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WORKING GROUP III CONTRIBUTION TO THE IPCC FIFTH ASSESSMENT REPORT (AR5)

Background information

(Submitted by the Co-Chairs of Working Group III)

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MITIGATION OF CLIMATE CHANGE

BACKGROUND

to the

PROPOSED OUTLINE FOR THE WG III CONTRIBUTION TO THE AR5

1. Background & Introduction

The proposed outline for the WG III contribution to the AR5 was prepared during the five day Scoping Meeting in Venice, Italy (13-17 July, 2009). Government comments were received and were then incorporated during the 40th session of the Bureau (17-18 September, 2009). This cover note describes the rationale behind the outline and provides additional information as put forward by the experts that participated in the Scoping Meeting, the government comments received and the subsequent Bureau discussions.

In the Fourth Assessment Report (AR4), the core of the description of mitigation options was structured according to the emitting sectors in the short and medium terms. Framing issues accompanied the introduction to the report, and the final section gave an analysis of the literature on international cooperation.

2. WG III AR5 Outline

2.1 Outline Overview

To build on the success of the AR4 and incorporate crucial dynamics across sectors, thereby improving the usefulness of the report to decision makers, the proposed outline for the WG III contribution to the AR5 is comprised of four parts:

Part I: Introduction (Chapter 1)

Part II: Framing Issues (Chapters 2-5)

Part III: Pathways for Mitigating Climate Change (Chapters 6-13)

Part IV: Assessment of Policies, Institutions and Finance (Chapters 14-17)

Following the introduction, Part II deals with several framing issues that lay out methodological foundations and underlying concepts for the detailed assessment of bottom-up and top-down approaches in the subsequent sectoral and cross-sectoral chapters of Part III. Part IV assesses policies on various scales and financing issues.

In comparison with previous assessment reports, there is a need to improve the treatment of the conceptual issues covered in Part II. This is particularly true for sustainable development (Chapter 2), equity and ethics (Chapter 3), risk and uncertainty (Chapter 4), and partially also for economic concepts (Chapter 5). Taken together, the literature on these issues is too extensive to be covered on an ad-hoc basis within the chapters of Parts III and IV. Therefore, these chapters are presented as framing issues in a dedicated section (as short and concise chapters) that clarify important concepts ahead of Part III, and the overall length of the report is thereby reduced, in addition it will facilitate readability of the entire report. These framing chapters form an indispensable part of WG III's contribution. It is important that the chapters of Part II will be written at an early stage, in order to provide insights to the chapters in Parts III and IV.

Part III will provide an integrated assessment of sectors (from a bottom-up perspective) and transformation pathways (from a top-down perspective). The final chapter of Part III (Chapter 13: Assessing Transformation Pathways) will provide a fully integrated, dynamic analysis: A top-down assessment with input from the bottom-up sectoral chapters and from Chapter 12 (Human Settlements, Infrastructure and Spatial Planning). The Memorandum of Understanding produced as a result of WG III's 'IPCC Expert Meeting on Modeling Renewable Energies: Coherence Between Model Assumptions and Latest Technological Knowledge', that was held within the writing process of the Special Report on Renewable Energy Sources and Climate Change Mitigation, describes a

roadmap for integrating bottom-up and top-down perspectives that will be an integral part of the AR5 process.

Part IV assesses policies across all scales. Beginning with international cooperation, it will proceed to the regional, national and sub-national levels. *Part IV* concludes with a chapter that assesses investment and financing issues.

2.2 General Issues Addressed in the WG III Outline

In close cooperation with WG II, *links with adaptation* will be examined in an integrated assessment. As different stabilization levels imply different adaptation needs and since feasible paths are determined by mitigative and adaptive capacities alike, mitigation and adaptation are interdependent. Furthermore, both mitigation and adaptation have financial implications, which will be addressed in Chapter 17 (Investment and Finance).

Regional differences and commonalities will be addressed throughout the contribution of WG III where relevant. In cooperation with WG II and where possible based on available literature, definitions of geographical regions will be combined with additional information, e.g. socio-economic regions, in order to enhance regional information.

The insights from the *Special Report on Renewable Energy Sources and Climate Change Mitigation* (SRREN) will be housed in various parts of the WG III contribution: Renewable energy technologies will be covered in Chapter 7 (Energy Systems), bioenergy-issues will be covered in Chapter 11 (Agriculture, Forestry and Other Land Use), scenarios will be assessed in Chapter 13 (Assessing Transformation Pathways) and related policies will be covered in the policy chapters of Part IV.

In the following, the four parts of the AR5 are presented in more detail with a presentation of chapter-by-chapter content specifics. It should be read in reference with the WG III AR5 Table of Contents.

