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Round Table on Sustainable Development

COMPARING CLIMATE CHANGE COMMITMENTS: TECHNICAL VERSUS POLITICAL JUDGEMENT

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1. INTRODUCTION

1. Ensuring comparable effort amongst countries' commitments to reduce greenhouse gas (GHG) emissions is a key issue in the current negotiations towards a post-2012 agreement on climate change. However, defining a broadly acceptable basis for comparison is challenging. A sceptical or minimalist view might regard comparability as limited to judgments that are essentially political and subjective. A more ambitious view is that comparability can be judged on the basis of systematic analyses that draw on common data, thereby providing an objective basis for measurable differences in national circumstances. A reasonable definition is likely to rely on elements of both approaches.

2. The importance of comparable effort is formally recognised in the UN Framework Convention on Climate Change (UNFCCC) and the Bali Action Plan. Under Article 3.1 of the UNFCCC, Parties should protect the climate system "on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities". The Bali Action Plan (paragraph 1b) is more precise, stating the need for:

> *…"enhanced national/international action on mitigation of climate change, including consideration of: …Measurable, reportable and verifiable nationally appropriate mitigation commitments or actions, including quantified emission limitation and reduction objectives, by all developed country Parties, while ensuring the comparability of efforts among them, taking into account differences in their national circumstances;"*.

3. Comparing effort is a delicate process, but dealt with systematically it could help smooth the path to an ambitious agreement. In the case of comparability amongst developed economies (the focus of this paper), a willingness to approach mitigation targets in a transparent and objective fashion can only send positive signals to other Parties looking for leadership from developed countries.

4. Political consensus appears to be emerging that an international climate agreement should aim for a stabilisation target that limits any increase in average temperature to 2°C or less.[1] As such, the distribution of effort needs to sit within an envelope of Annex I efforts that are consistent with achieving this objective over time. Gauging comparability will be crucial to any negotiated burden sharing outcome.

5. Looking beyond a negotiated outcome, comparability is needed to underwrite the durability of any agreement. Negotiators will be well aware that an outcome widely deemed comparable and reflective of national circumstances is necessary to ensure ratification and effective implementation.

6. An outcome which can be evaluated is an important part of this objective. This is reflected in the wording of the Bali Action Plan, which states that "comparability of efforts" is needed, implying a basis upon which effort can be compared and a "deal" evaluated.

7. Further, a robust deal will be sensitive to the need to minimise the collective cost of tackling climate change. A deal based on comparability which systematically takes account of national circumstances is more likely to be sustainable over time.

8. Submissions in the current climate negotiations contain a number of qualitative principles that might be used to gauge comparability of effort. Some have suggested quantitative approaches for evaluating each of these principles. Table 1 summarises these and some of the corresponding quantitative indicators that might be used to gauge comparability.

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[1] See G8 leaders declaration http://www.g8italia2009.it/static/G8_Allegato/G8_Declaration_08_07_09_final,0.pdf

Table 1. Principals and criteria for comparison

Principle	Rationale	Quantitative measures[2]
Capability	The economic and social ability of a country to take action on climate change. In general one would expect a wealthier country to have greater access to resources to combat climate change and therefore greater success in meeting more demanding mitigation commitments.	1. GDP per capita 2. Mitigation cost as a % of GDP 3. Human Development Index (HDI) 4. Population growth
Responsibility	Historical use of the atmosphere and contribution to climate change. Akin to the "polluter pays" principle.	1. GHG per capita 2. Cumulative emissions (e.g. 1990-2005)
Potential	The technical potential for emissions reductions taking account of the natural environment, existing industrial infrastructure and emissions intensity. For example, a country with high penetration of renewable electricity generation may have less opportunity to reduce emissions than countries with a low penetration.	1. Marginal abatement costs 2. Triptych 3. GHG per unit of GDP
Early action	Countries that have already acted to reduce emissions and perhaps incurred costs in doing so could reasonably expect this to be taken into account. To some extent this should be reflected in mitigation potential.	1. Recent emissions trend (e.g. change in GHG per capita1990-2005)

9. Accepting that a deal needs to be achievable to be sustainable does not mean accepting a process in which countries determine for themselves what is achievable. Indeed, a pure pledge and review system, underwritten by domestic calculations and consultations, creates incentives for countries to underestimate what can be achieved. This is because the process of establishing commitments is not just about who will take on costs of mitigation and how much, but also about the allocation of a valuable resource (in this case, scarce atmospheric space). The EU experience with national action plans for the first phase of the EU Emissions Trading Scheme (EU ETS) showed how a pledge and review system can create perverse incentives and stymie ambition (Ellerman and Loskow 2008).

10. The necessity of an outcome which is simultaneously adequate and achievable suggests a need to consider comparability as more than simply the evaluation of domestic mitigation targets. The capacity of countries to reduce emissions domestically is highly variable, and in any event this does not sum to an adequate outcome. In the presence of emissions trading and flexibility mechanisms, mitigation responsibility is more than domestic action. Targets can be translated into demand for external mitigation, including actions and measures in developing countries, and generate market-based finance for mitigation.

11. A balance needs to be struck, however, between systematic approaches to comparability of effort and the need for political judgement to be brought to bear. Different countries have different values and constituencies, thus necessitating political judgement about what will pass muster at home. These judgements are extremely difficult to assess for comparability. Conceptually, an attempt could be made to include political effort, but gauging such effort would be difficult and lacking in transparency.

2 The HDI is a composite index constructed using: life expectancy at birth (health); a combination of the adult literacy rate and combined primary, secondary, and tertiary gross enrolment ratio (knowledge); and GDP per capita (standard of living). Triptych is a bottom up approach for measuring mitigation potential based on information at the sector level. See Höhne, N., D. Phylipsen, and S. Moltmann (2007).

12. The downside of not including sufficient space for political judgement in any approach to comparability of effort is that a deal might be analytically comparable but not politically feasible.

13. To explore the trade-off between political judgement and technical analysis, this paper looks at the kind of information and results that quantitative analysis can be expected to deliver. Data presented to illustrate possible country commitments are by way of example only. The analyses in this report provide a cross-section of research and analytical approaches but are not intended to be comprehensive or definitive.

14. The first issue addressed is the extent of variation in national circumstances across Annex I countries. A series of indicators are compared in terms of what they imply about possible mitigation targets.

15. The second issue addressed is whether model-based analysis of mitigation costs is useful for assessing comparative effort.

16. A retrospective analysis of the deal struck in Kyoto then asks whether the nature of that deal can provide lessons on balancing political and technical judgement in the context of current negotiations.

17. The paper concludes with discussion about whether and how technical analysis can be given a greater role in creating a common basis for ensuring comparability of effort.

2. INDICATORS OF NATIONAL CIRCUMSTANCES AND COMPARABLE EFFORT

18. The simplest of the quantitative measures, or indicators, in Table 1 were chosen for the analyses that follow. The selection was based on the idea that simple measures are less open to argument over how they are constructed. Projections were also excluded for this reason. Simple measures are also more transparent compared with, for example, model-based estimates of mitigation costs and mitigation potential. The indicators chosen for analysis here are: [3]

1. GDP per capita as an indicator of capability.
2. GHG per capita and cumulative GHG emissions (1990-2005) as indicators of responsibility.
3. GHG per dollar of GDP as an indicator of mitigation potential.
4. Percentage change in GHG emissions per capita (1990-2005) as an indicator of early action.

