

The South African regulatory framework pertaining to bio-energy as a climate change mitigation driver in SADC

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ABSTRACT

Abrupt changes in our planetary climate system are one of the greatest threats to humanity's continued existence on the planet. These changes are exacerbated by the emission of greenhouse gases (GHG) into the atmosphere as a result of various anthropogenic activities. To curb this atmospheric anomaly, the international climate change mitigation mandate was established under the auspices of the United Nations Framework Convention on Climate Change (1992), the *Kyoto Protocol* (1996) and the *Paris Agreement* (2015). However, as the energy sector accounts for a vast majority of these emissions, discrepancies exist surrounding the extent to which countries have contributed to climate change. Therefore, the mandate prescribed by these instruments is subject to equity considerations such as the principle of common but differentiated responsibilities and respective capabilities.

Subsequently, mitigation within the energy sector facilitates a significant role in addressing the rate at which the greenhouse effect impacts on the global climate. Accordingly, renewable energy provides a means to displace fossil-fuels and mitigate climate change while continuing to nurture the development aspirations of individual countries. In this respect, many of the countries in the Southern African Development Community have a large proportion of their population that are without modern energies such as electricity. Consequently, traditional bio-energy technologies are still widely exploited within these areas to meet the energy demands of these indigenous people. However, as a region rich in biomass this renewable form of energy should not be exploited frivolously and should rather be managed in a way which allows for the development of these traditional bio-energy technologies along with their modern counterparts. Subsequently, this study explores these bio-energy considerations, conducting a country-specific analysis identifying how the South African regulatory framework on bio-energy contributes to achieving the objective of climate change mitigation in SADC.

Keywords: Climate Change; mitigation; renewable energy; bio-energy; SADC; regulatory framework

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LIST OF ABBREVIATIONS

AAUs	Assigned Amount Units
CBDR-RC	Common but Differentiated Responsibilities and Respective Capabilities
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CH ₄	Methane
CMA	Meeting of the Parties to the Paris Agreement
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
COP	Conference of the Parties
DNA	Designated National Authority
DOE	Designated Operational Entity
DTU	Technical University of Denmark
EB	Executive Board
ERUs	Emission Reduction Units
GHG	Greenhouse Gas
GWh	Gigawatt hours
HFCs	Hydrofluorocarbons
IDS	Institute of Development Studies
IEP	Integrated Energy Plan
INDC	Intended Nationally Determined Contributions
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
kWh	kilowatt hour

LTMS	Long-Term Mitigation Scenarios
LULUCF	Land-Use, Land-Use Change and Forestry
Mt	Megatonnes
MW	Megawatt
N ₂ O	Nitrous oxide
NCCRP	National Climate Change Response White Paper
NDC	Nationally Determined Contributions
NDP	National Development Plan
NEES	National Energy Efficiency Strategy
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management: Air Quality Act
NF ₃	Nitrogen Trifluoride
PDD	Project Design Document
PFCs	Perfluorocarbons
PP	Project Participants
PPD	Peak, Plateau and Decline
PPP	Pollution Prevention Plans
QELRC	Quantified Emission Limitation or Reduction Commitments
RE	Renewable Energy
REN21	Renewable Energy Policy Network for the 21st century
RMUs	Removal Units
SADC	Southern African Development Community
SAPP	Southern Africa Power Pool
SDG	Sustainable Development Goals
SDM	Sustainable Development Mechanism
SERPs	Sector Emission Reduction Plan

SETs	Sectoral Emission Targets
SF6	Sulphur hexafluoride
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

1 Introduction

1.1 Background

The countries comprising the Southern African Development Community (SADC) share in the international obligation to mitigate the emission of greenhouse gases (GHG). In terms of Article 2 of the *United Nations Framework Convention on Climate Change* (1992) (UNFCCC) the general international mitigation mandate relates to parties stabilising the quantity of GHG concentrations in the atmosphere within a reasonable period to provide ecosystems with adequate time to adapt, ensure food production is not negatively affected and allow for continuous economic development in the face of climate change. This general mitigation mandate is subject to the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC).¹ The principle acknowledges that there exists a distinct historical variant to the contributions of developed and developing nations to the ubiquitous changes in the climate system.² It further recognises that unlike developing countries, developed nations have had an extensive period of fossil fuel exploitation propelling their development, which places them in a better position to address climate change issues because of their economic and technical capacities.³ The CBDR-RC principle subsequently tasked developed nations with taking the lead to mobilise intergovernmental efforts to combat climate change while a less stringent onus was placed on developing countries to assist in these efforts.

The *Paris Agreement* (2015) is the latest international instrument addressing climate change. Adopted at the 21st Conference of the Parties (COP), the aim of the Paris Agreement is to enhance the implementation of the UNFCCC and keep global temperature increase beneath two degrees Celsius above pre-industrial levels.⁴ The Agreement further urges countries to peak their GHG emissions as soon as possible.⁵ However, in the 23 years following the UNFCCC, leading up to the adoption of the

¹ Article 3(1) UNFCCC.

² Lee 2015 *Vermont Journal of Environmental Law* 28.

³ Lee 2015 *Vermont Journal of Environmental Law* 37.

⁴ Article 2(1)(a) of the Paris Agreement.

⁵ Article 4(1) of the Paris Agreement.

Paris Agreement, developing nations have steadily increased their contribution to total global GHG emissions, seemingly looking to take advantage of the CBDR-RC principle. The Paris Agreement recognises this shortcoming and attempts to address the issue by including developing country parties to undertake specific mitigation measures. The most notable is the intended nationally determined contributions (INDC) which is the primary mechanism available to individual parties to communicate what steps they are intending to take nationally to achieve the objective of the Paris Agreement.⁶ By taking domestic circumstances and capacities into consideration, the INDC serves as the platform to involve developing regions in the pursuit of mitigation objectives.

The measures to be implemented in order to reach the mitigation objectives contained in the UNFCCC and Paris Agreement are to be found in the text of the *Kyoto Protocol* (1997). The Kyoto Protocol provides specific mitigation objectives to be reached and makes available flexible mechanisms to achieve these ends. These include Emissions Trading, Joint Implementation and the Clean Development Mechanisms (CDM).⁷ The CDM's provide developed countries with certified emissions credits, which allow them to take advantage of lower-cost emission reduction projects outside their own territories. They can subsequently use these credits to offset their own emissions and help them reach their emissions targets.⁸ The CDM's are of specific relevance to the current study, because bio-energy projects can be identified as emission reduction initiatives that are associated with energy sector reform.

1.2 Bio-energy and climate change mitigation in SADC

All members of SADC are ratifying states to the UNFCCC, the Kyoto Protocol and have signed on to the Paris Agreement and therefore have a duty to align their individual and collective mitigation actions with the measures prescribed by these

⁶ Article 3 of the Paris Agreement.

⁷ Article 7; Art 12; Art 17 of the Kyoto Protocol.

⁸ United Nations Framework Convention on Climate Change *Kyoto Protocol Reference Manual* 16.

documents.⁹ In this respect, the *Treaty of the Southern African Development Community* (1992) (SADC Treaty) mandates the co-operation of member states to integrate legal frameworks on areas of common concern.¹⁰ Climate change is undoubtedly one of these areas, although at the sub-regional level no single multilateral agreement exists on climate change that reflects the common position of all SADC member states.¹¹ However, policy documents have been accepted, the most prevalent of which is the *Southern Africa Sub-Regional Framework of Climate Change Programme 2010*. These policy documents, although not legally binding, provide a platform that guides the actions of individual states in their collective climate change mitigation efforts.

Another significant area of common concern which is interrelated with the above is the trans-boundary implications associated with energy sector activities. Although the overall percentage of GHG emissions of the SADC region are low compared to global scales, if the current fossil fuel reliance persists, coupled with the steady increase in the population the outcome could be contradictory to climate change mitigation efforts of the SADC region.¹² In this respect, the *SADC Protocol on Energy* (1996) (Energy Protocol) is the legal instrument that attempts to bring about harmonisation of sub-regional and national energy policies, strategies and programmes.¹³ The Energy Protocol further reiterates the mandate for sub-regional co-operation as contained in the SADC Treaty and prescribes the development and utilisation of new and renewable energy sources within the SADC region, the process of producing bio-energy from bio-mass potentially falls within this mandate.¹⁴

⁹ United Nations Framework Convention on Climate Change 2017 http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php; United Nations Framework Convention on Climate Change 2017 http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php; United Nations Framework Convention on Climate Change 2017 http://unfccc.int/paris_agreement/items/9444.php.

¹⁰ Article 21 of the Southern African Development Community 1992.

¹¹ Barnard 2014 *Journal of Energy in Southern Africa* 28.

¹² Barnard 2014 *Journal of Energy in Southern Africa* 29.

¹³ Article 3 (1) of SADC Protocol on Energy 1996; Barnard "Access to bio-energy vis-à-vis biodiversity conservation in SADC" 334.

¹⁴ Article 3 (3) Energy Protocol; Barnard "Access to bio-energy vis-à-vis biodiversity conservation in SADC" 323.

1.3 The regulation of bio-energy as climate change mitigation driver in South Africa

Currently, of the fifteen countries that are part of SADC, South Africa stands head and shoulders above the rest in relation to GHG emissions stemming predominately from its energy sector because of the countries' heavy reliance on fossil fuels.¹⁵ Although, as a ratifying party to the UNFCCC, Kyoto Protocol and the Paris Agreement, South Africa has voluntarily pledged to participate in the global climate change mitigation effort through *inter alia* energy sector reform.

Accordingly, the South African government set forth in the *White Paper on the Energy Policy of the Republic of South Africa* of 1998 (Energy White Paper) that the research, development and application of renewable energy initiatives must be undertaken to provide a more sustainable energy mix in the Republic. Additionally, the *White Paper on the Renewable Energy Policy of the Republic of South Africa* of 2003 (RE White Paper) provides that this sustainable energy mix must incorporate biomass into energy production. To strengthen the energy mix, increased consumption and generation of renewable energy is required by the *National Energy Act* 34 of 2008. Moreover, the *National Development Plan 2010 – 2030* of 2012 (NDP), the *Integrated Energy Plan* and the *National Climate Change Response White Paper* of 2011 (NCCRP) *inter alia* highlight the contribution of increased renewable energy production to climate change mitigation.

Although South Africa is a major energy-related GHG emitter, the country's existing climate change framework and energy legal framework provide a solid basis to conduct a country-specific analysis, in order to determine how the regulation of bio-energy and energy sector reform essentially may influence climate change mitigation action throughout the SADC region.

¹⁵ Barnard 2014 *Journal of Energy in Southern Africa* 31.

1.4 Research question

This study subsequently postulates the following question: How does the South African regulatory framework on bio-energy contribute to achieving the objective of climate change mitigation in SADC?"

1.5 Overview of this mini-dissertation

Against this backdrop this study attempts to answer the research question through an investigation under the following chapters. At the outset, Chapter 2 of this study examines the international legal mandate for climate change mitigation, identifying how the CBDR-RC principle has evolved within the climate regime to promote equity and the inclusion of all nations in the struggle against climate change. This chapter further addresses the CDM and the significance that this market-based instrument has had for developed and developing countries alike in providing direct influence on the global climate. This is followed by Chapter 3 which distinguishes between traditional and modern bio-energy technologies and discusses how the utilisation of bio-energy may be identified as a climate change mitigation driver. Chapter 4 investigates the climate change mitigation mandate of the SADC region and how energy sector activities intertwine with this mandate. In addition, it concentrates on the South African bio-energy regulatory framework and its role in the pursuit of climate change mitigation in SADC. Finally, Chapter 5 will provide a conclusion to the study and present recommendations which align with the objectives of this mini-dissertation.

1.6 Research Methodology

The study will comprise a literature review focusing on international, sub-regional and local climate change mitigation measures. The study will consider all relevant legislation, textbooks, policy documents and applicable electronic resources, specifically concentrating on international and South African instruments relating to the objective of climate change mitigation in the SADC region.

2 The international legal mandate for climate change mitigation

2.1 Introduction

In a New York Times article dated 23 March 2018, the United Nations Secretary General, António Guterres, proclaimed, as many have, that Climate change is "the most systemic threat to humankind".¹⁶ The ubiquitous nature of the problem will affect every facet of human existence directly or indirectly; for instance, in relation to basic human physiological needs such as food, water, shelter and safety.¹⁷ Changes in the climate system will inflict additional stresses on these fundamentals of human survival thereby exacerbating food security, water scarcity, resource conflicts, health concerns and displacement. In developing countries these adverse impacts will be aggravated due to high population densities, insufficient capacity to deal with climate impacts and poverty.¹⁸ Nevertheless, sovereign nations have been ineffective in reaching prompt unanimous consensus to address this potentially apocalyptic dilemma. This can in part be attributed to short-term political objectives, economic agendas and governmental prioritisation of developmental issues over long-term climate concerns.¹⁹ However, the global intricacy of the issue necessitates the harmonisation of domestic considerations and supranational co-operation if there is to be any hope of facilitating significant intervention to safeguard humanity's common interests.²⁰

Despite the egocentricity of sovereign states hampering the call for humanity to act against the uncertainty of climate change, there has been movement in the right direction. The development of an international climate regime, is testimony to the recognition by the global community of the dangers posed by the anthropogenically induced volatility observed in the climate system.²¹ Under the auspices of this regime, mitigation action is a critical component of the global communities' efforts

¹⁶ Sengupta 2018 <https://nyti.ms/2GkG215>.

¹⁷ Ruppel "Intersections of Law and Cooperative Global Climate Governance" 41.

¹⁸ Lawrence *Justice for Future Generations Climate Change and International Law* 6.

¹⁹ Bodansky, Brunnée and Rajamani *International Climate Change Law* 4.

²⁰ Haibach and Schneider "The Politics of Climate Change: Review and Future Challenges" 358.

²¹ Reddy *Climate Resilient Agriculture for Ensuring Food Security* 8.

to address climate change.²² Mitigation measures necessitate the limitation and reduction of GHG emissions at their source and the enhancement and preservation of reservoirs and sinks through human intervention.²³ The CBDR-RC principle underpins this mitigation mandate and requires domestic considerations be taken into account during its implementation.²⁴

This chapter analyses the development of the international climate regime since the adoption of the UNFCCC, as it relates to the international legal mandate for climate change mitigation, concentrating primarily on the UNFCCC, the Kyoto Protocol, the Paris Agreement and related decisions of the parties. The chapter further draws attention to the equity underpinning of the regime, specified by the CBDR-RC principle and how its evolution has sought to promote fairness in achieving the mitigation objectives of the climate regime. Additionally, the CDM market-based instrument will be discussed under the Kyoto Protocol in relation to the international mitigation mandate, and how projects such as bio-energy production may facilitate carbon offsets to achieve these mitigation objectives. Further, it discusses the impacts that the Paris Agreement has had on the continuation of the CDM and how it may influence mitigation outcomes.

2.2 The United Nations Framework Convention on Climate Change

The adoption of the UNFCCC lays the foundation for the international climate regime to combat the adverse anthropogenic impacts on the global climate system. The ultimate mitigation objective of the Convention is to stabilize the concentration of GHGs in the atmosphere in a timeframe and manner that would allow ecosystems to acclimatise to these changes, safeguard food production and not disturb economic development.²⁵ Correspondingly, this aspiration not only relates to the Convention, but also to any legal instruments adopted by the COP, thereby establishing a central goal for the climate regime.²⁶ The Convention subsequently

²² Bodansky, Brunnée and Rajamani *International Climate Change Law* 12.

²³ Maguire "Foundations of International Climate Law: Objectives, Principles and Methods" 84.

²⁴ Article 4(1) of the UNFCCC.

²⁵ Article 2 of the UNFCCC.

²⁶ Maguire "Foundations of International Climate Law: Objectives, Principles and Methods" 85.

provides the vehicle for parties to commence activities to achieve this objective by prescribing commitments that apply specifically and generally to member states.

2.2.1 CBDR-RC principle and the UNFCCC

The equity concerns surrounding the climate regime required the UNFCCC to depart from the traditional approach in international agreements whereby all parties are subject to collective obligations.²⁷ In this respect, the CBDR-RC principle acknowledges that all sovereign nations have a responsibility to safeguard humanity's common interests in relation to the climate system. However, these responsibilities are differentiated, attributable to considerations such as the distinct historical contributions of developed and developing nations. For instance, developed countries have benefited from an extensive period of fossil fuel exploitation propelling development, but also exacerbated climate change.²⁸ Therefore, developed nations are in a better position to address climate change issues because of their respective capabilities to avert, decrease and manage climate-related problems, while developing countries who have not enjoyed the same rate of development and played a lesser role have special domestic needs and circumstances.²⁹

Subsequently, the CBDR-RC principle by itself does not confer legal obligations as it does not comply with the requirements to be recognized as international customary law. However, this general principle of international law has significantly contributed to the promotion of equity in the climate regime.³⁰ Subsequently, under the Convention the inclusion of the CBDR-RC principle requires the protection of the climate system and the promotion of supranational cooperation, intragenerational equality and intergenerational equality balanced against the need for differentiation of parties' commitments.³¹ Accordingly, the Convention takes a *"categorical*

²⁷ Bodansky, Brunnée and Rajamani *International Climate Change Law* 27.

²⁸ Lee 2015 *Vermont Journal of Environmental Law* 28.

²⁹ Abeyasinghe and Arias "CBDR as a Principle of Inspiring Actions rather than Justifying Inaction in Global Climate Change Regime" 237.

³⁰ Abeyasinghe and Arias "CBDR as a Principle of Inspiring Actions rather than Justifying Inaction in Global Climate Change Regime" 238.

³¹ Article 3.1 and the Preamble of the UNFCCC.

approach to differentiation" whereby parties are catalogued into different groups and commitments are attached to each group.³²

2.2.2 *Specific mitigation commitments*

This dichotomy between Annex I and non-Annex I parties is the underlying basis for determining the extent of parties' obligations under the UNFCCC. Although SADC countries such as South Africa are non-Annex I parties and have no specific commitments under the UNFCCC, these obligations have remained influential for the development of the international climate regime. The document sets forth that Annex I parties, considering their individual circumstances, are to take the lead in achieving the ultimate objective of the Convention and provides specific mitigation commitments for these parties.³³ Subsequently, Annex I parties are to co-operatively or independently establish and report on national policies and measures on climate change mitigation, considering the best available scientific knowledge.

Additionally, Annex I parties are to coordinate relevant economic and administrative instruments, identifying and periodically reviewing policies and practices which exacerbate the greenhouse effect.³⁴ This was done with the aim of returning CO₂ emissions and emissions not controlled by the *Montreal Protocol* (1987) to 1990 levels by the year 2000.³⁵ However, these commitments are expressed in a relatively vague manner, to allow for maximum participation and flexible application.³⁶ Irrespective of the Conventions soft legal nature it has prompted member states to publicly disclose how they intend to address climate change concerns.

