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WORKING GROUP III CONTRIBUTION TO THE IPCC SIXTH ASSESSMENT REPORT (AR6)

Background information

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

IPCC Secretariat

c/o WMO • 7bis, Avenue de la Paix • C.P. 2300 • 1211 Geneva 2 • Switzerland
telephone : +41 (0) 22 730 8208 / 54 / 84 • fax : +41 (0) 22 730 8025 / 13 • email : IPCC-Sec@wmo.int • **www.ipcc.ch**

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MITIGATION OF CLIMATE CHANGE

BACKGROUND
to the

PROPOSED OUTLINE FOR THE WG III CONTRIBUTION TO THE AR6

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1. INTRODUCTION

The proposed outline for the WG III contribution to the AR6 was prepared during the five day AR6 Scoping Meeting in Addis Ababa, Ethiopia (1-5 May 2017). This Information Document describes: the call for nominations of experts; the selection of participants; and the WG III Bureau contribution to the Chair's Vision Document that informed the Scoping Meeting. It also explains the rationale behind the outline and provides an annotation of the proposed chapters developed by the WG III Technical Support Unit (TSU) and the proposed timeline leading to the approval of the WG III AR6 Report in July 2021. A set of Annexes cover: the selection process for participant in the Scoping Meeting; a list of WG III participants; the agenda for the WG III Breakout Group; the proposed chapter outline; and themes cutting across Working Groups that were discussed at the Scoping Meeting.

2. CALL FOR NOMINATIONS

A call for nomination for experts to attend the Scoping Meeting was issued to governments, observer organizations and IPCC bureau members on the 3rd October 2016. Governments were requested to submit their nominations via their focal points by the 14th November 2016.

Participants contributing to the scoping of the WG III Report were required to have a broad understanding of climate change and related issues, and collectively to have expertise in the following areas:

- Socio-economic scenarios, modelling and transitions at the global, regional, national and local scales including integrated assessment approaches.
- Energy systems including supply and energy demand sectors (e.g., industry, transport, buildings).
- Mitigation responses in agriculture, forestry, land use and waste.
- Consumption patterns, human behaviour and greenhouse gas emissions, including economic, psychological, sociological and cultural aspects.
- Policies, agreements and instruments at the international, national and subnational levels, including those at the city level.
- Technology innovation, transfer and deployment.
- Financial aspects of response options.

In addition, the following areas of expertise cutting across WGs were identified as relevant:

- Co-benefits, risks and co-costs of mitigation and adaptation, including interactions and trade-offs, technological and financial challenges and options.
- Ethics and equity: climate change, sustainable development, gender, poverty eradication, livelihoods, and food security.
- Perception of risks and benefits of climate change, adaptation and mitigation options, and societal responses, including psychological and sociological aspects.
- Climate engineering, greenhouse gas removal, and associated feedbacks and impacts.
- Regional and sectoral climate information.
- Epistemology and different forms of climate related knowledge and data, including indigenous and practice-based knowledge.

3. PARTICIPANT SELECTION

The process of selecting participants for the AR6 Scoping Meeting was conducted jointly by the WG I, II and III Bureau. The process followed IPCC principles and procedures and was agreed upon by IPCC Bureau Members. Each WG aimed to identify 60 invitees giving a total of 180 participants in all. The TSUs facilitated a process whereby Bureau Members identified suitable invitees, ensuring an appropriate balance based on the following criteria:

- Scientific, technical and socio-economic expertise, including the range of views;
- Geographical representation;
- Mixture of experts with and without previous experience in IPCC;
- Gender balance; and,
- Experts with a background from relevant stakeholder and user groups, including governments.

1259 nominations were received for participation in the AR6 Scoping Meeting. Of these, 599 nominees indicated that they had expertise relevant for WG III. Of the selected participants, 30% were female and 70% were male. 50% of invitees were from developed countries and 50% from developing countries or countries with economies in transition.

The process adopted by WG III was as follows. Following an initial round of voting by Bureau Members, a list of proposed participants was developed by the WG III. The Bureau then revised and added to this initial list. The WG TSUs collaborated in identifying individuals whose expertise cut across WGs. A final list of participants was agreed by WG III Bureau Members on 22nd February 2017.

The selection process and the profile of invited participants are described in more detail in the list of participants, together with the Bureau Members, IPCC Secretariat and WGIII TSU staff and others who participated in the WG III Breakout Group at the Scoping Meeting, is provided in .

4. VISION PAPER AND EXPERT MEETING

The WG III Bureau contributed to the AR6 Scoping Meeting Chairman's Vision Paper. The contribution was drafted initially by the WG III Co-chairs and revised in consultation with the WG III Bureau. The WG III contribution covered: scientific findings and main messages from the WG III AR5 Report and the Special Report on Renewable Energy (SRREN); responses to AR5 and gaps identified in the literature; the proposed framing and overarching aims of the WG III contribution; proposed elements of the WG III AR6 report; links to the work of other WGs and the Task Force on Inventories (TFI); and interfaces with other AR6 Special Reports and activities.

Immediately preceding the Scoping Meeting, WG III convened an Expert Meeting, also in Addis Ababa, on Mitigation, Sustainability and Climate Stabilization Scenarios. This addressed two challenges: a) the need to assess the linkages between high-level climate stabilization goals and scenarios, and the practical steps needed in the short- and medium-term to make the realization of these goals possible; and b) the need to anchor climate responses firmly in the context of development needs. Participation reflected a wide range of scientific skills not restricted to scenario building and modelling, as a key objective was to link these activities to practical action. Attendees included representatives from the UNFCCC, the government and business sectors and, as advised by the Panel, participants from the WG I and II communities. Recommendations from the Expert Meeting were fed into the first plenary session of the Scoping Meeting and into the Working Group III Breakout Group. In addition, a number of individuals participated in both the Expert Meeting and the Scoping Meeting. Consequently, the Expert Meeting had a significant impact on the outcome of the Scoping Meeting and the proposed WG III report outline.

5. SCOPING MEETING

The Scoping Meeting for the Special Report was held in Addis Ababa, Ethiopia, from the 1st to the 5th May 2017. The WG III contribution to AR6 was scoped in a Breakout Group that ran from the afternoon of Day 1 to the morning of Day 5. The agenda for the WG III Breakout Group is provided in

Annex II: Scoping meeting participants

List of scoping meeting participants

Last name	First name	Affiliation	Country
AKIMOTO	Keigo	Research Institute of Innovative Technology for the Earth (RITE)	Japan
ÁLVAREZ BRITO	Arnaldo Fabián	Agro-forest Research Institute	Cuba
AMINATH	Shafia	Ministry of Fisheries and Agriculture	Maldives
BASHMAKOV	Igor	Center for Energy Efficiency (CENEf)	Russian Federation
BATAILLE	Christopher	Institute for Sustainable Development & International Relations (IDDRI)	Canada
BLANCO	Gabriel	Universidad Nacional del Centro (UNICEN)	Argentina
BOSETTI	Valentina	Bocconi University	Italy
BROWN	Marilyn	Georgia Institute of Technology	United States of America
CHAVES CARDOSO DE OLIVEIRA	Rodrigo	Petróleo Brasileiro S.A. - PETROBRAS	Brazil
CHRISTOPHERSEN	Øyvind	Norwegian Environment Agency	Norway
DE CONINCK	Heleen	Radboud University	Netherlands
DE LA VEGA NAVARRO	Angel	UNAM - National Autonomous University of Mexico	Mexico
DE MELO	Jaime	University of Geneva	Switzerland

Last name	First name	Affiliation	Country
DEVINE-WRIGHT	Patrick	University of Exeter	United Kingdom (of Great Britain and Northern Ireland)
DHAKAL	Shobhakar		Thailand
DUBASH	Navroz Kersi	Centre for Policy Research	India
EDMONDS	James	Pacific Northwest National Laboratory	United States of America
ELGIZOULI IDRIS	ISMAIL	Self empolyed	Sudan
EYRE	Nicholas	University of Oxford	United Kingdom (of Great Britain and Northern Ireland)
FACKNATH	Sunita	University of Mauritius	Mauritius
FLANNERY	Brian	Resources for the Future	United States of America
FUSS	Sabine	Mercator Research Institute on Global Commons and Climate Change	Germany
HABERL	Helmut	Alpen-Adria Universität Klagenfurt, Wien, Graz	Austria
HALSNAES	Kirsten	DTU	Denmark
HARE	William	Climate Analytics	Germany
HERRERO	Mario	Commonwealth Scientific and Industrial Research Organisation	Australia
IVANOVA BONCHEVA	Antonina	Universidad Autónoma de Baja California Sur	Mexico
JIANG	Kejun	Energy Research Institute, National Development	China

Last name	First name	Affiliation	Country
		Reform Commission(NDRC)	
KAHN RIBEIRO	Suzana	Federal University of Rio de Janeiro - UFRJ	Brazil
KHAN	Jawed Ali	United Nations Environment Program	Pakistan
KOLSTAD	Charles	Stanford University	United States of America
KORECHA DADI	Diriba	Vice-Chair of WGIII	Ethiopia
KRIEGLER	Elmar	Potsdam Institute for Climate Impact Research	Germany
KUMAR	Mahendra		
LÈBRE LA ROVERE	Emilio	Federal University of Rio de Janeiro	Brazil
LECOCQ	Franck	AGROPARISTECH	France
LEIP	Adrian	European Commission, DG Joint Research Centre	Italy
MAHMOUD	Nagmeldin	Vice-Chair of WGIII	Sudan
MBAYE	Ahmadou aly	University Cheikh anta Diop	Senegal
NILSSON	Lars	Lund University	Sweden
OMENY	Peter	DIORECTORATE OF CLIMATE CHANGE , MINISTRY OF ENVIRONMENT	Kenya
PACHECO	Pablo	Center for International Forestry Research (CIFOR)	Indonesia
PAN	Jiahua	Chinese Academy of Social Sciences	China
PATT	Anthony	ETH Zürich	Switzerland

Last name	First name	Affiliation	Country
PICHS-MADRUGA	Ramón	Vice-Chair of WGIII	Cuba
REISINGER	Andy	Vice-Chair of WGIII	New Zealand
RIAHI	Keywan	IIASA	Austria
ROSENZWEIG	Cynthia	NASA	United States of America
ROY	Joyashree	Jadavpur University	India
SALAMEH	Awwad	Ministry of Planning and International Cooperation, Jordan	Jordan
SGOBBI	Alessandra	European Commission	Belgium
SHEINBAUM-PARDO	Claudia	Institute of Engineering, UNAM	Mexico
SHUKLA	Priyadarshi	Co-Chair of WGIII	India
SKEA	Jim	Co-Chair of WGIII	United Kingdom (of Great Britain and Northern Ireland)
SMITH	Pete	University of Aberdeen	United Kingdom (of Great Britain and Northern Ireland)
SULISTIAWATI	Linda		Indonesia
TOWPRAYOON	Sirintornthep	King Mongkut's University of Technology Thonburi	Thailand
TROFIMOVA	Iryna	Ukrainian Hydrometeorological Institute	Ukraine
ÜRGE-VORSATZ	Diana	Vice-Chair of WGIII	Hungary

Last name	First name	Affiliation	Country
WILLIAMS KAMARA	Mariama	South Centre	Switzerland
WINKLER	Harald	University of Cape Town	South Africa

Annex II.