19. There is no obvious single method available for translating individual indicators of national circumstances into mitigation targets. For example, what about a country whose GDP per capita is twice that of the Annex I average? One approach would be to make that country's target twice that of the Annex I average. However, it does not necessarily follow that twice the GDP per capita means twice the capability – therefore such a result is not necessarily comparable. Any simple method (such as the one used here and outlined below) for translating indicators into comparable efforts will include some element of arbitrariness. The approach taken here is to limit the introduction of arbitrary choices and let the data speak for itself as much as possible.

20. Each of the 5 measures has been converted into indices which are normalised to account for different units of measurement.[4] The indices are then converted into burden shares based on two formulae:

[3] Data is for 2005. The HDI is excluded as data is missing for some countries.

[4] Simple formula for normalisation = 100 x [(actual value - minimum value) / (maximum value-minimum value)].

- Cumulative GHGs 1990-2005, the only measure which is a level, is converted based on shares of the Annex I total.[5]
- GDP per capita, GHG per capita, GHG per dollar of GDP, percentage change in emissions per capita (1990-2005), i.e. relative or ratio indicators, are converted by calculating the distance of an index score from the Annex I average.[6]

21. The rationale for using these indicators is to highlight differences in national circumstances between countries, thereby providing some basis for assessing whether particular mitigation targets are comparable. Applying each of these individual indicators to Annex I countries produces widely varying levels of national effort. Figure 1 illustrates the extent of this variation.[7]

22. Assuming a desired aggregate emissions reduction effort of 32.5% (the mid-point of the 25-40% objective declared to be consistent with a temperature increase limited to 2°C), Figure 1 shows the range of emissions reductions that would be required of each country depending on the measure chosen (and the mid-point). The distribution of effort changes significantly depending on which individual measure is chosen. On average, the gap between the maximum and minimum targets each country might face amounts to 71%.

23. The variability shown in Figure 1 includes variability due to choice of base year. When the indices are converted into mitigation targets the choice of base year affects the distribution of effort. Countries with high growth in GHG emissions between 1990 and 2005, often linked to high population growth, face lower shares of the burden if the base year is 2005; the opposite is true for countries with low or negative growth in emissions over the same period. The choice of base years here are 1990 and 2005. Targets calculated using the 2005 base year have been converted into reductions relative to 1990 so they can be directly compared with targets calculated using the 1990 base year.

24. If Annex I Parties each chose the indicator of national circumstances and base year least demanding for them, the overall Annex I target would be a considerable distance from what is required. As shown in Figure 1, the minimum target for most Annex I parties includes an increase in emissions relative to 1990. If each Party chose the minimum then the overall Annex I reduction target would be 1% below 1990 levels – less than was agreed in Kyoto – while each could claim that their choice of indicators was consistent with a 32.5% reduction from 1990 levels.[8]

25. Thus, no single indicator of national circumstances can be expected to reflect all principles of comparability.[9] A common set of indicators is also needed. Indicators may be combined into composite indices taking account of multiple factors related to comparability of effort. This also simplifies the interpretation of the information by narrowing the variation in indicators.

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5 Score for country i divided by sum of index scores for all Annex I countries.

6 Taking account of the spread inherent in the data, i.e. (Country indicator – Annex I indicator)/(Standard deviation of indicator across all Annex I countries).

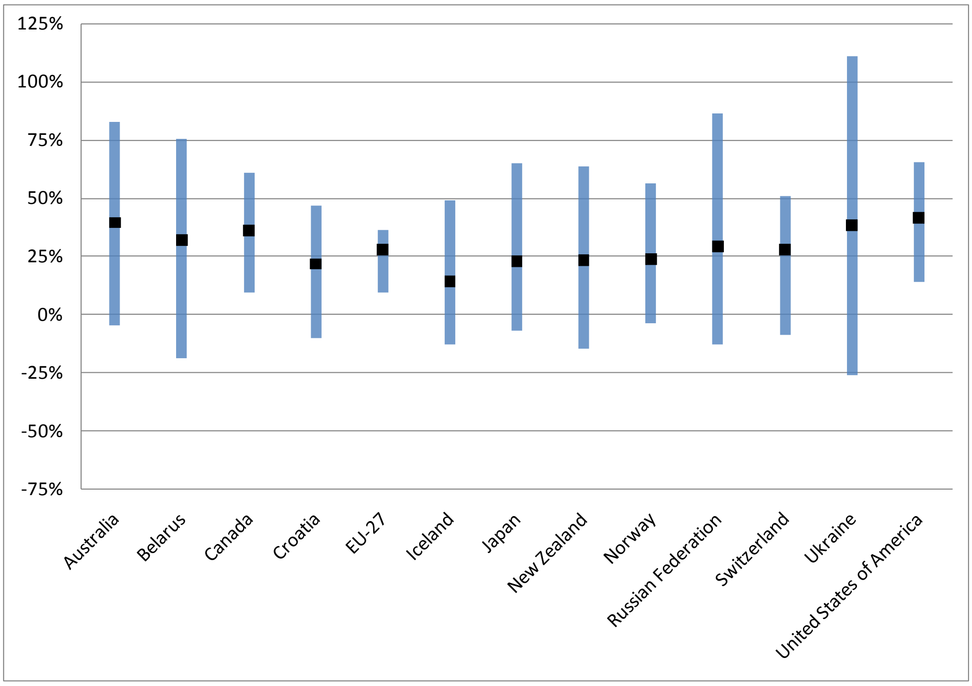
7 Tables of results are appended to this paper.

8 This result is heavily influenced by choice of base year.

9 For in-depth discussion on indicators and related issues see Karousakis, K., B. Guay and C. Philibert (2008).

Figure 1. Variation in single indicators used to imply comparable effort

(Midpoint and range, % GHG reduction in 2020 relative to 1990)



26. The three composite indices constructed here to illustrate the use of composite indicators are:

- **Composite index reflecting all four principles of comparability**. Assigning equal weight to each principle.[10]
- **Composite index reflecting capability, responsibility, and mitigation potential.** The early action measure is excluded, as large changes in emissions in some countries reflect economic changes unrelated to emissions reduction policies.
- **Composite index reflecting capability and responsibility.** Mitigation potential is also excluded because model estimates show that for some countries the individual indicator, GHG per unit of GDP, does not relate well to model-based estimates of mitigation potential.

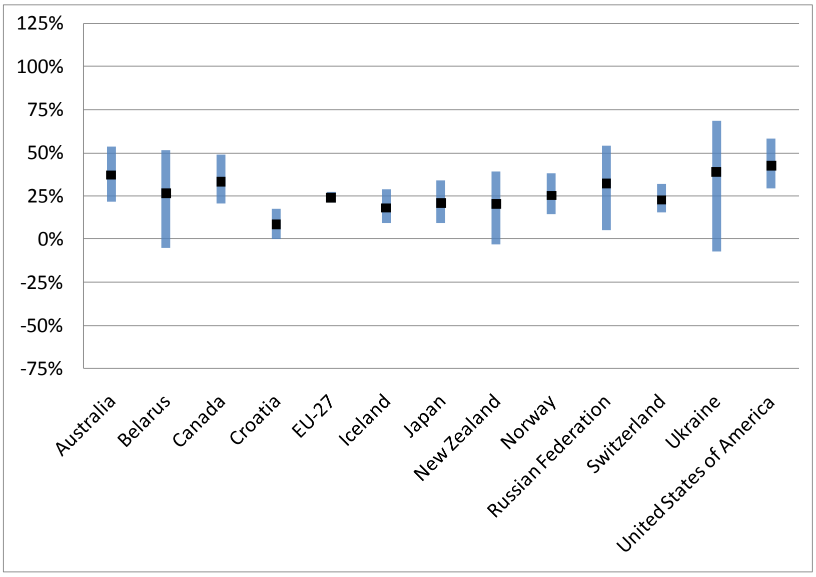
27. Each of the composite indices is calculated for different base years of 1990 and 2005.

