FIRST BIENNIAL UPDATE REPORT OF THE KINGDOM OF CAMBODIA

TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

The National Council for Sustainable Development

The Kingdom of Cambodia

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FOREWORD

Cambodia became a Party to the United Nations Framework Convention on Climate Change (UNFCCC) with official membership on 17 March 1996 after her ratification in December 1995. The country ratified the Kyoto Protocol in 2002, which entered into force in February 2005. Cambodia also signed the Paris Climate Agreement on 22 April 2016 and ratified it on 6 February 2017. This demonstrates Cambodia´s active participation with the global communities to address the adverse impacts of climate change.

The Convention and the Kyoto Protocol´s primary goal is to stabilize atmospheric greenhouse gas (GHG) concentrations at a level that will prevent dangerous human interference with the climate system. On this, Cambodia is committed to implementing a comprehensive response to climate change, while considering "common but differentiated responsibilities" aligned with respective country capabilities.

In reference to mitigation actions and targets, Cambodia presented her Nationally Determined Contribution (NDC) in 2015 proposing a GHG mitigation contribution for the period 2020–2030, conditional upon the availability of international community support. Based on the NDC, Cambodia is implementing actions in accordance with her sustainable development needs, which include addressing climate change.

Although Cambodia is one of the lowest contributors to the causes of climate change, she remains one of the most vulnerable countries to its impact. Hence, Cambodia takes climate change seriously in her development agenda to ensure a greener, low-carbon and climate-resilient, equitable, sustainable, and knowledge-based society, while contributing to global efforts to addressing climate change. This is reflected in the Rectangular Strategy Phase IV (2018-2023) and the National Strategic Development Plan (2019-2023).

Cambodia is implementing relevant measures: building institutional capacity, formulating and implementing her Climate Change Strategic Plan (2014-2023), and mainstreaming climate change into her planning and budgetary processes. Thus, Cambodia is conducting pioneering efforts to: increase climate change financing, create monitoring and evaluation frameworks, implement strategies that build community resilience and sustainable livelihoods, and promote a low-carbon development path.

In line with the UNFCCC requirements, Cambodia submitted two National Communications, the first in 2002 and the second in 2016. Further, Cambodia voluntarily submitted a national forest reference emissions level to the UNFCCC in 2017. The National Council for Sustainable Development/the Ministry of Environment of the Kingdom of Cambodia is now pleased to present the first Biennial Update Report (BUR) to the UNFCCC and requests for relevant stakeholders to use this as a reference for preparing policies and strategies to address climate change in the country.

The report includes relevant data and information regarding Cambodia´s major sources of GHG emissions and sinks, coupled with necessary mitigation measures already implemented or planned; thus, furthering her contribution to global efforts to reducing GHG emissions. The report is also developed in accordance with the UNFCCC BUR Guidelines. It has been integrated inputs and comments from a series of consultative meetings and workshops both at technical and management level with key line Ministries, Development Partners, Research Institutes and Academia, and relevant stakeholders. We thank all relevant stakeholders for their kind contribution to this report, particularly, the United Nations Environment Programme for the overall support and quality insurance.

Say Samal
Minister of Environment
Chair of the National Council for Sustainable Development

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LIST OF ACRONYMS

BaU	Business as Usual
CC	Climate Change
CCAP	Climate Change Action Plan
CCCA	Cambodia Climate Change Alliance
CCCSP	Cambodia Climate Change Strategic Plan
CDM	Clean Development Mechanism
CCCO	Cambodia Climate Change Office
CFL	Compact Fluorescent Lamps
CO2eq	Carbon Dioxide Equivalent
EU	European Union
FLEGT	Forest Law Enforcement, Governance and Trade
GDP	Gross Domestic Product
GERES	Group for the Environment, Renewable Energy and Solidarity
GHG	Greenhouse Gas
GSSD	General Secretariat of the National Council for Sustainable Development
GWh	Gigawatt hour
IGES	Institute for Global Environmental Strategies
IIED	International Institute for Environment and Development
INDC	Intended Nationally Determined Contribution
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
KHR	Khmer Riel
LULUCF	Land Use, Land Use Change, and Forestry
M&E	Monitoring and Evaluation
MAFF	Ministry of Agriculture, Forestry and Fisheries
MCA	Multiple Criteria Analysis
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MLMUPC	Ministry of Land Management, Urban Planning and Construction
MME	Ministry of Mines and Energy
MOE	Ministry of Environment
MOEYS	Ministry of Education, Youth and Sport
MOH	Ministry of Health
MOINFO	Ministry of Information
MOT	Ministry of Tourism
MoWA	Ministry of Women's Affairs
MoWRAM	Ministry of Water Resources and Meteorology
MPTC	Ministry of Posts and Telecommunications
MPWT	Ministry of Public Works and Transport
MRD	Ministry of Rural Development
MRV	Measurement, Reporting, and Verification
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NCDM	National Committee for Disaster Management

NCGG	National Committee of Green Growth
NCCC	National Climate Change Committee
NCSD	National Council for Sustainable Development
NGGSP	National Green Growth Strategic Plan
NGOs	Non-Governmental Organizations
PES	Payment for Ecosystem Services
PPCR	Pilot Programme on Climate Resilience
PV	Photovoltaic
REDD+	Reducing Emissions from Deforestation and Forest Degradation "Plus"
RGC	Royal Government of Cambodia
RUA	Royal University of Agriculture
SNC	Second National Communication
SCCAPs	Sectoral Climate Change Action Plans
SCCSPs	Sectoral Climate Change Strategic Plans
SIDA	Swedish International Development Cooperation Agency
SPCR	Strategic Programme for Climate Resilience
TAP	Technology Action Plan
TNA	Technology Need Assessment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
USD	United States Dollar

EXECUTIVE SUMMARY

Country Profile

Cambodia occupies a total area of 181,035 km^2 and shares its borders with Thailand, Lao PDR, and Vietnam. The country's topography broadly consists of the central plains surrounded by mountainous and highland regions, and a coastline to the south. The capital city of Phnom Penh is situated at the confluence of the Mekong, Tonle Sap, and Bassac Rivers. The Mekong River and its tributaries dominate the hydrology.

The geographical incidence of extreme weather events such as droughts and floods vary, and while floods affect lowlands areas, the geographical distribution of droughts is widespread. Though there are some actual benefits from seasonal flooding experienced in the central plains, providing fish as well as nutrients to the soil, the frequency of severe floods has increased over the last decade.

The Cambodian population increased from 11.4 million in 1998 to 15.85 million in 2017. The age dependency ratio of 66.5% in 2018 shows that the working-age population (aged 15–64) faces a greater burden to support the youth and elderly.

In 2018, Gross Domestic Product (GDP) stood at US$1,561 per capita. Although rapidly increasing, it is low compared with most neighbouring countries. Cambodia's two largest industries are textiles and tourism, while agricultural activities remain the main source of income for many Cambodians living in rural areas. Over the past two decades, Cambodia has undergone a significant transition, reaching lower middle-income status in 2015 and aspiring to attain upper middle-income status by 2030. Driven by garment exports and tourism, Cambodia's economy has sustained an average growth rate of 8% between 1998 and 2018, making it one of the fastest-growing economies in the world.

Table 1 - Socioeconomic indicators

Area	181,035	km^2
Population (2017)	15.85	Million inhabitants
Number of households (2016)	3.4	Million
Houses average floor area (2017)	11	m2 per house and per person
Age dependency ratio	66.5	%
Average growth rate (between 1998 and 2018)	8	%
Food poverty from 2014	0	%
Poverty rate (2014)	14	%
Enrolment in primary education (2016)	97	%
Lower secondary completion rate (2017)	57	%
Access to improved water	75	% of population
Access to improved sanitation	66	% of population
GDP (2018)	1,561	US$ per capita
Electricity consumption (2015)	335	kWh per capita
Total Primary Energy Supply (2015)	4,761	ktoe
Final energy consumption (2015)	3,413	ktoe
Transport sector consumption	1,549	ktoe
Number of registered vehicles (2017)	441.8	Thousand vehicles

In 2017, the agriculture sector contributed to 25.0% of the GDP, the industrial sector contributed 32.7%, and the service sector contributed 42.3%. The main subsectors in industry are garment production, construction, and food and beverage processing.

Poverty continues to decrease, the poverty rate in 2014 was 14% compared to 48% in 2007. Despite achieving the Millennium Development Goal (MDG) of halving poverty in 2009, those that escaped poverty did so only by a small margin. Around 4.5 million people remain near-poor, vulnerable to falling back into poverty when exposed to economic and other external shocks.

Cambodia's forests have experienced significant reduction in total forest and dense forest cover, due primarily to the increase in plantations, particularly rubber. Despite the creation of protected and community forests, illegal logging still poses a serious threat.

The country imports all its fossil fuels, including coal and oil. Total final energy consumption grew by an annual average of 6.9% during 2010–2015. Final energy consumption in 2015 was 3.4 million tons of oil equivalent, comprising 50.5% petroleum products, 36.0% biomass, 13.1% electricity, and 0.4% coal. The transport sector is responsible for nearly half (46%) of final energy consumption.

Waste disposal has notably improved over the past decade, with a more than doubling of waste disposed in landfills between 2005 and 2017. However, discharged wastewater remains mostly untreated.

Cambodia Policy and Planning Framework

Cambodia´s greenhouse gas emissions are low compared to most countries; however, it is one of the most vulnerable countries affected by climate change. Thus, it has made explicit efforts to mainstream climate change policy into national, sectoral, and sub-national planning. The Royal Government of Cambodia (RGC) has developed and implemented a series of National Policies (describing its policy goals), Strategies (describing the necessary steps to achieve policy goals), and Action Plans (detailing implementation of the strategies proposed).

The Cambodia National Policy on Green Growth, the National Green Growth Strategy, National Strategic Development Plans, Sectoral Strategic Plans, the National Forest Program and the National Environmental Strategy and Action Plan are meant to guide future development towards low-carbon and climate-resilient development and sustainable development. A ten-year strategic plan – the Cambodia Climate Change Strategic Plan 2014-2023 – has been created, and fourteen priority ministries and institutions have already developed their corresponding sectoral strategic plans and action plans.

The **National Policy on Green Growth 2013-2030** aims to balance economic development and the needs of the environment, society, and culture while ensuring the sustainable use of national resources to enhance people's well-beings and living conditions. This Green Growth Policy sets the path to stimulating the economy through low carbon options, creating jobs, protecting vulnerable groups, and improving environmental sustainability.

The **Strategic Plan for Green Growth 2013-2030** aims to guide Cambodia towards a greener economy, focusing on effective use of natural resources, environmental sustainability, green jobs, green technologies, green finance, green credit, and green investment. .

The **National Strategic Development Plan** (NSDP) provides a broad framework aimed at harmonizing development efforts and the effectiveness of aid to implement these strategies. Climate Change has also been integrated into this plan.

Cambodia's National **Environment Strategy and Action Plan, 2016–2023** (NESAP) serves as a roadmap for sustainable development. It identifies priority policy tools and financing options for sustainable natural resource management and environmental protection.

The Cambodia **Climate Change Strategic Plan 2014-2023** (CCCSP) aims at building a greener, low-carbon and climate-resilient, equitable, sustainable, and knowledge-based society to contribute to global efforts to addressing climate change. As a dynamic policy instrument, it will be periodically evaluated and revised to respond effectively to evolving realities. Additional practical solutions and best practices will be gathered to guide national capacity-building during its implementation.

Climate Change Action Plans (CCAPs), including a planning matrix identifying priority actions required to deliver climate change strategies and priorities have been prepared for fourteen ministries/institution for the period 2014-2018.

Institutional Arrangements

The National Council for Sustainable Development (NCSD) is responsible for climate change management and national response.

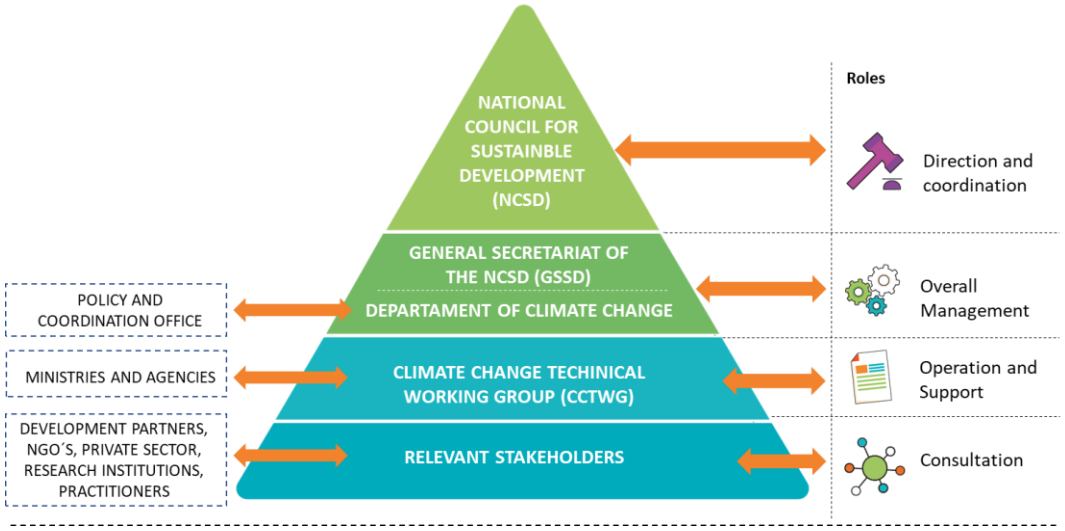


Figure 1 – Institutional arrangements for climate change management and national responses

The development of national communications and Biennial Update Reports under the UNFCCC falls under the purview of the GSSD. Besides institutional arrangements created to compile the national GHG emissions inventory, Cambodia has made significant progress in establishing Measurement, Reporting, and Verification (MRV) arrangements in five areas: GHG emissions; the Cambodia Climate Change Strategic Plan (CCCSP), which includes adaptation and mitigation; REDD+; Project level MRVs for two planned NAMAs, 12 CDMs, 6 JCMs, and 6 VERs; and monitoring of financial support received. Cambodia is placing great emphasis in the development of an integrated and detailed MRV system aimed at achieving NDC implementation.