2.3 Chapter Specifics of the WG III Outline

2.3.1 Part I: Introduction (Chapter 1)

Chapter 1 will provide an introduction to the WG III contribution and set the stage for the subsequent chapters. It will describe the lessons learned from the AR4 and the new challenges the AR5 is facing. The chapter will also give a brief overview of historical, current and future GHG emission trends. The mitigation challenges give an overview of the issues involved in climate change response policies including the ultimate objective of the UNFCCC (Article 2) and the human dimensions of climate change (including sustainable development). Furthermore, stabilization scenarios, including mitigation and adaptation, and low GHG development pathways including system interactions (lock-in, inertia, barriers, risks) will be introduced as well as the implications of long-term perspectives on short-term actions. Mitigation actions will be covered on a global, regional, national and sub-national scale including technology cooperation, transfer and development as well as public and private investments & financing. Finally, a roadmap will outline the structure of the report.

2.3.2 Part II: Framing Issues (Chapters 2-5)

As mentioned above, Part II will lay out the methodological foundations and underlying concepts for the detailed assessment of the bottom-up and top-down approaches in the subsequent sectoral and cross-sectoral chapters of Part III. Each chapter will address key overarching issues (Chapter 2: Sustainable Development; Chapter 3: Ethics and Equity; Chapter 4: Integrated Risk and Uncertainty Assessments; and Chapter 5: Economic Analyses) by way of a thorough assessment of the literature and will provide support for subsequent chapters, which will then be able to refer to in depth discussions of these general issues. In other words, these framing chapters are to be short and concise. They will explore general themes, providing insights that are to be used to answer specific questions addressed individually by chapter.

Chapter 2: Sustainable Development – Common and Specific Regional Aspects

Chapter 2 will lay out determinants and drivers of as well as barriers to sustainable development with regard to climate change. Different development patterns will be analyzed by using suitable indicators. An integral aspect of the chapter will be to point out common as well as specific aspects of different regions and their respective development stages wherever appropriate. The focus of the chapter will be on mitigation and mitigative capacity with respect to sustainable development. That is, development objectives at the national and sub-national level will be analyzed with respect to synergies and tradeoffs between development and mitigation policies. In cooperation with WG II, links to adaptation and adaptive capacity will be considered because of the interrelatedness of the issues. Integrating these two, different possible development pathways will be laid out in the face of possible synergies and tradeoffs between development objectives and climate policy. The chapter will conclude with implications of these results for the following chapters.

Chapter 3: Ethics, Equity and Climate Policy

Chapter 3 will explore the interrelations between ethics, equity and climate policy based on peer-reviewed literature. This chapter is not intended to derive ethical recommendations, but rather to assess the literature on the ethics of climate change, of which there is a significant collection. Within this context, it is important to distinguish between the terms 'Ethics and Equity' and 'Morality'. In the literature these terms are distinctly different: Morality is a prescriptive term whereas ethics and equity are not. Therefore, the analysis of different ethical and equity concepts does not prescribe any particular notion of morality. Furthermore, ethics and equity are distinct from the issues of political feasibility and barriers, which will be dealt with in the policy chapters of Part IV. Similarly, sustainable development is a distinct concept, to which Chapter 2 (Sustainable Development – Common and Specific Regional Aspects) is devoted. Furthermore, responsibilities for particular impacts of climate change (e.g. sea level rise or ocean acidification) will not be discussed in this conceptual chapter either.

In the beginning of this chapter, various concepts of ethical reasoning will be introduced, including consequentialism (i.e. utilitarianism as a broad theory), welfare economics, social choice and ethics. Furthermore, rights-based theories, human rights, climate and other environmental rights and virtue ethics will be included. The next section will focus on economics, rights and duties, i.e. on the linkages between economic theories and different types of ethical reasoning. This will include theories of economics and income distribution, non-monetary values rights and duties as well as the interrelations of risks, uncertainty and rights. Furthermore, the literature on discounting versus the rights of future generations as well as on tradeoffs and weighing goods will be assessed, followed by the literature on the concepts of justice and responsibility and their application to climate change. This will include concepts of intra-, inter- and transgenerational as well as compensatory and transitory justice. Furthermore, the interrelations between consumption patterns and climate change and the quality of living with respect to emissions will be analyzed. The chapter will conclude with implications for subsequent chapters.

Chapter 4: Integrated Risk and Uncertainty Assessment of Climate Change Response Policies

Chapter 4 is on the integrated risk and uncertainty assessment of climate change response policies. Although this issue is a cross-cutting method across working groups (see section 3.1), the basic concept should be laid out in the respective WG contributions as a stand-alone reference, in large part to clarify those aspects that are specific to individual WGs. Therefore, risk and uncertainty has been dedicated its own chapter in the WG III outline, and consistency with WG I and WG II will be inherent to its text.