Participants were invited to discuss all aspects of the scope, outline, and content of the report. A pre-defined structure for the report was purposely not provided to the participants. Instead a facilitated process was used which allowed an outline to emerge during the course of the meeting through a series of structured discussions (see Figure 1).

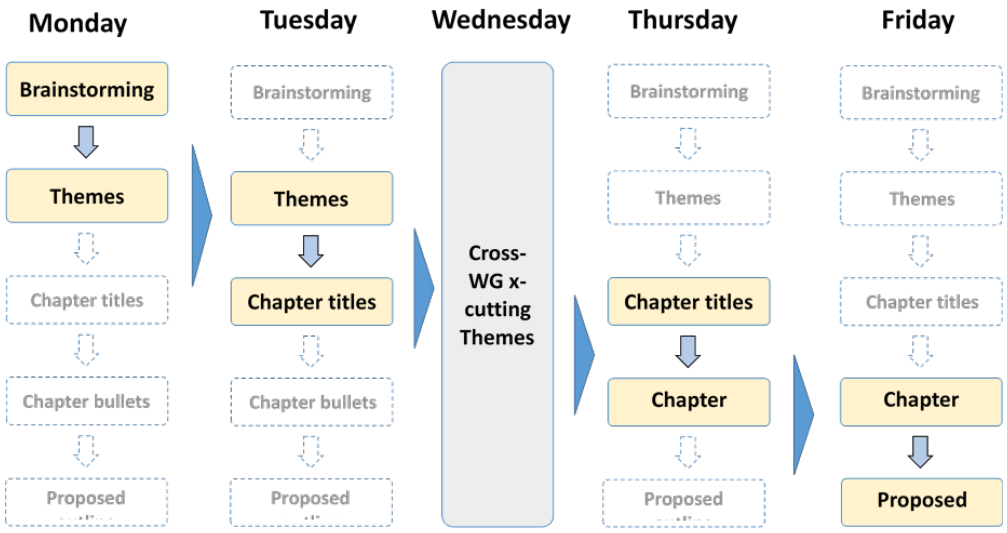

Figure 1. Meeting structure and progression.

6. PROPOSED WG III OUTLINE

6.1 Outline Overview

This section summarises the overall architecture of the propose outline; Section 6.2 provides an annotation of individual chapters.

Chapters 1 and 17 act as “bookends” for the report and will be used to set up sustainable development as a key framing concept. The proposed structure does not include the three separate framing chapters included in AR5. Instead, framing issues will be concentrated in Chapter 1. The chapter will be explicit that different strands of literature frame climate change mitigation in different ways (sustainable development, risk assessment, cost-benefit, systems analysis etc). Chapter 1 will set out the alternative approaches and how they are used in the overall assessment. Chapter 17 will return to sustainable development as a key framing concept (see below).

A group of three chapters (2-4) provides a high-level assessment of emission trends, drivers and pathways. Chapter 2 takes a retrospective look at recent trends and drivers. Chapters 3 and 4 are forward looking but consider different time horizons and will draw on different strands of literature. Chapter 3 focuses on long-term mitigation pathways across the 21st century, relying heavily on integrated assessment models. Chapter 4 focuses on the near-mid term and will consider a range of global, regional, national and sectoral scenarios and projections. Together, Chapters 3 and 4 will assess literature relevant to the Paris Agreement including the long-term temperature goal and the consistency of near to mid-term mitigation goals and pathways with that goal.

A group of sectoral chapters (6-11) forms the core of the outline. The structure is similar to that in AR5 and is intended to map on to the structure of emission inventories reported to the UNFCC by Parties. An additional chapter, *Urban systems and other human settlements*, reflects the IPCC decision to pay particular attention to cities in AR6 and, by taking a systemic approach, it will frame the two subsequent chapters on buildings and transport.

The sectoral block is preceded by Chapter 5 on *Demand, services and social aspects of transformation*. This will set up a framework for considering human dimensions in the sectoral chapters by establishing a link between sustainable development, demands for services (energy, food etc.) and mitigation responses. The sectoral block is succeeded by Chapter 12, *Responses across and beyond sectors.* This will cover responses that are not captured by a sectoral framing, notably those relating to food systems which cut across sectors, greenhouse gas removal and the governance and ethics of solar radiation management.

Chapters 13-16 are cross-cutting in nature. Chapters 13 and 14 cover institutions, policies and co-operation at the national, sub-national and international levels. Chapter 13 will focus more on institutional aspects than was the case in AR5, will focus less on the theoretical evaluation of individual policy instruments and will feature case studies. This chapter will also cover regional organisations that are Parties to the UNFCCC. Chapter 14 will cover a wide range of insightsfor international cooperation relevant to climate change mitigation.

Chapters 15 and 16 cover key cross-cutting areas mentioned explicitly in the Paris Agreement and for which there is an established and expanding literature. The proposed chapter on *Mobilising finance* will cover both public and private financial flows and options for incentivising them. Chapter 16 will assess the links between technology and innovation and sustainable development, the means for stimulating innovation, and the transfer of technologies at the international level.

Chapter 17, *Accelerating the transition in the context of sustainable development*, acts as a synthesis chapter assessing the links between sustainable development and climate change mitigation. It will draw together more specific insights drawn from individual cross-cutting and sectoral chapters.

Finally, WG III has traditionally made little use of case studies to support the mitigation assessment. The intention is to make greater use of these in AR6 to draw out empirical evidence on practical mitigation responses.

6.2 Annotation of proposed chapters

Chapter 1 will provide an assessment of important developments since the AR5. These include, for example, the Paris Agreement of 2015 and the multiplicity of issues that it raises, including nationally determined contributions (NDCs), markets and finance, and the long-term goal of limiting global warming to well below 2°C. It will also address the Sustainable Development Goals (SDGs) articulated in the *UN Transforming our world: the 2030 Agenda for Sustainable Development* and technological changes to tackle GHG emissions. The chapter will identify main themes that will be played out in the AR6, e.g. sustainable development including, but not limited, to the 17 SDGs, the overarching sectoral approach used by Working Group III, but taking note of regional diversity. It will discuss the multiplicity of approaches that can be used to obtain insights including models (both top-down and bottom-up), scenario analysis, uncertainty, risk assessment, and data. The chapter will articulate the AR6 solutions orientation — assessing progress toward societal goals and enhancing ambition. The chapter will summarise robust findings identified in previous assessments and in AR6 Special Reports that remain valid, but which will not necessarily be the focus of the AR6. Chapter 1 will have a strong link to Chapter 17, which will be synthesising new findings arising from the AR6.

Chapter 2 will assess past and present trends of GHG emission flows and cumulative GHG emissions. These trends will be differentiated by region, sector, GHGs and other dimensions. The analysis will look at past trends and drivers with special attention to the stabilisation of emissions over recent years, which will also link to the question of whether we are on track with respect to ambitious temperature goals. There will also be a bird's eye view of sectoral emissions, acknowledging that the sectoral chapters will be going into more detail. It will assess trends in socio-economic and demographic drivers, such as GDP and population, aiming to quantify their impact on emissions. Other drivers of emissions might not be fully quantifiable, but are important to assess as well are: production and consumption patterns; international trade; technological choices, change and breakthroughs including for example ICT; infrastructure lock-in and committed emissions; behavioural choices and lifestyles at individual and societal level; and how policies and measures have influenced all of these. This analysis will be strictly retrospective. Projections of future trends and mitigation potentials will be accommodated in later chapters.

Chapter 3, *Long-term mitigation goals and pathways*, will assess the literature on mitigation and development pathways reaching long-term (i.e. 2050 and beyond) mitigation goals. This will be done in the context of reference scenarios leading to higher warming levels. The assessment will include a discussion of secular trends reflected in mitigation and reference scenarios, including regional assumptions, and how they relate to recent trends and drivers assessed in Chapter 2. To the extent possible, it will group the studies according to these assumptions, e.g. by drawing on the concept of Shared Socio-economic Pathways and the literature on energy and other transitions. The chapter will describe the pathways in various dimensions, including the underlying transitions in individual sectors. Regional information on mitigation pathways will be taken up as available and relevant, *inter alia* to inform the regional perspectives on climate change mitigation in Chapter 17. Chapter 3 will closely interface with Chapter 4, *Mitigation and development pathways in the near- to mid-term*, to assess the implications of near- to mid-term climate actions to achieve long-term mitigation goals and, *vice versa*, the implications of keeping long-term mitigation goals within reach through near- to mid-term responses. It will also describe the range of assumptions on international climate policy cooperation in the mitigation pathways literature and assess relevant studies on international cooperation mechanisms to reach long-term mitigation goals, requiring close interaction with Chapter 14. This chapter will explore the link between mitigation pathways and sustainable development, assessing the literature on sustainable development benefits and adverse side effects of mitigation actions as well as the literature on multi-objective development pathways analysing synergies and trade-offs between different goals, informing Chapter 17 of the report on *Accelerating the transition in the context of sustainable development*. Risks and potential benefits associated with different GHG emission pathways and related uncertainty behind climate responses will also be examined in this chapter.

Chapter 4, *Mitigation and development pathways in the near- to mid-term*, will focus on mitigation pathways and development scenarios. This chapter will have a near- to medium-term temporal scale in terms of climate goals, financing and mitigation strategies. In addition, it will emphasise the national and sub-national scales, whereas Chapter 3 will emphasise the global. This chapter will aim to assess the literature on how to accelerate mitigation in the context of sustainable development at the national scale. It will assess studies of the aggregate effects of NDCs, as well as the methodologies used in these studies. It will also assess the literature on the implementation of NDCs in the context of broader national and sub-national action plans (including NAMAs), in close relation with Chapter 13 (*National and sub-national policies and institutions*). A major task of this chapter will be to report the rapidly expanding national and sub-national model-based literature on mitigation scenarios, and lessons regarding the conditions necessary to accelerate mitigation, including finance, technology and the broader enabling environment. Sectoral/system scenarios will be introduced with further detail in the sectoral chapters (Chapters 6-11). This chapter will draw

from the literature the implications of mitigation for national development objectives, and conversely the implications for mitigation of making development pathways more sustainable. Though the chapter will focus on the national and sub-natonal levels, literature on the potential tensions and synergies between national mitigation scenarios will be assessed in relation to Chapter 14 (*International cooperation*). The robustness of these scenarios will also be assessed, given large uncertainties regarding the international context for responses at the natonal level.