Significant in the context of encouraging general mitigation commitments from non-Annexed parties, the UNFCCC necessitates that Annexed parties and those included in Annex II to the convention shall make available financial support to developing countries, to achieve their general commitments under the treaty.³⁷ Subsequently,

³² Bodansky, Brunnée and Rajamani *International Climate Change Law* 28.

³³ Article 4(2)(a) of the UNFCCC.

³⁴ Article 4(2)(e) of the UNFCCC.

³⁵ Bodansky, Brunnée and Rajamani *International Climate Change Law* 132.

³⁶ Pereira and Jourdain "International and EU Climate Change Law" 142.

³⁷ Bodansky, Brunnée and Rajamani *International Climate Change Law* 138.

it requires that additional, adequate and predictable funding be made available to meet the full cost incurred by developing countries in complying with their obligations.³⁸ Furthermore, these parties are to take all practicable measures to assist in the transferral and access to relevant technologies and experiences to other parties, particularly developing countries.³⁹ These financial burdens further assert the obligation placed on Annexed parties under the UNFCCC to take the helm when traversing climate change considerations.

2.2.3 General mitigation commitments

The general commitments under the UNFCCC apply to both Annex I and non-Annex I parties. These commitments require member states to formulate, publish and periodically update inventories of their emissions by source and removal by sinks of GHGs.⁴⁰ Additionally, they are required to establish programmes nationally and where applicable regionally, containing measures to mitigate climate change by addressing emissions by sources and removal by sinks.⁴¹ Furthermore, it advises concentrating efforts on the transference of emissions reduction technologies, conservation and enhancement of sinks and reservoirs, promotion of information exchange, research, education, public awareness and training.⁴² Moreover, the Convention calls for climate change dynamics to be considered in existing domestic policies of individual states.⁴³

Consequently, these general commitments prescribe duties for developing countries such as those in the SADC region to address climate mitigation factors domestically. This consideration therefore asserts that differentiation under the annexed dichotomy does not provide developing countries with permission to further contaminate the climate system.⁴⁴ On the contrary, this distinction framed by limited

³⁸ Article 4(3) of the UNFCCC.

³⁹ Article 4(5) of the UNFCCC.

⁴⁰ Article 4(1)(a) of the UNFCCC.

⁴¹ Article 4(1)(b) of the UNFCCC.

⁴² Article 4(1)(c), (d), (g), (h) of the UNFCCC; Art 5 of the UNFCCC; Art 6 of the UNFCCC.

⁴³ Article 4(1)(f) of the UNFCCC.

⁴⁴ Abeyasinghe and Arias "CBDR as a Principle of Inspiring Actions rather than Justifying Inaction in Global Climate Change Regime" 238.

obligations and financial and technical support attempted to incentivize non-Annexed countries to participate in the climate regime. Despite this, the separation of the substantive content of parties' commitments, in relation to achieving mitigation objectives, has been a contentious issue throughout the history of the climate regime.⁴⁵

2.3 *Kyoto Protocol*

Although the Convention provided the blueprint for the climate regime, through its principles, objectives and establishment of institutions and processes, the international community asserted that the emission reduction provisions of the Convention were insufficient. Consequently, scarcely a year after the coming into force of the UNFCCC, states drew attention to this inadequacy and advocated that more specific emission limitation targets be set.⁴⁶ This led to the adoption of the *Berlin Mandate* (1995) at COP 1 establishing the Ad Hoc Group on the Berlin Mandate to negotiate a new legal instrument.⁴⁷ These negotiations gave rise to the Kyoto Protocol that entered into force in 2005 establishing nationally determined, internationally negotiated, legally binding, quantified emission limitation or reduction commitments (QELRC).

2.3.1 *CBDR-RC principle and the Kyoto Protocol*

The Kyoto Protocol attempts to reinforce and strengthen the mitigation commitments of Annex I parties under Article 4.2 of the UNFCCC, that sets out their specific mitigation commitments. Subsequently, it does not provide quantitative emission targets or additional commitments for developing country parties.⁴⁸ This limitation of commitments to Annexed countries indicates that the Kyoto Protocol continues the categorical differentiation of the UNFCCC in accordance with the CBDR-RC principle.⁴⁹ Additionally, the Protocol further distinguishes and prescribes

⁴⁵ Bodansky, Brunnée and Rajamani *International Climate Change Law* 28.

⁴⁶ Pallangyo *Climate change and Africa: The normative framework of the African Union* 66.

⁴⁷ Bodansky, Brunnée and Rajamani *International Climate Change Law* 160.

⁴⁸ Rajamani "From Berlin to Bali and Beyond: Killing Kyoto Softly?" 912.

⁴⁹ Article 10 of the Kyoto Protocol.

specific commitments, targets and timetables to each party specified under Annex B of the Protocol.

Under the auspices of the Kyoto Protocol emission targets are strict, legally binding and precise due to their quantitative nature and address an extensive array of economic sectors.⁵⁰ Simultaneously, the Protocol provides options such as the market-based mechanisms that allow parties to determine nationally how they intend to achieve their mitigation objectives. In this way, the Protocol provides a compliance structure which is strict yet flexible to assist in the achievement of emission targets.

2.3.2 The Kyoto market-based mechanisms

After the Kyoto Protocol was finalized, several key issues relating to its implementation still had to be flushed-out under the supervision of the climate regime. One such matter concerned the operationalization of the market mechanisms available to Annex B parties.⁵¹ Subsequently, consensus relating to these mechanisms was reached after 3 years of negotiations, culminating at COP 7 with the *Marrakesh Accords* (2001).⁵² These market-based mechanisms are Emissions Trading, Joint Implementation and the CDMs which assist Annexed parties in achieving their specific emission targets cost-effectively.⁵³ The notion behind the mechanisms assert that the emission reduction retains the same effect in slowing global warming irrespective of where they occur; for that reason reductions can be made where it is most cost-effective.⁵⁴

These mechanisms through their implementation generate emission units, which is denominated as a unit equal to one metric ton of CO₂ equivalent (CO₂e). These

⁵⁰ Bodansky, Brunnée and Rajamani *International Climate Change Law* 169.

⁵¹ David "The UN Framework Convention on Climate Change, the Kyoto Protocol, and the Kyoto Mechanisms" 8.

⁵² Netto and Schmidt "CDM Project Cycle and the Role of the UNFCCC Secretariat" 196.

⁵³ Vlachou and Konstantinidis *Review of Radical Political Economics* 35.

⁵⁴ Bodansky, Brunnée and Rajamani *International Climate Change Law* 179.

emission units can be separated into four variants.⁵⁵ Firstly assigned amount units (AAUs) produced straight from emission targets; Secondly, Emission Reduction Units (ERUs) awarded through Joint Implementation. Thirdly, Removal Units (RMUs) from sink activities such as land-use, land-use change and forestry (LULUCF) and Fourthly, Certified Emission Reductions (CERs) generated through implementation of the CDMs. However, there is a quantified limit placed on the amount of CERs and RMUs which developed countries can claim to achieve their emission commitments in order to prevent surplus emission credits from flooding the carbon market.⁵⁶ Nevertheless, the Protocol stipulates that the mechanisms only serve a supplementary role and that domestic action shall be fundamental in achieving parties QELRCs.⁵⁷

SADC countries as non-Annexed parties are not permitted to participate in the first two market-based mechanisms, but may host CDM projects that may contribute to the mitigation of GHG emissions. The CDM, as with all projects, comprises several phases which constitute the life-cycle of the project. The first step in this cycle is the design phase, which requires the project participants (PP) to make available information about the suggested CDM. This is done on the prescribed project design document (PDD) in accordance with established methodological baseline estimates and monitoring guidelines.⁵⁸ This phase is then followed by validation of the CDM activities by the designated operational entity (DOE) who insures that all requirements and national approvals and sustainable development criteria from the Designated National Authority (DNA) have been adhered to and may then request registration for the CDM-PDD.⁵⁹

Once the activities have been validated by the DOE, a request for registration of the project by the CDM Executive Board (EB) may be submitted. This registration shall

⁵⁵ Niland, Rumble and Lau "Towards Sustainable Development an African Perspective on Reforming the Clean Development Mechanism" 144; United Nations 2018 http://unfccc.int/kyoto_protocol/registry_systems/registry_functions/items/4066.php.

⁵⁶ Vlachou and Konstantinidis *Review of Radical Political Economics* 41; Netto and Schmidt "CDM Project Cycle and the Role of the UNFCCC Secretariat" 197.

⁵⁷ Article 6(1)(d) of the Kyoto Protocol.

⁵⁸ Netto and Schmidt "CDM Project Cycle and the Role of the UNFCCC Secretariat" 186.

⁵⁹ Netto and Schmidt "CDM Project Cycle and the Role of the UNFCCC Secretariat" 187.

serve as formal acceptance by the EB of the validity of the project.⁶⁰ The implementation of the project activities is monitored by the PP in accordance with the established methodology included in the CDM-PDD monitoring plans.⁶¹ The DOE verifies that GHG emission reductions have occurred in accordance with the amounts specified by the monitoring reports, made available by the PP. The DOE in turn provides written certification that the project activities have achieved these reductions.⁶² This verification and certification finally triggers the issuance of CERs that Annexed parties may use to achieve their commitments under the Protocol.⁶³ Accordingly, for CDMs to generate CERs, it must be confirmed that the project has reduced emissions that would otherwise have ended up in the atmosphere if intervention through the project had not occurred.⁶⁴

The CDM projects have widely been criticized due, *inter alia*, to financial concerns, fears of ecological impacts, and proliferation of projects in specific geographic locations.⁶⁵ Nevertheless, due to their flexibility, Annexed parties have continued to endorse the implementation of these mechanisms when formulating compliance strategies and have substantially influenced their development. These projects essentially provide the means for joint implementation amongst Annex B and non-Annex B parties.⁶⁶ The CDM project-based mechanism permits Annexed parties to reduce emissions or enhance sinks in non-Annexed countries, thereby providing a more cost-effective manner for developed countries to meet their commitments. These projects establish definite quantifiable long-term climate change mitigation benefits, by supporting developing countries in reducing their potential emissions.

Consequently, these considerations not only incentivise the participation of non-Annexed countries in the fight against climate change but provide foreign investment for these host nations which in turn further stimulates sustainable

⁶⁰ Netto and Schmidt "CDM Project Cycle and the Role of the UNFCCC Secretariat" 187.

⁶¹ Netto and Schmidt "CDM Project Cycle and the Role of the UNFCCC Secretariat" 188.

⁶² Netto and Schmidt "CDM Project Cycle and the Role of the UNFCCC Secretariat" 188.

⁶³ Netto and Schmidt "CDM Project Cycle and the Role of the UNFCCC Secretariat" 189.

⁶⁴ David *Legal Aspects of Implementing the Kyoto Protocol Mechanisms: Making Kyoto Work* 193.

⁶⁵ Calzadilla 2018 *Potchefstroom Electronic Law Journal* 14.

⁶⁶ Bodansky, Brunnée and Rajamani *International Climate Change Law* 183.

development.⁶⁷ Additionally, benefit-sharing promotes the transfer of cleaner technologies into host countries, further propelling these countries on a pathway toward renewable energy generation.⁶⁸ The CDM project-based mechanisms have assisted in mitigating more than 1 billion tons of GHGs and leads the global carbon market in carbon-offsets generating over 1.8 billion CERs.⁶⁹

For SADC countries to host CDM projects, it requires an understanding of the intricacies of the Kyoto Protocol which continues to be imperative in the overall development of the climate regime, as it relates to the international legal mandate for climate change mitigation. This need for equitable and appropriate mitigation measures are balanced against the CBDR-RC principle which takes the individual circumstances of Annex B parties into consideration to achieve the ambitions of the Protocol. Accordingly, the implementation of the Protocol is subject to a multi-year commitment structure that determines how mitigation action will be implemented.

2.3.3 Climate change mitigation under the Kyoto Protocol first commitment period

There exist specific and general commitments under the Kyoto Protocol as with the UNFCCC. Under Article 10 of the Protocol it asserts that these general commitments apply to developed and developing nations; however it makes no new commitments available to non-Annexed parties, but reiterates their commitments under Article 4 of the Convention. In this respect, these commitments required nationally and, where applicable, regionally cost-effective programmes to formulate, publish and periodically update inventories of their emissions by source and removal by sinks of GHGs.⁷⁰ Furthermore, it provides nationally and, where applicable, regionally for programmes that facilitate mitigation and adaptation measures.⁷¹ These general commitments are to be conducted in light of parties' specific national and regional development aspirations, concerns and circumstances in line with the CBDR-RC

⁶⁷ Huq and Reid "Benefit Sharing Under the Clean Development Mechanism" 229.

⁶⁸ Huq and Reid "Benefit Sharing Under the Clean Development Mechanism" 230.

⁶⁹ Calzadilla 2018 *Potchefstroom Electronic Law Journal* 14.

⁷⁰ Article 10(a) of the Kyoto Protocol.

⁷¹ Article 10(b) of the Kyoto Protocol.

principle.⁷² Consequently, these commitments for developing country parties are subject to financial and technical support from Annexed parties as was the case with the UNFCCC.⁷³

The specific commitments for Annexed parties initially concentrate their mitigation efforts on six gases identified in Annex A of the document.⁷⁴ Further, it is asserted that GHGs regulated by the Montreal Protocol, aviation and maritime transport are explicit exceptions from these commitments.⁷⁵ To establish a common metric to measure the Global Warming Potential of each gas, it is determined that non-CO₂ gases be translated into its CO₂e.⁷⁶ Accordingly, under the auspices of the Kyoto Protocol developed nations each have individual targets listed in Annex B of the document, which are nationally determined and internationally negotiated to achieve equitable QELRCs. The identified parties shall independently or co-operatively ensure that they do not surpass these specified aggregate CO₂e amounts.⁷⁷

Additionally, Article 3(1) of the Kyoto Protocol prescribes a collective target for reducing Annex A gases by at least 5% below 1990 levels during the first commitment period. Although, this provision provides a definite obligation for Annexed countries to reduce their GHGs it does not divulge any details in relation to how this is to be achieved.⁷⁸ Consequently, these collective targets are interpreted as goals rather than legally binding commitments due to their recommendatory language, while the mandatory language used to frame the individual targets contained in Annex B indicates the compulsory nature of these obligations.⁷⁹

⁷² Article 10 of the Kyoto Protocol.

⁷³ Bodansky, Brunnée and Rajamani *International Climate Change Law* 170.

⁷⁴ Carbon dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF₆).

⁷⁵ Article 2.2 of the Kyoto Protocol.

⁷⁶ Maguire "Foundations of International Climate Law: Objectives, Principles and Methods" 104.

⁷⁷ Article 3(1) Kyoto Protocol.

⁷⁸ Kulovesi "Climate Change and Trade: At the Intersection of Two International Legal Regimes" 427.

⁷⁹ Bodansky, Brunnée and Rajamani *International Climate Change Law* 172.

In achieving these emission targets Annexed parties may choose from a non-exhaustive list of policies and measures to implement nationally, which address, *inter alia*, energy efficiency, sinks, promotion of environmentally sound technologies and reformation in relevant emission sectors.⁸⁰ This further promotes the flexibility of the Protocol in relation to how Annexed parties may comply with their commitments and contributes significantly toward mitigation action.⁸¹ Additionally, effective reporting, monitoring and verification processes are essential to ensure the compliance of member states when implementing mitigation action. These measures utilize the national GHG inventories already required under the UNFCCC and national systems that estimate atmospheric emissions of GHGs by sources and removal by sinks.⁸²

Accordingly, of the parties listed in Annex B, thirty-six countries accounting for 24% of 2010 global GHGs were in full compliance with their first commitment period targets.⁸³ These countries achieved a 4% decrease in relation to their collective target and their total emissions were 2.4 GtCO₂e below the amount permitted under Annex B of the Protocol.⁸⁴ Although, 9 countries emitted GHGs above those that are permitted under Annex B, this aggregate amounted to less than 1% of the average annual emissions of these 36 countries.⁸⁵

2.3.4 Climate change mitigation under the Kyoto Protocol second commitment period

The Kyoto Protocol is dependent on a multi-year commitment period structure; the first period extended from 2008 to 2012.⁸⁶ Subsequently, Annex I parties are no longer legally compelled by emission reduction commitments under the first commitment period. To bridge the legal gap, the negotiations for the second

⁸⁰ Article 2(a) of the Kyoto Protocol.

⁸¹ Kulovesi "Climate Change and Trade: At the Intersection of Two International Legal Regimes" 427.

⁸² Bodansky, Brunnée and Rajamani *International Climate Change Law* 193.

⁸³ Bodansky, Brunnée and Rajamani *International Climate Change Law* 173.

⁸⁴ Grubb 2016 *Climate Policy* 679.

⁸⁵ Shishlov *et al* 2016 *Climate Policy* 779.

⁸⁶ Article 3(1) of the Kyoto Protocol.

commitment period commenced at COP 17 in Durban 2011, and led to the *Doha Amendment to the Kyoto Protocol* (2012) (Doha Amendments) which included the specifics for this period continuing from 2013 to 2020.⁸⁷ The Amendments substitute the table in the former Annex B of the Protocol setting out each party's QELRC, in terms of which parties will continue to ensure they do not exceed their individual CO₂e amounts provided under the Amendment.⁸⁸ Additionally, expanding the list of GHGs under Annex A to include nitrogen trifluoride (NF₃).⁸⁹ These Annexed parties will further endeavour to achieve a collective goal of reducing their aggregate emissions by at least 18% below 1990 levels.⁹⁰

However, these minimal aspirations are not sufficient to set global temperatures on a pathway to achieve the ultimate mitigation objective of the Convention.⁹¹ In this respect, Annexed parties were to re-evaluate QELRCs by 2014 in accordance with a decrease of 25% to 40% below 1990 levels by 2020.⁹² This ambition in relation to individual QELRC must be done in the prescribed manner provided for under the Doha Amendments.⁹³ Additionally, although there have been extensive negotiations regarding the implementation of the Kyoto mechanisms such as the CDM, the project-based mechanisms remained applicable subject to certain conditions. For example, it was determined that access to these mechanisms would be conditional and limited to annexed parties that agree to take on commitments in the second period.⁹⁴

Although the Doha Amendments have yet to enter into force in accordance with Article 20 and 21 of the Protocol there has been steady increase in the number of ratifying parties.⁹⁵ Presently, there exist no legal ramifications for annexed parties

⁸⁷ Bodansky, Brunnée and Rajamani *International Climate Change Law* 205.