28. The variation amongst countries based on these composite indices is substantially smaller. The average range of outcomes across the different composite indices closes to 33%. The range of mitigation commitments suggested by this series of composite indices is displayed in Figure 2.

[10] The two measures of responsibility are given half weights in the calculation before combining into the index, i.e. an index score is (GDP per capita x 0.25) +[((GHG per capita x 0.5) + (Cumulative GHG 1990-2005 x 0.5)) x 0.25] + (GHG per dollar of GDP x 0.25) + (Percent change in emissions 1990-2005 x 0.25).

Figure 2. Variation in composite indicators used to imply comparable effort

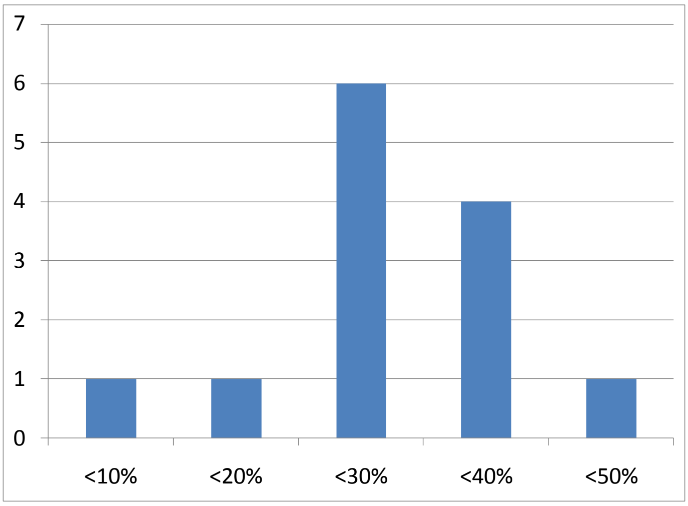
(Midpoint and range, % GHG reduction in 2020 relative to 1990)



29. The burden sharing arrangements implied by the composite indices (Figure 3) show a distribution of effort centred on the Annex I mean (32.5%) with only two countries at less than 30% and a large right-hand group with five countries over 30%.

Figure 3. Groupings according to midpoints across composite indices

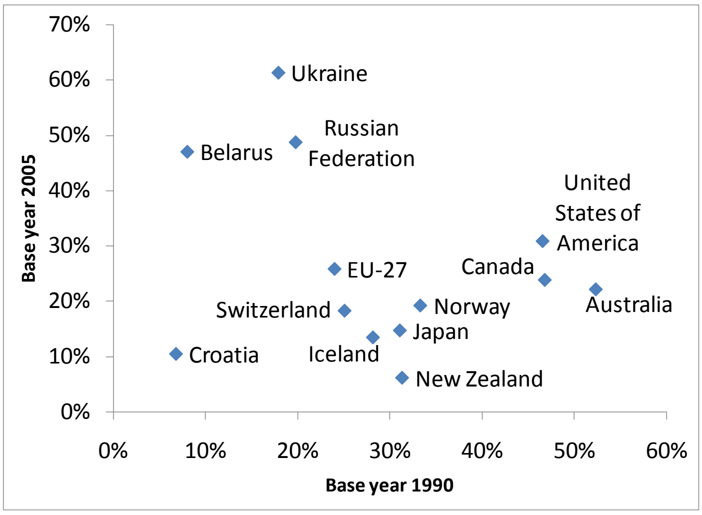
(Number of countries in each GHG reduction target band)



30. For some countries the spread in suggested targets remains large even with the use of composite indicators. This is true for countries with significant emissions growth between 1990 and 2005 and consequently where the choice of base year is a major factor in the range of results produced by the composite indices. Figure 4 charts the difference in reduction targets relative to 1990 depending on base year. The simple approach taken here to calculating the midpoint across the composite indices while taking account of the effects of base year choice means splitting the difference between targets suggested against a base year of 1990 and those suggested against a base year of 2005.

Figure 4. Effect of base year on targets suggested by composite indices

(Based on midpoint of range from composite indices, % reduction in GHG emissions relative to 1990)



31. The simplicity of this analysis means it is transparent. Composite indices can account for a range of principles for comparing mitigation effort; the reduced variation in results from these indices, compared to individual indicators, means they produce relatively clear and understandable results. As such, simple composite indices could be useful in evaluating comparability of effort.

32. However, these results should not be directly interpreted as recommending one target over another or one grouping of countries over another. Additional information and judgement may need to be taken into consideration. For example, some of the outliers in this analysis are equally those for whom model-based studies tend to show relatively high costs of mitigation relative to the Annex I average (Burniaux *et al.*, 2009). It is widely recognised that, given the magnitude of the climate change problem, it must be addressed at the lowest possible economic cost – thus further information might be taken into account to ensure cost-effective commitments.

33. Furthermore, additional national circumstances which have not been considered here could have important impacts on a country's efforts and the achievability of its mitigation efforts. Examples include population growth, trends in exports or imports, geographical differences such as population density or distributional impacts on low income groups. Indicators for these national circumstances have been excluded from the analysis above to keep the analysis simple. Cost models, discussed below, are better suited to taking account of a wide range of issues.

3. MODELLING COMPARABLE EFFORT

34. Model-based estimates of GHG mitigation potential and mitigation cost also play an important role in quantifying effort in the context of capability.[11]

35. There are two broad approaches to estimating mitigation costs.

1. Bottom-up economic models based on technical mitigation potential and costs.

[11] They may also summarise information on early action to the extent that past action to mobilise low cost mitigation options leads to higher future marginal abatement costs.

2. Top-down economic models based on macroeconomic depictions of the economy.

36. Both approaches can take in and distil a wide array of information about national circumstances as well as domestic mitigation costs and trade-related costs associated with purchasing emissions offsets from other Annex I or non-Annex I countries.

37. The main strength of bottom-up models is that they can be more precise about technological opportunities for mitigation. Top-down models, on the other hand, are useful because they incorporate feedback loops from mitigation policy such as consumer and trade responses to higher prices.

38. Both approaches have weaknesses, however, compared to simple evaluation of national circumstances based on existing socio-economic and environmental data and information. The main weaknesses are:

1. Uncertainty about the accuracy of projections about economic activity and emissions which underpin the evaluation of future mitigation costs.
2. Sensitivity to underlying model assumptions about technological opportunities and economic behaviour. This can lead to divergence across model results and concern that assumptions can reflect biases or particular national or sectoral interests.
3. Uncertainty about future policies and the shape of collective action on climate change. For example, mitigation costs faced by a particular country depend significantly on whether or not there is active trade in emissions permits.
4. Complexity, which limits transparency.
5. Aggregation of countries into regions or groups of countries. This limits the ability of some Annex I Parties to extract information on what the regional model results imply for them.