Chapter 5, *Demand, services and social aspects of transformation*, will provide a framing for the sectoral chapters. It will cover the cross-sectoral technological, economic and social aspects related to achieving mitigation and sustainable development priorities through the transformation of energy and other systems, with a particular focus on the demand side. This chapter will start with an overview of the services required to meet, at different levels, the human needs and wants linked to GHG emissions. This chapter will assess indicators of growth and welfare and discuss relevant aspects of sustainable consumption and production and behavioural factors that drive resource demand and potential implications to mitigation transformative pathways. A framework that maps GHG emissions from service needs through energy end-use sectors to energy supply will also be presented, framing and organising discussions in the following sectoral chapters. Several cross-sectoral strategies for reducing GHG emissions will be evaluated. The role of information and communication technologies (ICT) in both driving energy demand and facilitating mitigation strategies and social changes will also be considered. Furthermore, insights from life cycle assessment (LCA) and material flow analysis (MFA), and dematerialisation strategies will assessed. The social acceptability of supply and demand solutions will be addressed. The capacity for and feasible rates of change outlined in Chapters 3 and 4 will be evaluated. Opportunities for leapfrogging will be illustrated through examples. This chapter will also examine relevant cross-sectoral policies and strategies that do not fit into chapters on individual sectors. This chapter will draw on case studies and highlight specific regional aspects of cross-sectoral mitigation strategies throughout.

Chapter 6, *Energy Systems*, will focus on energy services, energy resources and their regional distribution, energy production, conversion, transmission and distribution supply chains, and interactions with other systems evaluated in other sectoral chapters. Starting from lessons learned in the AR5 and recent updates in the literature, this chapter will assess global and regional GHG emission trends from energy systems (including fugitive emissions and non-CO_2 emissions), drivers and policies, as well as developments in fossil fuel markets and energy technology cost trends. The chapter will examine the role of energy systems in transformation pathways, including a description of smart energy systems, decentralised networks, supply and demand integration systems, interconnection, storage, infrastructure, and technological lock-in. More than in the AR5, the WG III contribution to AR6 will examine the role of fossil fuel technologies and decarbonisation options. Emphasis will be put on mitigation technologies, such as carbon capture and storage (CCS), energy practices and behavioural aspects that bridge the gap between long-term targets and near- and mid-term policies and goals. This chapter will incorporate case studies to highlight linkages between mitigation pathways in the energy sector, adaptation pathways and sustainable development, including co-benefits, synergies and trade-offs. Gaps in knowledge and data will be identified, to support recommendations for future research.

Starting from findings in the AR6 Special Reports, especially the Special Report on Climate Change and Land (SRCCL), and updates in the literature since AR5, Chapter 7, *Agriculture, Forestry and Other Land Use*, will reflect trends in GHG emissions from land use and its drivers. It will discuss emerging technologies and supply and demand mitigation measures to

curb GHG emissions from the land use sector, in terms of effectiveness, costs, and economic feasibility. From this perspective, this chapter will cover the impacts of climate on GHG emissions and mitigation potential at the global and regional levels. In addition, this chapter will assess the interaction of adaptation and mitigation pathways and synergies with sustainable development, including co-benefits and trade-offs. The chapter will also cover competition and provision of ecosystem services from land, including food, animal feed, fibre, fuel and other land uses. Emphasis will be given to the effectiveness of social and policy responses, in both the public and private sectors. Similar to otherchapters, this will draw on case studies to assess constraints and opportunities across different contexts and regions.

Taking into account the active participation by cities in climate change mitigation responses and the emphasis on cities in the AR6 cycle, Chapter 8 will focus on *Urban systems and other settlements.* Since AR5, the scientific literature on urban areas and climate change has grown considerably. The chapter will cover drivers and key drivers of emissions and climate change mitigation responses, including demographic perspectives, migration, urbanisation trends, consumption, lifestyle, and linkages between urban and rural areas. In addition, Chapter 8 will document the contribution of urban areas to future GHG emissions and mitigation, the costs and potential of mitigation options, city mitigation actions and progress, and spatial planning strategies. A key topic will be how urbanisation can contribute to deep decarbonisation at global and national levels. The chapter will also assess the potential of integrated mitigation responses in urban settlements and infrastructure lock-ins. The chapter will assess opportunities to accelerate mitigation and their feasibility in regard to policies, governance, and capacity building. It will assess linkages in urban systems between climate change mitigation on the one hand, and impacts and adaptation pathways on the other hand. It will also assess the implications of climate change mitigation frameworks for sustainable development, including co-benefits (such as air quality and livelihoods), synergies, and trade-offs. As in other chapters, Chapter 8 will rely on case studies to draw attention to specific opportunities to promote climate change mitigation.

Chapter 9, *Buildings*, will focus on residential, commercial, and public buildings and the specific services they provide, such as illumination, comfort, health services, education, commerce, and communications. Adding to the insights of the AR5, the WG III contribution to AR6 will cover recent assessments of mitigation options and strategies including zero carbon buildings and systemic interactions between buildings and other sectors, with insights from life cycle assessment (LCA) and material flow analysis (MFA). Chapter 9 will also report recent trends and drivers of GHG emissions in the sector, based on scenario, cost and potential analyses. Sector specific policies and policy packages, including financing and enabling conditions, will be examined. Emphasis will be put on scalable decarbonisation strategies that can transform buildings and real estate markets, while highlighting linkages with sustainable development pathways, including co-benefits, synergies, trade-offs, and adaptation options. This chapter will draw on case studies to address specific regional and local specificities and drivers of mitigation strategies.

Chapter 10, *Transport*, will assess road, rail, aviation and maritime transport modes, covering both freight and passenger mobility services. In comparison with AR5, the WG III contribution to AR6 will pay particular attention to aviation and maritime transport. Emphasis will be given to emerging mitigation options and systemic interactions with other sectors, particularly with *Energy systems* (Chapter 6), *Urban systems and other settlements* (Chapter 8) and *Buildings* (Chapter 9). To this end, this chapter will incorporate insights from the LCA and MFA literature. This will require strong collaboration between authors across chapters. The discussion of scenarios, costs and mitigation potentials and linkage with sectoral targets, will specifically cover lifestyle, culture, efficiency, transport technologies, affordability, modal split and fuel substitution, as well as policy financing packages. Linkages

between transport sector mitigation strategies, sustainable development goals, climate change impacts and adaptation options will also be covered, including co-benefits, synergies and trade-offs. This chapter will draw on case studies to address specific regional and local mobility trends and drivers of mitigation strategies.

Chapter 11, *Industry*, will focus on industrial sector mitigation strategies and synergies with other sectoral policies. This chapter will assess industrial development pathways that support sustainable development in the context of the Paris Agreement, including strengthening local supply chains and the use of very low, net zero or even negative GHG emission technologies in heavy industry. It will assess fundamental process changes that will achieve net zero emissions, including the use of new feedstocks and material efficient technologies. It will also assess associated institutional changes, namely more intensive R&D, commercialisation support and policies that will drive the uptake of new technologies. By mapping the available options and analysing policy implications, this chapter will provide a basis for future research, e.g. on national RD&D priorities and policies, pathways, energy system development and integration, and international agreements. Its approach to the characterisation of mitigation technologies and practices will be similar that in other sectoral chapters, it will specifically cover efficiency improvements in heavy and light industry, CCS, cradle-to-cradle approaches, multi-gas trade-offs, industrial waste and circular economy perspectives.

Chapter 12, *Responses across and beyond sectors*, will focus on cross-sectoral issues and potential conflicts and synergies taking account of competition for finite resources. Large-scale mitigation strategies could require significant commitments of land, water, and ecosystem services, which can be managed most efficiently if coordinated with other societal requirements. Food systems will be highlighted as a prime example of a focus for cross-sectoral strategies. Food supply chains, including consumption aspects and food waste, offer opportunities to leverage mitigation along with strategies that curb GHG emissions. This chapter will also examine the potential and risks associated with ocean based GHG removal techniques and other techniques such as the direct air capture of CO_2. This will cover linkages between mitigation, adaptation and sustainable development pathways. A summary of sectoral mitigation strategies costs, potentials and co-benefits and trade-offs will be presented. The governance of potential solar radiation management (SRM) techniques and related ethical issues will also be examined, in terms of land and water resources and impacts.

Chapter 13, *National and sub-national policies and institutions*, will draw on cross-country comparative experience of mitigation plans, strategies, policies, institutions, and national climate legislation, as well as lessons learned from the implementation of NDCs. It will examine climate mitigation policies in the context of sustainable development at national and sub-national levels. Enabling conditions and obstacles will be assessed based on evidence of policy implementation. It will cover trends in public acceptance, opinion formation, the role of the media and cultural shifts, which complement climate policy and institutional change. Drawing on country case studies, this chapter will assess how different formulations and articulations of the linkages between climate change and sustainable development are likely to win support. The chapter will also assess climate change mitigation policy, including economic policy instruments, infrastructure planning, institutions, governance models, and their effectiveness in the context of sustainable development and distributional implications, with an emphasis on learnings from empirical evidence. The chapter will undertake a synthetic analysis of sectoral policies, based on close interactions with the framing and sectoral chapters. It will cover metrics and methodologies that have been developed by actors involved in planning, managing and monitoring climate actions. The assessment will focus on a range of metrics, including GHG outcomes and sustainable development indicators covering co-benefits, synergies, and trade-offs. Cross-sectoral linkages of

mitigation and adaptation, including case studies (reflecting different degrees of success) at local and national scales will be assessed.

Chapter 14, *International cooperation*, will cover cooperation efforts at the international level to promote climate strategies globally. Starting from lessons learned in AR5 and subsequent advances in the literature, this chapter will assess, at the aggregate level, the implementation of efforts and actions related to the Paris Agreement. Examples of other international agreements will be analysed and lessons for climate policy will be derived, examples include the International Civil Aviation Organization and the International Maritime Organization. Other multilateral and bilateral agreements across different scales will be also considered (MEF, G20, G7; WTO; World Bank, IRENA etc.). Alternative approaches to international climate policy architectures will be considered by evaluating existing literature that discusses experiences with international partnership policies, decentralised national policies and multilateral environmental agreements, capacity building institutions, and other enabling institutions for finance and investment. Frameworks for transparency and accountability will also be assessed, as well as lessons of implementation from relevant international agreements outside the climate arena. This chapter will point out possible linkages between international and national climate policies and other goals, such as the SDGs.

