assessments and ethical judgements to determine just how risk-averse today's society chooses to be on behalf of future generations. Future climate negotiations could usefully acknowledge and agree to manage certain types of risks in a particular manner, for example taking a precautionary approach, at least until better information is available to support subsequent decisions.

Chapter 5 makes a new proposal on the generic design of the future international climate regime. It is inspired by the notion of converging per capita emissions.

The "Contraction and Convergence" approach is often used as a reference for a simple and principle-based approach for international climate policy. Under this approach, all countries' per capita emissions would converge to the same low level within a few decades. But this approach is rejected by advanced developing countries, because they have to reduce emissions as developed countries with the same per capita emissions, although their historical responsibility is smaller. Furthermore, some developed countries do not accept the concept that some low-emission countries would be granted more emission allowances than they would need and that large resource transfers between the developed and developing countries would occur.

The new approach "Common but Differentiated Convergence" eliminates these two concerns. It is based on the principle that developed countries' per capita emissions converge within several decades to a low level, similar to that under "Contraction and Convergence". Individual developing countries also converge to the same level within the same time period but starting when their per capita emissions are a certain percentage above the time-dependent global average. Their participation is therefore conditional to developed country action. Until their participation, they may voluntarily take on "positively binding" or "no lose" targets.

We have shown that with the "Common but Differentiated Convergence" approach stabilization of CO_2 concentration at 450 ppmv in 2100 and 550 ppmv in 2150 can be reached with participation at roughly 0% and 50% above global average and convergence to around 3 and 4.5 $tCO_2eq./cap$ within 40 years.

It seems likely that the global community will adopt a climate regime in step-by-step decisions; the rules will not be fixed for the next century. Even if the "Common but Differentiated Convergence" approach is not implemented in its entirety, these future step-by-step decisions can be guided by the principles provided in the "Common but Differentiated Convergence" approach: that developed countries' per capita emissions converge and that developing countries do the same but delayed and conditional to developed country action.

Chapter 6 provides a quantitative comparison of several approaches for international climate policy after 2012. In the international negotiations it is very important for the countries involved to know the implications of several proposals and the amount of emissions that would be allowed to emit. Hence, we presented greenhouse gas emission allowances on a country level for 2020 and 2050 consistent with the stabilization of CO_2 concentration at 550 ppmv, 450 ppmv and 400 ppmv. Countries' future reference emissions are derived using the growth rates of the regional estimates. We considered four approaches for international climate regimes after 2012: Contraction and Convergence, Common but Differentiated Convergence, Multistage (participation in several stages) and Triptych (national emission targets based on sectoral considerations for all countries). From the analysis we draw the following conclusions:

To keep 450 ppmv CO_2 concentration within reach, developed country emissions would need to be reduced substantially. This applies to all studied approaches. For the exemplary global emission levels leading to stabilization and for the parameters of the approaches chosen here, Annex I countries (developed countries) would need to reduce emissions around -10% to -30% below 1990 levels in 2020 to aim at stabilization of CO_2 concentration at 450 ppmv. For 550 ppmv CO_2 it would be around -5% to -25%, and for 400 ppmv CO_2 around -25% to -50%.

To keep 450 ppmv CO_2 concentration within reach, the USA needs to be involved in the system most likely with stronger action than its national target of 18% improvement in emission intensity (greenhouse gas emissions per Gross Domestic Product) from 2002 to 2012. As this target can lead to absolute emissions of the USA over 20% above 1990 levels in 2010, the ambitious reduction levels given above for the group of Annex I countries may be out of reach. For 550 ppmv, the US national target may be sufficient, if other Annex I countries would undertake more ambitious reductions.

To keep 450 ppmv CO_2 concentration within reach, developing country emissions need to deviate from the reference as soon as possible, for some countries even as of 2020 (Latin America, Middle East, East Asia). For 550 ppmv CO_2 it would be less, for 400 ppmv CO_2 more countries. Actions from Annex I countries, such as technology transfer or financial contributions would be needed to keep emissions in Non-Annex I countries below their reference.