⁸⁸ Article 1 A of the Doha Amendments.

⁸⁹ Article 1 B of the Doha Amendments.

⁹⁰ Article 1 C of the Doha Amendments.

⁹¹ Allen, Millard and Stonehill *The Doha Gateway – opening a pathway for sustainable transport?* 15.

⁹² Bodansky, Brunnée and Rajamani *International Climate Change Law* 203.

⁹³ Amendment D and E of the Doha Amendments.

⁹⁴ Allen, Millard and Stonehill *The Doha Gateway – opening a pathway for sustainable transport?* 13.

⁹⁵ Currently, there are 109 ratified parties, 35 shy of the 144 ratifications needed to enter into force; Kosolapova 2018 <http://sdg.iisd.org/news/doha-amendment-reaches-109-ratifications/>.

in relation to their obligations under the Kyoto Protocol's second commitment period. However, the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) have safeguarded that no operational gaps exist between commitment periods, as parties may provisionally apply the amendments pending its entry into force, but will not be obligated to do so.⁹⁶ Annexed parties that do not provisionally apply these amendments are expected to carry out obligations and responsibilities, in a manner reasonably consistent with their domestic legislation.⁹⁷

Only a few of the countries mentioned under Annex B of the Kyoto Protocol have adopted targets for the second commitment period, which accrue to less than 15% of global GHG emissions.⁹⁸ Although this could be seen as a factor that hampered the effectiveness of the Kyoto Protocol, reaching consensus for this period was a critical factor of ensuring the development of a legal framework to seamlessly follow on after the second commitment period.⁹⁹ Moreover, the continuation of the market-based mechanisms and the reporting, monitoring and verification processes kept climate negotiations moving forward. To the extent that this momentum helped to consolidate the climate regime as parties looked toward the negotiations for a global climate instrument at COP 21 in Paris.¹⁰⁰ Conversely, the Doha Amendments and the Paris Agreements neither address the continued existence of the Kyoto Protocol post-2020, when the second commitment period is scheduled to end with the start of the Paris Agreements NDCs.¹⁰¹

2.4 The Paris Agreement

The Durban Platform for Enhanced Action (2011) (Durban Platform) envisioned that a "treaty applicable to all" would come into force by 2020; however, due to immense

⁹⁶ Paragraph 5 of the Doha Amendments.

⁹⁷ Paragraph 6 of the Doha Amendments.

⁹⁸ Morel and Shishlov *Ex-post evaluation of the Kyoto Protocol: four key lessons for the 2015 Paris Agreement* 26.

⁹⁹ Allen, Millard and Stonehill *The Doha Gateway – opening a pathway for sustainable transport?*.

¹⁰⁰ Morel and Shishlov *Ex-post evaluation of the Kyoto Protocol: four key lessons for the 2015 Paris Agreement* 30.

¹⁰¹ Bodansky, Brunnée and Rajamani *International Climate Change Law* 205.

political endorsement, the Paris Agreement entered into force much sooner than anticipated on 4 November 2016.¹⁰² The Paris Agreement is a treaty as defined by the Vienna Convention on the Law of Treaties, and, as with the Kyoto Protocol, is created under the auspices of the UNFCCC climate regime and therefore links the purposes of the Agreement to the enhancement of the Convention and its related objectives.¹⁰³ Additionally, the Paris Agreement makes use of many of the instruments already well-established under the UNFCCC such as the COP and financial institutions. The Agreement is a significant accomplishment in multilateral international relations under the climate regime, as, unlike previously-mentioned instruments, the Paris Agreement facilitates near-universal acceptance and influences roughly 99% of global GHG emissions.¹⁰⁴

2.4.1 CBDR-RC principle and the Paris Agreement

Differentiation instituted through the CBDR-RC principle is a continuously recurring theme throughout the history of the climate regime, although the cataloguing of states as Annexed or non-Annexed under the UNFCCC and Kyoto Protocol respectively, has not found consensus within the global community.¹⁰⁵ In consequence no explicit reference was made to equity or the CBDR-RC principle in the Durban Platform which initiated the negotiations for the post-2020 climate regime.¹⁰⁶ However the Platform does require the strengthening of the Convention's objectives which are to be implemented in light of the CBDR-RC principle and as such implicitly allude to equity within the document.¹⁰⁷

In contrast, The Paris Agreement unequivocally reaffirms the application of the CBDR-RC principle in the post-2020 climate regime. Subsequently, it stipulates throughout the document that developed countries shall continue to lead the charge against climate change and that developing countries will require more time and

¹⁰² Winkler and Rajamani 2014 *Climate Policy* 102; Bhore 2016 *International Journal of Environmental Research and Public Health* 1.

¹⁰³ Bodansky, Brunnée and Rajamani *International Climate Change Law* 212.

¹⁰⁴ Bodansky, Brunnée and Rajamani *International Climate Change Law* 249.

¹⁰⁵ Winkler and Rajamani 2014 *Climate Policy* 103.

¹⁰⁶ Lee 2015 *Vermont Journal of Environmental Law* 36.

¹⁰⁷ Voigt and Ferreira 2016 *Climate Law* 62.

support to phase-out GHG emissions.¹⁰⁸ Consequently, the Agreement represents a shift in the understanding of differentiation in the climate regime, replacing the annexed-based approach previously predominant in the regime with one framed by self-differentiation and different national circumstances.¹⁰⁹

However, this is not the first time that self-differentiation has come to the fore within the international climate regime. Under the negotiation at COP 15 in Copenhagen 2009, developed and developing nations made available nationally determined voluntary commitments to reduce emissions, which comprised roughly 87% of global GHGs.¹¹⁰ Although the negotiations failed and the resultant Copenhagen Accord was not legally binding, the negotiations signified that there was increased political consensus surrounding climate change considerations.¹¹¹ Consequently, the nationally determined form of differentiation set out in the Copenhagen Accord, laid the foundation for the development of the INDCs of the Paris Agreement.

The invitation to submit INDCs leading up to the Paris Agreement allowed countries the opportunity to customize their climate change responses to fit their national circumstances.¹¹² Subsequently, each country initially had the opportunity to determine the contribution that specifies its intentions and reflects its highest possible ambition in relation to these considerations.¹¹³ The INDCs after formal acceptance have converted into parties' NDCs under the Paris Agreement and are significant in the context of how sovereign nations shall comply with mitigation obligations under the post-2020 climate regime.¹¹⁴

In this respect, the negotiators of the Paris Agreement favoured neither a top-down nor bottom-up approach when determining the architecture of this climate regime, but rather a combination between these two.¹¹⁵ This hybrid method is embodied in

¹⁰⁸ Amusan and Olutola 2017 *Africa Review* 51.

¹⁰⁹ Campbell 2016 *Energy & Environment* 888.

¹¹⁰ Brown Weiss 2014 *Environmental Policy and Law* 85.

¹¹¹ Bodansky, Brunnée and Rajamani *International Climate Change Law* 21.

¹¹² Article 2(b) Decision 1/CP.19 Warsaw Outcomes; Decision -/CP.20 Lima Call for Climate Action.

¹¹³ Bodansky, Brunnée and Rajamani *International Climate Change Law* 223.

¹¹⁴ Bodansky, Brunnée and Rajamani *International Climate Change Law* 248.

¹¹⁵ Carazo and Klein "Implications for Public International Law: Initial Considerations" 390.

parties' NDCs that lay the foundation for the bottom-up approach, by privileging state autonomy and allowing individual states to determine the flexibility, extent and form of their contributions.¹¹⁶ This combined with specific top-down instructions such as the promotion of progression, ambition and accountability in the NDCs demonstrates how these two treaty structures come together.¹¹⁷ This approach facilitates firstly the extensive involvement of sovereign nation states, and then gradually increases its ambitions over time subject to national circumstances thereby striking a balance between the bottom-up and top-down approaches. However, the document is silent on who determines the extent of this anticipated progression, but does determine that it will occur on a 5-year cycle, each progressing beyond the last.¹¹⁸

2.4.2 Mitigation action under the Paris Agreement

The overarching intention in Article 2(1)(a) of the Paris Agreement prescribes a temperature objective to keep global warming "*well below*" 2°C above pre-industrial levels, while attempting to keep temperature increase below 1.5°C. The Article further promotes climate resilience and economic incentives for low GHG developments without negatively impacting on food security.¹¹⁹ For the moment this temperature goal appears to be the global consensus among sovereign nations, towards which the international climate regime shall aspire.¹²⁰ In this respect, the intention of the NDCs is to provide the pathway by which countries shall achieve this long-term mitigation objective. Subsequently, this requires all parties to the Agreement to consecutively communicate and maintain their contributions, while implementing national mitigation measures that seek to strengthen the international communities' response to climate change.¹²¹

¹¹⁶ Calzadilla 2018 *Potchefstroom Electronic Law Journal* 11.

¹¹⁷ Bodansky, Brunnée and Rajamani *International Climate Change Law* 214.

¹¹⁸ Bodansky, Brunnée and Rajamani *International Climate Change Law* 234.

¹¹⁹ Article 2(1)(b)-(c) of the Paris Agreement.

¹²⁰ Maguire "Foundations of International Climate Law: Objectives, Principles and Methods" 100.

¹²¹ Article 4.2 of the Paris Agreement.

However, Article 4.2 of the Paris Agreement that addresses the preparation of these contributions, conveys both hard-law and soft-law obligations. The drafters of the Agreement in using mandatory language created a legally binding obligation of conduct to establish NDCs, but conversely only created a *bona fide* expectation through recommendatory language, that parties will attempt to accomplish their NDCs.¹²² To ensure that this expectation is sufficiently addressed, the transparency framework holds states accountable for their contributions which apply to both developed and developing nations and moves away from the divergence previously evident between these two classifications.¹²³

The transparency framework establishes several review mechanisms and mandates extensive information requests on all parties, thereby tracking progress of NDCs.¹²⁴ Consequently, parties are required to provide national inventory reports on emissions and reductions of GHGs and any other information necessary to track the extent to which they have achieved their mitigation objectives under their contributions.¹²⁵ This mandatory obligation for information in relation to mitigation objectives is subject to technical expert review and is to be consistent with the guidelines prescribed by the Meeting of the Parties to the Paris Agreement (CMA).¹²⁶

The NDCs are strengthened by the duty to conduct global stocktakings to ensure that states are indeed progressing toward long-term mitigation goals.¹²⁷ Consequently, evaluation of this information can assist in determining whether national mitigation efforts are indeed limiting global temperature increase to well below 2°C. By considering collective rather than individual progress, it places stronger expectations on parties to enhance their contributions.¹²⁸ The first stocktaking is set to take place in 2023 and is applicable to all parties, considering

¹²² Bodansky, Brunnée and Rajamani *International Climate Change Law* 231.

¹²³ Article 13 of the Paris Agreement.

¹²⁴ Desgain and Sharma 2016 *UNEP DTU Partnership* 17.

¹²⁵ Voigt 2016 *Review of European Comparative & International Environmental Law* 168.

¹²⁶ Bodansky, Brunnée and Rajamani *International Climate Change Law* 243.

¹²⁷ Article 14 of the Paris Agreement.

¹²⁸ Desgain and Sharma 2016 *UNEP DTU Partnership* 14.

both science and equity to determine the adequacy of collective progression in slowing the gradual increase in global temperatures.¹²⁹

2.4.3 The Paris Agreement and the Clean Development Mechanism

Although non-market approaches remain a central concern, the Paris Agreement acknowledges the importance of the carbon market; granted, it does not expressly mention markets in the text of the document.¹³⁰ Nevertheless, as is evident from numerous INDCs that included market-oriented provisions, the carbon market developed under the Kyoto Protocol has become deeply entrenched within the climate regime.¹³¹ Consequently, to this effect the Paris Agreement contains an entire Article on market instruments in Article 6 of the document that attempts to keep the door open for the carbon market in the post-2020 climate regime.

In relation to the CDM, Article 6.4 of the Agreement makes available a new market-based instrument which intends to further mitigation efforts whilst promoting sustainable development. Under the auspices of the Agreement the proposed sustainable development mechanism (SDM) builds on the already established CDMs, in so far as it provides parties with assistance to achieve their mitigation objectives through the generation of emission units.¹³² This is subject to parties providing a percentage of the proceeds accrued to cover administrative costs and funding for adaptation in countries most vulnerable to changes in the climate system.¹³³

However, unlike the CDM the SDM is not restricted to project-based reductions in developing countries and may be instigated by either developed or developing countries, consequently amalgamating the CDM and joint implementation into one mechanism.¹³⁴ Furthermore, the emission reduction offsets of the CDM do not translate to the SDM which requires an overall net positive mitigation of global

¹²⁹ Amusan and Olutola 2017 *Africa Review* 52.

¹³⁰ Streck *et al* 2016 *Journal for European Environmental & Planning Law* 15.

¹³¹ Bodansky 2017 *American Journal of International Law* 307.

¹³² Bodansky, Brunnée and Rajamani *International Climate Change Law* 236.

¹³³ Streck *et al* 2016 *Journal for European Environmental & Planning Law* 16.

¹³⁴ Bodansky, Brunnée and Rajamani *International Climate Change Law* 237.

emissions going beyond mere offsetting of these emissions.¹³⁵ Further differences might arise as the guidelines, modalities and processes for the SDM's implementation are flushed out.¹³⁶

In this respect, the Paris Agreement determines that the SDM is under the guidance and authority of the CMA that will designate a supervisory body to manage the activities conducted under this mechanism.¹³⁷ The SDM shall subsequently build on the experiences and lessons of the Kyoto mechanisms and shall use this as a platform to formulate the implementation of the new mechanism in the post-2020 climate regime.¹³⁸ To facilitate the operationalisation of the SDM the CMA will need to further elaborate on the guidelines, modalities and processes of this mechanism.¹³⁹ However, at the time of writing this dissertation, the CMA have not as yet deliberated on the essential concepts pertaining to the implementation of the SDMs.

With the emergence of this new mechanism under the Paris Agreement the future of the CDM remains uncertain and undecided. The proponents of the CDM advocate, *inter alia*, a migration and transition of this mechanism into the Paris market framework while detractors of the CDM argue against the inefficiency of having both CDM and SDM operating simultaneously as they have similar scope and objectives.¹⁴⁰ In this respect, the CDMs are not directly acknowledged by the Paris Agreement and are not automatically accepted as part of the post-2020 regime.

Notwithstanding the uncertainty surrounding the CDM in the wake of the Paris Agreement it is likely that registered CDM activities should prevail under the Kyoto Protocol until mid-2023, with the EB continuing its supervisory functions and issuance and transaction of CERs.¹⁴¹ The mid-2023 date is significant as it refers to

¹³⁵ Streck *et al* 2016 *Journal for European Environmental & Planning Law* 15.

¹³⁶ Calzadilla 2018 *Potchefstroom Electronic Law Journal* 13.

¹³⁷ Calzadilla 2018 *Potchefstroom Electronic Law Journal* 12.

¹³⁸ Calzadilla 2018 *Potchefstroom Electronic Law Journal* 13.

¹³⁹ Marcu 2016 *Centre for European Policy Studies* 17.

¹⁴⁰ Chagas *et al* 2017 <http://www.climatefocus.com/publications/what-future-cdm-questions-and-answers>

¹⁴¹ Chagas *et al* 2017 <http://www.climatefocus.com/publications/what-future-cdm-questions-and-answers>

the conclusion of the true-up period after which the accessibility of CDMs resources becomes questionable.¹⁴² It could also be possible for CDM projects to apply under Article 6 to have its activities recognised by the Paris Agreement although these processes have not been flushed out. Consequently, for the time-being there still exists a place for the CDM projects under the climate regime.

2.5 Conclusion

The CBDR-RC principle is a fundamental concept within the climate regime promoting equity and inclusion of all global citizens in the fight against climate change. Consequently, the UNFCCC and the Kyoto Protocol's sharp separation of developing and developed countries, blinded itself to the magnitude of the dilemma and how the emergence of anthropogenically induced GHGs from developing countries would shape the climate landscape. To this extent all sovereign nations have been reunited under the glow of the Paris Agreement, but as we are not homogeneous in nature, the Agreement acknowledges countries' individuality and national circumstances. The realisation that no country or group of countries can by themselves adequately address climate change bodes well for climate mitigation action in the post-2020 regime when parties' NDCs finally take effect.

The international climate regime has over the last quarter of a century taken slow but steady strides towards addressing the mitigation of anthropogenically induced GHG emissions. We see this evolution of international instruments through the UNFCCC, the Kyoto protocol and Paris Agreement; but what is also evident is the growth of support by sovereign nations to be involved in mitigation action. Consequently, because the climate regime is subject to the whims of state sovereignty, the climate regime has had a rocky start. However, the overwhelming political support for the Paris Agreement rekindles the belief that the international legal mandate for climate change mitigation can in fact make inroads into achieving the ultimate mitigation objective of the UNFCCC.

¹⁴² Chagas *et al* 2017 <http://www.climatefocus.com/publications/what-future-cdm-questions-and-answers>

Consequently, a further issue of significance in the context of the discussion is the involvement that the CDM has had in providing an outlet for this twenty-first century conviction towards climate change mitigation action. This mechanism that provides participants with direct influence on the global climate has captivated the interests of both developed and developing nations. In this respect, the production of bio-energy by countries situated in the SADC region can be recognized as emission reduction projects associated with energy sector reform that can further propel the international communities' mitigation mandate.

3 Bio-energy as a climate change mitigation driver

3.1 Introduction

Since the turn of the 20th century the global population has rapidly increased by roughly 6 billion people.¹⁴³ The upsurge in the populace of the planet necessitates an increase in global energy production to meet the unrelenting demand for power.¹⁴⁴ This is because an inadequate supply of energy would be detrimental to a country's development, as energy is a crucial stimulus for economic and social progression and a significant component in the production of goods and delivery of services.¹⁴⁵ Accordingly, this exigency has largely been met through the combustion of fossil fuels that intensify the concentration of GHGs in the atmosphere, exacerbating climate change.¹⁴⁶ Therefore, through this reasoning it can be asserted that the current model of energy production and consumption is at the nexus between population growth and climate change.¹⁴⁷

This pattern of consumption indicates that increased energy use will predominantly take place in developing countries, as this is where around 90% of global population growth is anticipated to occur.¹⁴⁸ Consequently, if all developing nations follow the fossil-fuel precedent set by major developing countries such as China, India and South Africa, it could be devastating for the global climate.¹⁴⁹ For that reason, the existing position requires a drastic re-evaluation and reformation of energy production and consumption pathways. The exploitation of bio-energy may provide a means to achieve these ends as currently it is a significant resource being used to meet the energy demands of many citizens in the developing world.¹⁵⁰ Accordingly, the discussion to follow focuses particularly on the role of traditional bio-energy

¹⁴³ Worldometers 2018 <http://www.worldometers.info/world-population/world-population-by-year/>.