Chapter 15, *Mobilising finance*, will deal with the role of investment and finance to support climate strategies, programmes and policies including the Paris agreement targets and the NDCs. There are multiple ways to finance low-carbon investments. The assessment will examine public climate finance flows, including multilateral and bilateral international flows, as well as national and sub-national finance mobilisation. This chapter will also document innovative financial mechanisms and public-private partnerships to move needed resources to achieve climate mitigation targets, as well as emerging and innovative financing schemes, such as community involvement in climate finance, and sustainable investment criteria by institutional investors. Then, the focus will be on differences in climate-resilient financing consistent with different climate goals (e.g. 2°C, well-below 2°C etc.). Finally, linkages between financing mitigation and adaptation will be assessed. The discussion will focus on synergies and trade-offs between mitigation financing and other financing needs for adaptation and sustainable development priorities, especially in developing countries. This chapter will include case study analyses to address successful examples of mobilisation of financing flows for mitigation strategies.

Chapter 16, *Innovation, technology development and transfer*, will cover lessons learnt since AR5 concerning the role of innovation, technology development, diffusion and transfer in sustainable development and the Paris goals. It will asess systemic issues related to low-carbon technological innovations through case studies of technological innovation systems and innovation policy. The assessment will cover the role of international institutions relevant to technology and innovation, including the Paris Agreement, UNFCCC Technology Mechanism and other non-UNFCCC partnerships and cooperative approaches on R&D cooperation, such as Mission Innovation, Breakthrough Coalition and the Cement Sustainability Initiative. This chapter will also examine the capacity for transformative change, including, e.g., engineering capacity and capabilities for innovation, governance and R&D cooperation. In addition, experiences with accelerating technological change through innovation policy for climate change at the national level, including successful case studies, will be assessed. Specific challenges in emerging economies and least-developed countries will be addressed, e.g. SIDS and land-locked countries. The implications of new disruptive technologies will be documented. Potential linkages between low-carbon technological innovations and adaptation measures and other sustainable development efforts will also be reported.

Chapter 17, *Accelerating the transition in the context of sustainable development*, will wrap up and close the circle initiated by the introduction of sustainable development and mitigation in Chapter 1. It will synthesise findings from subsequent chapters. Conclusions on progress in the AR6 assessment of synergies between integrated perspectives on sustainable development and the acceleration of mitigation will be drawn. Rather than summarising individual chapter conclusions, the chapter will consider drivers, potential synergies and conflicts, policies, and enabling environments and partnerships that cut across the findings of individual chapters. Cross-cutting issues related to issues such as uncertainties, risks, social costs of carbon, and integrated mitigation and adaptation synergies will also be included. Policies reflecting multiple objectives, response capacities and enabling conditions, such as finance, technology transfer and cooperation will be addressed in the context of sustainable development. Near- and long-term conclusions will be brought together, as well as the issue of geographical scaling. The chapter will end with conclusions as to how to move forward in dealing with climate change responses and sustainable development.

ANNEX I: REPORT ON SELECTION PROCESS

Report on Scoping Meeting Participant Selection Process

Overview

Participants to the AR6 Scoping Meeting were selected following a process consistent with the IPCC policies and procedures. The selection process was undertaken by IPCC Bureau Members.

The objective of the selection process was to select 60 experts per Working Group, considering all criteria as stated in Appendix A of the Principles Governing IPCC Work:

"In selecting scoping meeting participants, consideration should be given to the following criteria: scientific, technical and socio-economic expertise, including the range of views; geographical representation; a mixture of experts with and without previous experience in IPCC; gender balance; experts with a background from relevant stakeholder and user groups, including governments."

Nominations for 1259 experts were received. Of these nominations, 599 nominations indicated having a relevant area of expertise for WG III. 60 participants were selected for the final list to participate in the scoping for the WG III AR6 report, taking into account expertise and all criteria as stated in Appendix A of the Principles Governing IPCC Work. Citizens coming from developing countries represented 44% of nominees; women represented 26% of nominees. Observer organisations nominated 19% of the experts, whilst focal points nominated the remaining 81%.

Overview of selection process

The total list of nominations was divided into three lists – one for each Working Group (WG) – according to the indicated areas of expertise of the participants. Each WG took the lead for their respective list, and then consolidated the lists to fill gaps and address overlaps.

The expert selection process occurred in four stages.

Stage 1 – Evaluation of candidate's expertise

All members of the IPCC Bureau were involved in identifying priority participants for their respective WG on the basis of their expertise. This included identifying experts within each WG, and experts with cross-cutting expertise who would be crucial in linking topics across the WGs.

Stage 2 – Identification and filling major gaps in WG III

The TSUs facilitated the WG Bureaus in identifying key gaps in expertise, regional representation and gender balance within each WG list, taking into account feedback from the IPCC Bureau. Suitable candidates to fill these gaps were then proposed by the Bureau with support of the TSUs.

Stage 3 – Identification and filling major gaps across the WGs

The lists of proposed experts from all three WGs were consolidated into one list by the WG III TSU. This was then reviewed by the Co-Chairs from all WGs to identify gaps and address overlaps.

Stage 4 – Fine tuning and approval

The penultimate list was circulated to the IPCC Bureau. Comments and feedback were used to further refine the total list to take into account balance and expertise. The IPCC Bureau approved the final list on 22nd February 2017. Invitations were extended by the Secretariat of the IPCC on 3rd March 2017.

Invited participant list

60 experts were invited on behalf of the WG III Bureau to attend the AR6 Scoping Meeting. Of the total invited participants, 50% were from developing countries and countries with economies in transition, and 50% were from developed countries. 34 nationalities (citizenship) are represented. 30% of invitees were female, and 70% were male. 75% of participants had previous IPCC experience, while 25% were new to the IPCC. The breakdown of invitees across a number of criteria is shown in the following figures. Table I - 1 provides a breakdown of invitees for WG III by country of residence. The full list of participants who attended the meeting is provided in Annex IV.

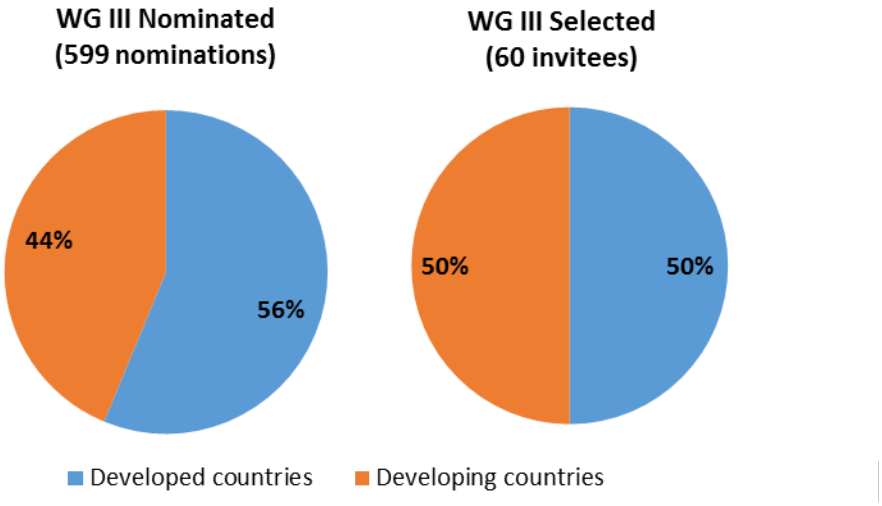

Figure I - 1. Percentage of participants from developed and developing countries (and economies in transition).

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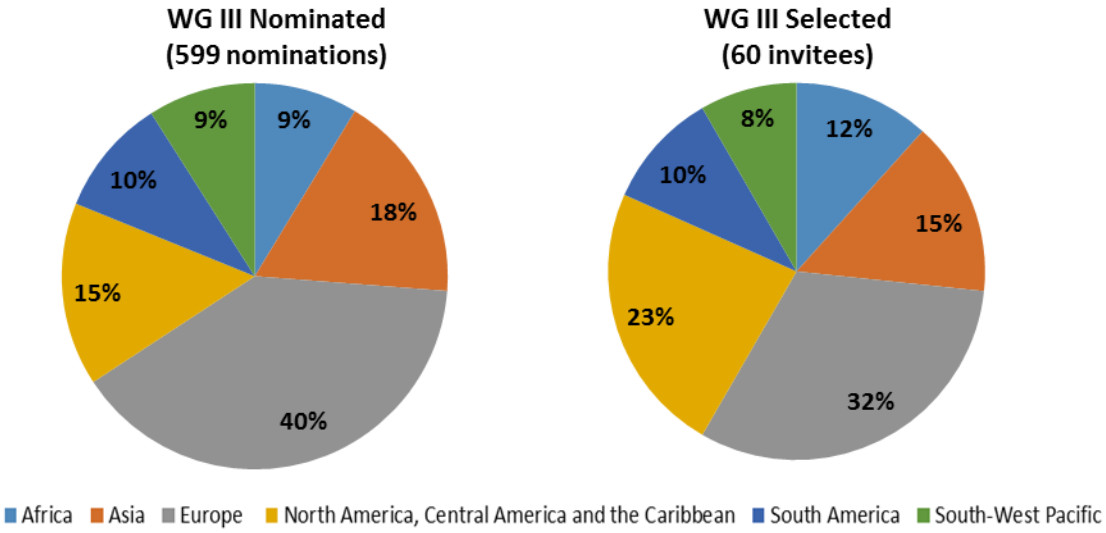

Figure I - 2. Distribution of participants across WMO Regions (based on citizenship).

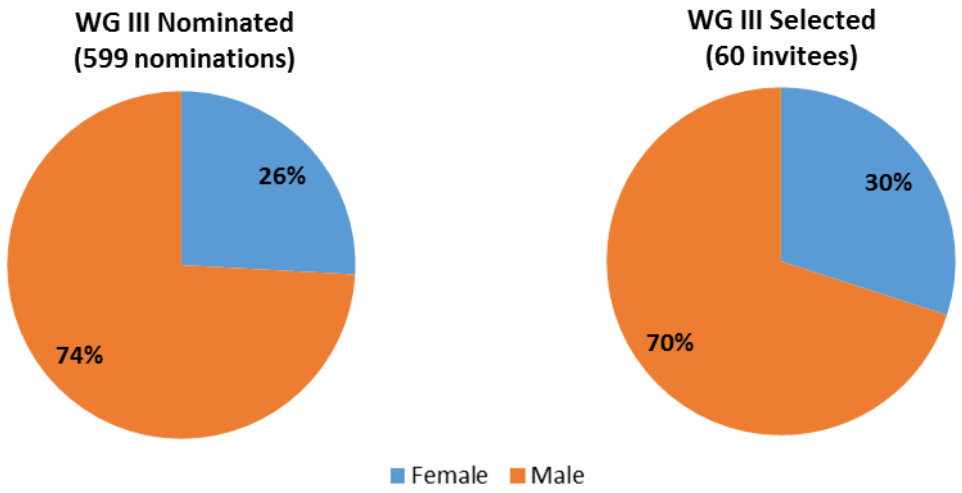

Figure I - 3. Gender balance of participants.