Institutional Arrangements for Mitigation Actions

Regarding institutional arrangements for REDD+, the Cambodia REDD+ programme is under direct management and implementation of the General Directorate of Administration for Nature Conservation and Protection (GDANCP) of the Ministry of Environment (MoE).

The Cambodia REDD+ programme and its secretariat have key responsibilities in formulating forest policies, strategic and action plans aligned with the Cancun decision, and the Warsaw framework on REDD+. Cambodia MRV System for REDD+ is included in the National Forest Monitoring System under the Ministry of Agriculture, Forestry and Fisheries, with active participation from the MoE, as well as guidance from the Cambodia REDD+ Taskforce, Technical Team, Consultation Group, and Gender Group.

Cambodia REDD+ Taskforce includes seven ministries, while the Cambodia REDD+ Consultation Group consists of 18 members representing constituents from nine different sectors (academia, international NGOs, local NGOs, community forestry, community fisheries, community protected areas, indigenous people, and private sector). In 2014, the MRV/REL Technical Team was established under Cambodia´s National REDD+ Taskforce.

The summary of institutional arrangements for mitigation actions besides REDD + are illustrated in the figure below.

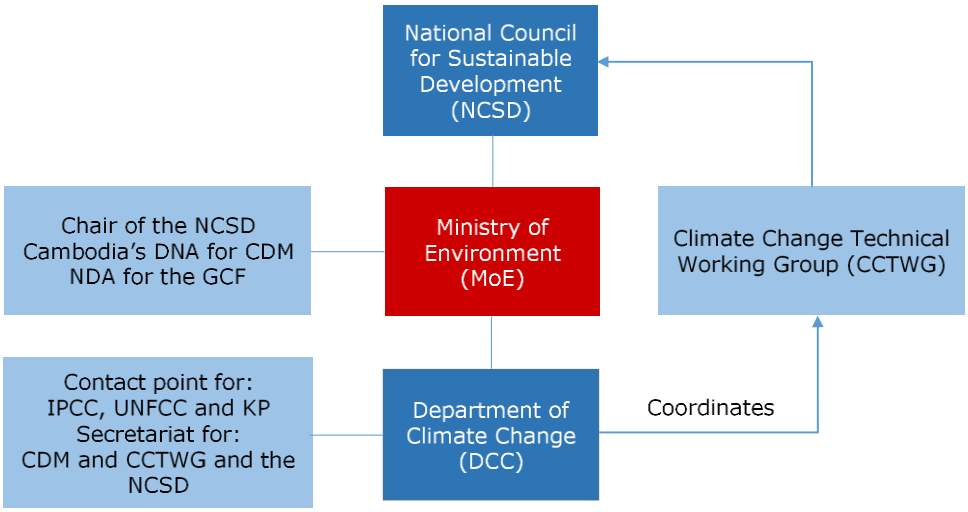


Figure 2 – Institutional arrangements for mitigation actions

To improve its current institutional arrangements, Cambodia is working on the following elements:

- The enhancement of National GHG Inventory Team (NIT) to enhance current coordination for the development of the GHG emissions inventory and assessment of mitigation policies and actions; and
- The reinforcement of a permanent National Authority to provide policies and procedures regarding the participation in all GHG Emissions Reduction mechanisms including CDM, REDD+, VCS, and JCM.

The MoE is the Designated National Authority (DNA) for the CDM.

The GSSD acts as the Secretariat of Cambodia's DNA for the CDM, while a selection of the Climate Change Technical Working Group members (relevant to mitigation activities) forms the Board of the Cambodian DNA. Board activities include technical and institutional capacity strengthening, CDM awareness raising, CDM project identification, and facilitation of host country approvals in accordance with the Kyoto Protocol requirements.

The designated NAMA focal point at the GSSD is responsible for approving all individual NAMAs prior to being recorded in the NAMA Registry. The NAMA Approver is Minister of Environment and the Chair of the National Council for Sustainable Development.

The Joint Crediting Mechanism (JCM) Joint Committee (JC) consisting of representatives from Japan and Cambodia is responsible for the implementation and administration of JCM projects.

Cambodia is making significant efforts on climate finance, mainly the streamlining of climate change on national and ministerial budgets, as well as the MRV of climate finance. The lead financial assistance entities include the Ministry of Economy and Finance (MEF) and the Cambodian Rehabilitation and Development Board (CRDB) of the Council for the Development of Cambodia (CDC).

Since 2012, using the ex-post expenditure data from the previous fiscal year, and also using data from the Official Development Assistance (ODA) database, the MEF has performed Climate Public Expenditure Reviews (CPER), where expenditures used in projects related directly or indirectly to climate change are measured and reported. The National Council for Sustainable Development (NCSD) and the Cambodian Climate Change Alliance (CCCA) provided technical support and verified the data on climate finance measured and monitored by the MEF. Data is currently available for fiscal years 2009-2018.

Greenhouse Gas Emissions Inventory

The Kingdom of Cambodia´s GHG inventory 2019 Edition includes emissions from 1994 through 2016, including CO2, CH4, N2O, and HFC emissions, and includes the following sectors: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), and Waste. The inventory has been developed following 2006 IPCC Guidelines. The global warming potentials (GWPs) used are those of the Fourth Assessment Report of the IPCC, based on the effects of GHGs over a 100-year time horizon. These GWPs were selected for two reasons: first, these were the ones used for the Cambodia NDC; and second, to allow for comparison with the GHG inventories of developing countries.

Due to limited information on their occurrence, the emissions of Perfluorocarbons (PFC), Sulphur hexafluoride (SF_6), and Nitrogen trifluoride (NF_3) have not been estimated. Gases considered ozone precursors: carbon monoxide (CO), oxides of nitrogen (NOx), non-methane volatile organic compounds (NMVOCs), and Sulphur dioxide (SO_2), have been estimated when the required data was available. For estimating the emissions of precursors, the Guidelines of EMEP/EEA 2016 have been used, as proposed by the IPCC.

Emissions in 2016

The following table shows the emissions estimated by gas and sector for year 2016.

Table 2 – Emissions by category and gas in mass unit (Gg), year 2016

Inventory Sector	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SOx
	(Gg)						
Energy	8 845.29	23.04	0.61	43.43	160.46	45.03	32.61
IPPU	1 449.46	NA	NA	NE, NA, NO	NE, NA, NO	NE, NA, NO	NE, NA, NO
Waste	524.56	79.7	0.82	NA	NA	NA	NA
Agriculture	17.42	645	7.56	NE, NA	NE, NA	NE, NA	NE, NA
Forest and Other Land Use (FOLU)	131 011.24	NA	NA	NA, NO	NA, NO	NA, NO	NA, NO
Total (without FOLU)	10 836.73	747.87	8.98	43.43	160.46	45.03	32.61
Total (with FOLU)	141 847.98	747.87	8.98	43.43	160.46	45.03	32.61

The total emissions of greenhouse gases (GHG) estimated are 163 592 Gg.CO_2-eq in 2016, which is 285% higher than that of in 1994. The main driver for this increase in GHG emissions is the deforestation reflected in the emissions of the FOLU sector.

Emission trends

In terms of the contribution of each GHG to total national emissions, CO2 is the main gas emitted, driven by the large contribution of the FOLU sector to total national emissions, followed by CH4, N2O, and HFC.

Table 3 – Contribution of each gas to total national emissions (%)

Gas	1994	2000	2005	2010	2015	2016
CO_2	69.57%	66.31%	63.11%	86.79%	86.79%	86.71%
CH_4	25.65%	28.71%	31.75%	11.38%	11.32%	11.43%
N_2O	4.78%	4.99%	5.12%	1.76%	1.69%	1.64%
HFC	0.00%	0.00%	0.01%	0.07%	0.20%	0.23%

Note – This contribution is calculated converting first the emissions of each gas to CO2-eq using global warming potentials of the AR4.

Table 4 – Trend of emissions by sector (total GHGs, Gg. CO_2-eq using the GWP of AR4)

Inventory Sector	1994	2000	2005	2010	2015	2016
Energy	2 690.95	3 102.73	3 454.41	5 306.37	8 356.31	9 601.61
IPPU	3.81	6.04	12.73	492.84	1 001.38	1 821.15
Waste	1 534.32	1 859.50	2 146.20	2 365.29	2 688.19	2 760.68
Agriculture (3A + 3C)	11 202.58	13 032.31	15 336.38	18 136.08	18 068.35	18 397.67
Forest and Other Land Use (FOLU) (3B)	27 018.62	27 018.62	27 018.62	131 011.24	131 011.24	131 011.24
Total (without FOLU)	15 431.65	18 000.59	20 949.73	26 300.58	30 114.23	32 581.11
Total (with FOLU)	42 450.28	45 019.21	47 968.35	157 311.82	161 125.47	163 592.35

The emissions of all sectors present an increasing trend from 1994 to 2016.

The main contributor to national GHG emissions during the entire period is the **Forest and Other Land Use** (FOLU) sector driven by the change in carbon stocks, primarily due to deforestation. The sharp increase in the emissions of the AFOLU from year 2010 is due to the major deforestation experienced during these years (the economic land concessions had increased significantly from 2009). Land use monitoring is based on three different maps related to 1994, 2009, and 2016 which gives two periods of land use changes[1]. The land use changes observed during the period 1994-2009 are much lower than the ones observed during the period 2010-2016. During this second period the loss of forest cover is very important (579 280 ha / year in average) compared to the previous period (132 733 ha /year in average). This loss of forest cover leads to high emissions.

[1] By knowing only two periods of land conversions it is difficult to further elaborate on the trend. Consequently, it was chosen to keep the average value for all the years of the respective periods covered by monitoring. It could be assessed that deforestation is increasing for all the covered period but it cannot be confirmed that deforestation is still increasing for the very last years of each period. These data sets are consistent with the Forest Reference Level (FRL). It means that the activity data, emission factors, and the methods to estimate the emissions used in the GHG inventory are the same used for the FRL (for the years 2006, 2010, 2014 using the mean values). Since there is no more data available, the GHG inventory takes into consideration these official data. Consequently, the trend of reported emissions and removals keeps the shape of stairs.

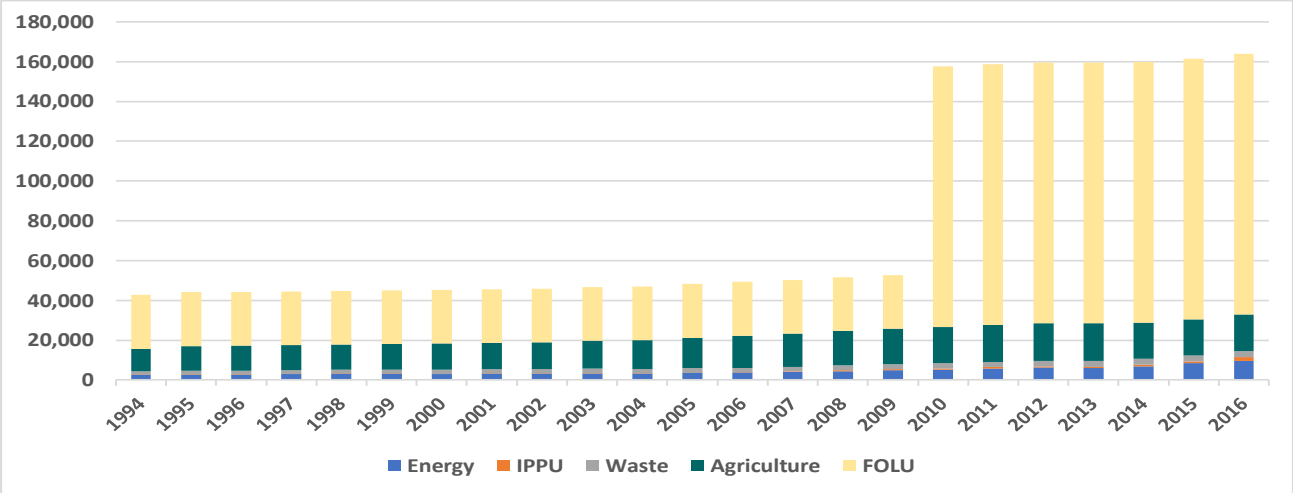


Figure 3 – GHG emissions; Years 1994-2016 (Gg. CO2-eq)

Agriculture represents the second largest emitter sector in the country. Cambodia´s economy is heavily influenced by the contribution of agriculture to total GDP, which is also reflected in emission patterns. The main driver for the increase in GHG emissions is the development of rice cultivations, whose activity level and emissions increased by a rate of ~2.5 in the period 1994-2016.

In the time span covered by the inventory, Cambodian GDP experienced significant expansion, along with its population. This is reflected in the increasing trend of emissions of the third and fourth largest emitter sectors in the country, the **Energy and Waste sectors**, respectively. Energy demand has experienced a significant increase, the transport sector is expanding, while the population migrates to cities; all these factors lead to increasing fuel consumption and higher GHG emissions in the energy sector. The increased population and changes in waste management and sanitation are the main drivers for waste sector emissions.