39. The last of these weaknesses presents a major challenge to using model-based analysis to inform negotiations. While aggregation of country groups is not a significant problem in the context of analysing the dynamics and impacts of climate policies for which these models were created, it is difficult to build a bridge between policy analysis and negotiations if all Annex I Parties cannot use the information to answer the question “what does this mean for us?”

40. Most top-down models and many of the major international bottom-up models aggregate some Annex I countries. Furthermore, different models use slightly different aggregations, making inter-model comparisons difficult.

41. One of the only prominent and publicly available international models of mitigation costs which provides sufficient country detail to form a basis for understanding comparability for Annex I countries in the 2020 time frame in the negotiating context is the GAINS model produced by the International Institute for Applied Systems Analysis (IIASA) (see Box 1).

Box 1. The GAINS model methodology
(Amann et al 2008)

In brief, the methodology [for the GAINS model] (i) adopts exogenous projections of future economic activities as a starting point, (ii) develops a corresponding baseline projection of greenhouse gas emissions for 2020 with information derived from the national GHG inventories that have been reported by Parties to the UNFCCC for 2005, (iii) estimates, with a bottom-up approach, for each economic sector in each country the potential emission reductions that could be achieved through application of the available mitigation measures, and (iv) quantifies the associated costs required for these measures under the specific national conditions. The approach includes all six gases that are included in the Kyoto protocol (i.e., CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) and covers all anthropogenic sources that are included in the emission reporting of Annex 1 countries to the UNFCCC (i.e., Energy, Industrial Processes, Agriculture, Waste, and from LULUCF). In addition, the analysis quantifies the implications of GHG mitigation strategies on air pollution.

42. It is not ideal that only one model provides sufficient detail across each of the Annex I countries. Ideally, a range of studies or models would be taken into account (Hoogwijk et al. 2008). But with different models using different aggregations, results cannot be easily compared across models, at least not in terms of individual country efforts and national circumstances.

43. For the time being, however, the GAINS model provides a useful analytical basis for describing mitigation potential and costs across Annex I countries.

44. Table 2 summarises results from the GAINS model based on an overall Annex I target of -32.5% relative to 1990 and countries facing the same mitigation costs as a percentage of GDP (in this case, 0.46%[12]). Country mitigation targets are shown in the third column and the contribution of domestic abatement to these targets is shown in the second column (Domestic mitigation potential based on an assumed price of €60/t CO_2e). The change in per capita emissions (fourth column) is based on a country's overall target. Table 2 shows that:

1. **Focussing on the magnitude of a target relative to a base year is misleading.** The changes in emissions shown in the table are all relative to 1990. Different base years imply different targets and in some cases different relativities between countries on account of differences in emissions growth since 1990. The effect of choosing a 2005 base year while still using change in GDP as the basis of comparability is shown in Table 2 to illustrate this point.
2. **Higher BAU emissions are associated with higher mitigation costs.** Those countries with high emissions growth and high projected emissions are generally those that face higher economic costs from mitigation. Thus cost estimates may give contrary signals about comparability relative to indicators of responsibility.
3. **Domestic mitigation potential is limited.** The results in Table 2 are based on an assumed carbon price of €60/t CO2e. At this price many countries are limited in the mitigation efforts they can undertake at home. The difference between the Annex 1 target for 2020 and the domestic mitigation potential in Annex 1 illustrates this point (i.e. about a third of the mitigation efforts will be through purchasing of international credits).

[12] The GAINS model uses purchasing power parity (PPP) methodology for GDP estimates in 2020

Table 2. Example of comparable mitigation targets based on equal costs as a percentage of GDP

(IIASA GAINS model[13], % change. Based on overall Annex I target of -32.5% relative to 1990 and assumed €60/t CO_2e.)

	2020 BAU emissions growth	Domestic mitigation potential	2020 target	Implied change in per capita emissions	GDP cost	2020 target, alternative base year
	Relative to 1990				Relative to BAU	Relative to 2005
Australia	17%	-3%	-8%	-33%	0.46%	-15%
Canada	37%	-5%	-20%	-39%	0.46%	-36%
EU-27	-3%	-24%	-40%	-43%	0.46%	-36%
Japan	5%	-7%	-30%	-30%	0.46%	-34%
NZ	35%	14%	1%	-27%	0.46%	-19%
Norway	26%	11%	-21%	-31%	0.46%	-27%
Russia	-20%	-45%	-46%	-39%	0.46%	-15%
Switzerland	-8%	-19%	-62%	-65%	0.46%	-63%
Ukraine	-50%	-63%	-63%	-55%	0.46%	-19%
USA	18%	-7%	-18%	-39%	0.46%	-29%
Annex 1	1%	-22%	-32.5%	-38%		-29%

45. These messages are reflected in results from other models. While other models' results cannot be directly compared with GAINS at the country level, they do deliver consistent insights supporting these observations (see for example Burniaux et al 2008 and 2009; McKinsey & Company, 2009; den Elzen et al., 2008).

46. Limits on the amount of abatement that can take place at manageable costs mean that analysis of mitigation costs needs to consider both mitigation potential and the costs of purchasing emission offsets internationally. Purchasing emissions offsets or reductions from outside Annex I countries will be an important part of Annex I country efforts in any negotiated outcome that is consistent with the UNFCCC (e.g. Articles 4.3 and 3.3) and consistent with a widely agreed objective of stabilising the atmospheric concentration of GHGs at 450ppm and preventing more than 2°C degrees of warming relative to pre-industrial levels.

47. A key issue here is how or whether to treat domestic mitigation potential and costs differently from carbon market finance aspects of Annex I country efforts. In the GAINS results above, the cost of carbon market finance and domestic mitigation targets are compared on the basis of a common metric of GDP cost (% change relative to BAU). However, a single metric may not sufficiently account for the different principles put forward for understanding comparability, such as responsibility.

48. One option is to consider comparability of domestic mitigation potential and carbon market finance on different bases and build up overall mitigation responsibilities – i.e. targets – based on these two components. For example, the domestic component of a country's target could be established based on mitigation potential, the carbon market finance component based on ability to pay using an indicator such as GDP per capita, and responsibility based on emissions per capita. To do this one might use the GAINS model evaluation of domestic mitigation potential and apportion the remainder of Annex I efforts to meet an Annex I target of -32.5% compared to 1990 based on indices of GDP per capita and GHG per capita as

[13] Australia's calculations include adjustments for deforestation emissions (in line with Article 3.7 of the Kyoto Protocol). Figures have been derived from the UNFCCC and estimates from 'Australia's low pollution future: The economics of Climate Change'. The targets for other countries are slightly different to some published GAINS results due to very minor differences in methodologies used in converting model results into targets.

discussed in the section above on national indicators. An application of this approach is illustrated in Table 3.

