	29	-16	6	10
Rest of OECD Pacific	0.8	0.1	0.5	1.4	-34	-48	8	12
Total developed	11.5	1.0	15.5	28.1	-43**	-43**	230	375

* Excludes Annex I countries; Belarus, Ukraine and Croatia due to cost curve regional groupings
** Total developed cap is same in 1990 and 2005 as total emissions were the same in both years (18 Gt) due to reductions in Russia and Eastern Europe
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Backup – Abatement relative to 2030 baseline (58% below 1990)

	Abatement relative to 2030 baseline, Gt				Emissions cap % reduction on base year		Public finance component, €b p.a. 2020–30	
	Domestic	Carbon market finance	Public finance	Total	1990	2005	Low	High
United States	4.8	1.4	6.5	11.6	-56	-62	97	158
EU27	3.0	1.2	5.6	8.9	-66	-63	83	137
Japan	0.7	0.4	1.5	2.5	-57	-60	27	43
Russia	1.5	0.3	0.0	1.8	-61	-39	0	0
Canada	0.4	0.1	0.5	1.1	-26	-41	7	10
Rest of OECD Europe	0.3	0.1	0.3	0.7	0	-35	5	7
Rest of OECD Pacific	0.8	0.2	0.4	1.5	-52	-62	6	8
Total developed	11.5	3.7	12.8	28.1	-58**	-58**	200	340

* Excludes Annex I countries; Belarus, Ukraine and Croatia due to cost curve regional groupings
** Total developed cap is same in 1990 and 2005 as total emissions were the same in both years (18 Gt) due to reductions in Russia and Eastern Europe
Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Backup – EU27 proposal for domestic abatement target

	Abatement relative to 2020 baseline, Gt				Emissions cap % reduction on base year		Public finance component, €b p.a. 2010–20	
	Domestic	Carbon market finance	Public finance	Total	1990	2005	Low	High
25% benchmark	1.4	1.0	2.1	4.4	-34	-29	18	29
40% benchmark	1.4	1.9	1.1	4.4	-51	-47	13	22
EU 20% proposal	1.0	0.5	0.0	1.5	-20	-14	n/a	n/a
EU 30% proposal	1.2	0.8	0.0	2.1	-30	-24	n/a	n/a

Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Backup – U.S. proposal for domestic abatement target

	Abatement relative to 2020 baseline, Gt				Emissions cap % reduction on base year		Public finance component, €b p.a. 2010–20	
	Domestic	Carbon market finance	Public finance	Total	1990	2005	Low	High
25% benchmark	2.0	1.0	2.4	5.5	-17	-28	21	33
40% benchmark	2.0	2.0	1.3	5.4	-33	-42	15	26
Waxman-Markey (1Gt offsets)	1.3	1.3	0.7	3.3	-9	-22	n/a	n/a
Waxman-Markey (1.5Gt offsets)	0.8	1.9	0.7	3.4	-11	-23	n/a	n/a

Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Backup – Japanese proposal for domestic abatement target

	Abatement relative to 2020 baseline, Gt				Emissions cap % reduction on base year		Public finance component, €b p.a. 2010–20	
	Domestic	Carbon market finance	Public finance	Total	1990	2005	Low	High
25% benchmark	0.3	0.3	0.7	1.3	-19	-24	6	9
40% benchmark	0.3	0.6	0.4	1.2	-41	-44	4	7
Old proposal	0.5	0.0	0.0	0.5	-9	-15	n/a	n/a
New proposal	0.7	0.0	0.0	0.5	-25	-30	n/a	n/a

Source: Project Catalyst analysis, McKinsey Global abatement cost curve v2.0, UNFCCC for 1990 and 2005 baseline

Appendix IV – Assumptions on current proposals

Country	2020 proposal or target	2050 proposal or target	Notes and assumptions	Source
Australia	5-15% below 2000 levels 25% below 2000 levels if global deal achieving 450ppm stabilisation	60% below 2000 levels	LULUCF included	UNFCCC submission
Belarus	5-10% below 1990 levels	None	LULUCF inclusion yet to be determined Assume emissions are flat at 2020 levels	UNFCCC submission stated under consideration
Canada	20% below 2006 levels	60-70% below 2006 levels	LULUCF included	UNFCCC submission
EU	20-30% below 1990 levels	80% below 1990 levels	LULUCF excluded for 20% and included for 30%	UNFCCC submission
Iceland	15% below 1990 levels	50-75% below 1990 levels	LULUCF included	UNFCCC submission
Japan	15% below 2005 levels / 25% below 1990 levels	60-80% below 2005 levels	LULUCF excluded / unclear for recent announcement	UNFCCC submission / Press reports on PM elects' speech
Liechtenstein	20-30% below 1990 levels	None	LULUCF excluded Assume emissions are flat at 2020 levels	UNFCCC submission
Monaco	20% below 1990 levels	None	LULUCF excluded Assume emissions flat at 2020 levels	UNEP
New Zealand	25-40% below 1990 levels	50% below 1990 levels	LULUCF excluded	New Zealand Climate Change Research Institute
Norway	30% below 1990 levels	100% reduction by 2030 (carbon neutral)	LULUCF included	UNFCCC submission
Russia	10-15% below 1990 levels	60-70% reduction, baseline unspecified	LULUCF excluded Assume baseline for 2050 reduction is 1990	UN Climate Change Conference quoting Russia's commitment, article from 6/23/2009
Switzerland	20-30% below 1990 levels	At least 50% below 1990 levels	LULUCF included	UNFCCC submission
Ukraine	20% below 1990 levels	50% below 1990 levels	LULUCF excluded	UNFCCC submission

References

1. IPCC Fourth Assessment, Working Group III, Chapter 13, Box 13.7.
2. 'Business as usual' as defined by McKinsey Global Abatement Cost Curve, version 2
3. 'Pathways to a Low-Carbon Economy' – Version 2 of the Global Greenhouse Gas Abatement Cost Curve, McKinsey & Company
4. Catalyst definition of developed countries is: US, Canada, EU27, Russia, Japan, rest of OECD Pacific (Australia, New Zealand South Korea) and rest of OECD Europe (Iceland, Norway, Turkey, Switzerland). This can be used as an approximation for Annex I in the Kyoto Protocol, but does not exactly match it –the definition excludes Belarus, Croatia and Ukraine which are in Annex I but not in the OECD or EU27, while it includes South Korea which is in the OECD but not Annex I. This approximation is necessary due to the spatial resolution of marginal abatement cost data in the McKinsey Global Abatement Cost Curve. For the calculations in this paper, the difference between the Catalyst definition of developed countries and Annex 1 is well below the error margins of the data.
5. The International Institute for Applied Systems Analysis (IIASA) has conducted an independent comparison of seven major marginal abatement cost (MAC) studies (paper forthcoming Fall 2009). Once adjusted for different baselines and other assumptions, the seven bottom-up studies were in general agreement identifying 20 percent reductions below 2005 by 2020 for Annex I countries available for under US$ 100 per tonne.
6. In this paper 1990 and 2005 baselines are as recorded by the UNFCCC, excluding LULUCF
7. IPCC AR4 WG3 Ch13
8. In the 40 percent case, Annex II countries see their share of the 13.8 Gt decrease slightly compared to the 20 percent case, as more of abatement is done through carbon market finance to which all developed countries are expected to contribute.
9. 'Emissions reduction under the Cap and Trade proposals in the 111th Congress', Larsen and Heilmayr, WRI
10. G8 countries committed to an 80% collective reduction below 1990 in 2050, July 2009

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