Finally, the small size of the carbon intensive-industrial sector in the country makes the **IPPU** the fifth contributor to national total GHG emissions. Nevertheless, the IPPU sector emissions experienced a growing expansion in the last period of the series, due to the rising contribution of cement production and consumption of fluorinated gases.

Emissions per capita have increased from 4.00 to 10.42 tons CO2-eq/person/year[2]. This increase is due mainly to the high deforestation occurring in the country. Conversely, GHG emissions per unit of GDP have been reduced from 15.41 to 8.24 tons CO2-eq/thousand USD/year. This reduction is due to GDP expansion, which is significantly higher than the increase of GHG emissions.

[2] This figure should not be compared with other countries figures because the methodologies used to elaborate the estimates differ. For a comparison please refer to the GHG (CO2, CH4, N2O, F-gases) emission time series 1990-2012 per capita for world countries estimated by the European Commission in its EDGAR database (https://edgar.jrc.ec.europa.eu/overview.php?v=GHGts_pc1990-2012).

Mitigation actions and their effects

Nationally Determined Contribution under the Paris Climate Agreement

Cambodia's Nationally Determined Contribution (NDC) was submitted to the UNFCCC in 2015, establishing planned actions to reduce greenhouse gas emissions, climate change adaptation, funding sources, as well as reporting and evaluation.

Cambodia prepared its NDC with the intention to reduce a maximum of 27% of GHG emissions by 2030 compared to the Business as Usual (BAU) level for the energy, industry, and waste sectors. Under the Land Use and Forestry sectors, Cambodia made a conditional commitment to increasing forest cover to 60% of the national land area by 2030, corresponding to removal of 4.7tCO_2eq./hectare/year.

Main mitigation instruments

The main mitigation instrument recently developed is the **National REDD+ Strategy 2017 – 2026**.

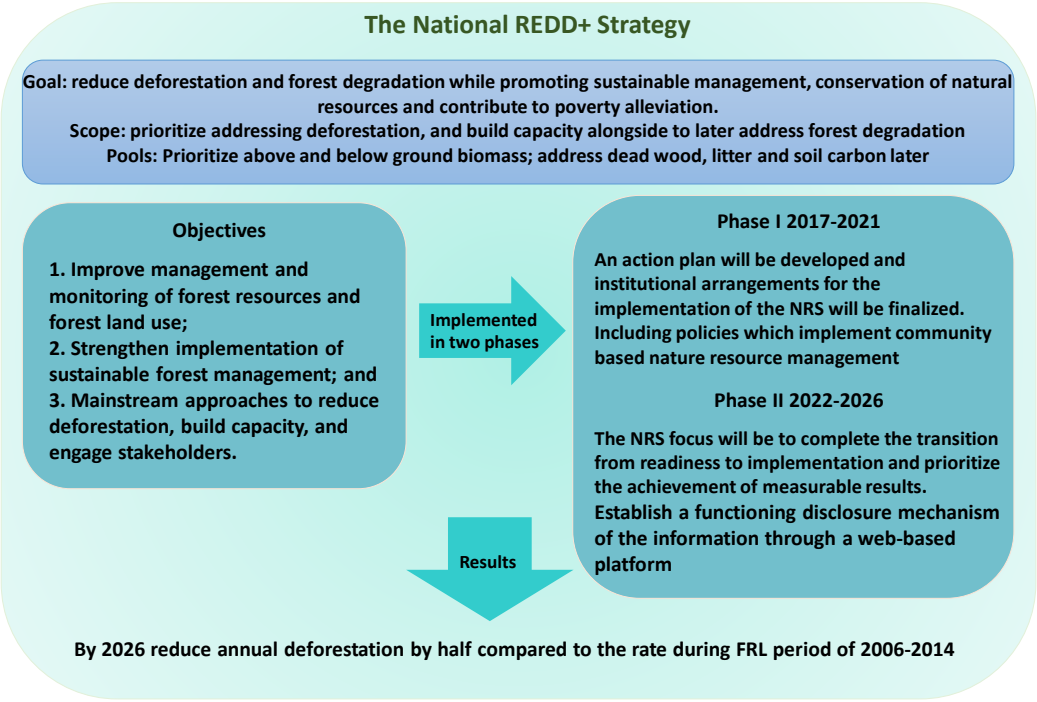


Figure 4 – The Cambodian REDD+ Strategy

It provides a roadmap for the implementation of policies and measures addressing drivers of deforestation and forest degradation. It is an expression of the country´s continued commitment to sustainable forest resource management in an era of climate change.

The **National Energy Efficiency Policy (2018-2035)** was prepared in 2018 with two main goals: Improve the management and maintenance of existing infrastructure (e.g. buildings) and

industrial processes (e.g. for the use of fuel wood) for increased energy efficiency; and Increase the transfer and adoption of energy efficient technology (e.g. fuel-efficient vehicles and light bulbs) to reduce energy intensity. The policy is currently under review by the Office of the Council of Ministers.

The overall objective of the National Energy Efficiency Policy is to reduce future national energy demand by 20 per cent in 2035 compared to the business as usual (BAU) projections. If it is effectively implemented, it will result in a reduction of Energy consumption of 1 million tons of oil equivalent (toe) by 2035 relative to the business as usual scenario; Energy intensity of 65% in 2035, relative to 2014; CO_2 emissions of 3 million tons in 2035, or 28.5 cumulative million tons between 2017 and 2035, relative to the BAU scenario.

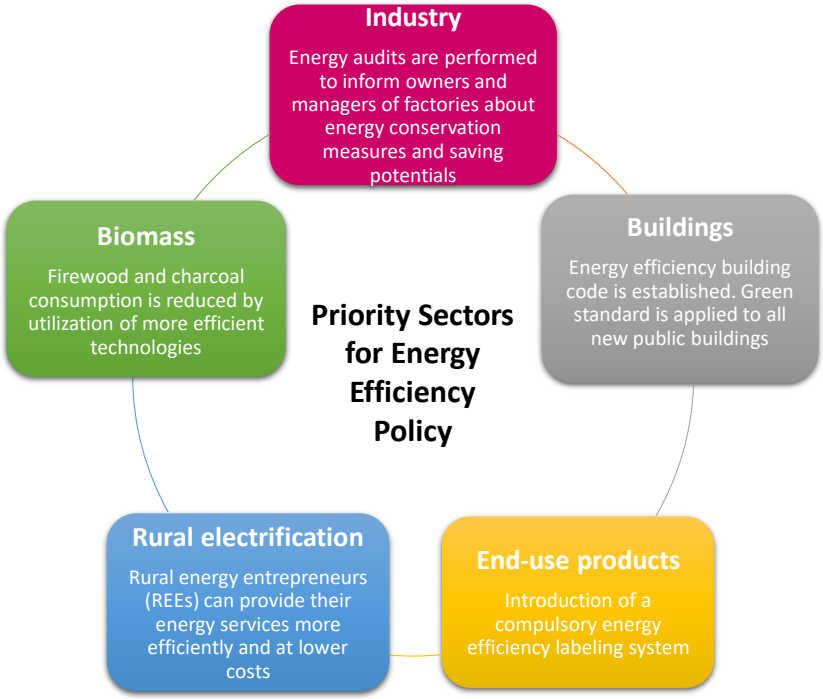


Figure 5 – Priority sectors for energy efficiency policy

Main mitigation projects

Over the last few years, in parallel to the development of the climate change policy framework, the Royal Government of Cambodia has developed and implemented a range of projects aimed specifically at mitigating GHGs emissions.

Market based mechanisms

As of 2019, the MoE, acting as the Cambodian DNA for CDM, has approved 12 CDM projects. Of these, 10 CDM projects and two PoAs have been registered at the CDM Executive Board of the UNFCCC. These CDM projects are associated with the use of renewable energy, industrial waste heat, agricultural and livestock wastes to generate electricity and heat, and hydropower. Most proponents of CDM projects are private companies.

Under the Joint Crediting Mechanism (JCM), there is one JCM project planned on water supply and sanitation, one started on REDD+, and four completed on energy efficiency/ renewable energy.

A few local organizations have implemented voluntary carbon standards as viable alternatives to the CDM. There are six Voluntary Emission Reductions (VERs) projects, including four REDD+ projects and two energy projects (for a more extensive description of these projects please refer to the mitigation projects section of this chapter). Five of the six projects are registered on Verra's VCS standard and one on Gold Standard.

Domestic Measurement, Reporting, and Verification

The Royal Government of Cambodia's approach to develop and operationalise its domestic measurement, reporting, and verification (MRV) systems focuses on integration into the existing climate change monitoring and evaluation (M&E) framework structure of the Cambodia Climate Change Strategic Plan (CCCSP) rather than setting up new layer institutional structures.

Cambodia considers this approach an efficient and cost-effective way of mobilizing institutions and setting up processes for performing MRV functions on a sustainable basis at all levels (project, sector and national levels) and for all MRV types (GHG emissions, impact of mitigation actions, adaptation and support received).

Cambodia's attention has been on designing a simple-to-integrate MRV structure that is acceptable and less burdensome to identified institutions, while at the same time meeting the essential ingredients for the MRV.

Given the MRV is seeking to integrate into the existing climate change M & E framework, performing any additional MRV function will not require new legislation. The institutions would rather draw their authority to perform their MRV functions from the existing legal framework that mandates them to carry out the development of the M & E framework for their climate change action plans (CCAPs).

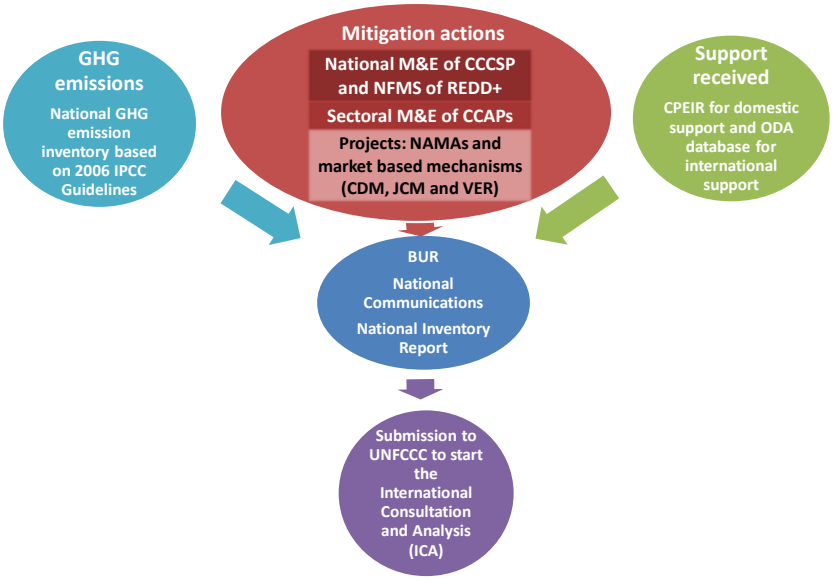


Figure 6 – Cambodia domestic MRV

The domestic MRV system aims at:

- reporting on (a) GHG Inventories, (b) mitigation actions and their effects and (c) support needed and received in a complete, transparent and timely manner;
- tracking the progress with the implementation of the NDC; and
- making sure that the existing sectoral and national climate change M&E systems integrate all MRVs at all levels in order to measure and monitor:

i. greenhouse gas (GHG) emissions trends;
ii. GHG emissions or reductions attributed to particular mitigation action (policy, programme, measure, or project) including the sustainable development benefits; and
iii. climate-related support provided by the Royal Government of Cambodia or received from donors or the market in a form of finance to enable implementation of a certain action or as a result of an action taken in a particular sector of the economy.

All this information is reported partly in the National Inventory Report (NIR) and the National Communications and completely in the BUR and communicated to the UNFCCC in order to start the International Consultation and Analysis (ICA) process, which will constitute the second layer of verification. The first layer of verification of information on GHG emissions, impacts of mitigation actions and support has been performed by international quality assurance (QA) experts and through national consultation and validation workshops.

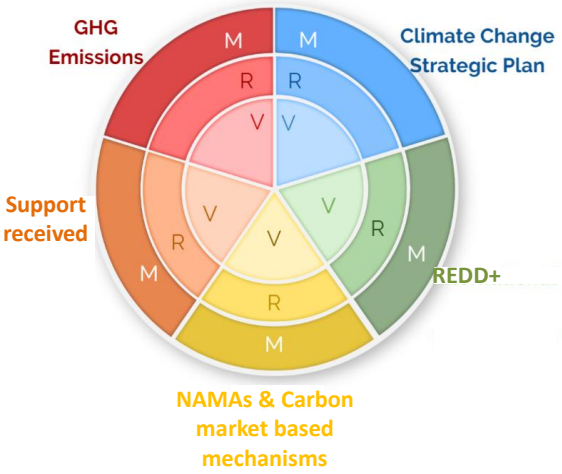


Figure 7 – Cambodian MRVs

Cambodia has made significant efforts in addressing the establishment of robust information systems for the measurement, reporting and verification of climate-change related data. At the time of the first BUR initiative, Cambodia had in place five well-established MRV systems (GHG emissions; CCCSP, which includes adaptation and mitigation; REDD+; Project level MRVs for two planned NAMAs, 12 CDMs, 6 JCMs, and 6 VERs; and Support received), and is placing greater emphasis in the development of an integrated and detailed MRV system aimed at achieving the implementation of the NDC.

The followings are Cambodia´s priority areas for guiding future MRV developments:

- Reinforce institutional arrangements to ensure the smooth functioning of MRV systems;
- Provide capacity building to all the institutions involved in MRV systems;
- Develop methodologies to estimate the support needed for NDC implementation; and
- Address the linkages between MRV systems.