¹⁴⁴ Jones and Warner 2016 *Energy Policy* 206.

¹⁴⁵ Keho 2016 *Energy Policy* 233.

¹⁴⁶ Stafford and Brent 2011 *Renewable Energy Law and Policy Review* 205.

¹⁴⁷ Jones and Warner 2016 *Energy Policy* 206.

¹⁴⁸ Souza *et al* 2017 *Environmental Development* 57.

¹⁴⁹ Papacostantis 2017 *Comparative and International Law Journal of Southern Africa* 278.

¹⁵⁰ REN21 *SADC Renewable Energy and Energy Efficiency Status Report* 9.

technologies as a staple energy resource for SADC countries and as a potential climate change mitigation measure.

Correspondingly, this chapter firstly considers the interrelated nature between averting dangerous climate change and renewable energy. Secondly, bio-energy as a source of renewable energy is discussed and a brief distinction is drawn between the two main technologies that have relevance for developing countries. Thirdly, the study considers modern bio-energy and the relevant conversion technologies best suited for the energy sector. Fourthly, with specific reference to Sub-Saharan Africa traditional bio-energy and improved efficiency technologies are discussed, whereafter attention is geared toward the role modern bio-energy may play in traditional bio-energy systems. Finally, the role of bio-energy is investigated in relation to mitigation action, identifying how it could contribute to the international climate change mitigation mandate.

3.2 Climate change and renewable energy

The exploitation of fossil fuel for energy production amounts to roughly two-thirds of annual GHG emissions globally, the overwhelming scientific evidence is a testament to the undeniable adverse impacts that the use of non-renewable resources has for the climate system.¹⁵¹ Consequently, for humanity to keep global temperature increase to well below 2°C above preindustrial levels as envisioned by the Paris Agreement it necessitates a move away from these harmful practices.¹⁵² An assessment by the International Renewable Energy Agency (IRENA) suggests that 90% of emission reductions required by 2050 can be met with energy efficiency practices and rapid implementation of renewable energy solutions.¹⁵³ Accordingly, the immense potential of renewable energy as a climate change mitigation measure

¹⁵¹ International Energy Agency *Energy and Climate Change: World Energy Outlook Special Report* 20.

¹⁵² Article 2(1)(a) of the Paris Agreement.

¹⁵³ IRENA *Untapped Potential for Climate Action: Renewable Energy in Nationally Determined Contributions* 11.

has a pivotal role to play in reducing the GHG emission profile of the international energy system.¹⁵⁴

Globally, renewable energy potential is immense and far exceeds the present and anticipated world energy demand.¹⁵⁵ Unlike fossil fuels, renewable energy is self-sustaining and can be replenished within a relatively short period, as it is derived from natural processes or natural energy storage mechanisms.¹⁵⁶ Accordingly, the generation of renewable energy provides a platform whereby humanity can find a beneficial solution to energy poverty, provide sustainability and avert further anthropogenic changes in the climate system.¹⁵⁷

The Paris Agreement in its preamble acknowledges the importance of universal sustainable energy access, particularly for developing countries in Africa through enhanced renewable energy deployment.¹⁵⁸ This requires an intensification of current renewable energy measures which are critical in achieving climate goals without slowing economic growth, employment opportunities and social prosperity.¹⁵⁹ As such, the role of bio-energy as a renewable energy resource has the potential to provide a cost-effective and flexible outlet to reach these objectives and can contribute to the global energy mix, while assisting in the achievement of the international climate change mitigation mandate.

3.3 Bio-energy as a renewable source of energy

The biosphere is the surface layer of the Earth where life exists; it is a small fraction of the planet's total mass but represents a tremendous source of accumulated energy for nourishment and fuel.¹⁶⁰ Since the discovery of fire, the organic matter found in the biosphere has been a significant energy source providing for mankind's heating and cooking needs. Yet, as our society develops, so too does our demand

¹⁵⁴ IRENA *REthinking Energy 2015: Renewable Energy and Climate Change* 9.

¹⁵⁵ IRENA *REthinking Energy 2017: Accelerating the global energy transformation* 23.

¹⁵⁶ Eluma and Momodub 2017 *Renewable and Sustainable Energy Reviews* 72.

¹⁵⁷ Jones and Warner 2016 *Energy Policy* 206.

¹⁵⁸ International Energy Agency *Bioenergy for Sustainable Development* 3.

¹⁵⁹ Papacostantis 2017 *Comparative and International Law Journal of Southern Africa* 285.

¹⁶⁰ Kurchania "Biomass Energy" 91.

for energy.¹⁶¹ Nonetheless, in poorer developing countries there still exists a heavy reliance on biomass to satisfy the day-to-day energy needs of native inhabitants.¹⁶² Respectively, within these countries there is potential for the development of biomass exploitation through both traditional and modern bio-energy technologies.¹⁶³

Goldemberg and Coelho¹⁶⁴ distinguish between these technologies stating that traditional bio-energy is largely exploited in an unsustainable manner in the domestic setting for cooking and heating via low efficacy conversion methods. While modern bio-energy technologies are more sustainable, used in the commercial sector and include *inter alia* several conversion methods for electricity generation from various forms of living or recently dead biological materials.¹⁶⁵ However, these technologies both represent different sides of the same coin as they depend exclusively on the same natural resource base to satisfy energy needs.¹⁶⁶ Accordingly, hereafter both modern and traditional bio-energy technologies are examined in more detail.

3.4 Modern bio-energy technologies

Modern energy production from biomass can be produced from various feedstocks, including dedicated energy crops, weeds, sewage, aquatic biomass, municipal solid wastes, numerous excesses such as agricultural, forestry, animal and biodegradable industrial residues.¹⁶⁷ The product obtained from the conversion process can be in solid, gaseous or liquid form depending on the composition and properties of the biomass used. Accordingly, the characteristics of biomass to be considered include *inter alia* particle size, calorific value, carbohydrate content, moisture, pyrolysis

¹⁶¹ Rose *et al* 2014 *Climatic Change* 478.

¹⁶² Karekezi, Lata and Coelho "Traditional Biomass Energy: Improving its Use and Moving to Modern Energy Use" 231.

¹⁶³ Smeets, Johnson and Ballard-Tremeer "Keynote Introduction: Traditional and Improved Use of Biomass for Energy in Africa" 4.

¹⁶⁴ Goldemberg and Coelho 2004 *Energy Policy* 711.

¹⁶⁵ Stafford and Brent 2011 *Renewable Energy Law and Policy Review* 205; Goldemberg and Coelho 2004 *Energy Policy* 711.

¹⁶⁶ Karekezi, Lata and Coelho "Traditional Biomass Energy: Improving its Use and Moving to Modern Energy Use" 233.

¹⁶⁷ Abbasi, Tauseef and Abbasi *Biogas Energy* 4.

characteristics, carbon, hydrogen and oxygen content.¹⁶⁸ These considerations will determine the type of conversion process which is best suited to generate the largest amount of energy from specific biomass feedstocks.¹⁶⁹

The established modern bio-energy technologies available to release stored energy from biomass are thermochemical and biochemical conversion processes.¹⁷⁰ These technologies can generally be categorised as either primary conversion technology, that convert biomass straight into heat for energy production, or into a more suitable energy carrier such as methane.¹⁷¹ The secondary conversion technology, however, changes the products of primary conversion technology like methane into the desired output, for example electricity.¹⁷² The following sub-sections identify the different established technologies available for biomass conversion most suited for the energy sector.

3.4.1 Thermochemical conversion processes

There are three main thermochemical conversion processes that have significance for the energy sector: they are direct combustion, pyrolysis and gasification. Through heating biomass feedstocks these conversion processes can produce gases, liquids and solids that can be used in different ways for energy production. Direct combustion is the oldest method for energy generation from biomass although this modern form of combustion is very distinct from traditional open fires or cook stove fires.¹⁷³ During the conversion process the feedstock is burnt in the presence of surplus oxygen to create heat. The chemical reaction between the heat, biomass and oxygen liberates the trapped energy within the biomass.¹⁷⁴ The carbon char that remains is further burnt, the heat that is exerted can subsequently be used to process water to steam that can drive steam powered turbines producing

¹⁶⁸ Pande and Bhaskarwar "Biomass Conversion to Energy" 8; Phyllis2 available at <https://phyllis.nl/> is an example of an online data bases that systematically characterized different biomass.

¹⁶⁹ Sarkar and Praveen "Utilization of Waste Biomass into Useful Forms of Energy" 119.

¹⁷⁰ Ghosh 2016 *Procedia Environmental Sciences* 31.

¹⁷¹ Pande and Bhaskarwar "Biomass Conversion to Energy" 7.

¹⁷² Kurchania "Biomass Energy" 95.

¹⁷³ Pande and Bhaskarwar "Biomass Conversion to Energy" 8.

¹⁷⁴ Pande and Bhaskarwar "Biomass Conversion to Energy" 83.

electricity.¹⁷⁵ However, the efficiency of this method of energy production is inferior if compared with pyrolysis and gasification.¹⁷⁶

Pyrolysis occurs when under anaerobic conditions and at high temperatures thermochemical decomposition of biomass takes place producing gases, solids and liquids.¹⁷⁷ The gaseous products that are created during this process can be used in gas turbines to create electricity, while the carbonaceous solids like charcoal can be used for heating and the liquid products such as bio-oils have various uses; it can be used for heating, power generation or converted to transport fuels.¹⁷⁸ Although pyrolysis is more effective than direct combustion, it necessitates extensive process control and is more cost intensive.¹⁷⁹

Gasification is a process whereby biomass is converted at high temperatures. This is done with the controlled addition of steam or air that results in the oxidation of biomass at the expense of liquid and solid production, thereby creating a gaseous mixture which has a high calorific value.¹⁸⁰ Gasification is a highly versatile process as almost any feedstock can be used in the conversion process. These gases are used directly for heat or electricity generation, or can be upgraded to higher value products.¹⁸¹ Depending on the secondary conversion technology used these combustible gases can have up to 50% biomass to energy efficiency, where the system for example recovers waste gas from the gas turbine to generate steam in a steam turbine.¹⁸² These biomass gasification plants have the potential to be as economically viable as coal-fired power plants if sufficient process control, implementation and investment are available.¹⁸³

¹⁷⁵ International Energy Agency *Bioenergy - A Sustainable and Reliable Energy Source* 31.

¹⁷⁶ International Energy Agency *Bioenergy - A Sustainable and Reliable Energy Source* 31.

¹⁷⁷ Sarkar and Praveen "Utilization of Waste Biomass into Useful Forms of Energy" 123.

¹⁷⁸ Pande and Bhaskarwar "Biomass Conversion to Energy" 17.

¹⁷⁹ Pande and Bhaskarwar "Biomass Conversion to Energy" 83.

¹⁸⁰ Sarkar and Praveen "Utilization of Waste Biomass into Useful Forms of Energy" 121.

¹⁸¹ International Energy Agency *Bioenergy - A Sustainable and Reliable Energy Source* 32.

¹⁸² Pande and Bhaskarwar "Biomass Conversion to Energy" 26.

¹⁸³ Pande and Bhaskarwar "Biomass Conversion to Energy" 26.

3.4.2 Biochemical conversion processes

Biochemical conversion processes are far more environmentally friendly than those of thermochemical conversion.¹⁸⁴ Biomass that is relatively difficult to handle and process such as organic waste; both agricultural and municipal solid waste can be treated through this conversion process.¹⁸⁵ The resultant products of biochemical conversion processes may include biogas, landfill gas and various liquid biofuels.¹⁸⁶ The established biochemical conversion processes for the energy sector can be classified into two categories, namely anaerobic digestion and aerobic digestion.

Anaerobic digestion involves the microbial degradation of biomass feedstocks in the absence of oxygen for a period of 2 to 8 weeks.¹⁸⁷ The main product of this process is biogas which comprises of 65–70% methane, 30–35% carbon dioxide, and traces of other gases and has a high calorific value.¹⁸⁸ Once the acidic compounds in the gas are eliminated, it can be used in gas turbines for electricity generation and the remaining solid digestate can be used as fertiliser.¹⁸⁹ Anaerobic digestion is particularly suitable for feedstocks with a high moisture content such as manure, sewage and wet agricultural residues.¹⁹⁰ This biochemical conversion method is commercially well-established and is economically feasible depending on the availability and cost of the feedstock.¹⁹¹

Aerobic digestion is a multi-faceted microbial process initiated by the decomposition of organic material in refuse deposited in landfill sites.¹⁹² Although, the process starts out as aerobic the continued exposure to oxygen decreases the methane yield, therefore to ensure the methane production is not compromised, landfill waste is passed through compactors which increase the density of the waste and limits

¹⁸⁴ Pande and Bhaskarwar "Biomass Conversion to Energy" 38.

¹⁸⁵ Pande and Bhaskarwar "Biomass Conversion to Energy" 38.

¹⁸⁶ Pande and Bhaskarwar "Biomass Conversion to Energy" 39.

¹⁸⁷ Sharma *et al* 2014 *IOSR Journal of Mechanical and Civil Engineering* 32.

¹⁸⁸ Pande and Bhaskarwar "Biomass Conversion to Energy" 40.

¹⁸⁹ International Energy Agency *Bioenergy – A Sustainable and Reliable Energy Source* 32.

¹⁹⁰ Faaij 2006 *Mitigation and Adaptation Strategies for Global Change* 355.

¹⁹¹ Pande and Bhaskarwar "Biomass Conversion to Energy" 40.

¹⁹² Sharma *et al* 2014 *IOSR Journal of Mechanical and Civil Engineering* 32.

oxygen content.¹⁹³ During this aerobic process carbon present in the biomass is converted by bacteria into CO₂ and water; this process is exothermic and subsequently increases the temperature of the waste, improving other micro-organism activity.¹⁹⁴ After the initial aerobic digestion process the waste becomes anaerobic as the oxygen concentrations are exhausted. The product of this process is a methane-rich gas that has a substantial calorific value and can be used in the production of electricity through gas turbines.¹⁹⁵

Consequently, the variety of different modern bio-energy conversion technologies, coupled with an extensive array of feedstocks, provides a flexible energy solution that can be prioritised depending on country specific factors to fit the heterogeneous nature of domestic energy infrastructure.¹⁹⁶

3.5 Traditional bio-energy technologies

Within Sub-Saharan Africa traditional bio-energy refers to the use of local solid biomass normally in low-income households, firewood is generally the staple fuel source due to its low cost, accessibility and unavailability of alternatives.¹⁹⁷ While in urban areas charcoal produced from biomass is used more readily, given its availability and higher energy content, requiring smaller amounts to achieve similar results.¹⁹⁸ Although, traditional bio-energy systems are associated with negative health impacts and increased mortality rates from indoor air pollution, currently these wood-based fuels account for over 70% of the total energy consumption in Sub-Saharan Africa.¹⁹⁹ Accordingly, some authors have indicated that a diminishing trend surrounds these biomass fuels, asserting that increased walking distances for collection and a decrease in the quality of the fuel confirm these observations.²⁰⁰

¹⁹³ Pande and Bhaskarwar "Biomass Conversion to Energy" 40.

¹⁹⁴ Pande and Bhaskarwar "Biomass Conversion to Energy" 39.

¹⁹⁵ Faaij 2006 *Mitigation and Adaptation Strategies for Global Change* 355.

¹⁹⁶ International Energy Agency *Bioenergy – A Sustainable and Reliable Energy Source* 55.

¹⁹⁷ International Energy Agency *Technology Roadmap: Delivering Sustainable Bioenergy* 18.

¹⁹⁸ Smeets, Johnson and Ballard-Tremeer "Keynote Introduction: Traditional and Improved Use of Biomass for Energy in Africa" 5.

¹⁹⁹ Smeets, Johnson and Ballard-Tremeer "Keynote Introduction: Traditional and Improved Use of Biomass for Energy in Africa" 4; Sawe "Sustainable Charcoal and Firewood Production and Use in Africa" 76.

²⁰⁰ Sawe "Sustainable Charcoal and Firewood Production and Use in Africa" 77.

Subsequently, from this it can be asserted that the over-exploitation of these traditional bio-energy fuels may result in social, environmental and economic difficulties for those individuals and communities that rely on these resources.²⁰¹

Typically, biomass exploitation is sustainable when the source is realistically replaced and the conversion thereof to energy is efficient. Unfortunately, for the most part, traditional bio-energy systems used in Sub-Saharan Africa are neither.²⁰² Consequently, when unsustainable harvesting of firewood or wood for charcoal production takes place, the emissions from combustion in traditional systems directly contribute to the increase of net carbon emissions in the atmosphere, because it is not directly offset by regrowth of the biomass.²⁰³ Therefore, when compared with modern technologies the quality of these energy systems is extremely low, and emits GHGs which have high global warming potential.

However, this technology must be seen holistically as part and parcel of a larger bio-energy scheme that can provide for the interim energy needs of the most vulnerable people in society, while progressing toward modern energy systems. Accordingly, Barnard²⁰⁴ determines that this will require sustainable alternative approaches to ensure access to traditional bio-energy while minimizing over-exploitation. Therefore, despite the negative connotations surrounding traditional bio-energy technology, if properly developed it may form part of a sustainable bio-based energy system contributing toward energy security and climate change mitigation.²⁰⁵

²⁰¹ Sawe "Sustainable Charcoal and Firewood Production and Use in Africa" 76.

²⁰² Barnard "Access to bio-energy vis-à-vis biodiversity conservation in SADC: conflicting objectives?" 328.

²⁰³ Smeets, Johnson and Ballard-Tremeer "Keynote Introduction: Traditional and Improved Use of Biomass for Energy in Africa" 6.

²⁰⁴ Barnard "Access to bio-energy vis-à-vis biodiversity conservation in SADC: conflicting objectives?" 325.

²⁰⁵ Amugune *et al* *Small Flame But No Fire: Wood Fuel in the (Intended) Nationally Determined Contributions of countries in Sub-Saharan Africa* 1.

3.5.1 Improved traditional bio-energy systems

Cooking with an open three-stone fire stove is inefficient as it requires considerable volumes of wood-based biomass to meet daily energy demands and provides only low-grade heat that cannot be regulated easily.²⁰⁶ The efficiency of these systems is represented as a percentage, with the three-stone stove having around 10% efficiency; therefore, only one-tenth of the energy available in the wood goes toward the cooking process.²⁰⁷ If improved cook stoves are used, some of which have an efficiency excess of 35%, it would translate into less fuel being required for the cooking process.²⁰⁸ Therefore, the increase in the overall efficiency of traditional energy systems will translate into a decrease in unsustainable biomass utilisation.²⁰⁹

Additionally, traditional earth and earth-mound kilns have an efficiency of between 10-20%, through the use of improved charcoal kilns, the overall effectiveness of the system can be enhanced.²¹⁰ Subsequently, improved kilns can provide an efficiency excess of 45% and enhance the quality and characteristics of charcoal, while increasing the overall production that can be extracted from the same quantity of wood.²¹¹ In this respect, it contributes to the sustainable use of wood-based fuels as less is required for greater productivity.