Table 3. Example of targets based on mitigation potential, responsibility, and ability to pay

(Change in emissions relative to 1990, Mt of CO_2e unless otherwise stated, based on Annex I target of -32.5%)

	Mitigation potential share[14]	**Ability to pay share**	**Responsibility share**[15]	**Total mitigation**	**Target**
	Based on GAINS model	Based on GDP per capita	Based on GHG per capita	Sum of components	% change
Australia	-12	-22	-35	-69	-17%
Canada	-29	-36	-34	-99	-17%
EU 27	-1,351	-268	-141	-1,760	-31%
Japan	-85	-59	-2	-147	-12%
NZ	8	-1	-3	5	8%
Norway	5	-4	0	1	3%
Russia	-1,335	-33	-294	-1,663	-56%
Switzerland	-11	-4	0	-14	-26%
Ukraine	-593	-9	-128	-730	-77%
USA	-425	-572	-370	-1,367	-22%

49. A limitation of this kind of approach is that the effects of trade in offsets or emissions units are not addressed in the same detail as with top-down models. In the GAINS model it is assumed that lower marginal costs of emissions through trade enable all parties to benefit. While this is true, some Parties will benefit more than others (Burniaux et al. 2009). This is not taken into account in indicator methods nor bottom-up modelling methods.[16]

50. While there uncertainties inherent in model-based mitigation cost estimates, any analytical assessment of comparability would ideally include them. Other indicators of national circumstances do not approximate them very well. Mitigation cost estimates are typically inversely related, albeit not perfectly, to other measures of comparability. This suggests that the kinds of simple approaches discussed above need to be complemented by measures of mitigation costs. Figure 5 charts Annex I targets suggested by the midpoint across composite indices against mitigation targets suggested by two different model estimates of mitigation cost.

51. The only individual indicator which delivers similar burden sharing results to mitigation cost estimates is GHG per unit of GDP.[17] The relationship is not strong, but it indicates that countries which currently rely heavily on income produced from processes creating greenhouse gasses are likely to face

[14] The absolute value of the percentage change in the domestic mitigation potential column of Table 2.

[15] Responsibility and ability to pay shares are the average of indicators calculated using 1990 and 2005 base years.

[16] Burniaux et al note that model results show some countries could be worse off as a result of emissions trading. They suggest, however, that such results (driven by the dynamic known as Dutch disease) should be discounted "as the ENV-Linkages model exacerbates them, due *inter alia* to lack of explicit modelling of the international capital market" (p.43).

[17] GHG per unit of GDP has a correlation coefficient of approximately 0.30 when compared with mitigation costs in the model results discussed here. This is in contrast to all other measures of national circumstances discussed above where correlation coefficients are negative and in some cases strongly negative (e.g. if mitigation targets distributed based on shares of GHG emissions in 2005 – i.e. grandfathered – have a correlation coefficient of -0.86 when compared against mitigation costs from the OECD ENV-linkages model). This suggests that grandfathering emissions would not be a least cost approach to burden sharing.

comparatively high marginal abatement costs. In this regard, data on GHG emissions is an incomplete proxy for the polluter pays principle. In addition, it is clear that a GHG intensive economy is not necessarily an economy with high mitigation potential – at least not for a given marginal cost of abatement.

Figure 5. Mitigation cost vs. composite index of national circumstances

(% emission reduction in 2020 from 1990 levels. Bottom axis is target implied by cost model. Left axis is target implied by mid-point across composite indices of indicators of national circumstances.)

Figure 5a.
Top-down model results (OECD ENV-Linkage)[18]

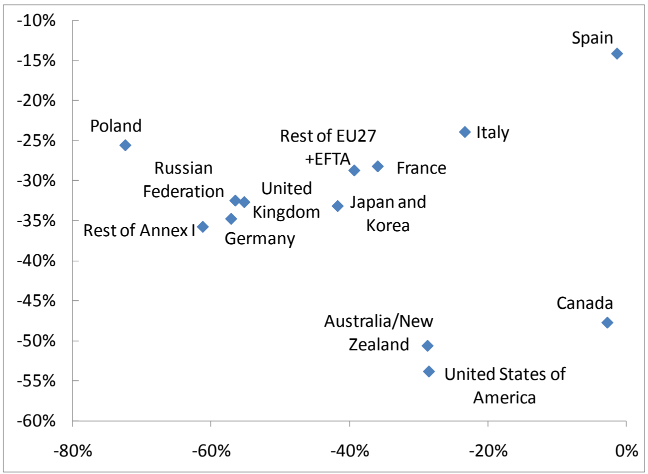
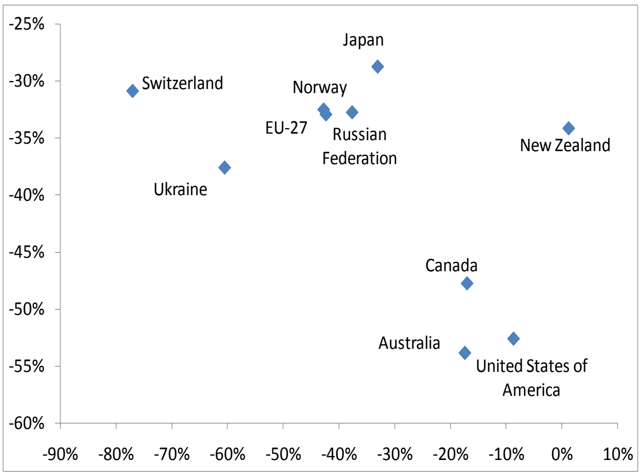


Figure 5b.
Bottom-up model results (IIASA GAINS)



52. Domestic mitigation potential and market-based carbon finance are only part of the picture. Significant additional financing commitments are needed. Here analysis can also provide a basis for comparing commitments.

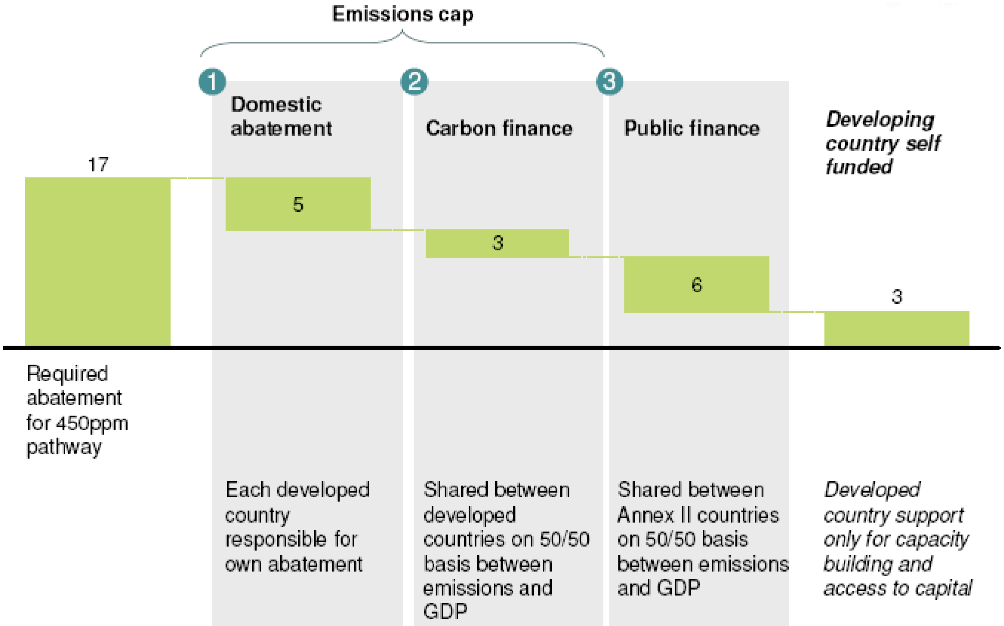
53. There is a large gap between what can be delivered by caps on developed country emissions and the global emission reductions required for controlling climate change. Figure 6 shows that emission caps (based on an aggregate Annex I target of -40% from 1990) may be able to deliver a little under half of the required global abatement, with 5Gt of abatement occurring in the developed world and 3Gt in the developing world financed through demand for offsets. Some of the remaining amount is negative cost abatement and would be self-funding in the developing world, but a third will need to be funded through other means.