The chapter will begin with a section on risk perception including psychological and sociological approaches. That is, it will deal with attitudes towards risk, risk communication, ignorance and societal institutions which manage risk. The next section will put the issue of risk and uncertainty into the context of climate change by explaining the scale and nature of the problem including the nature of probability distributions (e.g., thin vs. fat-tailed) and time scales of learning and response. Then, different types of uncertainty and risk will be categorized, and various measures of uncertainty, risk, and the reduction of uncertainty due to learning will be introduced. The relationship to the uncertainty categorizations used in AR4 and throughout AR5 will be established. This will be

followed by a discussion on managing uncertainty, risk and learning in a policy context, including decision frameworks for the evaluation of policies under uncertainty and an introduction to the principles of insurance and derivative markets including hedging strategies and option values. The section on tools for the analysis of uncertainty and risk will include sensitivity and scenario analyses, expert elicitations and sampling strategies. All concepts, measures, frameworks and tools will be assessed in the context of the scale and nature of climate change and the resulting implications for response policies. The concluding section will lay out the implications for the subsequent chapters.

Chapter 5: Economic Analyses of Climate Policy

Chapter 5 will deal with the economic analysis of climate policy. Due to the interlinkages between adaptation and mitigation, synergies and tradeoffs need to be identified (in cooperation with WG II) to enable an integrated assessment.

The first section of the chapter will assess different metrics and concepts of costs and benefits including gross domestic product (GDP), balanced growth equivalent, willingness to pay, willingness to accept, different measures of welfare as well as engineering cost vs. economic cost, social cost of carbon, avoided costs, employment, US dollars per ton. Furthermore, the implications of alternative metrics (global warming potential and other) for the timing of multi-gas abatement options (in cooperation with WG I) and related implications for adaptation (in cooperation with WG II) will be assessed. The various methods of policy choice will be assessed, including: cost-benefit analysis (CBA), cost-effective analysis, other methods of evaluation (e.g. multi-criteria analysis, weighted CBA), treatment of equity, international comparisons of costs and benefits, treatment of discounting, incidence (households and firms), game theory and supra-national agreements, shadow prices and market prices as well as critique of the economic paradigm, distortions and second-best solutions, and non-price models of consumer behavior. Then, the economic analysis will be broadened to an assessment of the literature on behavioral economics, which will also include relevant aspects of psychological and sociological approaches. These approaches, however, will be treated primarily under 'Risk Perception' in Chapter 4 (Integrated Risk and Uncertainty Assessment of Climate Change Response Policies).

The section on regulation will assess the literature on economic instruments to address climate change. It will include the identification of market failures, complementary policies, policy failures, the general principle of insurance markets, mixed economies and the public sector as well as commonalities and differences between developed and developing economies. This chapter will deal with the general principles of insurance in the literature, whereas its specific applications and implications will be found in Chapter 17 (Investment and Finance) where applicable. Since the focus will be on principles and mechanisms from an economic perspective, the assessment will be distinct from the assessment of policy instruments in Chapter 16 (National and Sub-national Policies). The next section will be on the economic analysis of technological change and related uncertainties including learning by doing, the process of technological and technical change including the process of research, development and demonstration (from basic science onward), economic incentives for R&D, price-induced technical change, spillovers as well as the transformational dimensions of technical change and the diffusion of technology and transitions theory. The section will also assess the conceptual differences and the differing representations in models of induced endogenous vis-à-vis exogenous technological change, as this has significant implications on forecasted cost and possible transition pathways.

Political feasibility considerations and non-economic policy options will be assessed in Chapter 16 (National and Sub-national Policies). As a framing chapter, Chapter 5 will assess economic methodologies and will therefore be distinct from the issue of systems perspective (treated in Chapter 6: Mitigation Options and Pathways in Context) and the integrated analysis of combining top-down and bottom-up approaches (treated in Chapter 13: Assessing Transformation Pathways).

2.3.3 Part III: Pathways for Mitigating Climate Change (Chapters 6-13)

As mentioned above, Part III will provide an integrated assessment of sectors (from a bottom-up perspective) and transformation pathways (from a top-down perspective). Chapter 6 (Mitigation Options and Pathways in Context) will provide the background and context for the subsequent

sectoral chapters (Chapters 7-11) and Chapter 12 (Human Settlements, Infrastructure and Spatial Planning), which will represent the bottom-up approach. The final chapter of Part III (Chapter 13: Assessing Transformation Pathways) will lay out various transformation pathways in order to provide a fully integrated, dynamic analysis: A top-down assessment with input from the bottom-up sectoral chapters and Chapter 12 (Human Settlements, Infrastructure and Spatial Planning).

In order to assure consistency in assumptions on mitigation potentials, there will be an iterative process between Chapter 6, Chapters 7 through 12 and Chapter 13, in which relevant information will be exchanged, assessed and fed back for incorporation, see Figure 1. Ideally, data on sectors and technologies would be transferred to the integrated assessment modeling (IAM) community, who would then incorporate this information into their models, reflecting the dynamics across sectors. These results would be returned to the sector and technology specialists for assessment in an iterative process.