Although, these improvements are important, they only provide short-term solutions to long-term energy problems. Subsequently, increasing the energy options available to households using not only improved traditional but also modern bio-energy technologies can diversify energy options. Consequently, this is opposed to the energy ladder that assumes people move linearly toward cleaner fuel depending on economic income; however, people generally rely on a combination of modern

²⁰⁶ Smeets, Johnson and Ballard-Tremeer "Keynote Introduction: Traditional and Improved Use of Biomass for Energy in Africa" 4.

²⁰⁷ REN21 *SADC Renewable Energy and Energy Efficiency Status Report* 59.

²⁰⁸ REN21 *SADC Renewable Energy and Energy Efficiency Status Report* 59.

²⁰⁹ REN21 *SADC Renewable Energy and Energy Efficiency Status Report* 59.

²¹⁰ Smeets, Johnson and Ballard-Tremeer "Keynote Introduction: Traditional and Improved Use of Biomass for Energy in Africa" 9.

²¹¹ Sawe "Sustainable Charcoal and Firewood Production and Use in Africa" 78.

and traditional fuels or devices depending on the task, availability, preferences and convenience.²¹²

3.5.2 The role of modern bio-energy technologies in traditional systems

Although many African governments advocate massive electrification roll-out, it is unrealistic to suggest that there can be an immediate switch from traditional energy as neither the people nor countries have the financial means to afford this transition.²¹³ Currently, it is evident that traditional technologies for the utilisation of biomass are anticipated to remain the prevailing source of energy in Sub-Saharan Africa.²¹⁴ However, there has still been insufficient effort placed on expansion and sustainability of the existing wood-based fuel sources and inadequate advancements made toward the productivity of these systems.²¹⁵

Subsequently, because bio-energy is part of a larger bio-economy spanning multiple sectors, the approach to the production and harvest of biomass for food, energy and other processes should develop from solitary end-use orientation to integrated production systems that sustain maximum resource use.²¹⁶ Therefore, the integration of traditional bio-energy concerns into modern bio-energy approaches will become increasingly important, requiring traditional systems to develop in unison with modern bio-energy policies and strategies to ensure sustainability for both.²¹⁷ Accordingly, modern bio-energy may provide a pathway that can facilitate sustainable biomass exploitation for traditional systems and contribute to the affordability and availability of energy options for households through national grids or decentralized systems for rural electrification.

²¹² Masera *et al* 2015 *Annual Review of Environment and Resources* 138.

²¹³ Sawe "Sustainable Charcoal and Firewood Production and Use in Africa" 78.

²¹⁴ Ramagoma and Adendorff 2016 *Journal of Energy in Southern Africa* 80.

²¹⁵ Barnard "Access to bio-energy vis-à-vis biodiversity conservation in SADC: conflicting objectives?" 322.

²¹⁶ International Energy Agency *Bioenergy for Sustainable Development* 4.

²¹⁷ Sawe "Sustainable Charcoal and Firewood Production and Use in Africa" 77.

3.6 Bio-energy and climate change

Essentially, the lifecycle of bio-energy production has the potential to contribute to climate change mitigation in two ways.²¹⁸ Firstly, by decreasing the dependence on non-renewables and reducing the amount of GHG emissions expelled into the atmosphere. Secondly, it may curb unsustainable biomass exploitation, through increased regulated cultivation of vegetative feedstocks to improve the biospheric carbon stock of land. Accordingly, bio-energy could address both aspects of climate change mitigation by limiting and reducing GHG emissions at the source, while enhancing and preserving reservoirs and sinks through human intervention.²¹⁹

3.6.1 Limitation and reduction of GHG emissions at the source

The stabilization of the global climate as envisioned by the UNFCCC requires the limitation and reduction of GHG emissions at the source. Accordingly, bio-energy can contribute to this mandate in several ways including diversifying household energy portfolios, displacement of fossil fuels and enhanced waste management practices. The subsections to follow discuss the possible function each of these aspects could have for bio-energy as a climate change mitigation driver.

3.6.1.1 Combination of traditional and modern bio-energy systems

Globally, around 2.6 billion people depend extensively on the exploitation of solid biomass to satisfy basic energy needs, with these consumers of wood-based fuels anticipated to increase at least through 2030.²²⁰ These systems are often unsustainable as the rate of wood harvest frequently exceeds productivity. This leads to a portion of CO₂ emitted during combustion remaining in the atmosphere, land degradation and other environmental and social complications.²²¹ The emissions data relating to traditional bio-energy systems vary because of the unregulated nature of these activities and uncertainty due to different analysis

²¹⁸ International Energy Agency *Bioenergy – A Sustainable and Reliable Energy Source* 55.

²¹⁹ Maguire "Foundations of International Climate Law: Objectives, Principles and Methods" 84.

²²⁰ Masera *et al* 2015 *Annual Review of Environment and Resources* 122.

²²¹ Bailis *et al* 2017 *Environmental Research Letters* 2.

factors.²²² However, according to studies compiled by Masera *et al*²²³ the anthropogenic climate impacts from traditional bio-energy systems are minor ranging between 2-8%; yet it contributes significantly to anthropogenic black carbon in the atmosphere, around 18-30%. Black carbon is an aerosol particle; it is a product of incomplete combustion and has a substantial impact on changes in regional and global climate systems due to its ability to accelerate atmospheric warming.²²⁴

The increased anticipated wood-based biomass exploitation and associated climate implications require action tailored to switching traditional bio-energy systems to more sustainable pathways.²²⁵ According to Cutz *et al*²²⁶ the introduction of improved traditional technologies and other cleaner fuels into household energy portfolios coupled with modern bio-energy technologies provide the highest net reduction of CO₂e emissions. This transition to cleaner fuels and devices will not be a straightforward task particularly for developing nations that have substantial biomass resources.²²⁷ Nevertheless, for the expansion to occur it requires the coordination of the entire biomass value-chain from start to finish.²²⁸ Accordingly, for governments to avoid under-utilization of biomass resources and promote fuel switching, especially in rural communities, it will require a strong energy policy and legal framework, to overcome economic, cultural and social barriers.²²⁹

3.6.1.2 Displacement of fossil fuels

To provide for the sustainable diversification of household energy portfolios, modern energy carriers such as electricity must be pursued as a long-term goal. However, presently a clear majority of global electricity demand is being unsustainably met through exploitation of non-renewable sources of energy, which is directly

²²² Masera *et al* 2015 *Annual Review of Environment and Resources* 125.

²²³ Masera *et al* 2015 *Annual Review of Environment and Resources* 137.

²²⁴ Smeets, Johnson and Ballard-Tremeer "Keynote Introduction: Traditional and Improved Use of Biomass for Energy in Africa" 8.

²²⁵ Cutz *et al* 2017 *Energy* 525.

²²⁶ Cutz *et al* 2017 *Energy* 523.

²²⁷ Masera *et al* 2015 *Annual Review of Environment and Resources* 142.

²²⁸ Cutz *et al* 2017 *Energy* 525.

²²⁹ Cutz *et al* 2017 *Energy* 515.

contributing to the concentration of GHG emissions in the atmosphere.²³⁰ Logically, the displacement of these fuels with energy sources that are less carbon intensive is a crucial measure to mitigate emissions that cause adverse changes in the climate system.²³¹ According to Pande and Bhaskarwar,²³² electricity generated from biomass has a much lower carbon intensity than from fossil fuels; it is reported to be 60g CO₂e/kWh, this is roughly one-fifth of the lowest CO₂ emissions produced from coal-fired power stations.

The use of modern bio-energy technologies has the potential to replace fossil fuels and place humanity on a more sustainable pathway for future electricity production, while simultaneously ensuring domestic energy supply.²³³ The versatility of bio-energy due to its wide range of feedstock and technology combinations makes it an ideal replacement for fossil fuels. This is because it can be tailored to domestic resources and needs, thereby diversifying the energy mix and decreasing the energy sector's contribution to GHG emissions.²³⁴ Accordingly, bio-energy utilisation is aligned with international programmes and goals calling for increased use of renewable energy to address matters such as climate change, energy access in developing countries and energy security.²³⁵

3.6.1.3 Elimination of waste

Methane is a potent GHG and per molecule has a global warming potential 25 times greater than that of CO₂; it is responsible for a third of global average temperature increase.²³⁶ Accordingly, although this gas is generated in nature, natural sinks absorb this excess, but with the increase in anthropogenic activity these natural absorption processes have been compromised.²³⁷ These activities include, for

²³⁰ International Energy Agency *Energy and Climate Change: World Energy Outlook Special Report* 20.

²³¹ Liddle and Sadorsky 2017 *Applied Energy* 213.

²³² Pande and Bhaskarwar "Biomass Conversion to Energy" 84.

²³³ El Bassam, Maegaard and Lawton Schlichting *Distributed Renewable Energies for Off-Grid Communities* 13.

²³⁴ International Energy Agency *Bioenergy – A Sustainable and Reliable Energy Source* 63.

²³⁵ Liddle and Sadorsky 2017 *Applied Energy* 212.

²³⁶ Abbasi, Tauseef and Abbasi *Biogas Energy* 25.

²³⁷ Abbasi, Tauseef and Abbasi *Biogas Energy* 26.

instance, sewage sludge, manure from livestock farming, biodegradable municipal solid waste and other industrial discharges; these all emit methane into the atmosphere.²³⁸ Consequently, if the energy potential of biomass, especially organic waste, is not processed and harnessed to recover the methane supply, it will result in the excess methane escaping into the atmosphere thereby exacerbating climate change.²³⁹

Additionally, urbanization and the steady increase of the population result in greater quantities of post-consumer waste from waste goods, construction waste and food waste all of which end up in landfills, yet have the potential to contribute toward bio-energy exploitation.²⁴⁰ Consequently, bio-energy can therefore promote recycling and lower humanity's carbon footprint, not only through energy generation practices but also through waste reduction that may ultimately decrease fugitive methane emissions. Through the careful management of these feedstocks and use of the available conversion technologies, fugitive methane emissions can be significantly reduced at the source and can potentially contribute to environmental clean-up depending on the method of conversion used.²⁴¹

3.6.2 Preservation of reservoirs and sinks

In the bio-energy production cycle, biomass serves as an effective CO₂ sink because plants and trees continuously consume CO₂ from the atmosphere and the energy of the sun and converts it through photosynthesis into carbon-rich compounds, which can be exploited when required to release the energy trapped within it.²⁴² Bio-energy therefore potentially creates a closed carbon loop, as the conversion of biomass puts CO₂ into the atmosphere, which returns to growing biomass by way of photosynthesis that is reconverted into carbon-rich compounds that may again be turned into energy.²⁴³ This carbon cycle can be considered carbon neutral, unlike

²³⁸ Abbasi, Tauseef and Abbasi *Biogas Energy* 25.

²³⁹ Abbasi, Tauseef and Abbasi *Biogas Energy* 25.

²⁴⁰ International Energy Agency *Bioenergy for Sustainable Development* 2.

²⁴¹ Pande and Bhaskarwar "Biomass Conversion to Energy" 2; Abbasi, Tauseef and Abbasi *Biogas Energy* 33.

²⁴² Pande and Bhaskarwar "Biomass Conversion to Energy" 3.

²⁴³ Pande and Bhaskarwar "Biomass Conversion to Energy" 3.

the production of energy from fossil fuels that is carbon positive, as the burning of fossil fuels release CO₂ into the atmosphere which remain there and gradually increase over time.²⁴⁴

The sustainable use of biomass is a key consideration for traditional and modern bio-energy technologies. Therefore, the value chain and feedstock used should not compromise the carbon cycle and should rather increase the overall biospheric carbon stock of the land where the biomass is produced or harvested.²⁴⁵ Consequently, to ensure sustainable expansion of bio-energy technologies it necessitates meticulous preparation across various sectors as the bio-economy will influence land, water, agriculture, forestry, and other related sectors.²⁴⁶ In this respect, from an energy systems transformation perspective these carbon sinks can further buy time for the development of other climate-friendly energy technologies to contribute toward energy sustainability and climate change mitigation.²⁴⁷

3.7 Conclusion

Within our climate-changing world the role of renewable energy is well-established; globally it is recognised that increasing the roll-out of these energy technologies will contribute to reducing the concentration of anthropogenic GHGs in the atmosphere. This decoupling of non-renewable energy from the global energy mix is one of the most significant sustainability hurdles that the international community will have to overcome as humanity moves toward a fossil-fuel free future. Though many countries in the developing world such as those situated in Sub-Saharan Africa have been endowed with abundant potential for bio-energy they still suffer from energy poverty. Accordingly, this chapter has outlined and discussed various aspects associated with the exploitation of bio-energy as a renewable resource that may contribute toward energy sustainability and climate resilience.

²⁴⁴ Pande and Bhaskarwar "Biomass Conversion to Energy" 3.

²⁴⁵ Rutz and Janssen "Keynote Introduction: Biomass Technologies and Markets in Africa" 64; International Energy Agency *Bioenergy – A Sustainable and Reliable Energy Source* 55.

²⁴⁶ Souza *et al* 2017 *Environmental Development* 62.

²⁴⁷ International Energy Agency *Bioenergy – A Sustainable and Reliable Energy Source* 63.

The distinction between the traditional and modern bio-energy technologies provides insight into the complexity behind biomass as a source of energy that can be tailored to the specific energy needs of countries. However, it is important to remember that for developing countries these technologies are part and parcel of each other and to foster sustainability they must develop together. Therefore, the diversification of household energy portfolios rests on the proper governance of the biomass value-chain, fostering strong policies and legal frameworks to strengthen the sustainable development of bio-energy. This co-ordination of the bio-economy could maximise the efficient exploitation of biomass, while ensuring that this natural resource is not squandered while people and the environment suffer.

4 South African bio-energy regulatory framework and its role in the pursuit of climate change mitigation in SADC

4.1 Introduction

South Africa is a hegemonic state within SADC, distinguishable not only politically and economically but also in relation to energy generation.²⁴⁸ The country is a literal powerhouse within Sub-Saharan Africa and contributes approximately 76% of the overall electricity generation capacity in SADC.²⁴⁹ While this provides the driving force behind the country's progression, it is derived primarily from coal which is identified as one of the dirtiest energy sources providing high emission levels of GHGs and other pollutants.²⁵⁰ In this respect, the majority of the South African fleet of coal-fired power stations are out-dated and inefficient, with some even being resurrected from decommissioning after the 2008 power crisis.²⁵¹ In an effort to diversify the country's energy supply and mitigate climate change, the South African government has committed itself to a development pathway which promotes sustainability by incorporating renewable resources into final energy demand.²⁵²

Accordingly, the following chapter first briefly discusses SADC's energy sector and its potential for bio-energy initiatives, focusing specifically on the sub-region's energy related climate change mitigation mandate and how South Africa's bio-energy regulatory framework may contribute toward achieving this directive. Secondly, attention is shifted to the South African bio-energy regulatory framework, initially concentrating on the *Constitution of the Republic of South Africa*, 1996 (the Constitution) and the *National Environmental Management Act* 107 of 1998 (NEMA) as the entry point for the country specific discussion. Thirdly, the study discusses the climate change framework distinguishing the mandate for energy sector mitigation as it relates to bio-energy. Thereafter focus is shifted to the energy legal

²⁴⁸ Nganje 2014 *Institute for Global Dialogue* 3.

²⁴⁹ Southern African Research and Documentation Centre *SADC Energy Monitor 2016: Baseline Study of the SADC Energy Sector* 35.

²⁵⁰ Ambali *et al* 2011 *Scientific Research and Essays* 1697; Lehmann "South Africa's Climate Change Commitments and Regulatory Response Potential" 3.

²⁵¹ Murombo "South Africa's Energy Mix - Towards a Low-Carbon Economy" 6.

²⁵² Department of Energy *State of Renewable Energy in South Africa* 144.

framework identifying instruments applicable to the implementation of bio-energy projects.

4.2 Climate change mitigation mandate in the SADC energy sector

The SADC intergovernmental economic block is one of the first regional communities to be established in Africa, it was founded under the SADC Treaty and consists of 15 member states.²⁵³ The expanding population of the sub-region is home to approximately 4% of the planet's inhabitants, with individual countries stemming from a wide array of economic and social circumstances.²⁵⁴ Grid electricity in Southern Africa is secured through the Southern Africa Power Pool (SAPP) consisting of several energy producers inter-connected throughout the sub-region.²⁵⁵ However, various country specific socio-economic issues, such as poverty, limit the access to electricity in the SADC region and this exigency is typically filled by biomass such as wood and charcoal.²⁵⁶

Conversely, according to a status report on SADC's renewable energy published in 2015, the sub-region has an estimated potential of 9,500 MW of electricity that can be generated from agricultural wastes alone.²⁵⁷ Nevertheless, this energy is not being exploited although of the 15 SADC states, 6 countries have a share of more than 70% of their population that are without access to modern forms of energy.²⁵⁸ This underutilisation goes against the UN Sustainable Development Goals (SDGs) which promotes universal access to affordable, reliable and clean modern energy sources.²⁵⁹ Subsequently, in order for SADC countries to align with these goals,

²⁵³ Mupedziswa and Kubanga 2017 *Development Southern Africa* 197; SADC member states Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, The Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

²⁵⁴ REN21 *SADC Renewable Energy and Energy Efficiency: Status Report* 9.

²⁵⁵ REN21 *SADC Renewable Energy and Energy Efficiency: Status Report* 26.

²⁵⁶ Davis-Reddy and Vincent *Climate Risk and Vulnerability: A Handbook for Southern Africa* 123.

²⁵⁷ REN21 *SADC Renewable Energy and Energy Efficiency Status Report* 41.

²⁵⁸ Souza *et al* 2017 *Environmental Development* 60; IRENA *Untapped Potential for Climate Action: Renewable Energy in Nationally Determined Contributions* 16.

²⁵⁹ IRENA *REthinking Energy 2017: Accelerating the global energy transformation* 17.

measures must be formulated at the sub-regional level and applied nationally to ensure equitable progression toward sustainability.