Support needed and received

By the end of 2017, fourteen ministries and agencies approved Climate Change Action Plans (CCAP) for the period 2014-18. Support needed from these fourteen institutions plus the Ministry of Posts and Telecommunications, whom CCAP was available in final draft form, is around 692 billion KHR, with KHR 645 billion allocated to adaptation and cross-cutting activities (93%) and KHR 47 billion allocated to mitigation (7%).

In 2017, one third of public expenditure, or 30.2%, was either fully or partially delivering climate change benefits. This share of public expenditures with some degree of climate change benefits has remained relatively stable since 2009, around 30.6% in average. This year public expenditure for climate change activities constituted 3.2% of total public expenditure. It has remained also relatively stable since 2009, around 3.8% in average, of total public expenditure. In absolute terms, public finance provided for climate change activities has risen around 23%, from KHR 770 billion in 2016 to KHR 912 billion in 2017. The proportion of climate change expenditure to the GDP is of 1.1% in average during the period 2009-2017. The amounts allocated from national budget for climate change increased steadily to KHR 331 billion in 2017, an increase of KHR 49 billion from 2016. Around 95% of climate change public expenditure was spent in adaptation and cross-cutting activities and 5% in mitigation in 2017.

The main donors for climate change activities in 2017 are the ADB (35%), China (29%), Japan (7%), the IFAD (4%), the USA (4%), the Republic of Korea (4%), and the EU (3%). Support received that year represents 86% for adaptation and cross-cutting activities and 14% for mitigation. Many capacity building assistance projects have been supported by Japan, Korea, the Netherlands, Denmark, UNDP, UNEP, ADB, EU, World Bank, and other donors.

Constraints, gaps and capacity building needs

Although many policies and strategies addressing climate change impacts have been developed, their implementation remain limited due to **insufficient financial support**. For instance, after the approval of the NAMA on Energy Efficiency in the garment industry, the proposed action has not been implemented. Additionally, only 14 out of the proposed 171 projects under the NAP received full financial support, while 16 of them are partially supported (GSSD, 2017).

The National Adaptation Plan (NAP) Financing Implementation Plan was also developed in 2017 to expedite the implementation of the NAP process. Fifteen sectoral climate change action plans were identified covering 171 actions, which require a total budget of around USD 865.5 million for implementation; however, only 7% of the proposed budget has been made available (GSSD, 2017). This indicates that some of the climate change finance available to Cambodia has been spent on activities not clearly aligned with national plans, such as NAP and CCAPs.

Some mitigation **technologies** have been transferred to Cambodia through various mechanisms (including the Clean Development Mechanisms under the Kyoto Protocol), yet substantial gaps remain. As the initial step to fill these gaps, a Technology Needs Assessment (TNA) for climate change mitigation technologies was conducted, while the associated Technology Action Plans (TAP) were prepared in 2013 (RGC, 2013a).

Renewable energy has significant potential, but still faces a shortage of facilities and appropriate regulations, slowing down the uptake. The promotion of solar energy is challenging because testing facilities for photovoltaic (PV) systems or PV panels for solar system are currently unavailable. Biomass gasification is an appropriate technology for rural areas, but hands-on-training is needed to increase capacity in operation and maintenance.

Apart from the Technology Action Plan of 2013, the country has not developed national policies or strategies to meet technology needs addressing climate change. It needs to promote and mobilize resources to implement the proposed seven project ideas on energy efficiency and transport raised in the TAP.

There is also a lack of **institutional and technical capacity on climate action**. For this reason, many officers have been assigned to participate in numerous climate change related short-term trainings both in the country and abroad since 2000 (GSSD, 2015). Long-term scholarships on climate change have also been awarded ranging from Master to Doctor of Philosophy. However, Cambodia retained limited experts and researchers in the fields of GHG inventory and mitigation, climate vulnerability assessment and adaptation measures, or climate finance.

Cambodia has conducted national GHG emission inventories under the national communications submitted in 1994 and in 2000, and in 2019 under the first BUR. These inventories relied mainly on assumptions, expert judgment, and default IPCC values. The emissions estimate was not conducted for all GHG and all categories and the completeness of the inventory remains limited. Cambodia acknowledges its limitations in obtaining reliable data and information, as well as the lack of national expertise to develop the national GHG inventory on a continous basis.

Further, more financial support should be mobilized and secured in the longer term as climate change impacts are likely to reduce GDP growth by 0.4%, 2.5%, 6.0%, and 9.8% in 2020, 2030, 2040, and 2050, respectively, (MEF and NCSD, 2018). The government has to increase its effort to raise government revenues or mobilize additional support from international sources to ensure stable GDP growth and therefore become a high-middle income country by 2030 and a high income country by 2050.

INTRODUCTION

The Kingdom of Cambodia as a Non-Annex I Party ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 and acceded to the Kyoto Protocol in 2002. The Initial National Communication (INC) was officially submitted in 2002 and the Second One was submitted in 2016.

Preparation of a comprehensive First Biennial Update Report (FBUR) in Cambodia continues to represent a challenging task. Although institutional reforms have been implemented recently for climate action, many functions and data remain unavailable and had to be developed in the process. Additional studies had to be conducted to produce essential information about current emissions, options for mitigation and support needed and received.

Chapter 1 describes Cambodia's circumstances, which include information about the geography, climate conditions, socioeconomic development including demography and economy, the policy framework and the institutional arrangements.

Chapter 2 provides information on the national greenhouse gas (GHG) inventory, which updates the amount of GHG emissions and removals from economic sectors for the period 1994 - 2016.

The results of a comprehensive review of national climate responses, main mitigation instruments developed, main mitigation projects implemented, market-based mechanisms and the domestic measuring, reporting, and verification framework are provided in Chapter 3.

Chapter 4 provides information on existing gaps and constraints, support needed, and support received.

Development of this first Biennial Update Report was made possible by funding from the Global Environment Facility (GEF) with the UNDP and the UNEP as implementing agencies, with the active participation of key line ministries and agencies.

CHAPTER 1: NATIONAL CIRCUMSTANCES

1. Climate conditions

Cambodia is located in Southeast Asia between latitudes 10° and 15°N and longitudes 102° and 108°E with a total land area of 181,035 km^2, sharing its 2,428 km land border with Thailand to the northwest, Lao PDR to the northeast, and Vietnam to the east and south (see Figure 1).

The country's topography broadly consists of the central plains surrounded by mountainous and highland regions, and a coastline to the south.

The capital city of Phnom Penh is located at the confluence of the Mekong, Tonle Sap and Bassac Rivers.

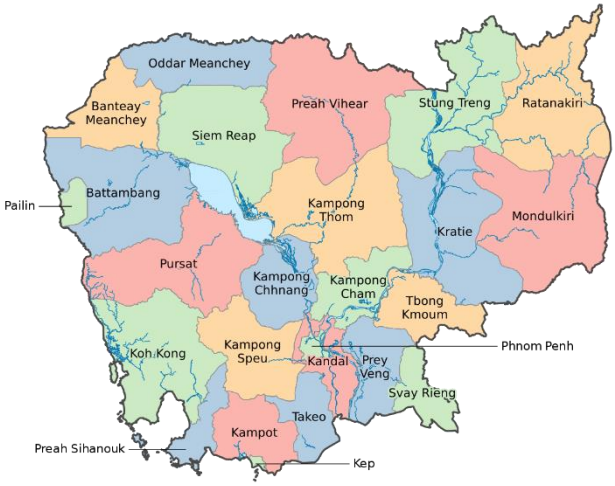


Figure 1. Map of Cambodia

The Mekong River and its tributaries dominate the hydrology. The Tonle Sap Lake, an outlet of the Mekong during the rainy season, covers an area of up to 10,400 km^2 in the northwest. The Tonle Sap ecosystem is a unique ecological phenomenon believed to be one of the most productive inland waters and one of the most fish-abundant lakes in the world. The total area of the Tonle Sap catchment is 85,790 km^2. When the level of the Mekong River is high, the flow of the Tonle Sap River reverses: water is pushed into the lake, raising its level by up to 10 meters and increasing its area from 2,000-3,000 km^2 in the dry season to 10,000-6,000 km^2 in the rainy season.

Cambodia is influenced by the tropical monsoons with distinct rainy and dry seasons. The first extends from May to October, while the latter ranges from November to April. The average annual rainfall is about 1,400mm on the central plain and increases to 3,800mm in the mountains and along the coast. The average annual temperature is about 27°C with the maximum mean temperature of about 28°C and the minimum mean temperature of about 22°C. The country is geographically favoured by its surrounding mountains and highlands and is far from the direct impacts of tropical cyclones and typhoons.

The central plains experience seasonal flooding that provides fish and nutrients to soils; however, the frequency of severe floods has increased over the last decades. Droughts have had a severe impact in the country. The 1998 drought led to crop failure; about 2.5 million people have been yearly affected by droughts in 1995, 1996, and 2002 (NCDM, 2002, 2008, 2008a, and 2011). Furthermore, the total damage and loss caused by the 2013 floods was USD356 million - USD153 million attributed to the destruction of physical assets damage and USD203 million attributed to losses in production and economic flows. Damage represented 43% of the total economic impact of floods, while the remaining 57% was loss (RGC, 2014). An assessment released indicated that if appropriate measures are not taken, Cambodia´s damages will represent around 3.5% of the total national GDP by 2050.

The atmosphere and ocean are getting warm, the amount of snow and ice have decreased, sea level has risen, and the concentrations of GHGs have increased (IPCC, 2013). Alarming trends are observed with more frequency including intensified floods, droughts, saline intrusion, and extreme weather events, especially over the last decades. In Cambodia specifically, the temperature continues to increase with mean temperatures increasing between 0.013°C to 0.036°C per year by 2099 (GSSD, 2015). The rate of temperature increase is higher in low altitude areas than in high altitude areas. In general, an increasing trend in seasonal rainfall between June and August is observed in the Northwest region with a decreasing trend in the Northeast. Under elevated CO_2, rainfall levels, and variability will change. Rainfall variability in some regions may decrease and increase in others depending on time horizons. Under elevated CO_2 with low rate of emission scenarios (Special Report on Emissions Scenarios-SRES B1), it is quite likely that the wet season rainfall will continue to increase and then possibly decrease after 2050; however, under the high emission scenario (Special Report on Emissions Scenarios - SRES A2), the direction of change will reverse.

2. Socioeconomic development

Table 1. Socioeconomic indicators

Area	181,035	km^2
Population (2017)	15.85	Million inhabitants
Number of households (2016)	3.4	Million
Houses average floor area (2017)	11	m^2 per house and per person
Age dependency ratio	66.5	%
Average growth rate between 1998 & 2018	8	%
Food poverty from 2014	0	%
Poverty rate (2014)	14	%
Enrolment in primary education (2016)	97	%
Lower secondary completion rate (2017)	57	%
Access to improved water	75	% of population
Access to improved sanitation	66	% of population
GDP (2018)	1,561	US$ per capita
Electricity consumption (2015)	335	kWh per capita
Total Primary Energy Supply (2015)	4,761	ktoe
Final energy consumption (2015)	3,413	ktoe
Transport sector consumption	1,549	ktoe
Number of registered vehicles (2017)	441.8	Thousand vehicles

The population was about 14.25 million in 2010, representing 2.3% of the Southeast Asian population (NIS, 2018). The population had increased to about 15.85 million in 2017-- more than 12 million living in rural areas and about 3.7 million living in urban areas (NIS, 2017 and RGC, 2018). The population is projected to be about 18.39 million in 2030 and about 21.96 million in 2050 (UN, 2011 and 2013). The overall and young dependency is expected to decrease from the present levels, while the old age dependency is likely to increase. Table 2

shows the trend in Dependency Ratio[3]. The RGC adopted the National Population Policy (2016-2030) in order to contribute to steady improvements in quality of life and poverty alleviation and ensure sustainable and equitable economic growth, social development, and environmental protection (RGC, 2016).

Table 2. Trend in Dependency Ratio

Age cohort/year (%)	1998	2008	2017	2018	2028	2038	2048
0-14	42.8	33.7	28.7	28.5	25.9	22.1	20.8
15-64	53.7	63.0	66.5	66.5	67.3	68.8	67.9
65+	3.5	4.3	4.8	5.0	6.8	9.1	11.3
Total	100	100	100	100	100	100	100

Source: RGC (2016)

The total number of households have increased from about 3.0 million in 2010 (NIS, 2012) to 3.4 million in 2016. The number of households both in urban and rural areas are expected to increase to about 4.2 million and 5.1 million in 2030 and 2050, respectively, (Mao, et al). The average persons per household are projected to decrease from 4.8 in 2010 to 4.2 persons in 2050 (Mao, et al).

The average floor area is about 11m^2 per person; however, it is only 10m^2 per person in Phnom Penh. The households with floor areas of about 100m^2 or more represent 5% in Phnom Penh, 9% in other urban areas and about 4% in rural areas (NIS, 2017). About 59% of all households occupied houses with only one room, about 30% with two rooms, and about 1% with five or more rooms. The households with one-room are predominate in rural areas (around 65%), about 44% in urban areas, and around 38% in Phnom Penh (NIS, 2017).

Over the past two decades, Cambodia has undergone significant transition, reaching lower middle-income status in 2015 and aspiring to attain upper middle-income status by 2030. Driven by garment exports and tourism, Cambodia's economy has sustained an average growth rate of 8% between 1998 and 2018, making it one of the fastest-growing economies in the world (World Bank, 2019).

Food poverty has decreased from 20% in 1993 to 4% in 2010 and zero in 2014, surpassing Cambodia Millennium Development Goals (CMDG) target number 1 (NSDP, 2016). The poverty rate had fallen sharply from 48% in 2007 to 14% in 2014, which far exceeded the Millennium Development Goal (MDG) of 20% (NSDP, 2016). About 90% of the poor live in rural areas. Although Cambodia reached the CMDG goal of halving poverty in 2009, the vast majority of families escaping poverty did so by only a small margin. Around 4.5 million people remain near-poor, vulnerable to falling back into poverty when exposed to economic and other external shocks.