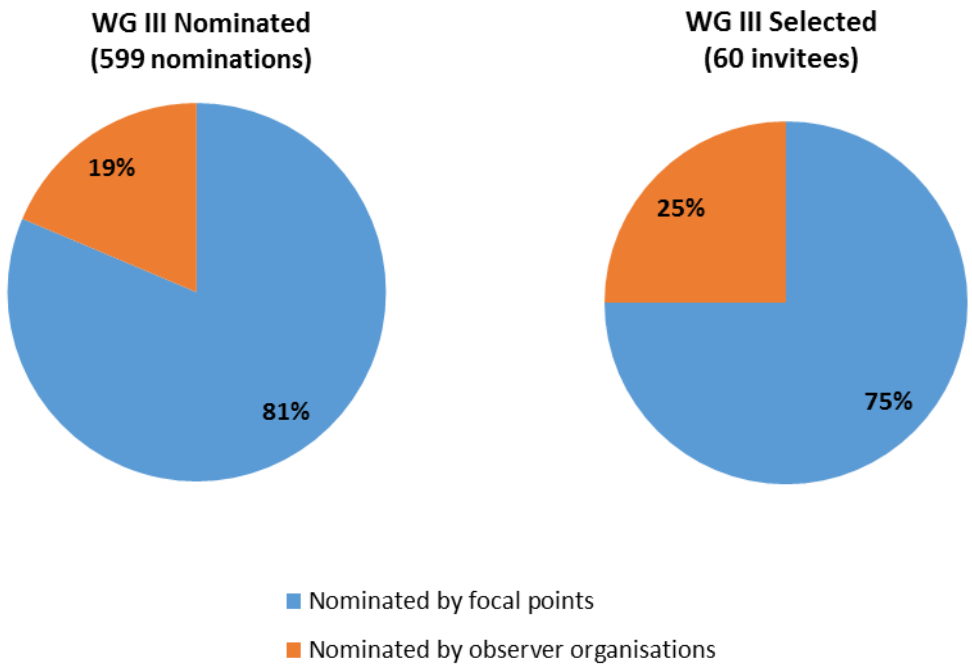

Figure I - 4. Nomination Source.

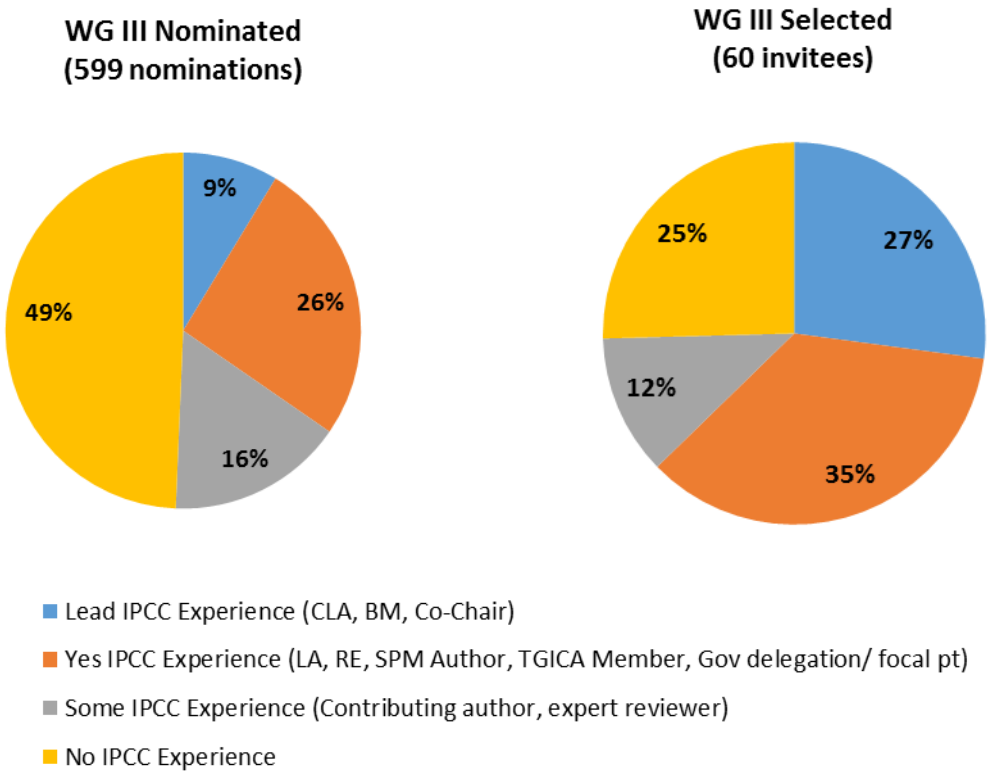

Figure I - 5. IPCC Experience.

Table I - 1: Regional distribution (citizenship) of Scoping Meeting participants.

Country (citizenship)	WG III Nominated (599 nominations)	WG III Selected (60 invitees)
Argentina	8	1
Australia	19	3
Austria	6	2
Bangladesh	1	0
Barbados	1	0
Belgium	2	0
Bolivia	1	1
Bosnia and Herzegovina	3	0
Brazil	35	4
Burkina Faso	1	0
Canada	7	1
Chile	8	0
China	29	2
Costa Rica	1	1
Cuba	3	1
Czech Republic	3	0
Denmark	3	1
Ecuador	3	0
Egypt	7	1
Finland	1	0
Fiji	1	1
France	13	1
Germany	58	3
Ghana	1	0
Greece	3	0
Hungary	1	0
India	21	2
Indonesia	23	0
Iran	2	0
Ireland	4	1
Israel	7	0
Italy	19	2
Jamaica	1	1
Japan	15	2
Jordan	3	1
Kenya	3	1
Malaysia	2	0
Maldives	1	0
Mauritius	2	1
Mexico	7	3
Morocco	4	1

Myanmar	2	0
Nepal	5	0
Netherlands	10	1
New Zealand	5	0
Nigeria	3	0
Norway	7	1
Pakistan	3	1
Philippines	3	1
Portugal	2	0
Republic of Korea	7	0
Romania	4	0
Russian Federation	7	1
Senegal	4	1
Singapore	1	0
Slovakia	1	0
Slovenia	1	0
South Africa	3	1
Spain	1	0
Sudan	8	1
Sweden	7	1
Switzerland	9	1
Thailand	13	1
Togo	1	0
Trinidad and Tobago	1	0
Uganda	1	0
Ukraine	7	1
United Kingdom (of Great Britain and Northern Ireland)	59	3
United Republic of Tanzania	12	0
United States of America	71	7
Venezuela	4	0
Vietnam	2	0
Zimbabwe	2	0

ANNEX II: SCOPING MEETING PARTICIPANTS

List of scoping meeting participants

Last name	First name	Affiliation	Country
AKIMOTO	Keigo	Research Institute of Innovative Technology for the Earth (RITE)	Japan
ÁLVAREZ BRITO	Arnaldo Fabián	Agro-forest Research Institute	Cuba
AMINATH	Shafia	Ministry of Fisheries and Agriculture	Maldives
BASHMAKOV	Igor	Center for Energy Efficiency (CENEf)	Russian Federation
BATAILLE	Christopher	Institute for Sustainable Development & International Relations (IDDRI)	Canada
BLANCO	Gabriel	Universidad Nacional del Centro (UNICEN)	Argentina
BOSETTI	Valentina	Bocconi University	Italy
BROWN	Marilyn	Georgia Institute of Technology	United States of America
CHAVES CARDOSO DE OLIVEIRA	Rodrigo	Petróleo Brasileiro S.A. - PETROBRAS	Brazil
CHRISTOPHERSEN	Øyvind	Norwegian Environment Agency	Norway
DE CONINCK	Heleen	Radboud University	Netherlands
DE LA VEGA NAVARRO	Angel	UNAM - National Autonomous University of Mexico	Mexico

Last name	First name	Affiliation	Country
DE MELO	Jaime	University of Geneva	Switzerland
DEVINE-WRIGHT	Patrick	University of Exeter	United Kingdom (of Great Britain and Northern Ireland)
DHAKAL	Shobhakar		Thailand
DUBASH	Navroz Kersi	Centre for Policy Research	India
EDMONDS	James	Pacific Northwest National Laboratory	United States of America
ELGIZOULI IDRIS	ISMAIL	Self empolyed	Sudan
EYRE	Nicholas	University of Oxford	United Kingdom (of Great Britain and Northern Ireland)
FACKNATH	Sunita	University of Mauritius	Mauritius
FLANNERY	Brian	Resources for the Future	United States of America
FUSS	Sabine	Mercator Research Institute on Global Commons and Climate Change	Germany
HABERL	Helmut	Alpen-Adria Universität Klagenfurt, Wien, Graz	Austria
HALSNAES	Kirsten	DTU	Denmark
HARE	William	Climate Analytics	Germany
HERRERO	Mario	Commonwealth Scientific and Industrial Research Organisation	Australia
IVANOVA BONCHEVA	Antonina	Universidad Autónoma de Baja California Sur	Mexico

Last name	First name	Affiliation	Country
JIANG	Kejun	Energy Research Institute, National Development Reform Commission(NDRC)	China
KAHN RIBEIRO	Suzana	Federal University of Rio de Janeiro - UFRJ	Brazil
KHAN	Jawed Ali	United Nations Environment Program	Pakistan
KOLSTAD	Charles	Stanford University	United States of America
KORECHA DADI	Diriba	Vice-Chair of WGIII	Ethiopia
KRIEGLER	Elmar	Potsdam Institute for Climate Impact Research	Germany
KUMAR	Mahendra		
LÈBRE LA ROVERE	Emilio	Federal University of Rio de Janeiro	Brazil
LECOCQ	Franck	AGROPARISTECH	France
LEIP	Adrian	European Commission, DG Joint Research Centre	Italy
MAHMOUD	Nagmeldin	Vice-Chair of WGIII	Sudan
MBAYE	Ahmadou aly	University Cheikh anta Diop	Senegal
NILSSON	Lars	Lund University	Sweden
OMENY	Peter	DIORECTORATE OF CLIMATE CHANGE , MINISTRY OF ENVIRONMENT	Kenya
PACHECO	Pablo	Center for International Forestry Research (CIFOR)	Indonesia
PAN	Jiahua	Chinese Academy of Social Sciences	China

Last name	First name	Affiliation	Country
PATT	Anthony	ETH Zürich	Switzerland
PICHS-MADRUGA	Ramón	Vice-Chair of WGIII	Cuba
REISINGER	Andy	Vice-Chair of WGIII	New Zealand
RIAHI	Keywan	IIASA	Austria
ROSENZWEIG	Cynthia	NASA	United States of America
ROY	Joyashree	Jadavpur University	India
SALAMEH	Awwad	Ministry of Planning and International Cooperation, Jordan	Jordan
SGOBBI	Alessandra	European Commission	Belgium
SHEINBAUM-PARDO	Claudia	Institute of Engineering, UNAM	Mexico
SHUKLA	Priyadarshi	Co-Chair of WGIII	India
SKEA	Jim	Co-Chair of WGIII	United Kingdom (of Great Britain and Northern Ireland)
SMITH	Pete	University of Aberdeen	United Kingdom (of Great Britain and Northern Ireland)
SULISTIAWATI	Linda		Indonesia
TOWPRAYOON	Sirintornthep	King Mongkut's University of Technology Thonburi	Thailand
TROFIMOVA	Iryna	Ukrainian Hydrometeorological Institute	Ukraine
ÜRGE-VORSATZ	Diana	Vice-Chair of WGIII	Hungary