54. As shown in Figure 6, the remaining third of abatement could be financed by Annex II countries on the basis of ability to pay and responsibility metrics in the same way as mitigation efforts, over and above mitigation potential, were distributed in the example in Table 3.

55. One advantage to comparing commitments across all three categories is that it provides space for trade-offs between the different components. Trade-offs will occur regardless, but analytical judgment can guide these trade-offs and make them more transparent.

[18] Based on a 40% reduction in emissions in 2020 across all Annex I countries compared to 1990 levels with effort distributed to equalise costs in terms of GDP per capita in 2020.

Figure 6. Three-part benchmarking approach to comparability



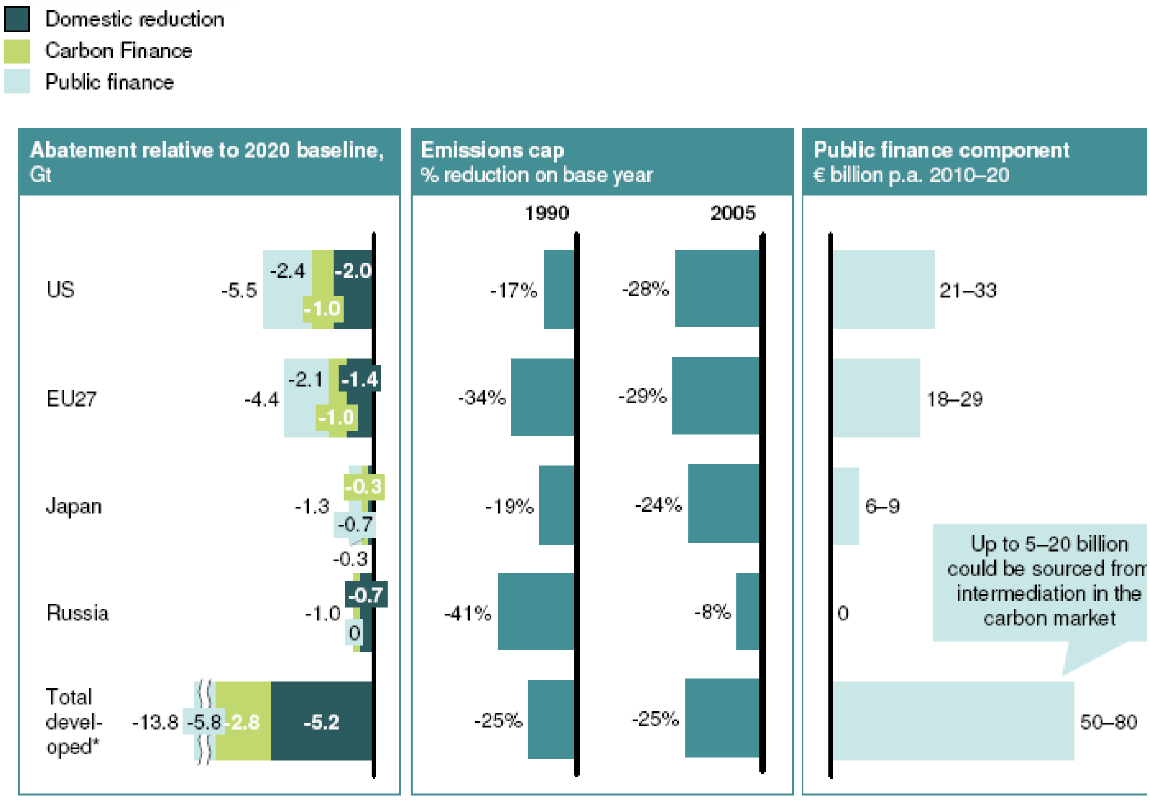
Source: Project Catalyst analysis based on McKinsey Global Abatement Cost Curve v2.0.

56. Analyses of developed country proposals currently on the table show that it is important to take account of a package of measures when considering comparability not least because proposals differ in form as well as substance. For example, while Japan announced domestic reductions, the EU has focused on an emissions cap, including both domestic reductions and international offsets. Meanwhile, a public finance component is mentioned in the climate and energy bill currently under discussion in the US Congress.

57. Figure 7 describes a worked example of how a package of commitments would come together using benchmarks established as in Figure 6. The left hand column shows each component of the three-part commitment abatement assigned to each country. The domestic reduction and carbon market finance components 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.

58. This worked example, when compared to developed country proposals currently on the table, shows that no major developed country region meets the overall benchmarks and that 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. While the amount of stretch is significant, it does not appear to be impossible, and the fact that each party must do so potentially makes the political dynamics easier than in a formulation where most of the responsibility falls on one or two parties.

Figure 7. Combined commitments, based on aggregate 40% emission reduction relative to 1990



Source: Project Catalyst analysis based on McKinsey Global Abatement Cost Curve v2.0.

4. COMPARABILITY AND THE PROCESS IN KYOTO

59. There is little evidence of a systematic approach to target setting or comparability of effort in the deal that was struck by Annex I countries in Kyoto in December 1997. While the question of country commitments was debated in the lead-up to Kyoto and proposals put forward to guide differentiation of commitments, it appears that more weight was placed on political judgements and compromises than on an attempt to apply an objective standard of comparability of effort or an equitable basis for differentiation (Andresen and Agrawala, 2002; Grubb, 1999). This is despite several countries proposing systematic burden sharing rules or guidelines in 1996 (UNFCCC, 1996).

60. What can be said then about the success of this largely political burden sharing arrangement? While we are not yet mid-way through the agreement's first commitment period, it can be observed that:

- Emissions in Annex I countries (excluding economies in transition) grew by 9% from 1990 to 2006.[19, 20]

[19] UNFCCC (2008), http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php.

[20] An increase of 9% is not necessarily out of step with the Kyoto Protocol, given the availability of flexibility mechanisms providing for Annex I countries to meet their obligations through actions elsewhere. However, there is an expectation that significant domestic abatement will take place. The Marrakech Accords include in the preamble "Affirming that the use of the mechanisms shall be supplemental to domestic action and that domestic action shall thus constitute a significant element of the effort made by each Party included in Annex I to meet its

- There has been limited success in establishing the kind of systematic global mitigation mechanisms (i.e. emissions trading) envisaged by the Kyoto Protocol.
- Ratification remains incomplete.
- The agreement created substantial “hot air” (allocation of excess emissions units to some countries).

61. In brief, the deal is far from perfect. Imperfection is not necessarily a bad thing; borrowing the negotiator’s cliché, one should not let perfection become the enemy of the good. However, the problem with a purely political negotiating process is that it can be difficult to gain any clear view of the relative merits of a particular outcome.

62. It is impossible to say whether the outcome at Kyoto would have been judged superior had it been based on a more systematic approach to comparability of effort. However, it is clear that the resulting protocol would have been different.