This will clarify differences across chapters and will ideally lead to convergence, ensuring strong interaction among Chapter 6, the sectoral chapters, Chapters 12 and 13. In practice, this will allow Chapter 13 to utilize precise sectoral numbers and Chapters 7 through 12 to take the context of transformation scenarios, e.g. the dynamics of sectors, into account in an assessment of the scenario outcomes. This iterative process will be an added value of the AR5 from AR4. As initiated in WG III's 'IPCC Expert Meeting on Modeling Renewable Energies: Coherence Between Model Assumptions and Latest Technological Knowledge', this iterative process could take the form of back-to-back meetings with AR5 lead author meetings.

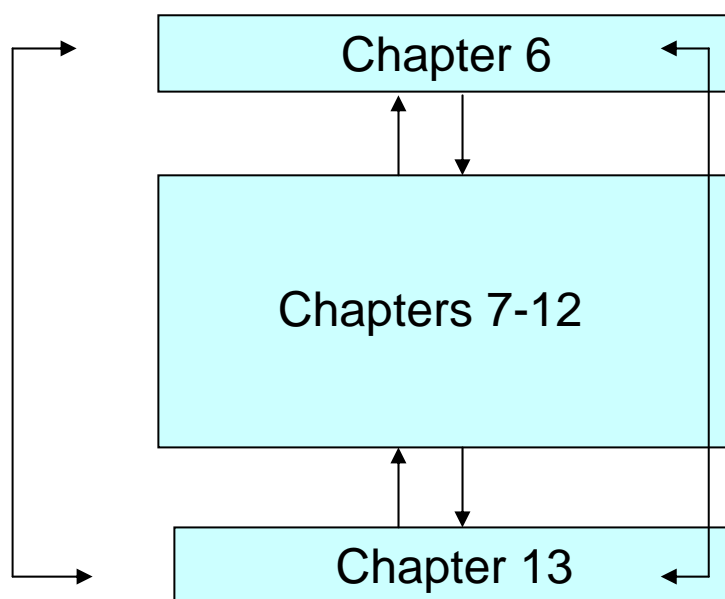


Figure 1: Information exchange within the iterative process of AR5.

The time horizon of analysis is 2020 for the short term, 2030 for the medium term and 2050 and beyond for the long term. The main focus of Part III is to be on mitigation, but (in strong cooperation with WG II) it will also address linkages to adaptation.

Chapter 6: Mitigation Options and Pathways in Context

This chapter is intended to provide the context for the subsequent sectoral chapters (7: Energy systems; 8: Transport; 9: Buildings; 10: Industry; and 11: Agriculture, Forestry and Other Land Use) and Chapter 12 Human Settlements, Infrastructure and Spatial Planning.

It will begin with a discussion of global trends in stocks and flows of greenhouse gases (GHGs) and short-lived species, in close cooperation with WG I and WG II. This will include black carbon, new GHGs and other short-lived pollutants. The role of coastal zones and marine ecosystems as carbon sinks will also be covered. The different metrics of global warming potentials (GWP) and their effect on costs and implications for mitigation will also be assessed. Then, impacts of life style choices on

stocks and flows (mobility patterns, diets, energy and other consumption) as well as emissions from international bunker fuels will be covered in a discussion of consumption patterns across countries. An examination of human settlements and infrastructure will follow, covering urban development patterns and links to stocks and flows of GHGs and short-lived species as well as the effect of infrastructure choices. The next section assesses the issues of co-benefits and co-costs, which will include a discussion of the links between climate mitigation activities and other environmental objectives such as reduction in local air pollution, benefits to human health and energy security. Health delivery systems will also be covered here. Additionally, a discussion of trends and technologies will include science and engineering frontiers, research and development efforts and any relevant technology discussions not covered in the sectoral chapters (Chapters 7-11) or Chapter 12 (Human Settlements, Infrastructure and Spatial Planning).

Geoengineering is discussed here under the title 'Carbon and radiation management and other geoengineering options'. Because it is one option in the portfolio of mitigation options, it has been included as a component of one chapter - rather than its own chapter. This will ensure that it is included in an even balance across technologies, e.g. in cost comparisons and other relevant analyses. This portion of the chapter will cover, inter alia, CO₂ capture from ambient air, ocean carbon management and enhanced weathering, stratospheric sulfates, space borne reflectors and cloud seeding and will be coordinated with WG I.