Last name	First name	Affiliation	Country
WILLIAMS KAMARA	Mariama	South Centre	Switzerland
WINKLER	Harald	University of Cape Town	South Africa

ANNEX II: SCOPING MEETING PROGRAMME

IPCC AR6 Scoping Meeting

Agenda – with WG III Detail highlighted

Monday, 1st May 2017

09:00	PLENARY (Main Conference Room, CR2)	
09:00	Opening ceremony	Hoesung Lee Abdalah Mokssit Ethiopian Government
10:15	*Break*	
10:45	PLENARY – Working Group Visions (Main Conference Room, CR2)	
10:45	AR6 Vision and meeting objectives	Hoesung Lee
11:00	WGI	Valérie Masson-Delmotte, Panmao Zhai
11:25	WGII	Hans-Otto Pörtner, Debra Roberts
11:50	WG III	PR Shukla, Jim Skea
12:15	Synthesis storyline	Hoesung Lee
12:30	Role and structure of the meeting	Hoesung Lee
12:45	What comes next	
13:00	*Lunch break*	
14:30	Working Group III Plenary 1 (Conference Room 6)	Chair: PR Shukla
14:30	• Introductions: Co-Chairs, Bureau, TSU and WG III scope	
14:40	• WGIII Vision	
15:00	• Lessons from AR5	
15:10	• Q&A	
15:25	• Clarify process + ice-breaking game to allocate participants to three randomised BOGs	

15:30	Working Group III – Breakout Group (BOG) 1		
	WG III BOG1-A (Caucus 7)	WG III BOG1-B (Caucus 8)	WG III BOG1-C (Caucus 9)
16:00	Coffee Break		
16:30	WG III BOG 1 Cont.		
	WG III BOG1-A (Caucus 7)	WG III BOG1-B (Caucus 8)	WG III BOG1-C (Caucus 9)
17:30	Working Group III Plenary 2 (Stock-taking session) (Conference Room 6)		
18:00	End of Day 1		

Tuesday, 2 May 2017

08:30	How the IPCC Works: Q&A for new participants (Main Conference Room, CR2)				Thelma Krug
09:00	Working Group III Plenary 3 (Conference Room 6)				
9:20	Working Group III – Breakout Group 2				
	WG III BOG2-A Policies, Institutions (Caucus 7)	WG III BOG2-B Economics, Finance (Caucus 8)	WG III BOG2-C Consumption (Caucus 9)	WG III BOG2-D Sustainable Development (Conf Room 6)	
10:30	*Coffee Break*				
11:00	Working Group III – Breakout Group 2 continued				
	WG III BOG2-A (Caucus 7)	WG III BOG2-B (Caucus 8)	WG III BOG2-C (Caucus 9)	WG III BOG2-D (Conf Room 6)	
12:00	Working Group III Plenary 4 (Conference Room 6)				
12:30	*Lunch*				
13:30	Q&A on SYR – Lessons Learnt from AR5				Thelma Krug
14:00	Working Group III – Breakout Group 3				
	WG III BOG3-A Cross-cutting (Caucus 7)	WG III BOG3-B NDCs & Regions (Caucus 8)	WG III BOG3-C Cities & Urban (Caucus 9)	WG III BOG3-D Systems, Services (Conf Room 6)	
15:00	Working Group III Plenary 5 (Stock-Taking Session) (Conference Room 6)				
16:00	*Coffee Break*				
16:30	PLENARY – All Working Groups (Main Conference Room, CR2)				
18:00	End of Day 2				
19:00	Reception, transport provided to/from UNECA				

Wednesday, 3 May 2017

09:00	PLENARY – All Working Groups (Main Conference Room, CR2)		
10:15	*Coffee Break*		
10:45	Cross-Cutting Breakout Group		
	X-Cut BOG 1 – Regions (Conference Room 2, main plenary room)	X-Cut BOG 2 – Scenarios (Large Briefing Room)	X-Cut BOG 3 – Risks (Conference Room 3)
	X-Cut BOG 4 – Cities (Small Briefing Room)	X-Cut BOG 5 – Global stocktake (Conference Room 5)	Option to continue WG III Meeting in parallel (Confernce Room 6)
12:15	*Lunch*		
13:45	Cross-Cutting Breakout Group		
	X-Cut BOG 1 continued – Regions (Conference Room 2, main plenary room)	X-Cut BOG 2 continued – Scenarios (Large Briefing Room)	X-Cut BOG 6 – Geoengineering (Caucus 1)
	X-Cut BOG 7 - Adaptation & Mitigation (Conference Room 5)	X-Cut BOG 8 – Process Approach (Caucus 2)	Option to continue WG III Meeting in parallel (Confernce Room 6)
15:15	*Coffee Break*		
15:45	WG III Plenary 6 (Conference Room 6)		
18:30	End of Day 3 / Dinner Break		
19:00-20:00	*Evening Session Brainstorm on SYR storyline* *(Main Conference Room, CR2)*		

Thursday, 4 May 2017

	WORKING GROUP III MEETINGS			SYNTHESIS REPORT MEETINGS
09:00	Working Group III Plenary 7			Synthesis Report Breakout Group (CR2)
				WG SYR Breakout Groups occurring in parallel
10:00	Working Group III – Breakout Group 4			Synthesis Report Breakout Group (CR2)
	WG III BOG4-A (Caucus 7)	WG III BOG4-B (Caucus 8)	WG III BOG4-C (Caucus 9)	WG SYR Breakout Groups occurring in parallel
10:30	*Coffee Break*			
11:00	Working Group III – Breakout Group 4 continued			Synthesis Report Breakout Group (CR2)
	WG III BOG4-A (Caucus 7)	WG III BOG4-B (Caucus 8)	WG III BOG4-C (Caucus 9)	WG SYR Breakout Groups occurring in parallel
12:30	*Lunch*			
14:00	Working Group III Plenary 8			Synthesis Report Breakout Group (CR2)
14:30	Working Group III – Breakout Group 5			
	WG III BOG5-A (Caucus 7)	WG III BOG5-B (Caucus 8)	WG III BOG5-C (Caucus 9)	WG SYR Breakout Groups occurring in parallel
16:00	*Coffee Break*			
16:30	PLENARY – ALL WGs (Main Conference Room, CR2)			
18:00	End of Day 4			

Friday, 5 May 2017

09:00	Working Group III Plenary 9 (Conference Room 6)
10:30	*Coffee Break*
11:00	Working Group III Plenary 9 continued (Conference Room 6)
12:30	*Lunch*
14:00	CONCLUDING PLENARY – All Working Groups (Main Conference Room, CR2)
17:30	End of the Meeting

ANNEX IV: PROPOSED CHAPTER OUTLINE

Outline with Chapter Headings

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Summary for Policy Makers

Technical Summary

Chapter 1: Introduction and framing

Chapter 2: Past emissions trends and drivers

Chapter 3: Long-term mitigation goals and pathways

Chapter 4: Mitigation and development pathways in the near- to mid-term

Chapter 5: Demand, services and social aspects of transformation

Chapter 6: Energy systems

Chapter 7: AFOLU

Chapter 8: Urban systems and other settlements

Chapter 9: Buildings

Chapter 10: Transport

Chapter 11: Industry

Chapter 12: Responses across and beyond sectors

Chapter 13: National and sub-national policies and institutions

Chapter 14: International cooperation

Chapter 15: Mobilising finance

Chapter 16: Innovation, technology development and technology transfer

Chapter 17: Accelerating the transition in the context of sustainable development

Annex A: Glossary

Annex B: Definitions, units and conventions

Annex C: Scenarios and modelling methods

Annex D: Contributors to the IPCC WG III Sixth Assessment Report

Annex E: Expert reviewers and government reviewers

Outline with Chapter Headings and indicative bullet points

Chapter 1: Introduction and Framing

- Recent developments (Paris Agreement: NDCs, global stocktake, markets and finance, below 2^{o}C goal; SDGs; technology and other developments; multiple entry points to climate mitigation)
- Sustainable development (including SDGs)
- Policy (multiple goal setting)
- Regional breakdown as relevant — local institutions, cultures, circumstances
- Solution orientation: Are we on track?, How can we realise ambition?, How do we accelerate progress?
- Sectors, services and systems
- Methods and framings (models, analysis, top-down/bottom-up, scenario framework, cost-benefit, treatment of uncertainty, risk assessment, data, including social science framings)
- Strong link with Chapter 17
- Robust findings so far: AR5, SR1.5, SRLCC and SROCC

Chapter 2: Past emissions trends and drivers

- Past and present trends of cumulative emissions and flows (per region, sector, GHG, GDP, etc.)
- Trends of consumption-based emissions
- Socio-economic and demographic drivers (GDP and population) and their trends
- Bird's eye view of sectoral emission drivers and their trends
- Policies and measures, related to NDCs, sustainable development perspectives and other policy goals
- Production and consumption patterns, international trade
- Technological choices and changes and impacts of technological breakthroughs
- Infrastructural lock-in and committed emissions
- Behavioural choices and lifestyles at individual and societal levels

Chapter 3: Long-term mitigation goals and pathways

- Methods of assessment, including approaches to analysis of mitigation and development pathways
- Socio-cultural-techno-economic assumptions and projections, including regional differences (referring to baseline and mitigation scenarios, shared socio-economic pathways, etc.)
- Emission pathways compatible with long-term goals and reaching higher warming levels, taking into account CO_2, non-CO_2 and short-lived climate pollutants (including peaking, rates of change and balancing sources and sinks)
- Role of changing climate on emissions
- System transformations compatible with long-term goals, including supply and demand and [integrating] sectoral information
- Economics of mitigation and development pathways, including mitigation costs, investment needs, employment effects, etc.
- Technological and behavioural aspects of mitigation pathways and socio-technical transitions
- Interaction between near- to mid-term action, including NDCs, and long-term mitigation pathways and goals

- International cooperation in mitigation pathways in the context of international mechanisms, including financial contributions
- Links to sustainable development (including co-benefits, synergies and trade-offs)
- Risk analysis of emission pathways considering uncertainty about climate response
- Benefits of mitigation, including information from WG II