Nevertheless, climate change will undoubtedly place significant strain on sub-regional development. Accordingly, the mounting research regarding climate change points toward the unequivocal reality that impoverished and vulnerable persons shall suffer the most as a result of changes in the climate system, though they contribute the least towards it.²⁶⁰ In this respect, all members of SADC have ratified the UNFCCC and Kyoto Protocol and have signed the Paris Agreement and therefore have a duty to align their national and sub-regional mitigation actions with these documents.²⁶¹ Consequently, these and other climate related considerations require SADC member states to strive for greater sub-regional efforts geared towards ensuring sustainable long-term energy security while addressing climate issues.²⁶²

4.2.1 SADC Treaty and Energy Protocol

Although, the SADC Treaty does not expressly mention climate change within the document, this sub-regional instrument does however contain a clause dedicated to environmental protection.²⁶³ This clause is contained under the article housing the treaties objectives and specifies that SADC member states shall "achieve sustainable utilisation of natural resources and effective protection of the environment".²⁶⁴ Accordingly, the document determines that in order to achieve this purpose and the other socio-economic objectives, SADC shall *inter alia* strive toward the harmonisation of policies and plans of member states.²⁶⁵ Furthermore, the SADC Treaty specifies several areas that necessitate co-operation and environmental

²⁶⁰ Chikunda and Mandikonza "Climate Change and Environmental Challenges in Southern African Development Community (SADC)" 109.

²⁶¹ Davis-Reddy and Vincent *Climate Risk and Vulnerability: A Handbook for Southern Africa* 133.

²⁶² Southern African Research and Documentation Centre *SADC Energy Monitor 2016: Baseline Study of the SADC Energy Sector* 45.

²⁶³ Libebe *Climate Change Governance in the SADC Region: Towards Development of an Integrated and Comprehensive Framework Policy or Protocol on Adaptation* 53.

²⁶⁴ Article 5(1)(g) of the SADC Treaty.

²⁶⁵ Article 5(2) of the SADC Treaty.

concerns are identified as one such area.²⁶⁶ In this respect, the treaty provides that member states are to coordinate, rationalise and harmonise their overall policies, strategies, programmes and projects via the suitable institutional channels of SADC.²⁶⁷ Subsequently, climate change brought about through anthropogenic GHG emissions are one of the greatest threats to the environment and therefore warrants cooperation between SADC member states.

The energy sector accounts for a large proportion of these GHGs and at the sub-regional level the Energy Protocol is accepted as the instrument to guide energy related matters. The document outlines the co-operative means whereby member states shall develop energy in the sub-region to ensure affordable and reliable energy supply in an environmentally sound manner.²⁶⁸ In this respect, similar to the SADC Treaty, the Energy Protocol necessitates the cooperation between member states to harmonise national and sub-regional policy, strategies and programmes on matters of common concern related to sustainable energy services.²⁶⁹ Though the Energy Protocol does not provide specific deadlines or targets it does determine that this co-operative energy development shall include renewable energy resources.²⁷⁰ Subsequently, within this sub-regional context the implementation of bio-energy projects may align with the mandate for sub-regional cooperation in the development of renewable energy that may contribute to climate change mitigation.

4.2.2 Southern Africa Sub-Regional Framework of Climate Change Programmes

Adverse changes in the climate system is a global challenge interrelated with energy sector activities and requires SADC member states to cooperatively integrate policies and programmes related to climate change.²⁷¹ The Southern Africa Climate Change Framework attempts to address sub-regional climate matters, though at this level no single instrument exists which enshrines the common position of all SADC

²⁶⁶ Article 21(3)(f) of the SADC Treaty.

²⁶⁷ Article 21(2) of the SADC Treaty.

²⁶⁸ Schreiner and Baletab 2015 *Aquatic Procedia* 96.

²⁶⁹ Barnard 2014 *Journal of Energy in Southern Africa* 30.

²⁷⁰ Barnard "Access to bio-energy vis-à-vis biodiversity conservation in SADC: conflicting objectives?" 323.

²⁷¹ Pallangyo *Climate change and Africa: The normative framework of the African Union* 217.

states.²⁷² Despite the fact that this document is suggestive and not legally binding on member states, it does provide a starting point whereby climate change responses may be streamlined at the SADC level.²⁷³

The document determines that climate change mitigation actions shall highlight four categories including, *inter alia*, energy sector activities and international carbon markets.²⁷⁴ In this respect, the document stipulates that development and scaling-up of affordable renewable energy resources shall be one of the primary mitigation responses in the energy sector.²⁷⁵ This reform of the energy sector shall decrease reliance on fossil fuels, thereby mitigating climate change through reducing energy sector emissions in the sub-region.²⁷⁶ Additionally, the document concludes that increasing the number of policies, projects and programmes while strengthening institutions related to international carbon markets such as the CDM shall further facilitate mitigation action.²⁷⁷ Subsequently, bio-energy projects focused on both traditional and modern technologies may contribute to achieving the climate change mandate as prescribed by the Southern Africa Climate Change Framework.

4.2.3 Linking SADC's energy sector-related climate change mitigation mandate and the South African bio-energy regulatory framework

The contribution of SADC member states toward global GHG emissions fluctuate from country to country, yet some emit considerably more than others. In that regard, globally South Africa is ranked amongst the highest contributors of CO₂ emissions and was placed 13th in the world in 2016 emitting 468 MtCO₂, stemming primarily from its energy sector.²⁷⁸ Subsequently, the Republic stands far above other countries within the sub-region, as the total combined emissions from the other 14 SADC member states only amounted to approximately 97,9 MtCO₂ for the

²⁷² Barnard 2014 *Journal of Energy in Southern Africa* 28.

²⁷³ Barnard 2014 *Journal of Energy in Southern Africa* 30.

²⁷⁴ Sub-Regional Framework 48.

²⁷⁵ Sub-Regional Framework 22.

²⁷⁶ Barnard 2014 *Journal of Energy in Southern Africa* 31.

²⁷⁷ Sub-Regional Framework 23.

²⁷⁸ REN21 *SADC Renewable Energy and Energy Efficiency: Status Report* 22; Global Carbon Atlas 2018 <http://www.globalcarbonatlas.org/en/CO2-emissions>.

same period.²⁷⁹ It is therefore evident that South Africa contributes substantially more to climate change than other SADC countries and should bear greater responsibility toward propelling mitigation actions at the sub-regional level.²⁸⁰

Accordingly, this gives effect to the CBDR-RC principle, because although all SADC members have a common duty to address climate change, the responsibility falls on more-developed states such as South Africa to lead the way for its less developed neighbours.²⁸¹ Subsequently, the country's sophisticated climate change framework and energy legal framework offers a concrete foundation for a country-specific analysis. In this respect, bio-energy as a renewable form of energy is identified throughout the Republic's climate change framework and energy legal framework as a means to promote low-carbon development in the pursuance of a climate resilient future. This governmental perspective to use bio-energy to facilitate energy sector reform could contribute to climate change mitigation throughout SADC and therefore warrants enquiry into both the above-mentioned frameworks.

4.3 The South African bio-energy regulatory framework

In a South African context, a discussion concerning a bio-energy regulatory framework should be anchored within the Constitution. The Constitution is a statute distinct in its status as the highest law of the country. As such obligations created in terms of this document must be fulfilled and any laws or conduct deemed incompatible with its writings are invalid.²⁸² In this respect, chapter 2 of the Constitution encompasses various fundamental rights including one devoted to the environment, which stipulates that everyone has the right:

- (a) to an environment that is not harmful to their health or well-being; and
- (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that

²⁷⁹ Global Carbon Atlas 2018 <http://www.globalcarbonatlas.org/en/CO2-emissions>; These figure however do not include the CO₂ emissions for Lesotho.

²⁸⁰ Barnard "Climate Change Mitigation in the African Union - Differentiated Responsibilities in the Progressive Realisation of Human Rights" 319.

²⁸¹ Barnard "Climate Change Mitigation in the African Union - Differentiated Responsibilities in the Progressive Realisation of Human Rights" 328.

²⁸² Section 2 of the Constitution.

- (i) prevent pollution and ecological degradation;
- (ii) promote conservation; and
- iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.²⁸³

The construction of this substantive right draws significantly from international environmental legal thinking with its use of phrases such as "health or wellbeing", "present and future generations" and "sustainable development".²⁸⁴ The considerations provided for in section 24(b) place an onus on government to ensure sustainability and environmentally-friendly development.²⁸⁵ Consequently, it can be inferred that an effective transition to a low-carbon economy is a significant step on the road to achieving this constitutional right by promoting the utilisation of energy sources alternative to fossil fuels.²⁸⁶

This constitutional provision provides the imprimatur from which all other national environmental legislation emanates, such as the NEMA established to give effect to this fundamental right.²⁸⁷ The NEMA provides a legislative framework for ecological protection underpinned by environmental management principles such as the principle of sustainable development.²⁸⁸ Subsequently, section 1 of the NEMA defines sustainable development as the consideration of social and economic aspects alongside ecological factors to ensure that development serves not only present but also future generations.²⁸⁹ In this respect, the NEMA and the environmental right promote South Africa's global responsibility to address climate change alongside the country's development aspirations.

²⁸³ Section 24 of the Constitution.

²⁸⁴ Couzens and Lewis "South Africa" 33.

²⁸⁵ Moyo *The Role of the South African Renewable Energy Legal Framework in Climate Change Mitigation - A Focus on the Construction of Buildings* 27.

²⁸⁶ Lehmann "South Africa's Climate Change Commitments and Regulatory Response Potential" 3.

²⁸⁷ Masonda and Rambau "Climate Change Mitigation in South Africa" 710.

²⁸⁸ Glazewski and Collier "South Africa" 322.

²⁸⁹ Glazewski and Collier "South Africa" 323.

4.3.1 Climate change framework

4.3.1.1 National Climate Change Response White Paper

The establishment of South Africa's climate change policy framework commenced in early 2000 with the release of the *National Climate Change Response Strategy for South Africa* of 2004.²⁹⁰ Accordingly, the South African government expanded on this 2004 document mandating a policy development process between 2005 and 2008 which culminated in the *Long-Term Mitigation Scenarios* (LTMS).²⁹¹ The LTMS outlined different mitigation options to facilitate the development of long-term national policy to galvanize the country's position in prospective climate change negotiations post-2012.²⁹² Consequently, this process facilitated the policy development needed to produce the *National Climate Change Response Green Paper* of 2010 and its immediate successor the NCCRP.²⁹³

The NCCRP is a policy instrument which seeks to encourage and monitor the implementation of climate change mitigation programmes spanning various sectors including energy.²⁹⁴ The document stipulates that South Africa's climate change response shall be achieved in accordance with various principles including the CBDR-RC principle as developed under the climate regime.²⁹⁵ Therefore, country-specific considerations form an integral part of how government intends to achieve its mitigation objectives.

The document provides two key objectives to be achieved by the South African government.²⁹⁶ The first objective acknowledges the unavoidability of changes in the climate system and that these changes must be effectively managed to ensure sustainable development and climate resilience.²⁹⁷ The second component reiterates

²⁹⁰ Fløttum and Gjerstad 2013 *South African Journal on Human Rights* 64.

²⁹¹ Department of Energy *State of Renewable Energy in South Africa* 22; this process was led by the then Department of Environment Affairs and Tourism.

²⁹² Kidd and Couzens "Climate Change Responses in South Africa" 625.

²⁹³ GN 757 in GG 34695 of 19 October 2011.

²⁹⁴ Department of Energy *State of Renewable Energy in South Africa* 3.

²⁹⁵ NCCRP 12.

²⁹⁶ NCCRP 11.

²⁹⁷ NCCRP 11.

the ultimate objective of the UNFCCC, requiring South Africa to reasonably contribute to global efforts to stabilise atmospheric GHG concentrations.²⁹⁸ Consequently, mainstreaming the intentions of the international climate regime into the Republic's climate change policy.

The NCCRP presents several flagship programmes as integral policy considerations to contribute toward mitigation efforts and energy sector reform.²⁹⁹ Accordingly, two of these programmes specifically apply to bio-energy as a climate change mitigation option. Firstly, the Renewable Energy Flagship Programme: although bio-energy is not expressly mentioned, the document does identify the *Integrated Resource Plan for Electricity 2010 - 2030* (IRP 2010-2030) as a basis for the proposed renewable energy scale-up.³⁰⁰ Correspondingly, this latter document does briefly mention bio-energy as a potential viable renewable energy resource for the country.³⁰¹

Secondly, the NCCRP identifies the Waste Management Flagship Programme. While waste considerations generally fall outside the scope of energy discussions, the bio-energy implications of waste are substantial.³⁰² This programme incites investigation into various waste streams and waste-to-energy opportunities especially in relation to the generation, capture and conversion of methane emissions.³⁰³ In this respect, the waste as a source of renewable energy contributes to both the Renewable Energy Flagship Programme and the Waste Management Flagship Programme.

The NCCRP concludes that climate change impacts must be considered for new developments to avoid ensnarement in emission-intensive technologies, thereby stipulating that low-carbon energy options present the greatest mitigation

²⁹⁸ Article 2 of the UNFCCC; NCCRP 11.

²⁹⁹ Murombo "South Africa's Energy Mix - Towards a Low-Carbon Economy" 13; Although, the use of traditional forms of bio-energy for cooking and heating may have found application under the Energy Efficiency and Energy Demand Management Flagship Programme the document is silent on these points.

³⁰⁰ NCCRP 31.

³⁰¹ The IRP 2010-2030.

³⁰² NCCRP 32.

³⁰³ NCCRP 32.

potential.³⁰⁴ Considering this, The NCCRP promotes and incentivises the use of market based instruments such as the CDM to support the country's desired mitigation objectives.³⁰⁵ These CDM considerations resonate with the need for increased investment and implementation of sustainable energy technologies as part of the above-mentioned flagship programmes.³⁰⁶ Consequently, as a viable renewable energy resource bio-energy may contribute to the achievement of the objectives of the NCCRP, as it aligns the country's energy development needs and international climate obligations.³⁰⁷

4.3.1.2 National Environmental Management: Air Quality Act

The South African environmental legislative framework has been inadequate to comprehensively confront the ubiquitous multi-faceted problems presented by climate change.³⁰⁸ However, Kidd and Couzens³⁰⁹ suggest that from a pollution prevention and air quality perspective the *National Environmental Management: Air Quality Act* 39 of 2004 (NEMAQA) has the potential to address anthropogenic GHG emissions. This air quality statute is promulgated under the auspices of the NEMA and gives effect to Section 24 of the Constitution. In this respect, the objective of the document is to reform the law regulating the protection and enhancement of ambient air quality in the Republic, through preventative action.³¹⁰

Although this statute does not provide a definition for climate change, it does define GHGs as:

gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation, and includes carbon dioxide, methane and nitrous oxide;³¹¹

³⁰⁴ NCCRP 26; NCCRP 27.

³⁰⁵ NCCRP 26; NCCRP 40.

³⁰⁶ NCCRP 31.

³⁰⁷ NCCRP 9.

³⁰⁸ Masonda and Rambau "Climate Change Mitigation in South Africa" 705.

³⁰⁹ Kidd and Couzens "Climate Change Responses in South Africa" 622.

³¹⁰ Section 2 of the NEMAQA.

³¹¹ Section 1 of the NEMAQA.

While the NEMAQA does not directly attend to the multiplicity of issues presented by climate change, it does present an opportunity to focus mitigation efforts on GHGs. In this respect, section 29(1) stipulates that the Minister of Environmental Affairs or designated Member of the Executive Council may gazette a declaration announcing any substance exacerbating air pollution to the status of "priority air pollutant".³¹²

Consequently, in July 2017 the Minister of Environmental Affairs declared several GHGs priority air pollutants and required persons falling within specified categories to formulate and submit pollution prevention plans to the Department of Environmental Affairs for approval.³¹³ The pollution prevention plans are to be submitted by persons directed by the Minister or persons performing production processes releasing GHG emissions in excess of 0.1 Megatonnes (Mt) annually reported in CO₂e.³¹⁴ These production processes are set out in Annex A of the Declaration and include *inter alia* pulp and paper production along with electricity generation.

The Minister of Environmental Affairs published the *National Pollution Prevention Plans Regulations* (PPP Regulations) in terms of section 53(a), (o) and (p) read in accordance with section 29(3) of the NEMAQA.³¹⁵ The document stipulates the requirements and various reporting obligations to which a Pollution Prevention Plan must conform in order to be consistent with national legislation.³¹⁶ In this respect, the PPP Regulations require a description of mitigation measures, specifying deviation from baseline GHG emissions over the planning horizon, which include overall projected emission reductions.³¹⁷ Consequently, once a pollution prevention

³¹² Kidd and Couzens "Climate Change Responses in South Africa" 623.

³¹³ GN 710 in GG 40996 of 21 July 2017 (Declaration); In this respect, The GHGs listed in the Declaration include all gases identified in Annex A of the Kyoto Protocol, but does not include NF₃ as expanded upon by the Doha Amendments.

³¹⁴ Paragraph 3 of the Declaration.

³¹⁵ GN 712 in GG 40996 of 21 July 2017.

³¹⁶ Regulation 2 of the PPP Regulations; For instance, the PPP Regulations asserts that these plans must be concluded in accordance with the *National Greenhouse Gas Emission Reporting Regulations* published in GN 275 in GG 40762 of 3 April 2017.

³¹⁷ Regulation 3(1)(f) of the PPP Regulations; The first planning horizon covers the period from promulgation of these regulations up to 31 December 2020 with additional plans covering five calendar year periods.

plan has been accepted by the Department of Environmental Affairs, an onus is placed on this person to provide annual progress reports to the Department of Environmental Affairs for approval.³¹⁸ These progress reports shall include details of the mitigation measures implemented, specific information of any deviation from the approved plan and remedial action taken to address such deviation and how risks and limitations were managed.³¹⁹

Accordingly, these planning and reporting obligations specified for the production processes referred to in the Declaration may provide a significant opportunity for the implementation of bio-energy projects under the CDM. This is because these projects can be used as a vehicle to facilitate compliance with air quality preventative action under national legislation.³²⁰ while being quantified as viable climate change mitigation measures resulting in actual deviation from baseline emissions as required under the PPP regulations. For instance, in relation to the pulp and paper industry, Combined Heat and Power projects may provide electricity derived from excess biomass not used during the production process. This is considered a carbon neutral activity and will also decrease the reliance in this industry on grid-electricity derived from fossil-fuel.

4.3.1.3 Nationally Determined Contributions

The discussion in Chapter 2 of this dissertation set out the significance of the NDCs in the international arena. This sub-section specifically addresses the South African NDC submitted in accordance with the country's climate change obligations.³²¹ To begin with, the NDC is formulated on the assumption that all commitments shall give effect to the CBDR-RC principle highlighting equity and national considerations.³²² As a result, though the South African government acknowledges

³¹⁸ Regulation 5(1) of the PPP Regulations.

³¹⁹ Regulation 5(2)(a)-(c) of the PPP Regulations; Any person convicted for contravention of these regulations are liable to a fine or imprisonment specified under Reg 8 and 9 of these regulations.