Cambodia's most recent Demographic and Health survey (2014) indicates 32% (or approximately 500,000) of children under five are stunted. While net enrolment in primary

[3] Percentage of working-age population. Further information can be obtained from https://data.worldbank.org/indicator/SP.POP.DPND?locations=KH

education increased from 82% in 1997 to 97% in 2016, lower secondary completion rates, at 57% in 2017, are significantly below the average for lower middle-income countries. As of 2015, 25% of Cambodia's population (3.8 million people) limited access to improved water, and 44% (6.8 million people) limited access to improved sanitation.

The government has developed several national strategies, i.e. the National Strategic Plan for Rural Water Supply Sanitation and Hygiene (NSPRWSSH) 2014-2025, the National Strategy for Food Security and Nutrition (NSFSN) 2014-2018, and the National Action Plan for Zero Hunger Challenge (NAPZHC) 2016-2025 to improve physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences and optimize the utilization of this food to keep a healthy and productive life (RGC, 2014a and NSDP, 2016).

Per capita GDP has increased from 216 USD in 1992 (RGC, 2012) to roughly 1,561 USD in 2018 (RGC, 2018a). The highest contributor to the GDP was the service sector (42%) with the tourism sector as the main contributor, followed by the industry sector with 33% (mainly contributed by the construction sector), while the agriculture sector contributed only 25% in 2017 (NSDP (2016) and MAFF (2017)). Table 3 shows the GDP share from the agriculture, industry, and service sectors. The Government set an economic development target to reach the status of an upper-middle income country by 2030 and a high-income level by 2050 (RGC, 2018a). The National Strategic Development Plan (NSDP) was also developed to improve natural resources management, build peace, political and social stability, and promote socioeconomic development (RGC, 2009 and 2014b).

The RGC recognizes that healthy people constitute the key basis for human resource development and sustainable socio-economic progress by emphasising on enhancing the general well-being of all citizens, particularly the poor, women, and children. Thus, the RGC will continue implementing the Health Sector Strategic Plan (HSSP) 2016-2020 to promote individual well-beings and higher nutritional standards and to reduce maternal and infant/child mortality through strengthening and improving quality, effectiveness and efficiency of health services (RGC, 2018a). The implementation of the NSDP and the HSSP set the policy direction to strengthen quality of life, improve the status of women who form the backbone of the national economy and society, and to transform youth to become an important driving force for development in every sector.

Table 3. Share and Growth of Agriculture, Industry and Service Sector (%) (at constant prices)

Share by sector (%)	2013	2014	2015	2016	2017
Agricultural sector	24.2	22.7	21.2	26.3	24.9
Crop	13.1	12.3	11.5	11.3	13
Industrial sector	29.9	30.7	32.1	31.3	32.9
Textile	17.7	17.6	18.1	18.0	18.0
Construction	5.7	6.5	7.2	7.7	7.7
Service sector	39	39.6	39.6	42.4	42.2
Hotel & Restaurant	5.4	5.4	5.1	5.1	5.1
Growth by sector (%)					
Agricultural sector	1.6	0.3	0.2	1.4	1.7
Crop	0.6	0.5	0.3	0.2	0.2
Industrial sector	10.7	10.1	11.7	11.8	11.8
Textile	10.7	6.6	9.8	10.6	10.6
Construction	13.7	21.4	19.2	15.0	15.0
Service sector	8.7	8.7	7.1	7.1	7.1
Hotel & Restaurant	13.8	6.1	2.4	7.0	7.0

Source: NSDP (2016) and MAFF (2017)

The industrial sector plays an important role for the Cambodian economy with its GDP share increasing from around 13% in 1993 to 30% in 2017, which already reached the target set in the national policy on industry (30%) by 2025 (RGC, 2015).

The Government shaped its policy toward enhancing rice production through developing a policy paper on the Promotion of Paddy Production and Rice Export with a vision to transform Cambodia into a **"**rice basket**"** and a key milled rice exporting country in the global market. Further, it set a target to export at least one million tons of milled rice by 2015 (RGC, 2010). The Government is also focusing on increasing agriculture production by shifting from the extension of cultivated areas to intensive farming on existing land (Jeremy and Rebeca, 2010).

The government adopted the Agricultural Sector Strategic Development Plan (ASDP) to provide guidance on achieving policy goals and objectives, to indicate development outcomes, and to achieve expected output indicators and activities for a five-year period of implementation (MAFF, 2018). Additionally, the MAFF formulated "Agricultural Sector Master Plan toward 2030" with a vision to promote a modern agriculture sector, which should be competitive, inclusive, resilient, and sustainable to contribute to food security, safety, and nutrition for the prosperity and individual well-beings. The Master Plan intends to increase agricultural growth and to expand agricultural exports with high quality and safety through enhancing agricultural productivity, value added, and enabling competition, while considering the sustainable use of land and ensuring sustainable fisheries and forestry resource management.

Agriculture land for rice crop production increased from about three million hectares in 2013 to 3.21 million hectares in 2017 (2.66 million hectares of rainy season paddy and 0.55 million hectares of dry season paddy). Average paddy yield in both dry and rainy seasons increased from 3.16 tons/ha in 2013 to 3.30 tons/ha in 2017 (MAFF, 2018). Table 4 shows rice production from 2010 to 2017 in Cambodia, while Table 5 shows the production of subsidiary crop and industrial crop.

Table 4. Rice production 2010-2017

Items	Unit	Year				
		2013	2014	2015	2016	2017
Total Cultivated Area	**ha**	**3,052,420**	**3,055,507**	**3,051,412**	**3,118,160**	**3,210,000**
Wet Season	ha	2,567,723	2,564,572	2,561,957	2,599,586	2,660,000
Dry Season	ha	484,697	490,935	489,455	518,574	550,000
Total Harvested Area	**ha**	**2,968,967**	**3,028,836**	**3,025,630**	**3,099,769**	**3,190,000**
Wet Season	ha	2,485,521	2,537,976	2,536,175	2,581,255	2,640,000
Dry Season	ha	483,446	490,860	489,455	518,514	550,000
Average Yield	**T/ha**	**3.16**	**3.08**	**3.09**	**3.21**	**3.30**
Wet Season	T/ha	2.93	2.82	2.83	2.96	30,470,000
Dry Season	T/ha	4.38	4.44	4.42	4.47	45,080,000
Total Production	**T**	**9,389,961**	**9,324,416**	**9,335,284**	**9,952,270**	**10,520,000**
Wet Season	T	7,271,251	7,143,521	7,170,684	7,636,906	8,050,000
Dry Season	T	2,118,710	2,180,896	2,164,600	2,315,364	2,470,000
Food requirement	T	2,137,878	2,178,050	2,222,078	2,266,335	-
Surplus/Deficit (Rice)	T	3,090,452	3,013,783	2,975,809	3,275,089	3,560,000
Surplus/Deficit (Paddy)	T	4,828,832	4,709,036	4,649,702	5,117,327	5,560,000

Source: MAFF (2018)

Table 5. Production of subsidiary crop and industrial crop

	Subsidiary crop production		Industrial crop production	
Year	Cultivated Areas (ha)	Production (t)	Cultivated Areas (ha)	Production (t)
2013	775,320	9,431,530	165,720	1,105,210
2014	775,820	13,022,960	177,770	1,704,300
2015	849,050	15,291,500	135,080	857,260
2016	933,370	16,022,950	101,270	856,870
2017	946,800	15,634,990	100,110	748,090

Source: MAFF (2018)

The RGC has set a goal to ensure food security, increase incomes, create employment, and improve nutrition status for all people (RGC, 2014b). The National Strategic Planning Framework for Livestock (2016-2025) was prepared with the objective to improve the livelihoods of small producers, household income, and food security and to provide a safe and sufficient supply of livestock products to consumers, as well as for export (RGC, 2016a). The plan's vision calls for the sustainable development in the animal sector. The Ministry made efforts to ensure the implementation of good animal health and production through effective development of human resources, research and dissemination, development of policy and the strengthening of legal enforcement, as well as developing public and private partnerships.

Table 6 shows the number of livestock from 2013 to 2017. The number of livestock has gradually increased from 2013 to 2017, notably the number of pigs and poultries. However, it can be observed that the number of cattle has gradually decreased (MAFF, 2018). MAFF (2018) released that the number of commercially raised animals has increased by around 27% (from 6.6 to 8.4 million heads) over the five-year period (2013-2017). According to the FAO, the average meat consumption in Cambodia is 17.59 kg per capita per year, including 5 kg of beef and buffalo meat, 9.29 kg of pork, 3.3 kg of poultry, and another animal meat (MAFF, 2018). Local production is capable of supplying around 298,158 tons of the demand, including 81,962 tons of beef, 165,399 tons of pork, and 51,378 tons of poultry meat (MAFF, 2018).

Table 6. The number of livestock in Cambodia from 2013-2017

Annual average population (head)	2013	2014	2015	2016	2017
Cattle (non-dairy)	3,430,895	3,053,537	2,903,421	2,897,126	2,951,359
Buffaloes	619,114	541,827	506,166	523,320	508,458
Pigs	2,454,426	2,360,823	2,357,839	2,371,283	2,331,512
Birds (poultry)	27,316,415	25,461,910	26,506,407	28,230,663	28,559,702
Horses	7,119	9,078	7,486	5,610	5,055
Sheep	100	238	378	400	461
Goats	12,856	16,454	21,489	22,719	28,542

Source: MAFF (2018)

To manage and conserve forest, the government adopted the Law on Forestry in 2002 stipulating that the Permanent Forest Estate (PFE) must be managed in a sustainable way in order to maximize social, economic, and environmental benefits and cultural values. Furthermore, the government adopted the Law on Protected Areas in 2008, aiming mainly to manage and effectively implement the conservation of biological resources and the sustainable use of natural resources in protected areas. However, forest cover has gradually decreased from approximately 73% in 1960 to 57% in 2010, further declining to 50% in 2014 (RGC, 2016b), which was below the target of maintaining the forest cover at 60% by 2015. Table 7 shows forest cover change between 2010 and 2014.

In terms of forest management, there are two main government institutions responsible for managing forest resources--the MoE and the MAFF. The MoE manages all protected areas (PAs), declared by the Royal Decree in 1993 (23 Pas). While, the MAFF manages commercial and reproductive forests. PAs have increased to 49, and includes eight categories: National Parks, Wildlife Sanctuaries, Protected Landscapes, Multiple Use Areas, Ramsar Sites, Biosphere Reserves, Natural Heritage Sites, and Marine Parks and Biodiversity Conservation Corridors, covering over seven million ha (39% of total land) (RGC, 2017).

To enhance and drive sustainable forest management, the RGC developed the National Forest Program (NFP) (2010 to 2029) with its main focus to implement a REDD-plus scheme (Reducing Emissions from Deforestation and forest Degradation, forest conservation, sustainable forest management, and enhancement of carbon sinks) (RGC, 2010a). The government also prepared the National REDD+ Strategy 2017-2026 to contribute to national and global climate change mitigation by improving resources and forest land management and sustainable biodiversity conservation. Additionally, the National Protected Area Strategic Management Plan (NPASMP) 2017-2031 was approved with a vision to ensure sustainable economic development, including poverty reduction, through the conservation and sustainable use of its biological, natural, and cultural resources and other ecosystem services (RGC, 2017). In 2015, the RGC also announced its intention to develop an "Environment and Natural Resources Code" that would establish overarching legal principles to guide the implementation of existing laws related to natural resource management in support of sustainable development (RGC, 2017).

In parallel to the implementation of these initiatives, the RGC has undertaken important institutional reforms to face the challenges associated with the development, management, protection, and conservation of natural resources and the environment. Accordingly, the RGC

has halted the issuance of new Economic Land Concessions (ELCs), the progress of the existing ELCs is being examined, and the concessions' validity is reduced from 90 years to only 50 years (RGC, 2017). Moreover, decentralization reforms led by the National Committee for Sub-National Democratic Development (NCDD) have been used by the MoE to delegate a number of functions to local authorities, which include the delegation of community involvement to Commune/Songkat Administrations (MoE Prakas #37 dated 10th Feb., 2016) and responsibilities for awareness raising, livelihoods development and enforcement to Municipal/ District Administrations (MoE Prakas #36 dated 10th Feb. 2016) (RGC, 2010c and RGC, 2017).