Chapter 4: Mitigation and development pathways in the near- to mid-term

- Accelerating mitigation in the context of SD at a national scale
- Aggregate effects of NDCs in the context of long-term goals, including methodologies and gap analysis
- NDC implementation in the context of national and subnational action plans and policies
- Regional and national modelling of mitigation and development pathways, including scenarios consistent with Paris goals, NDCs and mid-century strategies, and transformative changes in sectors
- Implications of mitigation for national development objectives, including: employment, competitiveness, GDP, poverty, etc., and contributions of sustainable development pathways to mitigation (E.g.: green growth)
- Enabling conditions for mitigation, including technology development and transfer, capacity building, finance, and private and public sector participation
- Interactions between national actions across countries (E.g.: transboundary infrastructure, trade)
- Uncertainties and risks to the achievement of mitigation goals

Chapter 5: Demand, services and social aspects of transformation

- Mitigation, sustainable development and the SDGs (human needs, access to services, and affordability)
- Patterns of growth and welfare indicators
- Sustainable consumption and production
- Linking services with demand, sectors, systems - implications for mitigation and sustainable development
- Culture, social norms, practices and behavioural changes for lower resource requirements
- Sharing economy, collaborative consumption, community energy
- Implications of ICT for mitigation opportunities taking account of social change
- Insights from life cycle assessment and material flow analysis
- Social acceptability of supply and demand solutions
- Leapfrogging, capacity for and feasible rates of change, lock-ins
- Identifying actors, their roles and relationships
- Impacts of non-mitigation policies (welfare, housing, land use, employment, etc.)
- Policies facilitating behavioural and lifestyle change
- Case studies and regional specificities

Chapter 6: Energy systems

- Key conclusions from AR5. Do we have progress with filling gaps in knowledge after AR5?
- Energy services, energy systems and energy sector, integrations with other systems (including food supply system, buildings, transportation, industrial systems)

- Energy resources (fossil and non-fossil) and their regional distribution
- Global and regional new trends, drivers and policies, fossil fuel prices and supply systems (natural gas, coal, petroleum etc.)
- Emissions trends (including fugitive emissions and non-CO_2).
- Global and regional new trends for electricity and low carbon energy supply systems, including renewables deployment and costs.
- Smart energy systems, decentralized systems and the integration of the supply and demand
- Mitigation options (including CCS), practices and behavioural aspects (including public perception and social acceptance)
- Interconnection, storage, infrastructure and lock-in
- Role of energy systems in the transformation pathways
- Bridging long-term targets with short and mid-term policies
- Sectoral policies and goals (including feed-in tariffs, renewables obligations and others)
- Mainstreaming climate into energy policy
- Case studies
- Adaptation-mitigation co-benefits, synergies and trade-offs
- Links to sustainable development: co-benefits, synergies and trade-offs (E.g. air quality, energy access)
- Gaps in knowledge and data

Chapter 7: AFOLU

- Robust findings from the SRCCL and other SRs, and updates since AR5
- Trends in emissions and drivers
- Emerging technologies
- Mitigation measures – supply and demand - effectiveness, costs, economics
- Impacts of climate on emissions and mitigation potentials
- Adaptation-mitigation co-benefits, synergies and trade-offs
- Links to sustainable development (including co-benefits, synergies and trade-offs)
- Mitigation potentials – supply and demand - global and regional
- Constraints and opportunities across different contexts and regions
- Provision of food, feed, fibre, fuel, and ecosystem services from land
- Effectiveness of social and policy responses (public and private)
- Accounting for emissions and stocks in AFOLU and non-managed land for GST
- Case studies

Chapter 8: Urban systems and other settlements

- Links to climate change impacts and adaptation
- Links to sustainable development (including co-benefits, such as air quality and livelihood, synergies, and trade-offs)
- Demographic perspectives, migration, and urbanisation trends
- Consumption, lifestyle, and linkages between urban and rural areas
- Urbanisation wedge in future emissions and mitigation at global and national levels
- City emissions and drivers analysis, including waste and wastewater, city typologies

- Urban emissions and infrastructure lock-in
- Low-carbon city scenarios, options and costs, deep decarbonisation
- Urban form, design, and role of spatial planning
- Urban disruptive technologies and big data
- Innovative strategies and climate actions, urban experimentation, city networks and coalitions
- Urban mitigation governance – levels, barriers, and opportunities
- Policy instruments and infrastructure investments
- Rural settlements: leapfrogging opportunities
- Case studies

Chapter 9: Buildings

- Summary of key messages from AR5
- Components (building shell, appliances, lightning), system boundaries
- Links to SD
- Access to sector specific services (E.g. affordability, energy poverty)
- Services (including comfort, nutrition, illumination, communication)
- Mitigation options and strategies towards zero carbon buildings: developments since AR5 and emerging solutions
- Trends and Drivers (regional specificities)
- Systemic interactions, insights from LCA, MFA
- Scenarios, costs and potentials, links with targets (including sectoral targets)
- Sector specific policies and policy packages, financing, and enabling conditions
- Links to sustainable development (including co-benefits, synergies and trade-offs)
- Links to climate change impacts and adaptation options and its synergies and trade-offs with mitigation
- Regional specificities
- Case studies

Chapter 10: Transport

- Summary of key messages from AR5
- Components and system boundaries
- Links to SD
- Access to mobility services, affordability
- Aviation and shipping (including the treatment of aviation and maritime inventories)
- Mobility Services (passengers and goods)
- Mitigation options and strategies towards zero carbon transport: developments since AR5 and emerging solutions
- Mobility trends and drivers (regional specifies)
- Systemic interactions (E.g. energy sector, urban) and insights from LCA, MFA
- Scenarios, costs and potentials, links with targets (including sectoral targets)
- Sector specific policies and policy packages, financing. Enabling conditions
- Links to sustainable development (including co-benefits, synergies and trade-offs)
- Links to climate change impacts and adaptation options and its synergies and trade-offs with mitigation
- Regional specificities
- Case studies

Chapter 11: Industry

- What is new for AR6 based on knowledge gaps in AR5?
- Boundary and scope of the chapter
- Changing context: Paris Agreement, Kigali Agreement, SDGs, etc.
- Emission drivers, policies and trends
- Industrial development patterns and supply chains
- Circular economy
- Evolving demand for industrial products in the context of cross sectoral demand and supply developments
- Mitigation technologies, efficient system options and potential costs, including industrial waste and carbon capture and utilisation
- Scenarios and mitigation options for deep decarbonisation, potential costs and cross system implications
- Assessment of the effectiveness of policies
- Implications of ambitious climate targets and SD for future policy
- Knowledge gaps and FAQs

Chapter 12: Responses across and beyond sectors

- Scope of the chapter
- Competition for finite resources from large-scale land-based mitigation: land, water, management and governance
- Food systems including aquaculture and fisheries, regional aspects
- Interaction of food supply chains including food waste and human waste and leverages for mitigation, including emerging food technologies
- Links to adaptation and sustainable development (including co-benefits, synergies and trade-offs)
- Mitigation opportunities in diet changes
- Policies related to food system and food security including food waste and food demand
- Ocean based GHG removal techniques, potentials and spill-over effects, costs and governance
- Techniques for direct air capture of CO_2 and other GHGs, potentials and limitations, costs and governance
- Summary of sectoral costs and potentials
- Summary of sectoral co-benefits and trade-offs
- Ethics and governance of land, water and space based solar radiation management

Chapter 13: National and sub-national policies and institutions

- Cross-country lessons from NDC implementation, including national and sub-national plans and strategies
- Trends in national climate legislation, strategies and institutions, in the context of sustainable development
- Building public agreement - public opinion formation, media roles, policy frames and normative change
- Political systems and climate action – comparative case analysis
- Policy instruments and regimes – effectiveness, links to multiple objectives of sustainable development (including co-benefits synergies and trade-offs)

- Integrated analysis of sectoral policies – integration with national policy, interactions across sectors, policy packages, enabling conditions, and infrastructure planning and investment
- Institutions for climate governance – lessons from cross country experience, including for capacity building, coordination, implementation, and monitoring
- Subnational climate action, including cities and states/provinces - prevalence, effectiveness, and lessons from comparative cases
- Partnerships for climate governance – multi-sectoral networks of government, civil society and private sector, private governance, and community-led governance
- Metrics to monitor climate action in the context of sustainable development (including co-benefits, synergies and trade-offs) – national, sub-national, and local
- Mitigation and adaptation linkages

Chapter 14: International cooperation

- Lessons learnt from AR5 and what is new since AR5
- International cooperation and institutions
- Paris Agreement and UNFCCC- efficacy, implementation and enhancement
- International Civil Aviation Organization and International Maritime Organization
- International sectoral agreements and approaches
- Linkages with International Organizations and processes (E.g.: WTO, World Bank, G20, IRENA and others)
- Implementing the energy transition and mitigation pathways
- Enabling institutions for finance and investment
- Capacity building institutions and approaches
- International Partnerships, including business partnerships (E.g.: Oil and gas Climate Initiative)
- International co-operation at the regional, sub-national and city level
- Transparency and accountability frameworks
- Lessons of implementation from relevant international agreements outside the climate arena
- Links to non-climate development policy (SDGs)
- International climate policy and international emissions trading system

Chapter 15: Mobilising finance

- Lessons learnt from AR5 and what is new since AR5
- Need for finance – the Paris temperature targets and the NDCs
- Public climate finance flows, including multilateral and bilateral, and taking into account effectiveness and scaling up of such flows
- International private flows of climate finance
- National and sub-national climate finance mobilization and flows, including link to climate policy
- Links between national and international finance: Moving the Trillions, including innovative financial mechanisms and public-private partnerships
- Successful case studies
- The difference in climate-resilient financing consistent with 2, well-below 2 and 1.5 degrees scenarios or pathways
- Links to adaptation and sustainable development (including co-benefits, synergies and trade-offs)
- Financial accountability, including disclosure of climate risks to assets

- Emerging trend (E.g.: community involvement in climate finance, sustainable investment criteria by institutional investors)

Chapter 16: Innovation, technology development and transfer

- Relevant findings in AR5 and what is new since AR5
- Role of innovation, technology development, diffusion and transfer in sustainable development and the Paris temperature targets
- Innovation and technology as systemic issues, evaluating literature on cases of technological innovation systems and innovation policy
- Assessment of international institutions relevant to technology and innovation, including the Paris Agreement, UNFCCC Technology Mechanism
- Non-UNFCCC partnerships and cooperative approaches on R&D cooperation, such as Mission Innovation, Breakthrough Coalition and the Cement Sustainability Initiative.
- Capacity for transformative change, including, e.g., capabilities for innovation, governance, R&D cooperation and engineering capacity
- Assessment of experiences with accelerating technological change through innovation policy for climate change at the national level, including successful case studies
- Specific challenges in emerging economies and least-developed countries, e.g. SIDS and land-locked countries
- Acceptability and social inclusion in decision-making, communication and information diffusion
- Implications of new disruptive technologies
- Links to adaptation and sustainable development (including co-benefits, synergies and trade-offs)

Chapter 17: Accelerating the transition in the context of sustainable development

- Learning from integrative perspectives on sustainable development and climate change responses (synergies and trade-offs)
- Pathways for joint responses to climate change and sustainable development challenges
- Climate change mitigation responses in the context of multi-objective policies across scales
- Climate change mitigation response capacities and enabling conditions, including technology, finance & cooperation for sustainable development
- Mitigation-adaptation interlinkages, including potential synergies & conflicts
- Regional perspectives on climate change mitigation, including regional case studies on mitigation-adaptation interactions
- Other emerging issues dealing with climate change responses and sustainable development in relation to the Agenda for Development 2030 and beyond

ANNEX V: THEMES CUTTING ACROSS WORKING GROUPS

Several themes cut across different WGs. These topics must be considered in an integrated manner to guarantee consistency across the contributions of the different WGs to the AR6 and to avoid redundancy and/or overlapping content. Coordination between authors and TSUs is required to achieve a consistent treatment across the WGs and to strengthen the coherence of the AR6.