Chapters 7-11 (Sectors)

The sectoral chapters are all to be similarly structured to ensure coherence across them, with variation where there are sectoral specificities. They will begin with new developments in emission trends and drivers and move through discussions of mitigation technologies and practices, infrastructure and systemic perspectives, climate change feedback and interaction with adaptation, technological, environmental and other risks and uncertainties, social acceptability, co-benefits, co-costs and spillover effects (including air pollution, black carbon and health, and energy security), barriers and opportunities (technical, financial, institutional, cultural and legal), sustainable development aspects (including impacts on poverty and gender, as well as the water/energy nexus), costs and potentials (static and dynamic as well as short- and mid-term) and conclude with gaps in knowledge. Chapter 11 (Agriculture, forestry and other land use) will deviate from this template because of the unique characteristics of the sector – all variances are listed in its chapter description below. All sections will consider regional specificities as appropriate to developed and developing countries and economies in transition.

Chapter 7, Energy Systems, will focus on energy production, conversion, transmission and distribution and will include, where relevant, insights on renewable energies from the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN). There will be a description of mitigation technologies and practices, including all electricity and heat generation technologies, CHP, CCS (including storage capacity in geological formations and other reservoirs), liquid and solid fuels, storage, transmission and distribution technologies including smart grids, demand side management and hydrogen routes to decarbonization. Technology maturity, diffusion and deployment rates, short- and long-term dynamics in mitigation options, and synergies/tradeoffs/interactions with adaptation and other mitigation options will also be considered here. The section on infrastructure and systemic perspectives will cover system integration, intermittency and life-cycle emission assessments of bioenergy. Unlike other sectoral chapters, there will also be a thorough discussion of resources and resource depletion, covering both conventional and unconventional resources.

Chapter 8, Transport, will cover both freight and passenger transport on land and sea and in air. Its descriptions of mitigation technologies and practices will be similar to Chapter 7 (Energy Systems) and will also specifically include lifestyle, culture, efficiency, transport technologies, modal split and fuel substitution. Its discussions of infrastructure and systemic perspectives will include partially or fully electrically powered vehicles used for electricity storage and multi-gas tradeoffs in product life cycles.

Chapter 9: Buildings, will cover commercial, residential and public buildings. Its descriptions of mitigation technologies and practices will be similar to preceding sectoral chapters, and will also specifically include lifestyle, culture, efficiency, low energy architecture, energy efficient appliances as well as energy efficient, zero energy and energy plus buildings and building components, building integrated measures such as renewables, heat pumps, micro polygeneration and other socio-technical measures. Infrastructure and systemic perspectives will incorporate literature on community heating and cooling.

Chapter 10: Industry, will have a section on material reuse and waste, unlike the other sectoral chapters, that will address mitigation potential in terms of e.g. improved recycling of materials. Its descriptions of mitigation technologies and practices will again be similar to the other sectoral chapters and will specifically include efficiency improvements in heavy and light industry, CCS, cradle-to-cradle approaches, multi-gas tradeoffs, and household and industrial waste. Its 'Infrastructure and Systemic Perspectives' section will discuss embodied emissions and life cycle assessments.

Chapter 11: Agriculture, Forestry and Other Land Use, will reflect the structure of the other sectoral chapters with some deviations due to the nature of the sector. It will include a section titled 'Challenge: Need for an Integrated View of Land-Use Sector Mitigation' that will discuss biofuel production, will include bottom-up and regional assessments, sustainable development implications, and will give a framework for analysis in terms of forests, agriculture and rangelands. Also unique to Chapter 11 will be a discussion on mitigation effectiveness that will include short- and long-term perspectives, non-permanence, leakage and saturation and the impacts of air pollution on mitigation effectiveness. The chapter will also cover competition of energy, food, livelihood, infrastructure and other land uses in addition to the standard sectoral chapter structure.

Further deviations in Chapter 11 from the structure of other sectoral chapters include the title of section 'Emission Trends and Drivers, Agricultural Productivity Patterns' that covers agriculture, forests, rangelands, deforestation, land degradation, food production, infrastructure, timber needs, diet, and energy production. In addition, the section on systemic perspectives will be comprised of an integrated land use assessment as well as multi-gas considerations including displacement and life-cycle assessment. Finally, climate change feedback and natural disturbance will be assessed in close coordination with WG I. Assessments of interactions with adaptation have been moved to its own topic 'Synergies/Tradeoffs/Interactions with Adaptation and Other Mitigation Options'. The titles differ from other sectoral chapters to better reflect the sector-specific substance contained in the chapter.

The remainder of the sections in Chapter 11 will mirror the structure of the other sectoral chapters. The section 'Mitigation Technologies and Practices in Forestry, Agriculture, Other land uses' covers afforestation, the reduction of deforestation and forest degradation rates. This includes deployment rates, saturation, soil carbon management (including biochar), diets, livestock and livestock agriculture in connection with mitigation options, cross-sectoral mitigation, biofuels, sinks turning into sources of CO₂ at higher temperatures, water and phosphorus as constraints, afforestation, reforestation and deforestation (ARD) and albedo effects, effects on biodiversity and other options. Finally, 'Sustainable Development Aspects' will cover additional topics of impacts on poverty, employment, land ownership and food.