63. A retrospective analysis of mitigation targets set in Kyoto shows that the variation in targets, from reductions of 8% relative to 1990 levels to an increase of 10% relative to 1990 levels, was very different from what would have resulted from indicators based on national circumstances. Burden sharing on that basis would have resulted in targets ranging between reductions of 17% from 1990 levels to a maximum permitted increase of 4% (this range is generated using the measures of national circumstances discussed earlier, working from the overall Annex I target agreed at Kyoto of -5.2% below 1990 levels and taking account of all combinations of indices and individual indices using data that would have been available in 1997).

64. Figure 8 charts Kyoto commitments against comparable targets suggested by a composite index of metrics on national circumstances (composed of GHG per capita, GDP per capita, and GHG per dollar of GDP as proposed by Norway in 1996). The dashed line is the line on which each country would sit if targets conformed to these quantitative measures of national circumstances. The chart further illustrates that the Kyoto outcome contained a much higher degree of variation in outcomes than might be suggested by socio-economic and environmental variations between Annex I countries.

65. The Kyoto targets are clustered into three groups. Within each group, national circumstances vary significantly and as much as between groups.

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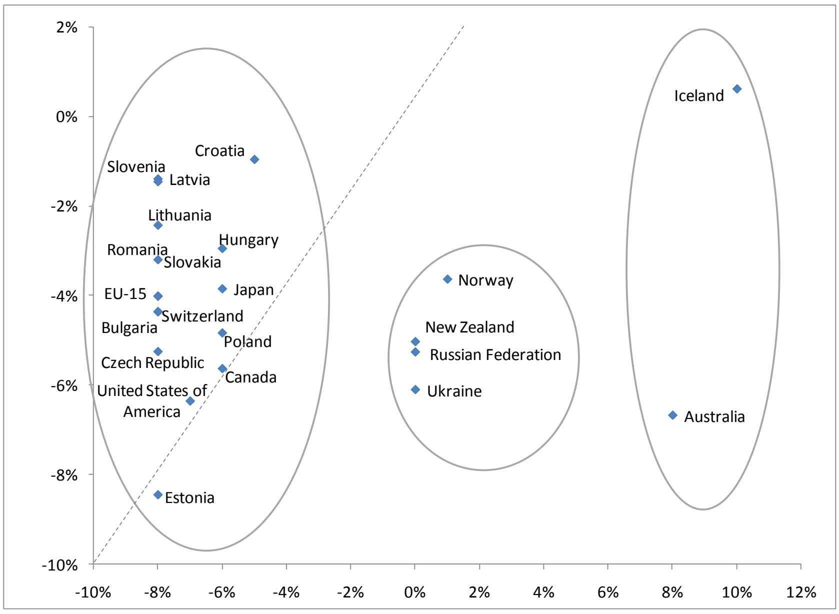
quantified emission limitation and reduction commitments under Article 3, paragraph 1” Decision 15/CP.7, FCCC/CP/2001/13/Add.2.

Figure 8. Kyoto targets compared against composite index of national circumstances

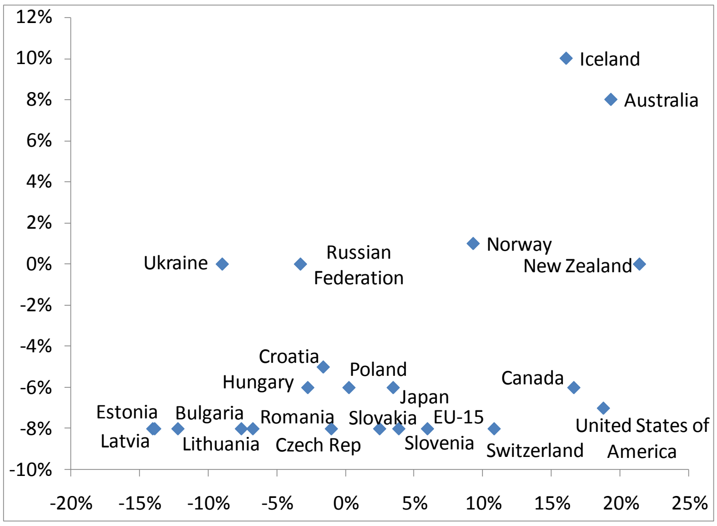
(Bottom axis is Kyoto Target, left axis is target suggested by composite index summarising national circumstances)



66. Neither do the Kyoto Protocol targets appear to reflect other possible candidate comparability guidelines such as population growth (Figure 9) or model-based estimates of mitigation costs that were produced around that time (Figure 10).

Figure 9. Kyoto target vs. population increase (1990-2005)

(Bottom axis is population change (%). Left axis is Kyoto target.)

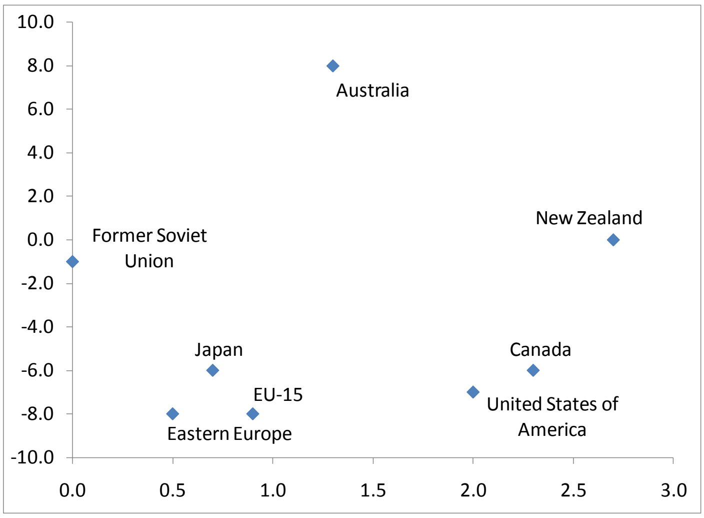


67. Shortly after the Kyoto Protocol was finalised in 1997, the OECD analysed Annex I country targets in search of a de-facto burden sharing rule (OECD, 1999). The analysis concluded that some relationship existed between projected emissions reduction in 2010 (% reduction compared to BAU) and

GDP per capita, but that the relationship was not strong and appeared to be influenced heavily by the systematic target-setting approach used in the EU burden sharing arrangement.

Figure 10. Kyoto target vs. mitigation cost estimates

(Bottom axis is mitigation cost (Tupulé et al 1998). Left axis is Kyoto target.)



68. A relationship also appears to exist between projections of emissions growth around the time that the Kyoto Protocol was signed and the targets that were agreed. The relationship is not especially strong.

69. One may conclude that it is impossible to discern whether these outcomes were comparable or not. To make a judgement on comparability one would first have to determine a basis upon which to make such a judgement. The analysis here suggests there is no such common basis.

70. It may well be that the deal struck in Kyoto was the best possible under the circumstances. However, this does not diminish the fact that it is difficult, *ex post*, to gauge the comparability of effort encapsulated in that deal. The question is whether this lack of comparability is a good or bad thing.

71. One may observe that the EU countries, which took account of a systematic method when apportioning mitigation targets amongst themselves (the Triptych approach), have been most successful in implementing systematic emission reduction policies. Perhaps there is a lesson in this?

5. ELEVATING ANALYSIS IN THE NEGOTIATING PROCESS

72. A number of countries, non-governmental and intergovernmental organisations have analysed comparability of effort and the potential for systematic or rules-based approaches to setting climate commitments. Indeed, research efforts on comparable post-2012 commitments began soon after the Kyoto Protocol was agreed (e.g. Ringius et al 2008). The question is whether this work can or should be elevated in the negotiating process so that its guidance is reflected in a post-2012 climate agreement.