³²⁰ Humphris *South Africa's Law and Policy Framework for the Regulation of the Clean Development Mechanism* 27.

³²¹ United Nations Framework Convention on Climate Change 2015 <http://www4.unfccc.int/ndcregistry/PublishedDocuments/South%20Africa%20First/South%20Africa.pdf> (NDC).

³²² NDC 3.

the seriousness of climate change, it provides that national concerns such as poverty alleviation, reductions in unemployment and economic growth shall be given precedence.³²³ However, it must be reiterated that the international perception of this principle within the climate regime has evolved from differentiation amongst developed and developing nations, to reunification of all parties under the Paris Agreement.

At the nucleus of the mitigation component of South Africa's NDC rests the so-called peak, plateau and decline trajectory (PPD trajectory).³²⁴ In this respect, the document determines that the PPD trajectory is anticipated to commence at the end of 2020 with the country's emissions escalating between 2025 and 2030 to between 398 and 614 MtCO₂e.³²⁵ The NDC therefore asserts that South Africa's emissions should peak between 2020 and 2025, plateau for roughly 10years and decline in absolute terms thereafter.³²⁶

It is determined that achievement of this mitigation pathway shall be realized through various legislative, policy and planning instruments working in unison to bend the curve of the country's GHG emissions towards this trajectory.³²⁷ Additionally, financial support and foreign investment are significant considerations under the NDC which provides that the countrys commitments are conditional subject to assistance from the international climate regime.³²⁸ Consequently, from the discussion to follow under the energy legal framework, one can ascertain from the multitude of energy planning and policy documents which refer to bio-energy that it may meaningfully contribute to the achievement of the PPD trajectory.³²⁹

³²³ NDC 7.

³²⁴ NDC 1.

³²⁵ NDC 6.

³²⁶ NDC 7.

³²⁷ NDC 2.

³²⁸ NDC 9.

³²⁹ The NDC determines that modern forms of bio-energy are recognized as technologies that could help further reduce anthropogenic emission in the Republic.

4.3.1.4 Climate Change Bill

The South African government is in the process of drafting national legislation specifically focused on addressing climate change and has recently gazetted the Climate Change Bill for public comment.³³⁰ Although, the document is not legally binding it does provide insight into the country's proposed statutory position on climate change for the near future and several noteworthy considerations can be identified that may contribute to the current study. The Bill specifies that the proposed Act shall endeavour to make a fair contribution to global mitigation efforts in accordance with the international climate regimes mandate while fostering sustainable development.³³¹ Additionally, stipulating it shall coordinate all spheres of government in response to climate change and provide effective national management to reduce vulnerability and strengthen climate resilience.³³²

The Bill identifies a number of principles to guide the interpretation and application of the proposed Act, these include, *inter alia*, those mentioned in Section 2 of the NEMA.³³³ Additionally, the CBDR-RC principle is specifically identified as a guiding principle for the country's future climate change legislation.³³⁴ The equity underpinning of the principle is a significant motivator for developing countries and is highlighted in the Bill placing emphasis on taking national circumstances into consideration.³³⁵ This position was echoed in the writings of South Africa's NDC; however, under the post-2020 global climate agreement all nations are required to proactively engage in addressing climate change. Therefore, the South African government acknowledges the duty bestowed upon the country to balance national development against the responsibility to address anthropogenic impacts on the climate system.

³³⁰ GN 580 in GG 41689 of 8 June 2018 (the Bill).

³³¹ Section 2(c) of the Bill.

³³² Section 2(a)-(b) of the Bill.

³³³ Section 3 of the Bill.

³³⁴ Section 3(c) of the Bill.

³³⁵ Section 3(c) of the Bill.

Furthermore, the Bill identifies that monitoring and evaluation activities shall contribute significantly to the country's statutory climate change response and provides several mechanisms which facilitate mitigation action.³³⁶ These mechanisms include, firstly, a National GHG Emission Trajectory containing Emission Reduction Objectives,³³⁷ secondly, the designation of Sectoral Emission Targets (SETs) for GHG emitting sectors and sub-sectors.³³⁸ Thirdly, GHG emission thresholds must be determined for the purpose of allocating carbon budgets,³³⁹ and finally, a Phase Down or Phase Out Plan focused on synthetic GHGs such as HFCs, PFCs and SF₆ must be established.³⁴⁰ All of these mechanisms trigger supplementary mitigation action that must be achieved by the competent person designated by the document. For instance, the SETs require the Minister accountable for the sectors to formulate a Sector Emission Reduction Plan (SERPs), providing a detailed account of how the SETs shall be accomplished.³⁴¹

4.3.2 Energy legal framework

4.3.2.1 White Paper on Energy Policy

Under South Africa's post-apartheid constitutional dispensation, the first energy policy document drafted in connection with section 24 of the Constitution was the Energy White Paper.³⁴² The document provided an outline for the country's energy ambitions, containing several objectives to provide increased access to reasonably priced energy services and improve energy governance.³⁴³ This is to be pursued while stimulating development of the economy, enhancing management of health and environmental impacts stemming from energy activities and ensuring energy

³³⁶ The Minister of Environmental Affairs is the competent authority tasked with formulating these climate change mitigation mechanisms, however the Bill does provide instances where consultation with relevant stakeholders are required.

³³⁷ Section 11 of the Bill.

³³⁸ Section 12 of the Bill.

³³⁹ Section 13 of the Bill.

³⁴⁰ Section 14 of the Bill.

³⁴¹ Section 12(4) of the Bill.

³⁴² Barnard 2012 *Potchefstroom Electronic Law Journal* 224, GN 3007 in GG 19606 of 17 December 1998.

³⁴³ Energy White Paper 8.

supply through diversity.³⁴⁴ Subsequently, though the Energy White Paper recognised that coal would for the foreseeable future continue to be a major energy source, it understood the need to secure energy supply through renewable energy expansion.³⁴⁵ Accordingly, the document referred to the implementation of the Kyoto Protocol CDMs to support and finance sustainable development through renewable energy initiatives.³⁴⁶

Consequently, as identified by the document both modern and traditional forms of bio-energy conversion technologies have application in achieving the country's energy demands. Regarding modern bio-energy the Energy White Paper asserts that as a renewable form of energy it warranted immediate prioritisation for research and development for use in South Africa.³⁴⁷ In this respect, specific linkages are made in the document regarding bio-energy. For instance, it prescribes the use of products and residues from agricultural, forestry and agro-forestry activities for conversion and use in electric power generation.³⁴⁸

Moreover, traditional bio-energy is acknowledged within the very first paragraph of the Energy White Paper as the primary energy source for the rural domestic sector.³⁴⁹ Accordingly, at that stage bio-energy resources including firewood, wood waste and charcoal accounted for close to 60% of household energy consumption, roughly 10% of net energy use.³⁵⁰ Additionally, the document touches on the adverse health outcomes associated with indoor air pollution from these traditional sources of energy, and provides that increased electrification roll-out is the primary response to alleviate this issue.³⁵¹ Consequently, modern bio-energy projects could

³⁴⁴ Energy White Paper 8-9.

³⁴⁵ Moyo *The Role of the South African Renewable Energy Legal Framework in Climate Change Mitigation - A Focus on the Construction of Buildings* 39.

³⁴⁶ Energy White Paper 92.

³⁴⁷ Energy White Paper 80; Although the Energy White Paper identifies biofuels as briquettes, charcoal, biogas, producer gas, ethanol and bio-diesel fuel, while later this term has become synonymous with liquid fuels used in the transportation sector.

³⁴⁸ Energy White Paper 40.

³⁴⁹ Energy White Paper 2.

³⁵⁰ Energy White Paper 79.

³⁵¹ Energy White Paper 88-90.

have assisted in achieving greater electrification roll-out through decentralised mini-energy grids within this sector.

Subsequently, bio-energy as a form of renewable energy has been on the energy policy radar of South Africa for the past two decades. Although the Energy White Paper was an essential step for energy policy development in South Africa the ambiguity and misalignment of the document between energy and environmental concerns negatively shaped government's approach to renewables.³⁵² Nonetheless, as observed by Klees,³⁵³ while the document has never been "withdrawn" government's policy has gradually deviated from the path outlined by the Energy White Paper. As a result, there has been little significant progression on some of the policy considerations presented in the document, including those involving bio-energy.

4.3.2.2 Integrated Energy Plan

The *Integrated Energy Plan* of 2003 (IEP 2003) considers various energy planning scenarios from different economic sectors for the purpose of ensuring that sufficient energy supply is available to meet the anticipated demand.³⁵⁴ In this respect, the document identified coal as the primary energy source for South Africa due to its inexpensive nature and because national reserves were estimated at around 55 billion tonnes.³⁵⁵ However, the document notes the importance of diversifying energy resources with other forms of energy such as renewables to improve security of supply, improve the quality of the environment and foster development in the sub-region.³⁵⁶ Subsequently, the IEP 2003 indicated that government recognised that although the introduction of renewable energies into the energy mix would be more costly, the importance of these energy sources outweighed the cost implications. Accordingly, the document aligned with governments aims and

³⁵² Murombo "South Africa's Energy Mix - Towards a Low-Carbon Economy" 10.

³⁵³ Klees *Electricity Law in South Africa* 28.

³⁵⁴ Kidd and Couzens "Climate Change Responses in South Africa" 635.

³⁵⁵ IEP 2003 10.

³⁵⁶ IEP 2003 25.

asserted that 10 000 GWh of renewable energy expansion was to be commissioned by 2012.³⁵⁷

The IEP 2003, as was the case with the Energy White Paper, recognised the use of bio-energy as a form of renewable energy in addition to the relatively extensive consumption of biomass in rural areas throughout the country.³⁵⁸ Accordingly, the document considers bio-energy an economically viable resource for the future energy mix, stating that "there are renewable energy sources that are economic in the South African energy sector, such as biomass, especially in industry".³⁵⁹ Subsequently, in relation to the country's electricity generation capacity from bio-energy, the bagasse industry is identified as an energy source with a capacity of 105 MWe.³⁶⁰ Moreover, the IEP 2003 determines that in relation to the domestic energy sector, biomass as an energy carrier for traditional bio-energy technologies accounted for 8% of South Africa's energy demands in the year 2000.³⁶¹

Recently, the *Draft Integrated Energy Plan* of 2016 (IEP 2016) was released by the Department of Energy and is the latest version of this document which has already undergone a public participation process.³⁶² Subsequently, several key objectives are identified in the new document including:

Ensure security of supply; minimise the cost of energy; promote the creation of jobs and localisation; minimise negative environmental impacts from the energy sector; promote the conservation of water; diversify supply sources and primary sources of energy; promote energy efficiency in the economy and increase access to modern energy.³⁶³

Consequently, as with the 2003 version, the new draft continues to acknowledge bio-energy as a resource that can contribute to the future energy mix of South Africa.³⁶⁴ In this respect, the IEP 2016 recognizes wood and to a lesser extent

³⁵⁷ IEP 2003 25; the South African government was not able to achieved this renewable energy target within the proposed planning horizon.

³⁵⁸ IEP 2003 6.

³⁵⁹ IEP 2003 25.

³⁶⁰ IEP 2003 9.

³⁶¹ IEP 2003 7.

³⁶² A *Draft Integrated Energy Planning Report* of 2012 was also released by the Department of Energy in 2013 for public consultation.

³⁶³ IEP 2016 11-12.

³⁶⁴ IEP 2016 19.

charcoal as one of the primary feed stocks for energy related activities in the residential sector with about 7 Mt of wood being used a year.³⁶⁵ The document affirms the presumption that low income households are more prone to a reliance on traditional bio-energy conversion processes and necessitates a minimization in the use of this form of energy.³⁶⁶ Accordingly, the IEP 2016 refers to other governmental programmes to bring about this minimization which calls for national electrification, fuel switching in households and off-grid alternatives.³⁶⁷

Furthermore, the document deems the use of biomass feed stocks as a viable form of energy in the industrial sector for both co-generation purposes and electricity generation for the national grid or nearby consumers.³⁶⁸ Consequently, these bio-energy applications depend largely on the availability of affordable feed-stocks within that specific industry or within close proximity to operations.³⁶⁹ As such, the IEP 2016 identifies paper manufacturers, the sugar industry and municipal waste as potential avenues through which bio-energy may permeate the energy sector.³⁷⁰ It highlights the pursuance of co-generation processes using available feed stocks to address short and medium term electricity capacity constraints.³⁷¹ Accordingly, the document stipulates that the energy content obtainable from these sectors is roughly 11 000 GWh per annum which could be directly incinerated or converted into higher yield energy carriers such as methane.³⁷² Where this electricity generated through bio-energy incentives are fed into the national grid it may contribute to the generation capacity of the entire network.³⁷³ Subsequently, it can therefore be concluded from this relatively recent draft energy policy document that

³⁶⁵ IEP 2016 56.

³⁶⁶ IEP 2016 178.

³⁶⁷ IEP 2016 178.

³⁶⁸ IEP 2016 55.

³⁶⁹ IEP 2016 56.

³⁷⁰ IEP 2016 56.

³⁷¹ IEP 2016 168; This will reduce dependency on the national grid, alleviate transmission losses and reduce GHGs; The exact conversion efficiency, GHG reduction and energy saving depend on the details of the specified project.

³⁷² IEP 2016 57.

³⁷³ IEP 2016 168.

bio-energy considerations have remained consequential for South Africa's future energy mix.

4.3.2.3 National Energy Efficiency Strategy

The *Energy Efficiency Strategy of the Republic of South Africa* of 2005 (NEES 2005) represents the first consolidated national instrument aimed specifically towards energy efficiency practices in the Republic. The NEES 2005 takes its mandate from the Energy White Paper, the document provides national targets for improving energy efficiency by 12% by 2015 against the 2000 baseline.³⁷⁴ The strategy's vision is:

To encourage sustainable energy sector development and energy use through efficacy practices thereby Minimising the undesirable impacts of energy usage upon health and the environment, and Contributing towards secure and affordable energy for all.³⁷⁵

The document provides several goals to facilitate social, environmental and economic sustainability. These include, *inter alia*, alleviation of energy poverty, reduction in CO₂ emissions and enhanced energy security.³⁷⁶ The NEES 2005 stipulates that energy efficiency represents a cost-effective approach to reduce GHG emissions and contributes to climate change mitigation and also allows for the use of financial mechanisms, such as the CDM.³⁷⁷ Additionally, the document prescribes energy demand reduction targets for several areas including the residential sector, which is set at 10% reduction by 2015.³⁷⁸ The document determines that the residential sector accounted for 16,4% of final energy demand in 2000 and of the 360.5 Petajoules used by the sector approximately 53% was derived from biomass in rural areas.³⁷⁹ The document specified *inter alia* increased electrification roll-out and increased improved cooking technology roll-out as measures to achieve the reduction targets.

³⁷⁴ NEES 2005 6.

³⁷⁵ NEES 2005 4.

³⁷⁶ NEES 2005 5.

³⁷⁷ NEES 2005 5.

³⁷⁸ NEES 2005 15.

³⁷⁹ NEES 2005 32.

Although the planning horizon for the NEES 2005 lapsed in 2015, the Department of Energy published for public comment a *Draft post 2015 National Energy Efficiency Strategy* of 2016 (Draft-NEES 2016) to supersede the 2005 document.³⁸⁰ Accordingly, the Draft-NEES 2016 attempts to promote energy efficiency as the "first fuel" for sustainable development.³⁸¹ The document identifies that of the three dominant consumption areas according to 2012 statistics, the residential sector accounts for 25% of total final energy consumption.³⁸² However, the document states that total biomass energy consumption is strongly influenced by estimations where statistics are provided.³⁸³

The Draft-NEES 2016 provides that within low income households biomass for cooking and water heating is a significant factor with around 60% of these households being dependent on this fuel source.³⁸⁴ Subsequently, the document determines that the propagation of improved cooking technologies has the potential to reduce wood consumption by between 40% and 60% if achieved in all households using wood-based fuels.³⁸⁵ The Draft-NEES 2016 states that improved biomass cook stoves as a non-electricity related energy opportunity has huge potential for individual households in the country.³⁸⁶ Consequently, it has the potential to not only save time and money but also to improve the quality of living conditions of citizens by reducing indoor air pollution and related respiratory illnesses.³⁸⁷ Therefore, unlike previous policy instruments, where bio-energy is concerned, the NEES 2005 and Draft-NEES 2016 focus primarily on initiatives directed at the rural domestic sector to provide sustainable cooking practices. Accordingly, these documents recognise that not all citizens have access to grid-electricity or other energy resources yet still have energy needs. As such they

³⁸⁰ GN 948 in GG 40515 of 23 December 2016.

³⁸¹ Draft-NEES 2016 3.

³⁸² Draft-NEES 2016 6.

³⁸³ Draft-NEES 2016 6.

³⁸⁴ Draft-NEES 2016 12.

³⁸⁵ Draft-NEES 2016 12.

³⁸⁶ Draft-NEES 2016 9.

³⁸⁷ Draft-NEES 2016 9.

endorse non-electric bio-energy projects as a way to address energy access while conserving bio-diversity and mitigating climate change.

4.3.2.4 White Paper on Renewable Energy

Building on the position set forth in the 1998 document, the RE White Paper was promulgated.³⁸⁸ The RE White Paper communicates the urgency of the transition to renewable energy resources for South Africa as a mitigation strategy within the context of the UNFCCC and the Kyoto Protocol.³⁸⁹ The document provides the vision of government to promote the implementation of renewable energies into South Africa's energy mix through policies, strategic objectives and deliverables.³⁹⁰

Consequently, this required the integration of renewable energy technologies into the South African energy sector, despite the fact that at this stage these technologies were costly, underdeveloped and posed difficulties for investment.³⁹¹ Nevertheless, the RE White Paper specifies that within 10 years of publication of this document renewable energy should contribute 10 000 GWh to final energy consumption, reiterating the target for renewables referred to in the IEP 2003.³⁹² This amounted to approximately 4% of anticipated 2013 energy demand or electricity supply for around 2 million households, which was equivalent to replacing two of South Africa's coal-fired power stations.³⁹³ However, despite the renewable energy target envisaged by government in these documents, the country was unable to achieve its objective.³⁹⁴

Subsequently, through the development of a renewable energy-enabling framework the RE White Paper provided a prospective path through which CDM projects could be implemented in South Africa.³⁹⁵ Although, the document does not explicitly

³⁸⁸ GN 513 in GG 26169 of 14 May 2004.

³⁸⁹ Murombo "South Africa's Energy Mix - Towards a Low-Carbon Economy" 11.

³⁹⁰ Kidd and Couzens "Climate Change Responses in South Africa" 636.