Where relevant, insights on bioenergy from the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) will be included.

Chapter 12: Human Settlements, Infrastructure and Spatial Planning

This chapter will be an integrative summary of all sectoral chapters, and will include insights from the joint WG III/WG II Expert Meeting 'Human Settlements and Infrastructure – Mitigation and Adaptation Strategies'. Chapter 12 will also contain an assessment of the mitigation potential of all aspects of waste, excluding industrial waste which is found in Chapter 10 (Industry) and will focus on e.g. methane from landfills and incineration. Urban and rural development and climate discussions will include planning and local regulations, buildings, transport and waste.

Chapter 13: Assessing Transformation Pathways

Chapter 13 will assess transformation pathways in a fully integrated and dynamic analysis by integrating the bottom-up and sectoral information of the previous chapters with the top-down approaches of scenarios. The scenarios assessed here are the backbone of consistency between the three working groups.

The chapter will begin with a discussion of the tools of integrated analysis, including integrated assessment models, bottom-up approaches and qualitative assessment tools. Integrated assessment models may consist of a number of model types and may include a number of components such as energy systems, macro-economics, computational general equilibrium models (CGEs), land-use & agriculture, carbon cycle, atmospheric chemistry, climate. Links to one or both of the other working groups will be possible for the topics of: Land-use & agriculture (WG I & II), carbon cycle (WG I), atmospheric chemistry (WG I) and climate (WG I). Possible inputs and outputs of the integrated assessment models include drivers (e.g. demographics, economics, infrastructure choices), policies & institutions, decision making rules and technology assumptions.

In addition, a number of climate stabilization concepts will be assessed. As a basis, four representative concentration paths (RCPs) will define emission profiles with peak emission dates. These will include: Not-to-exceed and overshoot pathways, defining individual GHG concentrations, aerosols and Montreal gases. RCPs are strong tools to reach consistency between WG I, II and III¹. The assessment of stabilization targets will also cover co-benefits such as reduced ocean acidification, reduced air pollution and other goals. Fully closed scenarios will consistently cover emission reduction, climate change impacts, adaptation and socio-economic implications and assumptions of baseline scenarios. Different sets of policies will be considered: A 1st best set of policies without externalities will be examined as the benchmark, a 2nd best set of policies will take a number of other factors into account (timing, delayed participation, limited availability of mitigation options, fragmented markets and market power, etc.). Results will be derived from cost benefit and cost effectiveness analyses. The macro-economic cost analysis will consider the cost of stabilization scenarios and the impacts of mitigation strategies on GDP and other macroeconomic parameters.

In order to make the assessment as comprehensive as possible, long- and short-term perspectives will be integrated to include the implications of long-term transformation paths for short-term measures as well as the implications of lock-in effects from short-term measures for the long-term. The integration of technological and societal change will cover social acceptability, social impacts and benefit of transformation. The issue of sustainable development and transformation pathways (incorporating differences across regions) will be considered. This will examine co-benefits and externalities, such as air pollution, as well as environmental, economic and social side effects. It will also address undiversified economies (small and large), including case studies. The risks of transformation pathways will be explored by looking at the tails of extreme scenarios and comparing them with the risk from unabated climate change.

Subsequently, Chapter 13 will integrate sectoral analyses and transformation scenarios by synthesizing sector specific costs with macroeconomic costs and by integrating the timing of sectors and the overarching macro-economy. Sectors will thereby be integrated into the framework: reconciling bottom-up and top-down approaches. As mentioned above, the Memorandum of Understanding produced as a result of WG III's 'IPCC Expert Meeting on Modeling Renewable Energies: Coherence Between Model Assumptions and Latest Technological Knowledge' describes a roadmap for integrating bottom-up and top-down perspectives that will be an integral part of the AR5 process. This will be an added value compared to AR4 and will allow reports on scenarios at a macro scale but also in technological and sectoral resolution. Different methods for bridging scales will be examined, such as hybrid models, soft coupling, dynamic cost curves and agent based models. Sub-regional constraints might constrict global transformations, e.g. by infrastructure effects, capital constraints, market distortions, and other barriers of implementation (e.g. institutional, informational, and technological barriers).

¹ In order to increase consistency among WG III and II concerning socio-economic scenarios underlying the RCPs a joint IPCC Expert Meeting, to be held in 2010, will be proposed to the 31st plenary session.

2.3.4 Part IV: Assessment of Policies, Institutions and Finance (Chapters 14-17)

Part IV will assess policies on all scales. Insights from the Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) regarding policies and finance will be included where appropriate.

Chapter: 14 International Cooperation: Agreements & Instruments

Chapter 14 will begin with a consideration of the relevant framing issues for assessing potential principles of international cooperation. This will include the global public goods problem, intra- and intergenerational equity, cost-effectiveness and implications for sustainable development. The 'Principles for International Cooperation' will represent certain analytical criteria, which are to be policy relevant, not policy prescriptive.