73. Under the status quo, Annex I parties are using and will continue to use analyses to motivate their own positions and understand the perspectives of others. These analyses may be handed over at the negotiating table and used to justify a particular position or apply pressure on counterpart negotiators. It is unclear whether this sort of process will deliver an outcome that ensures comparability. The example of the Kyoto Protocol shows that negotiations can consider analytical information and systematic approaches to comparability, but produce outcomes that are not easily compared on a common basis.

74. Parties could lift analytical judgement to a more central role in the negotiating process. An informal understanding of the importance of analytical judgement could increase the likelihood that Annex I country commitments are established on a common and comparable basis. This does not imply a need for new analyses; existing research could be used or adapted for this purpose. Before this could be done, however, a number of issues would need to be addressed.

75. One such issue is ownership. Analysis of comparability has been conducted by a range of organisations and governments representing quite different interests. There will inevitably be suspicion about the motivations that may lie behind different analyses and the potential for bias in their findings. For analytical judgement to play a greater role in negotiations there needs to be a sense of shared ownership of the analysis amongst Annex I Parties and indeed all UNFCCC Parties. The IPCC has played a valuable role in increasing the authoritativeness and the sense of ownership that it attaches to the results of scientific research into climate change. A similar approach may commend itself to arriving at a defensible approach to burden sharing.

76. Complexity is also a problem that would need to be addressed. Comparability itself has a number of dimensions: capability, responsibility, mitigation potential and early action. In addition, analysing comparability requires constructing scenarios and making assumptions from a long menu of possible options. The number of permutations of scenarios and assumptions and modelling approaches rise exponentially as soon as models are introduced. Even the limited number of indicators analysed above could be combined into more than 60 different individual or composite indices. Information must therefore be distilled. Agreement may be needed on the number of key parameters that can be used to inform the policy-making process, so as to minimise complexity without a loss of analytical integrity.

77. Bringing these elements together to establish a common basis for gauging comparability will not be straightforward. It may, however, be necessary if the process of developing fresh Annex I commitments is to avoid a race to the bottom. Countries can benefit from free-riding on the emissions control efforts of others (Burniaux et al. 2009). The incentive to free ride, despite the best political intentions, threatens global efforts to control climate change and is the very *raison d'être* of the UNFCCC.

78. Policy-makers will need to make judgements about what an outcome means for their particular interests and make the case as to where more or less flexibility is required given their particular national circumstances. Elevating analytical judgement as one part of the decision making process would help to contextualise these claims. It would provide a basis upon which observers and participants in the climate change negotiations could claim that comparability of efforts has been ensured and national circumstances taken into account.

79. Analytical judgement is not perfect. There is sometimes a sense that the result of indicator-based or model-based analysis is akin to pulling numbers out of a black box. For all that, it may be the price to pay for ensuring that they are not pulled from thin air.

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Table 4. Data

Country	GHG emissions (MtCO2e)	Population (millions)	GDP (USD million, PPP)	GHG/cap (tCO2/capita)	GDP/cap	GHG/GDP	Cumulative emissions (MtCO2e)
Year	*2005*	*2005*	*2005*	*2005*	*2005*	*2005*	*1990-2005*
Australia	560	20	690,077	27.5	33,836	0.81	5,044
Belarus	84	10	81,744	8.5	8,327	1.03	1,116
Canada	733	32	1,115,467	22.7	34,527	0.66	8,008
Croatia	31	4	58,719	7.0	13,216	0.53	309
Iceland	4	0.3	10,257	13.2	34,685	0.38	34
Japan	1,387	127	3,844,105	10.9	30,162	0.36	18,918
New Zealand	81	4	100,796	19.6	24,521	0.80	469
Norway	53	5	173,550	11.5	37,439	0.31	567
Russian Federation	1,995	143	1,539,906	13.9	10,756	1.30	26,649
Switzerland	57	7	262,658	7.7	35,299	0.22	715
Ukraine	490	47	262,769	10.4	5,598	1.86	6,180
United States of America	7,070	303	12,416,510	23.4	41,014	0.57	86,957
Annex I	17,893	1,192	33,444,837	15.0	28,049	0.53	219,661
EU-27	5,348	489	12,888,277	10.9	26,376	0.41	64,696
Memo item: EU-15	4,419	386	11,488,899	11.4	29,738	0.38	52,239

Source: OECD and CAIT version 6

Table 5. Indicator results

				Percentage reduction target relative to 1990 based on an overall Annex I target of a 32.5%								Target level in per capita terms in 2020			
				Individual indicators				Composite indicators				Individual indicators		Composite indicators	
	GHG emissions (MtCO2e)			Range		Midpoint		Range		Midpoint		Midpoint		Midpoint	
	1990	2005	Per capita (2005)	Base 1990	Base 2005	Base 1990	Base 2005	Base 1990	Base 2005	Base 1990	Base 2005	Base 1990	Base 2005	Base 1990	Base 2005
Australia	412	560	24	33% - 83%	-5% - 60%	47%	23%	48% - 53%	21% - 27%	52%	22%	9	13	8	14
Belarus	138	84	9	-19% - 52%	30% - 75%	-3%	37%	-5% - 14%	39% - 51%	8%	47%	16	9	14	8
Canada	581	733	20	29% - 61%	9% - 40%	49%	23%	42% - 49%	21% - 24%	47%	24%	8	12	8	12
Croatia	32	31	7	-10% - 47%	-6% - 39%	20%	25%	0% - 17%	3% - 17%	7%	10%	6	6	7	7
Iceland	3	4	11	0% - 49%	-13% - 31%	18%	4%	23% - 29%	9% - 13%	28%	13%	8	9	7	8
Japan	1,214	1,387	11	7% - 65%	-7% - 45%	37%	20%	24% - 34%	9% - 18%	31%	15%	6	8	7	8
New Zealand	61	81	17	6% - 56%	-4% - 39%	30%	17%	27% - 38%	14% - 23%	33%	19%	6	8	6	7
Norway	48	53	10	6% - 56%	7% - 45%	30%	26%	27% - 38%	23% - 31%	33%	27%	6	7	6	7
Russian Federation	2,967	1,995	15	-13% - 70%	26% - 86%	21%	45%	5% - 27%	38% - 54%	20%	49%	17	12	18	11
Switzerland	56	57	7	-7% - 51%	-9% - 39%	33%	27%	21% - 32%	15% - 24%	25%	18%	5	5	5	6
Ukraine	941	490	11	-26% - 107%	37% - 111%	5%	50%	-7% - 31%	47% - 69%	18%	61%	21	11	18	8
United States of America	6,078	7,070	20	23% - 66%	14% - 48%	45%	25%	46% - 58%	29% - 39%	47%	31%	10	13	9	12
EU-27	5,629	5,348	11	9% - 34%	13% - 36%	28%	28%	21% - 24%	24% - 27%	24%	26%	8	8	8	8
Memo item: EU-15	4,330	4,419	11	11% - 42%	8% - 37%	32%	28%	24% - 30%	19% - 24%	28%	23%	7	8	8	8

Source for 2020 population projections: World Population Prospects: The 2008 Revision - United Nations Population Division Medium variant.