The parameters of the approaches are stretched to their limits for the low stabilization levels. The parameters are relatively relaxed for the global emission level leading to a stable CO_2 concentration at 550 ppmv: participation of Non-Annex I countries at Annex I average per capita emissions in the Multistage approach, 45% renewables and emission-free fossil fuels in the electricity sector and industrial energy efficiency improvement 30% beyond today's best available technology by 2050 for the Triptych approach or participation in CDC at 30% above world average per capita emissions. But for the global emission level leading to a stable CO_2 concentration at 400 ppmv, parameters are very strict: almost immediate participation of many Non-Annex I countries in the Multistage approach and emission reductions of more than 5% per year in the last stage, 85% renewables and emission-free fossil fuels in the electricity sector and industrial energy efficiency improvement 70% beyond today's best available technology by 2050 for the Triptych approach or participation in CDC at 45% below world average per capita emissions.

This analysis provides the emission allowances under various approaches for individual countries calculated in a globally consistent framework. We find that differences between countries in one region can be large but differences between approaches for one country are smaller. For example, the UK under the 450 ppmv case has to reduce around 25% to 30% below 1990 levels in 2020 for all approaches, Germany in the range of 30% to 35% and France of 10% to 20%. The starting point in 2010, the Kyoto target, makes a significant difference.

For those countries that participate under all approaches, i.e. Annex I countries and the rest of the Eastern Europe and the Middle East, the difference in reductions between stabilization targets (400, 450 and 550 ppmv) is larger than the difference between the various approaches aiming at the same stabilization target. For these countries, the choice of the long-term ambition level is more significant than the choice of the approach.

Some countries of the EU announced national long-term emission targets that are ambitious, but differ in which stabilization levels could be reached. The national target of the UK aiming at 60% below the 1990 level in 2050 is consistent with our findings for 550 ppmv CO_2. The

target of 40% below the 1990 level in 2020 of Germany is consistent with our findings for 450 ppmv or below, if followed by further reductions. The reduction for France by a factor of 4 to 5 by 2050 is consistent with our findings for 450 ppmv CO_2 or below.

We find that only for developing countries that participate under some and do not participate under other approaches, the differences between approaches are large. For those countries the criteria for participation are an important determinant. The differences in time of participation can be several decades for individual countries within one region, e.g. between Malaysia and the Philippines.

Chapter 7 takes a broad view of the problem and provides a systematic qualitative assessment of options for the evolution of commitments under the UNFCCC after 2012. It describes six scenarios of the future development of the regime covering a large range of ideas. It then assesses the scenarios against a broad set of evaluation criteria (see Table 1).

Comparing the different approaches across the different criteria is a subjective task, which depends on the judgement, whether an approach meets the criterion, and on the selection of, and the weight given to, the individual criteria. Table 1 provides an attempt for a summary of the comparison.

Table 1. Indicative assessment matrix for the qualitative comparison of the scenarios

Criterion \ Scenario for a future regime	Continuing Original Kyoto	Multistage	Intensity targets	Contraction and convergence	Global Triptych	Technology approach
Environmental criteria						
Environmental effectiveness	+	+	+	++	++	0
Encouragement of early action by Parties that do not yet have binding commitments	0	+	0	++	0	0
Economic criteria						
Accounting for structural differences between countries	0	+	-	--	++	++
Economic efficiency	0	+	+	+	+	+/-
Technical criteria						
Compatibility with UNFCCC and Kyoto Protocol	++	+	0	+	+	-
Moderate political and technical requirements for the negotiations and implementation	+	0	-	++	-	0
Political criteria						
Equity principles	+	++	0	0	+	0
Agreement with fundamental positions of major constituencies	-	+	0	-	+	0

Note: Relative valuation, not absolute
'--': Criterion completely not met
'-': Criterion mainly not met
'0': Neutral
'+': Criterion mainly met
'++': Criterion completely met
'+/-': Uncertain