In the chapter, examples of international agreements will be analysed and lessons for climate policy will be derived. From international relations and political science literature, assessments on compliance, participation, information collection and dissemination, etc. can be made. Such an evaluation of previous and existing policies might provide insight into the mechanisms by which cooperation and policy harmonization can influence the outcome and efficiency of the transition to a low-carbon economy. Further, market-based policies and other initiatives are to be assessed and a literature review on international emission trading schemes is to be undertaken. The Kyoto and post-2012 climate treaty mechanisms will be assessed. Multilateral and bilateral agreements across different scales will be considered (international: UNFCCC, MEF, G20, G8, etc.; regional: OECD, ASEAN, NAFTA, COMESA, SADC, APP, CARICOM, MERCOSUR, ALADI, etc.).

For climate policy architectures, a taxonomy of generic elements will be defined considering goals and targets, participation and burden sharing. Alternative approaches to international climate policy architectures will be considered by analyzing and evaluating existing literature that discusses experiences with centralized policies, harmonized domestic policies, decentralized and coordinated national policies and multilateral environmental agreements. Furthermore, possible mechanisms for technology transfer will be assessed.

Successful climate policy relies on the incorporation of a number of key design elements. These elements will be assessed in this chapter, inter alia registries and accounting, measurement, reporting, and verification (MRV) protocols, metrics for evaluating policy commitments and performance, trade and competitiveness, financial flows, technology transfer, voluntary agreements of private sector, NGOs and others, verification, compliance and enforcement, institutional requirements for geoengineering and its associated risks and possible implementation, and finally the institutional changes needed in their support.

Also, the chapter will point out possible linkages between international and national policies by looking at competitiveness effects, hybrid instruments and other. Since any climate policy has to be considered in a global political and economic context, the effect of international trade agreements and capital markets on climate policy will be assessed by examining WTO-rules, regional trade agreements (RTAs) and others.

Chapter 15: Regional Development and Cooperation

Chapter 15 will assess opportunities of and barriers to regional cooperation, current development patterns and goals, the issues of energy and development, urbanization and development, consumption and development, and will investigate opportunities of and barriers to low carbon development. Also, synergies and conflicts between sustainable development and mitigation policies, e.g. leap-frogging, will be assessed. While Chapter 2 (Sustainable Development – Common and Specific Regional Aspects) will review the literature on sustainable development on a conceptual level incorporating regional information and differences, Chapter 15 is placed within the framework of the policy chapters and will therefore be more focused on analyses of peer-reviewed literature discussing regional policies, covering sustainable development only in the context of real world regional development and cooperation.

Chapter 16: National and Sub-national Policies

Chapter 16 will assess policies on the national and on sub-national levels using a taxonomy of policy instruments and criteria for the evaluation of policy instruments. Then, based on literature assessing common experiences across countries (developed and developing respectively), evidence on policy implementation and performance will be collected and reported.

Within the framework of the taxonomy of policy instruments, the direct and indirect policies to control GHG emissions will be analyzed. Direct policies include emission taxes, tradable permits, GHG intensity standards and voluntary measures. Indirect policies include those aiming to support renewable energy (renewable portfolio standards, renewable fuel standards, feed-in tariffs, production tax credits) and energy efficiency (energy taxes, appliance standards, building codes, subsidies, labelling and information programs, government procurement). Furthermore and importantly, the taxonomy will include investment in technologies, such as RD&D, and will take human and physical capital investments into account. For each policy instrument the performance with regard to the chosen criteria will be discussed including economic efficiency, certainty of environmental outcomes, etc.

The following criteria will be used in the evaluation of policy instruments: Environmental effectiveness, cost-effectiveness, implications for economic development, distributional incidence, implications for trade and competitiveness, implications for investment in technological innovation and deployment, impact of market structure on regulation, technological innovation and diffusion, political feasibility and administrative cost. The differences in applicability of policy instruments between developed and developing countries will be discussed.

An assessment of the literature describing experiences with multi-sectoral or economy-wide policies, with sector-level policies, with policies for RD&D and with voluntary policies will provide the basis for the evidence to be presented on policy implementation and performance. It will focus on common experiences across countries, developed and developing countries respectively. Experiences with public-private partnerships will be assessed where relevant.

This policy assessment will take the role of institutions and governance as a framework in developed as well as developing countries into account. The chapter will investigate the links across national, state and local policies as well as the relevant links to adaptation. The analysis of synergies and conflicts among policies, e.g. the co-existence of policies and the dynamics of policy evolution and path dependence will be an integral part of this examination, as will an assessment of options for policy design.