³⁹¹ Moyo *The Role of the South African Renewable Energy Legal Framework in Climate Change Mitigation - A Focus on the Construction of Buildings* 49.

³⁹² RE White Paper 25; IEP 2003 25.

³⁹³ RE White Paper 25.

³⁹⁴ Lehmann "South Africa's Climate Change Commitments and Regulatory Response Potential" 18.

³⁹⁵ Murombo "South Africa's Energy Mix - Towards a Low-Carbon Economy" 13.

address how this is to be achieved, it did determine that the CDM will affect the country's overall renewable energy production.³⁹⁶ In this respect, the RE White Paper determined, *inter alia*, that biomass would be one of the primary renewable energy sources to satisfy the exigency for both electrification and non-electric projects.³⁹⁷

The RE White Paper briefly assesses the applicability of biomass as a South African renewable energy resource, concentrating on viable feed stocks such as dedicated energy crops, bagasse, agricultural residues, fuel wood and animal manure.³⁹⁸ Similarly, the document identified waste such as landfill gas and municipal solid waste as a potential renewable energy to be harnessed for electricity generation.³⁹⁹ Furthermore, the document supports the conservation of biodiversity and necessitates increased efficiency of traditional bio-energy conversion technologies as an important concern for the achievement of the policy's objectives.⁴⁰⁰ Under the RE White Paper these matters continued the status quo surrounding South African energy policy and bio-energy as a residential fuel and as part of the country's renewable energy potential for the electricity sector.

4.3.2.5 National Energy Act

Although the *National Energy Act* 34 of 2008 (Energy Act) only references bio-energy under the definitions in section 1, the document nevertheless lays the legislative bedrock on which South Africa's renewable energy intentions are formulated. The Energy Act was promulgated to strengthen the policy position set forth in the previously mentioned energy white papers and governs various aspects associated with the energy sector reform process.⁴⁰¹ Within the preamble it is stipulated that increased production and utilisation of renewable energy at affordable prices shall significantly contribute to achieving sustainable development

³⁹⁶ RE White Paper 23-24.

³⁹⁷ RE White Paper 25.

³⁹⁸ RE White Paper 14-17.

³⁹⁹ RE White Paper 22-23.

⁴⁰⁰ RE White Paper 12.

⁴⁰¹ Klees *Electricity Law in South Africa* 12.

and poverty alleviation within the Republic.⁴⁰² To this extent the document acknowledges the harmful impacts of fossil fuels and that they should be restricted, advocating diversification of South Africa's energy sector through increased implementation of renewable energy alternatives.⁴⁰³

Correspondingly, the Energy Act provides a number of objectives, such as, *inter alia*, ensuring energy supply and security, commercialisation of renewable technologies, the inclusion of environmental and health concerns into energy planning and increased energy access.⁴⁰⁴ However, though these objectives are important considerations, the document makes no express reference to the impact the energy sector has on the global climate and how GHGs exacerbate climate change.⁴⁰⁵ Moreover, the Energy Act does not provide any specific timelines or targets and might be construed as a missed opportunity to manoeuvre renewable energies into a position where it can extensively contribute to the South African energy mix.⁴⁰⁶ Nevertheless, despite these short-comings the Energy Act does provide for the development of the country's energy roadmap in the form of the IEP; though it is a policy document it does take these considerations into account.⁴⁰⁷

4.3.2.6 Integrated Resource Plan for Electricity

The IRP 2010-2030 was drafted under the auspices of the *Electricity Regulation Act* 4 of 2006, the document is an energy blueprint focused on electricity generation and the creation of a sustainable domestic energy mix.⁴⁰⁸ Subsequently, the drafters of the document anticipated that energy demand would double between 2010 and 2030, necessitating the establishment of new generation capacity.⁴⁰⁹ In this respect,

⁴⁰² Barnard 2012 *Potchefstroom Electronic Law Journal* 228.

⁴⁰³ Moyo *The Role of the South African Renewable Energy Legal Framework in Climate Change Mitigation - A Focus on the Construction of Buildings* 58.

⁴⁰⁴ Section 2 of the Energy Act; the Act additionally establishes institutional arrangements to promote green energy research and initiatives.

⁴⁰⁵ Murombo "South Africa's Energy Mix - Towards a Low-Carbon Economy" 19.

⁴⁰⁶ Moyo *The Role of the South African Renewable Energy Legal Framework in Climate Change Mitigation - A Focus on the Construction of Buildings* 59.

⁴⁰⁷ Murombo "South Africa's Energy Mix - Towards a Low-Carbon Economy" 20.

⁴⁰⁸ Murombo 2016 *Journal of World Energy Law and Business* 162; The *Integrated Resource Plan* was originally gazetted in 2009 and later withdrawn and replaced in GN 25 in GG 32898 of 29 January 2010, which was subsequently overtaken by the IRP 2010-2030 gazetted in 2011.

⁴⁰⁹ Klees *Electricity Law in South Africa* 31.

the document addresses various energy scenarios and outlines an electricity trajectory of 17,8 GW of new generation capacity to be derived from renewable energy sources.⁴¹⁰ This is equivalent to approximately 20% of the intended installation capacity, which translates to around 9% of the total domestic energy supply by 2030.⁴¹¹ The document accented the facilitation of reductions in CO₂ emissions and claimed this is consistent with emission constraints of 275 million tonnes of CO₂ annually after 2024.⁴¹²

To all intents and purposes, the document supports the notion that a diversified energy mix will minimize the inherent risks associated with expanding power-supply systems.⁴¹³ However, the vision and targets of the IRP 2010-2030 perpetuated the country's reliance on fossil-fuels, particularly coal, and regarded it as indispensable for satisfying the country's energy needs.⁴¹⁴ In this respect, renewables such as bio-energy are intended to remain on the periphery of the energy mix and may have been perceived as a fringe resource supplementary to fossil fuels.⁴¹⁵ As such, the potential for more intricate renewables such as bio-energy had been overlooked by the IRP 2010-2030 and the document provides no specific provisions for electricity generation from biomass apart from minor projects equating to a mere 63 MW by 2030.⁴¹⁶

Nonetheless, it must be kept in mind that the plan is essentially a "living document" and was initially anticipated to be adjusted every two years.⁴¹⁷ In this regard, the document does acknowledge bio-energy as a viable technology option that requires further investigation as part of the research agenda for future IRPs.⁴¹⁸ Although, the IRP 2010-2030 is still the official plan enforced by government more than 7

⁴¹⁰ IRP 2010-2030 6.

⁴¹¹ Baker "Post-Apartheid Electricity Policy and the Emergence of South Africa's Renewable Energy Sector" 380.

⁴¹² IRP 2010-2030 8.

⁴¹³ IRP 2010-2030 17.

⁴¹⁴ Murombo 2016 *Journal of World Energy Law and Business* 162.

⁴¹⁵ Kidd and Couzens "Climate Change Responses in South Africa" 637.

⁴¹⁶ Department of Science & Technology *Bioenergy Atlas for South Africa - Synopsis Report* 12.

⁴¹⁷ Klees *Electricity Law in South Africa* 31.

⁴¹⁸ IRP 2010-2030 22.

years after being gazetted new drafts have been published by the Department of Energy.⁴¹⁹

This includes the draft IRP released in 2016 (IRP 2016-2030) recognising the ministerial determinations which propose a slight growth for bio-energy as a form of renewable energy in the electricity generation sector.⁴²⁰ The IRP 2016-2030 anticipated this generation capacity to account for 195 MW in 2019 from landfill gas, biomass and biogas respectively.⁴²¹ Additionally, the document identifies several bio-energy renewable energy power plant options including the use of biomass forestry residues, biomass municipal solid waste, landfill gas, biogas and bagasse which equate to 161.5 MW.⁴²² Although, these considerations are small when compared to solar and wind, their inclusion keeps bio-energy in contention as a viable source of renewable energy to be used not only for traditional conversion processes but also within the electricity generation sector.

Moreover, the latest IRP draft (IRP 2018-2030) was recently released and is currently undergoing a 60-day public comment process, scheduled to end in late October 2018.⁴²³ A significant concern related to this document is the inclusion of 1000 MW of additional electricity derived from coal proposed for the country's energy mix, in addition to the coal-fired power stations already under construction.⁴²⁴ Accordingly, this is certainly a consideration that will be challenged during the comment process.

Nonetheless, several positive considerations are prevalent within this latest draft, such as the move away from costly nuclear power, which has been a significant concern within South Africa.⁴²⁵ Additionally, the IRP 2018-2030 places increased emphasis on renewable energy; yet, unlike previous IRP drafts this new document

⁴¹⁹ Baker 2017 *IDS Bulletin* 108.

⁴²⁰ Department of Energy 2018 <http://www.energy.gov.za/IRP/irp-2016.html>.

⁴²¹ IRP 2016-2030 13.

⁴²² IRP 2016-2030 18.

⁴²³ GN 897 in GG 41865 of 27 August 2018.

⁴²⁴ IRP 2018-2030 39; Mining Review 2018 <https://www.miningreview.com/coal-irp/>.

⁴²⁵ Gosling 2018 <https://www.dailymaverick.co.za/article/2018-08-29-draft-energy-irp-welcomed-but-some-doubts-remain/>.

is relatively silent on the future of bio-energy in the proposed energy mix for the Republic.⁴²⁶ However, the document provides that some technologies are missing from the base case results, including bio-energy projects and it is determined that this concern will be addressed through a policy position in the IRP update.⁴²⁷ Subsequently, while bio-energy does not facilitate a central role in the IRP 2018-2030, this new document does potentially provide the foundation for the future electricity plan that will influence energy sector activities.

4.3.2.7 National Development Plan

The NDP, as the name suggests, is a policy document determining the development path of South Africa leading up to 2030, formulated by the National Planning Commission. Consequently, one of the primary objectives of the NDP is to reduce inequality and eliminate poverty in the Republic while promoting sustainable development.⁴²⁸ In this respect, the NDP acknowledges this mandate for balancing the country's socio-economic objectives against critical environmental concerns, particularly in relation to national resources exploited for energy purposes.⁴²⁹ Although, the NDP recognises coal as the country's largest energy resource for the foreseeable future, it does promote the use of renewables.⁴³⁰

The NDP anticipates that approximately 40 000 MW of new generation capacity will be required by 2030, of which 7 000 MW of renewable energy shall be procured in the medium term from the private sector by 2020 and more than 20 000 MW in the long term by 2030.⁴³¹ However, the NDP does not specify how these energy contributions are to be allocated amongst the available renewable energy technologies; however, considering the common position regarding energy policy, bio-energy projects should likely be included.⁴³² Accordingly, the document links

⁴²⁶ Mining Review 2018 <https://www.miningreview.com/coal-irp/>.

⁴²⁷ IRP 2018-2030 73.

⁴²⁸ Klees *Electricity Law in South Africa* 31.

⁴²⁹ Papacostantis 2017 *The Comparative and International Law Journal of Southern Africa* 298.

⁴³⁰ NDP 163.

⁴³¹ NDP 168, 176, 177.

⁴³² Moyo *The Role of the South African Renewable Energy Legal Framework in Climate Change Mitigation - A Focus on the Construction of Buildings* 6.

these proposed renewable energy developments with those envisaged by the integrated resource plan and determines that by 2030 South Africa should have significantly transitioned toward a low-carbon economy and an environmentally sustainable society.⁴³³

4.4 Conclusion

The countries within the SADC region have all voluntarily committed themselves to participate in international climate change action under the UNFCCC, Kyoto Protocol and the Paris Agreement. Subsequently, as an issue of common concern within SADC climate change exacerbated through energy sector activities is one of the most prolific issues impacting on the environment and requires inter-governmental co-operation between member states within the sub-region. Moreover, South Africa as a major developing country and highest emitter of GHGs in SADC, shoulders a greater burden to drive climate change mitigation action than other member states. In this respect, the country's well-developed climate change framework and energy legal framework provide a solid basis for a country-specific analysis on bio-energy.

The South African Constitution provides a fundamental right for environmental protection and has developed specific legislative means to ensure the fulfilment of this right. Accordingly, the NEMA stands at the summit of these legislative environmental protective measures and guides the interaction between humans and the environment within South Africa. The country's climate change policy and anticipated legislative instrument complement this fundamental right and guides South Africa's mitigation action. In this respect, the damaging role of the country's GHG intensive energy sector is acknowledged within the climate change framework and it provides a mandate for energy sector mitigation.

Consequently, though coal remains central to South Africa's development aspirations, the energy legal framework covers various document and policy trends to facilitate renewable energy promotion, energy efficiency and ultimately strives for energy sector reform. Therefore, when the multitude of energy planning and

⁴³³ NDP 199.

policy documents which refer to bio-energy is considered, it is a clear indication that this form of renewable energy has the potential to contribute to the achievement of energy sector mitigation action. Subsequently, these considerations bear relevance nationally for South Africa, but also for the pursuit of climate change mitigation in SADC.

5 Conclusion and recommendations

5.1 Conclusion

The equity concerns encapsulated by the CBDR-RC principle have been a significant consideration within the international climate regime since the adoption of the UNFCCC in 1992.⁴³⁴ Accordingly, the Paris Agreement which followed 23 years later breathed new life into this general principle of international environmental law, unifying the efforts of developed and developing nations in the fight against climate change.⁴³⁵ This is significant given that developing nations are more susceptible to the adverse impacts of climate change, because of various national considerations such as high population density and rampant poverty.⁴³⁶ Therefore, mitigation action should be a primary concern of governments in the developing world, not merely as a result of their vulnerability, but also since this is where a vast majority of the anticipated global population growth will occur.

The developing world is where most energy expansion and consumption will take place, considering that population growth and development are interconnected with energy serving as the catalyst for national progress.⁴³⁷ This is because, the availability of energy resources facilitates an essential role within the development process as the production of goods and the delivery of services are all heavily dependent on energy supply. However, this need for energy has largely been fulfilled by fossil-fuels which add to the concentration of GHG emissions in the atmosphere, which exacerbates global climate change.⁴³⁸ In this respect, the majority of SADC countries still contribute very little to these emissions, as a large proportion of the population are still exclusively dependent on traditional bio-energy technologies.⁴³⁹ However, if intervention in the energy sector to displace fossil-fuels does not occur and these countries latch onto these non-renewable energy resources it will be harmful to the global climate.

⁴³⁴ See para 2.2.1 above.

⁴³⁵ See para 2.4.1 above.

⁴³⁶ See para 2.1 above.

⁴³⁷ See para 3.1 above.

⁴³⁸ See para 2.2.1 above.

⁴³⁹ See para 4.2 above.

This is where bio-energy as a renewable resource and means to displace fossil-fuels enters the fray. Bio-energy may address both the limitation and reduction of GHGs at the source, in addition to the enhancement and preservation of reservoirs and sinks through human intervention.⁴⁴⁰ In this respect, this form of renewable energy could very well contribute to the ultimate mitigation objective of the UNFCCC, which provides the underlying aspirations for the entirety of the international climate regime.⁴⁴¹ However, the implementation of bio-energy projects through the Kyoto Protocol's CDM will not be simple straightforward remedies to ensure energy access and reduce climate change, but will require significant planning and organisational development.

These concerns relate to South Africa's position as one of the most developed countries within SADC, as well as the SADC mandate for climate change mitigation.⁴⁴² The fact that South Africa is by far the leading emitter of GHGs in SADC means the country has a greater responsibility to address climate impacts and spearhead mitigation action.⁴⁴³ In this respect, South Africa's climate change framework and energy legal framework consistently refer to bio-energy as a renewable resource which may aid in reforming energy sectors.⁴⁴⁴ Therefore, in answering the research question these instruments as the bases for the South African bio-energy regulatory framework may in several ways contribute to achieving the objective of climate change mitigation in SADC.

Firstly, South Africa's climate change considerations are at the outset framed under the Constitution and relevant environmental legislation; as such other SADC countries may draw from this rights-based approach to mitigate climate change and ensure ecological protection.⁴⁴⁵ Secondly, the bio-energy regulatory framework acknowledges the urgent need to transition toward renewable energy resources, identifying this as an important mitigation strategy which aligns with the

⁴⁴⁰ See para 3.6 above.

⁴⁴¹ See para 2.2 above.

⁴⁴² See para 4.1 and 4.2 above.

⁴⁴³ See para 4.2.3 above.

⁴⁴⁴ See para 4.3 above.

⁴⁴⁵ See para 4.3 above.

international climate regime.⁴⁴⁶ Thirdly, both traditional and modern bio-energy technologies are recognized to varying degrees as economically viable options to contribute towards present and future energy use.⁴⁴⁷ Additionally, it provides instruction for the incorporation of bio-energy as low-carbon energy projects under the CDM for domestic and industrial energy supply which contributes to energy sector mitigation.⁴⁴⁸ Lastly, the bio-energy regulatory framework identifies that traditional bio-energy exploitation should be minimized and replaced by modern energy resources over time, through the implementation of, *inter alia*, energy efficiency measures, fuel switching and off-grid alternatives.⁴⁴⁹

5.2 Recommendations

The changes in the climate system exacerbated through energy sector activities are matters of common concern and require SADC countries to cooperate and harmonise their national instruments to ensure co-operation within the sub-region. Where bio-energy is concerned the following recommendations are proposed to facilitate energy sector related climate change mitigation within SADC:

- At the SADC level a climate change protocol should be formulated in the spirit of co-operation to guide member states toward a climate resilient future.
- SADC should place greater emphasis on the expansion of bio-energy projects as the sub-region is well-endowed with biomass resources and as a renewable energy it is diverse in its application and can be moulded to fit the heterogeneity of individual states.
- Biomass will for the foreseeable future still facilitate a major role in meeting final energy demands of individual SADC countries. Therefore, increased energy efficiency through improved traditional bio-energy initiatives should be pursued within the sub-region.
- Nationally within SADC strong renewable energy legal frameworks and policies should be developed which address both traditional and modern bio-

⁴⁴⁶ See para 4.3.1 and 4.3.2 above.

⁴⁴⁷ See para 4.3 above.

⁴⁴⁸ See para 4.3.1.1 and 4.3.2.3 above.

⁴⁴⁹ See para 4.3.1 and 4.3.2 above.

energy. Accordingly, these technologies must develop in unison to increase energy options for households and industry while safeguarding that biomass resources are not squandered.

- Increasing research and investigation into domestic biomass trends and feasibility studies on bio-energy should be an important consideration enshrined within these proposed SADC instruments.
- Modern bio-energy technologies should complement traditional bio-energy exploitation; as such the bio-economy must develop from solitary end-use orientation to integrated production systems fostering sustainability within the entire biomass value chain.
- Significant emphasis should be geared towards improving the biospheric carbon stock of land to prevent unsustainable biomass exploitation.

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