During the AR6 Scoping Meeting, an entire day (Day III – Wednesday, see Figure 1) was dedicated to cross-cutting Breakout Groups (X-BOGs). The Co-chairs, consulting their Bureaux, identified cross-cutting themes, which included: processes for integration during the AR6 cycle; risk and uncertainty analysis; geoengineering; scenario analysis; regional aspects; cities and urban systems; potential contributions to the global stocktake under the Paris Agreement; and adaptation and mitigation synergies. The X-BOGs were organised jointly by the three WGs. However, only their relevance for WG III is described below, including a description of where these methods and themes are located in the proposed WG III outline.

Consistent analysis of risk and uncertainty

Risk and uncertainty are crucial concepts when evaluating climate change mitigation. Therefore, they are explicitly included in the proposed outline of the WG III contribution to the AR6, particularly in Chapter 1 (Introduction and framing), Chapter 3 (Long-term mitigation goals and pathways), Chapter 4 (Mitigation and development pathways in the near- to mid-term), and Chapter 15 (Mobilising finance).

During the AR6 Scoping Meeting, participants proposed further improvements to the AR5 risk framework, in order to develop an updated framework that better incorporates the science from all WGs and makes climate risk more salient to users.

Such widening of the concept is already reflected in the evaluation of risk in relation to metrics other than temperature (e.g., rate of change, ocean acidification, and sea level rise (IPCC AR5 SYR). A more integrated framework may be able to provide connections between the assessment of quantifiable climate risks with the more qualitative resolution of the risks identified in the WG II regional and sectoral analysis. It could also contribute to defining opportunities for mitigation options and their risks.

In order to bring coherence to the report across the three WGs, participants recommended the adoption of a common AR6 terminology and glossary definitions on hazard, vulnerability, and exposure. Lessons could be learned from other frameworks, for example the Sendai Framework, and from the conceptualisation of climate risks emerging from the private sector, notably from finance and insurance. Participants also suggested early coordination between the WGs and the elaboration of *Uncertainty Guidance*. During the X-BOG, participants identified the competence of WG III with regard to risk- and uncertainty-related issues:

- Consideration of the role of risk perception, risk attitudes, and the capacity to react by decision makers, business (E.g., farmers), and individuals in assessing the efficacy of mitigation policies;
- Risks associated with low probability, high-climate-change scenarios which may dominate the assessment of the expected benefits of mitigation;
- Based on information from WG I and WG II, evaluation of climate mitigation impacts along with the most likely outcomes.

Geoengineering evaluation

Geoengineering is an *umbrella* term widely applied in the literature to describe climate interventions that deliberately change the Earth's atmospheric composition or climate system with the aim of limiting adverse global warming. The most discussed categories are carbon dioxide removal (CDR) and solar radiation management (SRM). Given that these are categorically different (as highlighted in the AR5), there is a clear need to separate their assessment in AR6.

Following literature updates since AR5, CDR is explicitly included in the WG III contribution to the AR6 outline, including in the Introduction and Framing (Chapter 1), the high level chapters on recent trends and future pathways Chapters (2-4), sectoral chapters, mainly in Chapter 6 (Energy systems), Chapter 7 (AFOLU), Chapter 11 (Industry) and Chapter 12 (Responses across and beyond sectors), and in Chapter 16 (Innovation, technology development and transfer). SRM is included only in Chapter 12.

Experts identified several aspects that need close coordination between WG III and other WGs. For CDR, this includes the potential for carbon removal, the carbon cycle, water surfaces and social acceptability. For SRM, relevant topics included radiative forcing, risks, governance and ethics and social acceptance. Mechanisms to facilitate alignment across WGs could be cross-cutting platforms with different WG authors to establish a common base of work in the AR6 preparation.

Scenario analysis

Scenario analysis of climate pathways is a framing issue in the WG III outline. Evaluation methods for model frameworks, analysis, top-down/bottom-up approaches, and scenario frameworks are introduced in Chapter 1 (Introduction and framing), and further detailed in Chapter 2 (Past emissions trends and drivers), Chapter 3 (Long-term mitigation goals and pathways), and Chapter 4 (Mitigation and development pathways in the near- to mid-term). The last chapter of the outline, Chapter 17 (Accelerating the transition in the context of sustainable development) wraps up scenario perspectives in terms of climate strategies and regional perspectives on sustainable development.

Scoping Meeting participants identified the following topics which require better integration across WGs: (i) consistent characterisation of climate projections, including historical baselines, climate response, carbon budget and its drivers, (ii) consistent alignment of climate model outcomes (CMIP 5 and 6) and the matching of CMIP information to the SSPs and to MAGICC outputs; (iii) coherent definition of scenario elements, including common SSPs, RCPs or global average temperature levels, regional scenarios, climate-resilient sustainable development pathways, transformative, vulnerability and adaptation pathways (e.g., the difference in outcomes over different time horizons for reaching goals), and short-lived climate forcers; (iv) integrated synthesis of scenario-based research; and (v) t a shared scenario framework for assessment.

In order to facilitate the coordination of WGs, participants suggested establishing a common set of scenarios across WG reports to develop consistent indicators to characterise scenario outcomes, to ensure cross-WG expertise in scenario-related chapter author and reviewer teams and to create a scenario team to develop guidelines on scenarios and their use. The individual WG contributions to AR6 should include scenario approaches in their respective framing chapters, be explicit about scenario-related content in which chapter outline and identify chapters with scenario-relevant content/interfaces to enable the selection of authors with scenario expertise. In addition, it was suggested that WGs set up internal scenario teams to coordinate across chapters . For the SYR, the recommendation was to strongly

consider using the scenario framework to synthesize results (scenarios as connectors across WG results), with scenarios distinguished according to temperature ranges. It was recommended that scenario researchers be included in writing teams.

Regional aspects

Regional aspects are an integral part of the WG III contribution to AR6 and will be addressed wherever appropriate within individual chapters. Common and specific regional aspects will be addressed in the early chapters (Chapter 1-5), in all sectoral chapters (Chapters 6-11), and in the final Chapter 17. Case studies in cross-cutting Chapters 13-16 could explicitly address regional aspects of climate mitigation governance, institutions and policies.

Consistent treatment of regional issues requires cooperation across all three WGs, including a need to better understand the different scientific cultures and priorities, as well as the complications of different use of language. It is important, for instance, to align information from WG I models with WG II and III assessments of regional literature.

Cities and urban systems

While climate change is an environmental problem at a planetary scale, impacts and mitigation strategies are different across cities and urban systems. Following AR5, cities and urban systems have become an important focus of potential mitigation strategies (smart cities, urban planning, sustainable design, green consumption and production, links to investments, sustainable water and waste management, air pollution co-benefits). The proposed WG III outline contains a specific chapter on urban systems and other settlements (Chapter 8). In addition, the transport and industry chapters, 10 and 11, will also asssess city-level issues, such as waste, energy flow, mobility, etc.

To harmonise concepts and methodological aspects, participants agreed that there should be strong coordination among the WGs during the AR6 writing process on the assessment of the urban literature related to climate change. Mechanisms to facilitate cross-cutting group collaboration need to be considered. Potential options might include dedicated groups of authors and Bureau Members and the adoption of harmonised tools and databases (e.g., remote sensing, data, Global Risk Atlas).

Global stocktake

The UNFCCC's Paris Agreement includes provision for a five-year Global Stocktake, including the assessment of mitigation pathways from 2023 onwards. In this context, the IPCC is considering the provision of relevant information and the alignment of its assessments with the global stocktake cycle. To this end, the WG III contribution will assess literature on the collective progress towards achieving the purpose of the Paris Agreement and its long-term goals. This is explicitly in the outline of WG III contribution report, especially in the early chapters, namely in Chapter 1 (Introduction and Framing), Chapter 2 (Past emissions trends and drivers) Chapter 3 (Long-term mitigation goals and pathways), and Chapter 4 (Mitigation and development pathways in the near- to mid-term).

Experts at the Scoping Meeting identified crosscutting issues that require further harmonisation between WG III and other WGs:

- insight into temperature and emission pathways, including peaking and balancing sources and sinks (WG I → WG III);
- up-to-date assessment of climate sensitivity and carbon cycle/climate feedbacks and the carbon budget (WG I → WG III);
- insight into mitigation options, and their effectiveness and sustainability, perhaps drawing upon case studies (WG III → WG I and II);
- Assessment of relation between adaptation needs, and its limits, and mitigation efforts required at different levels of global temperature change (WGII → WGIII);
- informing the distinction between "development" and "adaptation" (WGII → WGIII) ;

- o Assessment of options for decarbonisation in different sectors, and the effectiveness of options such as technology development and dissemination (WG III → WG I and II);
- o Potential assessment of the effectiveness of financial support (WG III → WG I and II); and
- o Synthesis of the literature/concepts related to mitigation financial flows (WG III → WG I and II)

Adaptation and mitigation synergies

Synergies and trade-offs between mitigation and adaptation are addressed throughout the proposed WG III outline, particularly in Chapter 3 (Long-term mitigation goals and pathways), and in Chapter 4 (Mitigation and development pathways in the near- to mid-term), as well as in the sectoral chapters (Chapter 6-10), including urban and rural considerations. Mitigation and adaptation synergies and trade-offs are also evaluated in relation to responses across and beyond sectors (Chapter 12), national and sub-national policies and institutions (Chapter 13), mobilisation of climate finance (Chapter 15), Innovation, technology development and transfer (Chapter 16), and acceleration to the transition in the context of sustainable development (Chapter 17). Participants in the scoping meeting recommended the creation of cross-cutting groups to deal with synergies and trade-offs between adaptation and mitigation: (i) analysis of the economic and social benefits of mitigation and adaption including avoided impacts in the context of sustainable development (the work of this group could lead to a potential joint chapter of WG II and WG III); and (ii) social aspects (e.g., geopolitical, gender, ethnic, equity) of the impacts of adaptation and mitigation in the context of sustainable development.