Chapter 17: Investment and Finance

Chapter 17 will deal with the role of investment and finance for mitigation. There are a number of ways to finance low-carbon investments, each of which will be assessed accompanying a thorough literature review. This assessment will include global institutional investors, carbon markets, the financing of technology transfer and of R&D, micro-finance and the issue of finance and deforestation. The financing of mitigation activities in developing countries including technology transfer will also have to be discussed. One focus of the chapter will be on financing infrastructure and institutional arrangements, which will consider long-term investments and financing infrastructure in developed and in developing countries.

Finally, synergies and tradeoffs between financing mitigation and adaptation will be assessed. The discussion of financial aspects (needs and tradeoffs) of adaptation and mitigation is one area in which a comparison is possible. In most other contexts a comparison is more difficult as discussions are on very different scales.

3. Cross-cutting Issues

There are a number of methods and issues that concern more than one working group (WG). These methods and themes require additional coordination efforts in order to achieve a consistent treatment across the WGs and to strengthen the coherence of the AR5. The cross-cutting methods (CCM) and cross-cutting themes (CCT) are laid out in more detail in a dedicated document to the

31st plenary session (IPCC-XXXI/Doc. 4). Their relevance for WG III is described here, including a description of where these methods and themes are housed in the WG III contribution.

3.1 Cross-Cutting Methods (CCM)

Consistent evaluation of Uncertainties and Risks

As risk and uncertainty is one of the framing issues outlined in Part II of the WG III outline, this CCM will be vital to the contribution of WG III. The methodological foundations will be addressed in Chapter 4 (Integrated Risk and Uncertainty Assessment of Climate Change Response Policies) and later applied in the sectoral and cross-sectoral chapters of Part III as well as the policy chapters of Part IV.

Costing and Economic Analysis

Similarly to risk and uncertainty, economic analyses of climate policy is a framing issue in the WG III outline, so this CCM will also constitute an integral part of the WG III contribution. Here, the methodological foundations will be laid out in Chapter 5 (Economic Analyses of Climate Policy) and the application will take place in Chapter 6 (Mitigation Options and Pathways in Context), which contains general discussions of mitigation options, and in the other sectoral and cross sectoral chapters of Part III. The issue of costing and economic analysis will be at the heart of Chapter 13 (Assessing Transformation Pathways), which will integrate the bottom-up information of the preceding chapters with top-down model analyses and will assess the various types of models and associated costs. Finally, Chapter 17 (Investment and Finance) will address matters of finance and investments.

Regional Aspects

Regional aspects will also be an integral part of the WG III contribution and will be addressed wherever appropriate. Common and specific regional aspects will be specifically addressed in Chapter 2 (Sustainable Development – Common and Specific Regional Aspects) and will be considered in all the sectoral and cross-sectoral Chapters 7-13. Finally, Chapter 15 (Regional Development and Cooperation) is explicitly devoted to regional development and cooperation, while Chapter 16 (National and Sub-national Policies) will specifically take regional aspects into account in a more focused discussion of national and sub-national policies.

3.2 Cross-Cutting Themes (CCT)

Water and earth system: changes, impacts and responses

This CCT will be covered in various places in the WG III contribution. Issues of side effects on mitigation technologies (and vice versa) will be covered in Chapter 6: Mitigation Options and Pathways in Context (incl. CCS, Geo-engineering and desalination) and Chapter 12: Human Settlements, Infrastructure and Spatial Planning, the latter of which will cover infrastructure-related issues. Issues related to bio-energy (incl. land use changes) will be covered in Chapter 11 (Agriculture, Forestry and Other Land Use).

Carbon cycle including ocean acidification

This CCT will be part of the assessment of Chapters 6 (Mitigation Options and Pathways in Context) and 13 (Assessing Transformation Pathways) since different mitigation targets are associated with different GHG emission and concentration levels. The latter two have an effect on carbon reservoirs (incl. ocean acidification) and agricultural productivity, influencing the attractiveness of land-use policies as a mitigation option. Furthermore, synergies and tradeoffs between carbon reservoir management on the one hand and bio-energy policies and associated land use changes on the other hand will be assessed in Chapter 11 (Agriculture, Forestry and Other Land Use). Interrelations between carbon pools due to land use changes caused by human settlements, infrastructure policies and spatial planning will be assessed in Chapter 12 (Human Settlements, Infrastructure and Spatial Planning).

Ice sheets and sea-level rise

The issue of sea level rise (SLR) is particularly relevant for densely populated mega-deltas. It will be dealt with in Chapter 12 (Human Settlements, Infrastructure and Spatial Planning), as this has an effect on infrastructure policy and spatial planning.

Mitigation, adaptation and sustainable development

Mitigation comprises the essence of the WG III contribution, and therefore this CCT is present throughout the WG III outline. The links between mitigation, adaptation and sustainable development will be addressed in Chapter 2 (Sustainable Development – Common and Specific Regional Aspects), in the sectoral and cross-sectoral chapters of Part III as well as in the chapters on policy and regional development of Part IV.