Table 7. Forest cover change between 2010 and 2014

No	Forest Cover Type	Forest Land Cover				Forest Cover Change	
		2010		2014		2010-2014	
		Ha	%	Ha	%	Ha	%
1	Evergreen Forest	3,573,925	19.68%	2,973,903	16.38%	-600,022	-3.30%
2	Semi-evergreen Forest	1,391,117	7.66%	1,108,320	6.10%	-282,797	-1.56%
3	Deciduous Forest	4,498,397	24.77%	3,480,532	19.17%	-1,017,865	-5.60%
4	Flooded Forest	524,005	2.89%	481,078	2.65%	-42,927	-0.24%
5	Regrowth Forest	249,341	1.37%	228,560	1.26%	-20,782	-0.11%
6	Bamboo	130,930	0.72%	130,678	0.72%	-253	0.00%
7	Mangrove	31,443	0.17%	33,002	0.18%	1,559	0.01%
8	Rear Mangrove	27,371	0.15%	25,906	0.14%	-1,464	-0.01%
9	Pine Forest	8,157	0.04%	8,196	0.05%	40	0.00%
10	Pine Plantation	11	0.00%	3,710	0.02%	3,699	0.02%
11	Tree Plantation	17,214	0.09%	44,289	0.24%	27,074	0.15%
Total Forest Land Cover		**10,451,912**	**57.55%**	**8,518,173**	**46.90%**	**-1,933,739**	**-10.65%**
Total Non-Forest		**7,708,762**	**42.45%**	**9,642,501**	**53.10%**	**1,933,739**	**10.65%**
Grand Total		**18,160,674**	**100.00%**	**18,160,674**	**100.00%**		

Source: RGC (2016b)

Rubber is a main strategic crop providing multiple benefits to its growers, the nation economy, smallholders' economy and the environment, while preventing soil erosion and contributing to the maintenance of the national green cover (MAFF, 2018). The Government plans to increase rubber plantation areas to around 400 thousand ha by 2020. In 2016, rubber production reached 145,200 tons, increasing by 18,339 tons compared to 2015. The average rubber yield has slightly increased from 1,141 kg/ha in 2015 to 1,143 kg/ha in 2016. Based on the most current data, rubber smallholdings own 36% of total rubber crop plantations, while the remaining 64% is owned by former state farms and ELC[4]. Table 8 shows rubber plantation areas from 2010 to 2017.

[4] Economic land concessions (ELC) are long term leases granted over land for agro-industrial exploitation

Table 8. Rubber plantation areas from 2010 to 2017

Rubberb Plantations (ha)	Year							
	2010	2011	2012	2013	2014	2015	2016	2017
Rubber Plantations Agro-industry	99,620	117,174	172,658	191,354	217,463	239,102	278,280	280,228
Former state farms	47,092	50,715	54,209	55,908	55,786	54,850	54,522	-
ELC Rubber Plantations	52,528	66,459	118,449	135,446	161,677	184,252	223,758	-
Farmily Rubber Plantations	81,813	95,930	107,696	137,417	140,346	149,854	154,454	156,112
Total	**181,433**	**213,104**	**280,354**	**328,771**	**357,809**	**388,956**	**432,734**	**436,340**

Source: MAFF (2018)

Cambodia's rapid economic growth was accompanied by a steady increase in energy demand. Per capita consumption of electricity has increased from around 15 kWh/year in 1993 (RGC, 2012) to 335 kWh/year in 2015 (MME-CERIAEA, 2016). Energy supply and demand are expected to increase substantially due to increases in population, economy, outputs of industry, national grid improvements, and reduced electricity tariffs (RGC, 2018a).

Cambodia imports all fossil fuels that it consumes, including coal and oil. The Total Primary Energy Supply (TPES) increased from 3,350 kilotons of oil equivalent (ktoe) in 2010 to 4,761 ktoe in 2015 at an average annual growth of around 7%. Electricity supply increased at an average of 20% per year from 968 GWh to 4,645 GWh in 2010 and 2015, respectively, while electricity imports from Viet Nam, Thailand, and the Lao PDR accounted for 25% in 2015 compared to 61% of the total supply in 2010 (MME-CERIAEA, 2016). Coal consumption for power generation increased largely in 2014 and 2015 due to the operation of new coal power plants (Sihanoukville 100 MW and the first 270 MW of the CIIDG Erdos Hongjun Electric Power Co., Ltd.) (MME-CERIAEA, 2016). Hydropower plants contributed about 43% of the domestic generation in 2015 compared to only 3% in 2010, while electricity generation from oil-based power plants, which shared about 93% in 2010 decreased to only 5% in 2015. Table 9 shows power generation by source from 2010 to 2015, while Table 10 shows electricity generation by source from 2010 to 2015. The Total Final Energy Consumption (TFEC) increased at an average annual growth rate of around 7% from 2,449 ktoe in 2010 to 3,413 ktoe in 2015 (MME-CERIAEA, 2016).

The transport sector consumed the most in petroleum products with the average growth at 10% per year, from 950 ktoe in 2010 to 1,549 ktoe in 2015. "Other" sector consumption, covering the service (commercial and public), the residential, the agriculture, etc., increased from 1,014 ktoe in 2010 to 1,329 ktoe in 2015. Table 11 shows total final energy consumption by sector from 2010 to 2015. Final users' electricity consumption increased at an average growth rate of 18% per year between 2010 and 2015. The service sector increased at a faster rate at 23% per year. The industrial sector increased at an annual average rate of 18% per year, while that of the residential and other sectors increased at 12% per year. Table 12 shows final users' electricity consumption from 2010 to 2015.

Nearly five million Cambodians lack access to grid electricity and are reliant on car batteries, wood, and other traditional fuels for energy.

To promote and sustain energy supply, the government adopted the "Law on Electricity" in 2000, which covered all activities related to the supply, provision of services and use of electricity, and other power sector associated activities. The government set two main energy development targets - the first is to achieve 100% level of village electrification (47% level as an intermediate target of household electrification) by 2020; and the second is to achieve 70% level of household electrification with grid quality electricity by 2030 (JICA, 2006).

In 2008, the Government declared the "implementation of electricity saving measures" to reduce energy demand and CO_2 emissions while simultaneously providing reliable and affordable energy services to all end users in the most sustainable manner. To this end, it required all Government ministries and public institutions to participate in a programme on "electricity saving consumption". It also developed the National Energy Efficiency Policy in 2018 with two main goals: 1) improve the management and maintenance of existing infrastructure (e.g. buildings) and industrial processes (e.g. for the use of fuel wood) for increased energy efficiency; and 2) increase transfer and adoption of energy efficient technologies (e.g. fuel efficient vehicles and light bulbs) to reduce energy intensity (RGC, 2017a). JICA (2006a) estimated that Cambodia could generate an average annual solar irradiation of more than 5.10 kWh/m^2/day, while Rogier (2011) indicated that solar power is a good alternative energy option for people living in rural areas where the national grid cannot be accessed. Accordingly, Cambodia developed a solar roadmap towards 2020 aiming at professionalizing the solar market to be affordable, attractive, and accessible for households that are currently relying on car batteries and kerosene lamps. Table 13 shows the detailed list of power plants commissioned/to be commissioned up to 2020.

Table 9. Power generation by sources from 2010 to 2015

Power Generation by Source (Gwh)				
Year	Hydro	Coal	Diesel/HFO	Wood & Biomass
2010	31.73	32.08	898.73	5.82
2011	51.52	46.50	908.61	11.91
2012	517.37	37.42	856.56	11.75
2013	1,015.54	168.75	578.99	6.68
2014	1,851.60	863.02	326.97	16.79
2015	2,000.38	2,376.49	227.62	40.47

Source: MME-CERIAEA (2016)

Table 10. Electricity generation by sources from 2010 to 2015

Electricity Generation (Gwh)						
Year	Hydro	Coal	Diesel/HFO	Biomass	Import	Total
2010	32	32	899	6	1,546	2,515
2011	52	47	909	12	1,830	2,848
2012	517	37	857	12	2,104	3,527
2013	1,016	169	579	7	2,282	4,052
2014	1,852	863	327	17	1,803	4,861
2015	2,000	2,376	228	40	1,541	6,186

Source: MME-CERIAEA (2016)

Table 11. Total final energy consumption by sector from 2010 to 2015

Total Final Energy Consumtion by Sector (ktoe)							
Year	Industry	Transport	Other				
			Service	Residential	Agriculture	Others	Total
2010	483	952	133	849	32	0.2	2,449
2011	518	1,090	154	933	38	0.5	2,739
2012	546	1,250	153	923	43	0.9	2,922
2013	530	1,259	166	969	42	0.6	2,966
2014	543	1,354	161	1,020	50	11.1	3,140
2015	535	1,549	238	1,052	38	0.6	3,413

Source: MME-CERIAEA (2016)

Table 12. Electricity consumption by final users from 2010 to 2015

Electricity Consumption by Final Users (Gwh)					
Year	Residential	Commercial	Industrial	Other	Total
2010	869.08	892.89	489.88	2.19	2,254.04
2011	854.16	1,082.45	629.87	6.26	2,572.74
2012	1,079.28	1,275.90	900.32	10.31	3,256.81
2013	1,186.58	1,539.47	820.04	6.50	3,552.59
2014	1,223.08	1,639.29	1,054.35	127.39	4,144.12
2015	1,527.15	2,530.31	1,136.84	7.18	5,201.49

Source: MME-CERIAEA, 2016

Table 13. Power development plan in Cambodia

No.	Generation Expansion Plan	Fuel	MW	Year
1	Kamchay Hydro Power Plant	Hydro	193.2	2011
2	200 MW Coal Power Plant (I) in Sihanouk Ville -Phase 1	Coal	100	2011
3	Kirirom III Hydro power Plant	Hydro	18	2012
4	Atay Hydro Power Plant	Hydro	110	2012
5	200 MW Coal Power Plant (I) in Sihanouk Ville -Phase 2	Coal	100	2012
6	Tatay Hydro Power Plant	Hydro	246	2013
7	Lower Stung Rusey Chhrum Hydro Power Plant	Hydro	338	2013
8	700 MW Coal Power Plant (II) in Sihanouk Ville -Phase 1	Coal	100	2013
9	700 MW Coal Power Plant (II) in Sihanouk Ville -Phase 2	Coal	100	2014
10	700 MW Coal Power Plant (II) in Sihanouk Ville -Phase 3	Coal	100	2015
11	700 MW Coal Power Plant (II) in Sihanouk Ville -Phase 4	Coal	100	2016
12	Lower Sesan II + Lower Srepok II	Hydro	400	2016
13	Stung Chay Areng Hydro Power Plant	Hydro	108	2017
14	700 MW Coal Power Plant (II) in Sihanouk Ville -Phase 5	Coal	100	2017
15	700 MW Coal Power Plant (II) in Sihanouk Ville -Phase 6	Coal	200	2018
16	Steung Treng Power Plant	Hydro	980	2018
17	Sambor Hydro Power Plant	Hydro	2600	2019
18	Coal Power Plant (III) or Gas Power Plant	Coal/NG	450	2020

Source: MME-CERIAEA (2016)

There are four main types of transport modes in Cambodia, including road, rail, maritime and waterway, and aviation. Road transport is the largest subsector, with an estimated modal share of more than 90% for passenger and freight (ADB, 2019).

Cambodia's road infrastructure was almost obliterated after more than 20 years of civil conflict. Nevertheless, significant efforts have been made for its restoration and enhancement to accelerate economic development and meet increasing transport demand. Total road length in Cambodia currently includes more than 61,000 km. The population and economic development have significantly increased, and infrastructure has also been constructed and restored almost national wide; hence, the national fleet has also grown. Between 2008 and 2017, the number of registered vehicles increased by more than 100%, especially the number of motorbikes (MPWT, 2018). Table 14 shows the number of registered vehicles from 2008 to 2017.

Table 14. Registered vehicles from 2008 to 2017

Mode (number)/year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Tourist car	15,902	20,435	15,563	22,127	22,046	19,973	24,656	36,418	34,168	60,400 (*)
Small passenger bus	2,338	2,514	2,510	2,894	3,167	3,021	3,357	4,628	4,051	-
Big passenger bus	231	324	224	404	448	318	386	520	459	-
Small freight truck	4,808	5,065	3,815	5,199	6,360	6,976	7,556	9,781	9,176	-
Big freight truck	3,274	3,241	2,243	2,888	4,969	4,693	5,072	6,781	9,625	-
Motorbike	188,915	275,471	236,614	218,217	214,351	225,256	268,786	304,932	377,476	381,400
Total	**215,468**	**307,050**	**260,969**	**251,729**	**251,341**	**260,237**	**309,813**	**363,060**	**434,955**	**441,800**

* Here also referes to small and big passenger bus and small and big freight truck

Source: NIS (2015) and MoPWT (2018)

The existing railway system consists of two lines: the 264 km Southern Line (SL) from Phnom Penh to Sihanoukville City, and the 336 km Northern Line (NL) from Phnom Penh to Poipet on the Thai border. Infrastructure of both lines continues to be in poor condition due to civil war damages. The RGC and its development partners are making a significant effort to rebuild and upgrade the national railway system (Council for the Development of Cambodia, 2019). The passenger train service ceased operations in 2009, while the freight gradually decreased since 2002 and only the southern line remained in operation (MPWT, 2010 and 2012). However, further rebuilding efforts have led to freight movements significantly increasing between 2013 and 2017 and the passenger train starting operations again in 2016. Table 15 shows train transport modes from 2013 to 2017. The rail transport mode is expected to grow by 7.0-12.0% per year by 2030, with a projected increase in locomotives (ADB, 2011).

Table 15. Train transport mode from 2013 to 2017

Train transport mode/year	2013	2014	2015	2016	2017
Cargo transport (t-km/year)	82,534	419,201	538,345	710,496	850,100
Passenger transport (person-km/yea	-	-	-	13,995	14,407

Source: MoPWT (2018)

The marine and water way also plays a very important role for both passenger and freight demand. Inland water has a total navigable length of around 1,750 km of which only 580 km are navigable all year round. The Mekong River accounts for about 30% of the total length of navigable inland waterways, Tonle Sap 15%, Tonle Bassac 5%, and the remaining waterways 50%.

Over the past several years, total cargo and vessels have significantly increased both at Phnom Penh and Sihanouk. Table 16 shows cargo quantity and vessels in Cambodia from 2013 to 2017.

Table 16. Cargo and vessels in Cambodia from 2013 to 2017

Description/year	2013	2014	2015	2016	2017 (est)
Quantity of cargo and vessels at Sihanouk international port					
Quantity of throughput cargo (thousand ton)	3,012	3,432	3,763	4,040	4,304
Quantity of vessel (number)	988	1,103	1,292	1,322	1,300
Quantity of container throughput (TEU)	286,450	333,904	391,819	400,187	454,592
Quantity of cargo and vessels at Phnom Penh international port					
Quantity of throughput cargo (thousand ton)	1,404	1,627	1,862	2,409	2,757
Quantity of vessel (number)	1,445	1,462	1,596	1,679	1,676
Quantity of container throughput (TEU)	110,500	133,666	144,813	151,781	184,805
Quantity of cargo and vessels at the Cambodia Shiping Agency and Broker (CAMSAB)					
Quantity of vessel (number)	4,312	4,568	4,370	4,398	3,577
Imported cargo (thousand ton)	4,410	5,634	6,637	7,030	7,378
Exported cargo (thousand ton)	2,100	2,565	1,998	1,788	1,768
Numbers of vessel recorded at Phnom Penh (number)	920	1,122	13,021	1,147	1,133
Numbers of vessel recorded at Sihanouk (number)	631	664	840	858	729

Source: MoPWT (2018)

The State Secretariat of Civil Aviation of Cambodia (SSCA) manages all airport operations, except the Phnom Penh International Airport (1995), Siem Reap International Airport (2001), Preah Sihanouk Airport (2006), and Kampong Chhnang Airport. However, it has an important role of regulation in the broader administration of government owned airports and has ultimate oversight for the licensing, certification, and approval of the development of all airports.

The number of passengers and cargo transported have increased considerably over the last decade. Table 17 shows passengers and cargo carried by air from 2013 to 2017. In addition, since the Government policy aims to attract seven million foreign tourists annually by 2020 (MoT, 2012), Cambodia will expand international airports and will rehabilitate national airports located in several tourist destination provinces to support eco-tourism. The improvements of local airports are under discussions to support eco-tourism industry (KoC, 2015).

Table 17. Quantity of passengers and cargo carried by air from 2013 to 2017

Description/year	2013	2014	2015	2016	2017
Departure and arrival of both national and international flights (number)					
Domestic	5,295	6,954	8,755	8,122	11,323
International	23,412	25,233	26,251	28,317	33,731
Transit	40,258	41,160	46,940	55,079	59,098
Domestic and international passengers (person)					
Domestic	214,418	298,904	436,167	423,476	517,687
International	4,606,281	5,168,687	5,606,317	6,201,338	7,665,717
Domestic and international baggage (kg)					
Domestic	1,903,218	2,752,677	3,679,048	7,233,358	4,832,756
International	58,301,357	62,925,401	66,178,758	72,517,540	84,579,260
Domestic and international cargo (kg)					
Domestic	6,243	183,222	252,147	153,050	76,049
International	31,612,068	32,665,787	36,897,845	46,308,744	63,872,741

Source: MoPWT (2018)

The country adopted the Law on Land Traffic in April 2014, aiming to maintain order and safety in road trafficking, allowing public traffic throughout Cambodia; to protect human and animal lives and environment; to curb the effect on human health and the damage on state and private properties; and to curb offenses stemming from road use.

Similarly, the Law on Roads passed in December 2014, aiming to protect public property, protect and enhance roads quality, maintain orders, facilitate traffic, and transport.

The government also prepared an Urban Transport Master Plan (UMP) targeting year 2035 for solving the current transport problems/issues and support the 2035 Urban Vision and Urban Structure, which will maintain people-environment-friendly urban conditions and revitalize urban activities. Two important orientations were established in the UMP: 1) to shift from a private-oriented urban transport system to a well-balanced system of public and private transport, and a combination of road, public transport, and traffic management for improving the mobility of citizens; and 2) to materialize the urban potential of Phnom Penh City (KoC, 2015).

Without effective and timely management of rapid growing solid waste, it will negatively affect public health, ecological systems, and contribute to climate change. Most importantly, it will negatively impact water quality, soil, air, and ground water, and threaten the sustainability of natural resources and economic development, as well as negatively impact tourism.

Waste disposal in Cambodia has notably improved over the past decade, with a more than doubling of waste disposed in landfills between 2005 and 2017 (MoE, 2018). Figure 2 shows the quantity of solid waste disposed at landfill sites from 2005 to 2017. Organic waste is the largest component of waste with an estimated national average of 51.9%. Simultaneously, recycled solid waste increased considerably from 2010 to 2017 (see Table 18). Waste generation per capita is expected to increase from 0.3 kg/person.day in 2010 to 1.16kg/person.day in 2030 and 2.13 kg/person.day in 2050 (Hoornweg and Bhada-Tata, 2012, and Mao et al, 2016).

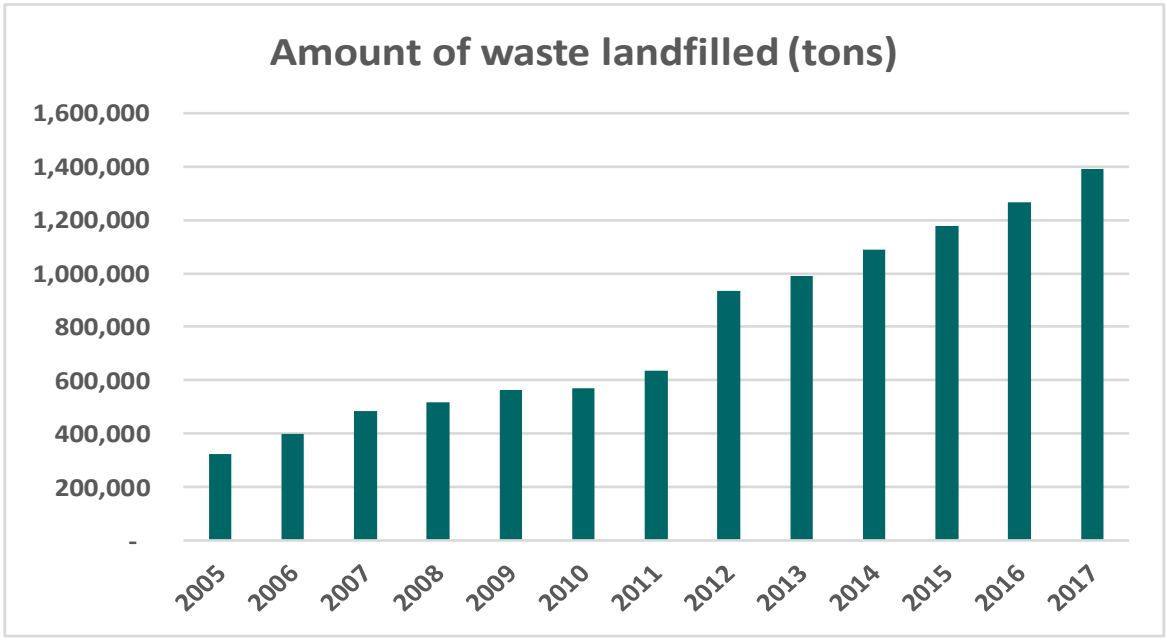


Figure 2. Quantity of waste landfilled from 2005 to 2017 (Source: MoE, 2018)

The RGC has developed national regulations and policies to manage waste. For instance, the government adopted the sub-decree No. 36 on solid waste management in April 1999, a fundamental solid waste management regulation that regulates not only the management of simple solid wastes and/or garbage properly, but also hospital, industrial, and other hazardous wastes. As a supplement to this sub-decree, the MoE and the Ministry of Interior (MoI) issued

a joint Declaration (Prakas) No. 80 in 2003 (MoE/MoI, 2003) to improve the responsibility of an authority and to engage institutions for efficient implementation of solid waste management in provinces and cities for protecting human health, environmental quality, aesthetics, and biodiversity. The declaration clearly states that disposal of waste in public areas, streets, and canals is illegal. The Government also issued an inter-ministerial (MoE/MoI) circular to monitor the effective implementation of this Sub-decree (MoE/MoI, 2015). The Government also approved the Sub-decree on municipal solid waste management on August 27, 2015 with the objective to improve municipal solid waste management in an efficient, transparent, and accountable manner to ensure the protection of aesthetics, public health, and environment (RGC, 2015a).

Furthermore, the MoE and the MoEYS made an inter-ministerial declaration on the establishment of a working group for facilitating the cooperation between the two entities in the framework of environmental education, training, research, and consultation (MoE/MoEYS, 2016).

Table 18. Quantity of recycled solid waste from 2010 to 2017 (Kg)

Types\year	2010	2011	2012	2013	2014	2015	2016	2017
Paper	26,522	25,340	14,856	18,004	22,838	14,769	33,857	52,112
Plastics	23,583	21,689	13,960	12,820	15,842	12,678	30,907	44,865
Aluminium	8,449	7,297	9,866	10,113	15,942	100,050	87,741	31,352
Iron	63,077	68,366	30,013	19,955	29,930	17,184	74,328	68,052
Glass	1,367	14,469	9,083	13,652	14,311	9,028	20,134	32,829
Total	122,997	137,160	77,777	74,544	98,863	153,709	246,967	229,210

Source: MoE (2018)

Wastewater generation has also increased over the past decade; however, the country has not maintained statistics on wastewater. The RGC adopted the Sub-decree on water pollution control in 1999 to regulate water pollution control and prevent and reduce pollution of public water areas, and therefore ensure the protection of human health and conservation of biodiversity. The MoE has encouraged implementation of its surveillance on major pollution sources, *e.g.* factories and large enterprises, by encouraging the installation of liquid waste treatment plants at the source, air purification devices before emitting, and noise reduction equipment (MoE, 2018).

3. Institutional Arrangements

To ensure more efficient and effective work, especially in the context of climate change and sustainable development, the RGC has conducted a few institutional reforms as described hereinafter.

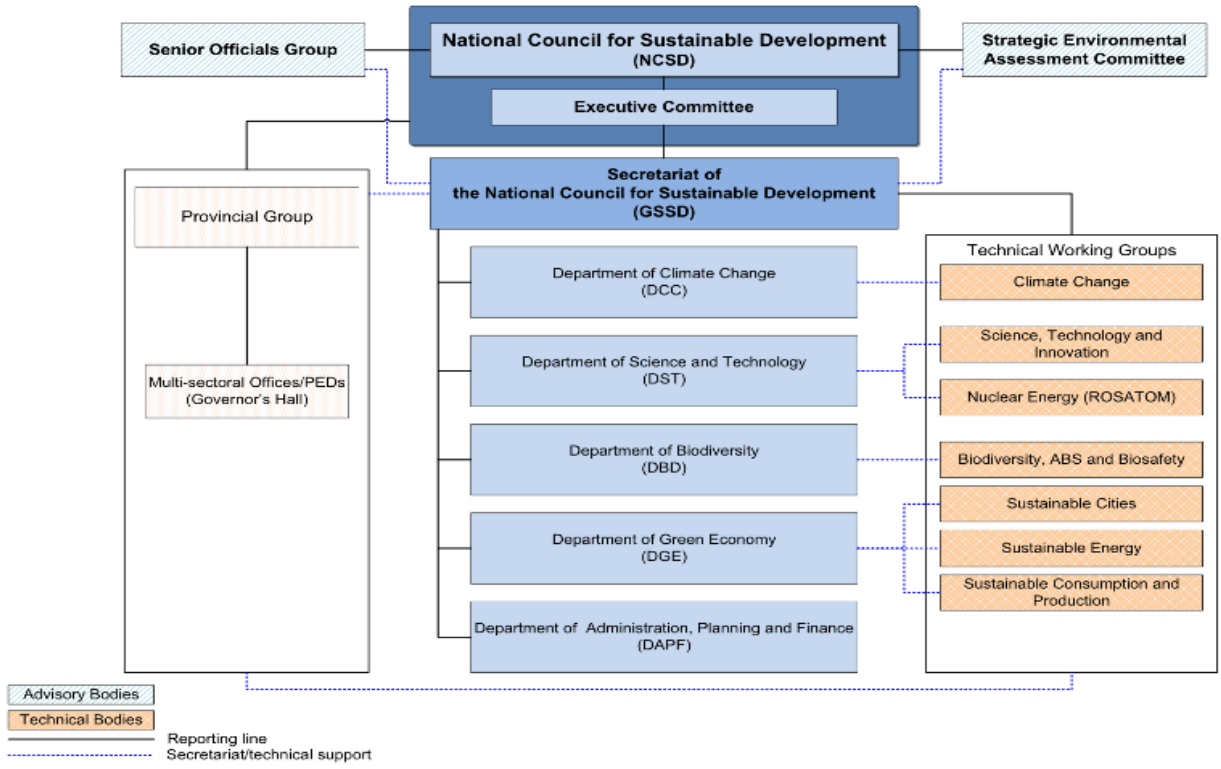
3.1. National Council for Sustainable Development (NCSD)

The National Climate Change Committee (NCCC) was established in 2006 with a mandate to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans and programmes of the Royal Government of Cambodia.

The NCCC was created as an inter-ministerial mechanism, cross-sectoral and multi- disciplinary in nature, to coordinate climate change response. The National Council for Sustainable Development (NCSD) took over functions since its establishment in May 2015. The Council is composed of high-level representatives (Secretaries and Under-Secretaries of State) of key

government ministries and agencies, with the Prime Minister as its Honorary Chair and the Minister of Environment as its Chair. Council membership has increased compared to the NCCC, covering a greater number of ministries and agencies, including provincial governors. The organic structure of the NCSD is shown in the following figure.

Figure 3. Structure of the National Council for Sustainable Development



3.2. General Secretariat of the National Council for Sustainable Development (GSSD)

The Cambodia Climate Change Office (CCCO) of the Ministry of Environment (MoE) was established in 2003 to be responsible for wide-ranging climate change related activities: formulation of draft climate change plans and policies, assessment of new technologies to adapt to the adverse effects of climate change or to mitigate greenhouse gas (GHG) emissions, and capacity building and awareness raising. The Government upgraded the status of the CCCO from office to department (Department of Climate Change, DCC) in October 2009. This upgrade reflected Cambodia´s commitment to strengthening their climate change institutions. The DCC was subsequently included as one of the five Departments of the General Secretariat of the National Council for Sustainable Development in 2015.

The DCC serves as secretariat of the Climate Change Technical Working Group (CCTWG) and convenes and coordinates the CCTWG to discuss key priorities: the update and review of national institution indicators, which are part of the National Monitoring and Evaluation (M&E) Framework; the Review of the Implementation of Cambodia's Climate Change Strategic Plan 2014-2023 (CCCSP); and Cambodia's Nationally Determined Contributions (NDC).

The development of national communications and Biennial Update Reports under the UNFCCC fall under the purview of the NCSD to provide the basis for institutional continuity at both the policy-making and technical levels, across a comprehensive range of government stakeholders.

3.3. Climate Change Technical Working Group

The Climate Change Technical Team (CCTT) was restructured to be a Climate Change Technical Working Group (CCTWG), including representatives of the General Secretariat of the National Council for Sustainable Development (GSSD) and line ministries. The CCTWG's mandate and priority program is to support the NCSD for strengthening Cambodia's capacity to respond to climate change. The CCTWG is an integral part of the NCSD structure coordinated by the GSSD, and it facilitates the review, formulation, and implementation of policies, strategies, action plans, and programs to enhance climate change response. The CCTWG is used to coordinate and facilitate the preparation and development of the BUR.

3.4. National GHG Inventory Team

The Climate Change Technical Working Group has proved essential for the inter-ministerial coordination needed for developing national GHG emission inventories and vulnerability assessments, especially in the energy and forestry sectors. To enhance this coordination, the country set up a National GHG Inventory Team (NIT) to coordinate and develop the BUR aiming at enhancing and improving the coordination of the different entities involved. The members of the NWGIM include representatives from academia and line ministries.

3.5. Institutional arrangements for compiling the GHG inventory

The NCSD through its general secretariat (GSSD) has the overall responsibility for inventory preparation. The Climate Change Technical Working Group has proved essential for the inter-ministerial coordination needed for developing the national GHG emission inventory, especially for data gathering and validation purposes.

For the development of the 2019 edition of the GHG inventory, the GSSD signed a letter of agreement (LoA) with the General Directorate of Administration for Nature Conservation and Protection (GDANCP) of the Ministry of Environment (MoE) to assist the GSSD in the preparation of national greenhouse gas inventory and the inventory chapter of the BUR.

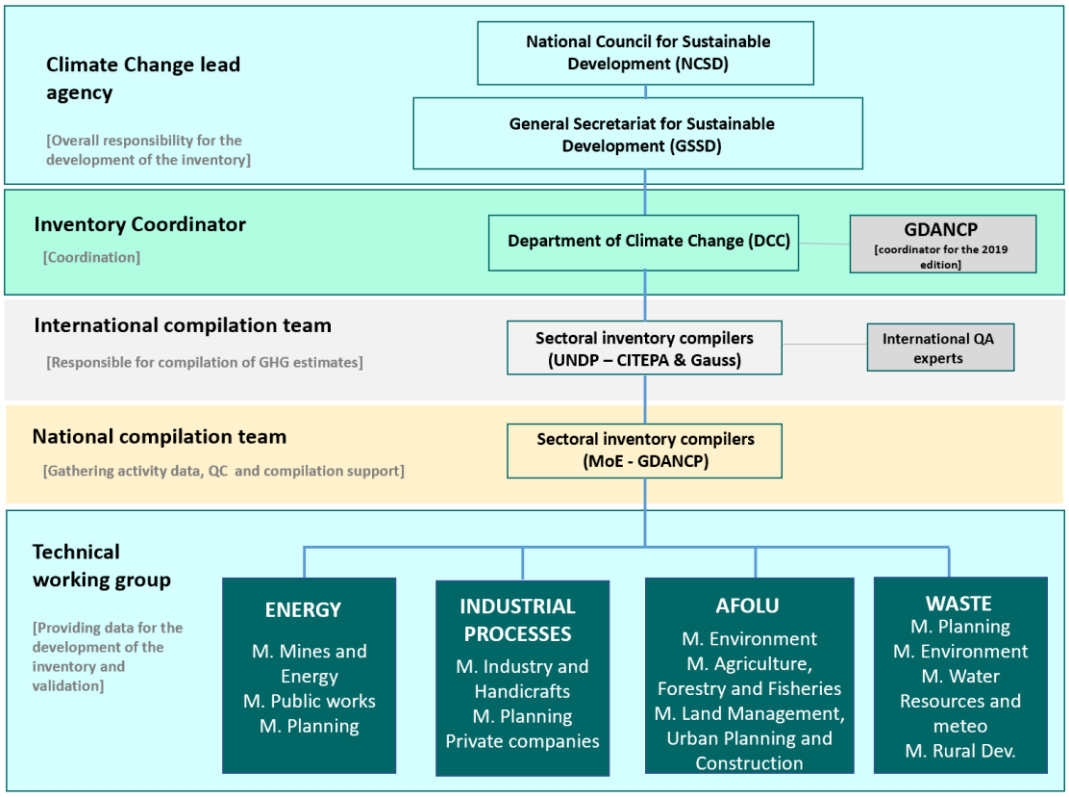


Figure 4. Institutional arrangements for the GHG inventory compilation

For the development of the 2019 edition of the GHG emission inventory, which covers the years 1994-2016, the detailed roles and responsibilities for the inventory development include the following:

Table 19. Roles and responsibilities for the development of the GHG-I

Role	Responsibility
Climate Change lead agency	Validation of results, supervision, and strategic oversight.
Inventory coordinator	Coordinate and oversee the work of international and national consultants.
UNDP coordinator	Oversee the work of the international compilers and supports the coordination with the national inventory coordinator.
International inventory compilers	Estimate the GHG emission inventory, perform quality control processes, write the inventory report, and provide capacity building to national compilers.
National inventory Compilers	Gathering activity data, supporting the compilation of GHG emissions estimates and perform quality checks in line with the QA/QC plan.
International QA experts	Carry out the quality assurance of the inventory, in line with the QA/QC plan.
Data providers	Provide the information available as needed for the development of the national inventory.
Sectoral stakeholders	QA through consultation and validation workshops.

3.6. Institutional arrangements for the national climate change response

In addition to the institutional arrangements created for compiling the national GHG emissions inventory, Cambodia has made significant progress in establishing Monitoring, Reporting, and Verification (MRV) arrangements in five key areas: GHG emissions; the Cambodia Climate Change Strategic Plan (CCCSP) including adaptation and mitigation; REDD+; Project level MRVs for two planned NAMAs, 12 CDMs, 6 JCMs, and 6 VERs; and Support received, and is placing greater emphasis on the development of an integrated and detailed MRV system aimed at achieving the NDC implementation. The NCSD holds the primary role and responsibility for the Cambodian MRV systems for climate change.

Institutional arrangements for mitigation actions

The summary of institutional arrangements for mitigation actions are illustrated in the following figure.

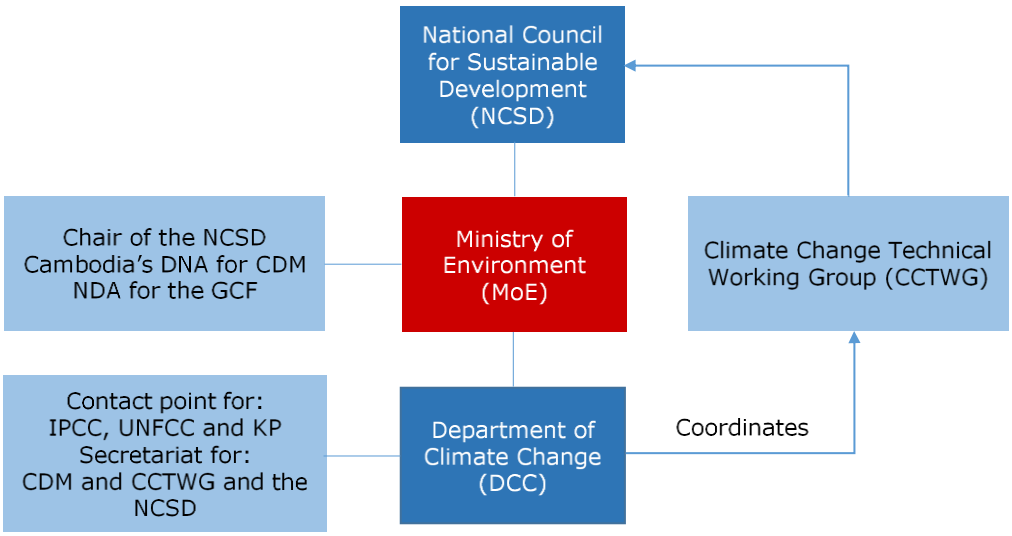


Figure 5. Institutional arrangements for mitigation actions

The MoE was appointed as the Designated National Authority (DNA) for the Clean Development Mechanism (CDM) in July 2003 (Government Decision No. 01). To date, the MoE is the national implementing agency for numerous projects that aim to generate broad understanding and develop institutional and human capacity to fully participate as an equal partner with developed countries in the formulation and implementation of potential CDM projects in Cambodia. The Cambodian DNA is responsible for assessing proposed CDM projects against national sustainable development criteria and is authorized to provide written approval for proposed CDM projects in accordance with these criteria. To do so, Cambodia uses a sustainable development matrix as a tool for assessing the contribution of CDM projects in four aspects of sustainable development: economic, social, environmental, and technology transfer.

The GSSD[5] acts as the Secretariat of Cambodia's DNA for the CDM, while a selection of members of the Climate Change Technical Working Group relevant to mitigation activities form the Board of the Cambodian DNA. Board activities include technical and institutional capacity strengthening, CDM awareness raising, CDM project identification and facilitation of host country approvals in accordance with the requirements of the Kyoto Protocol of the UNFCCC.

The designated NAMA focal point at the GSSD is responsible for approving all individual NAMAs prior to being recorded in the NAMA Registry. The NAMA Approver is Minister of Environment and Chair of the National Council for Sustainable Development.

The responsibility for the MRV of NAMAs are defined in the specific NAMA measurement plan, and generally lies on the NAMA implementer. Government entities responsible for collecting statistics could also be involved in collecting data by integrating data collection formats in their regular data collection activities.

Two entities are involved in the development of NAMA´s measurement plans:

- The national socioeconomic and environment data collection entity; and
- The entity responsible for preparing national GHG inventories, the NCSD.

These entities provide information on data already collected, thus providing a good starting point for understanding which data to be measured could be sourced from these entities and which data should be collected during the NAMA implementation.

Finally, the Joint Crediting Mechanism (JCM) Joint Committee (JC) is responsible for the implementation and administration of JCM projects. It consists of representatives from Japan and Cambodia as illustrated in the following figure.

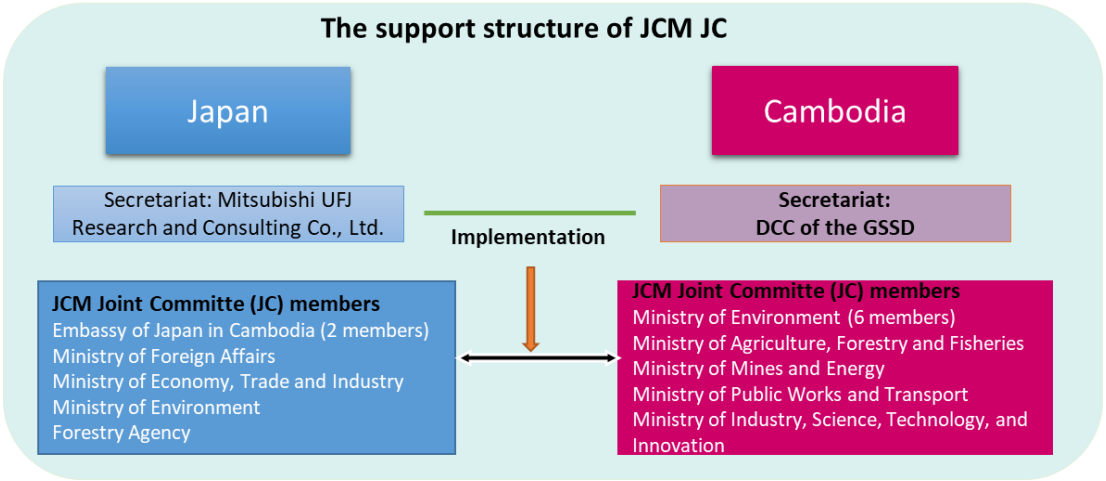


Figure 6. Organic structure of the JCM Joint Committee

[5] The GSSD has been actively promoting CDM projects in Cambodia, with technical and financial support from the Institute for Global Environmental Strategies (IGES) of Japan, the Government of the Netherlands via the United Nations Environment Programme (UNEP), and the European Union (EU).

A Draft Sub-Decree on rules and procedures for the participation in GHG emissions reduction mechanisms has been prepared to be approved in 2020.

The main purpose of the sub-decree is to establish a permanent National Authority and to provide the rules and procedures regarding the participation in all GHG Emissions reduction mechanisms including but not limited to CDM, REDD+, VCS, and JCM.

Institutional arrangements for REDD+

Regarding the institutional arrangements for REDD+, the Cambodia REDD+ programme is under direct management and implementation of the General Directorate of Administration for Nature Conservation and Protection (GDANCP) within the MoE.

The Cambodia REDD+ programme and its secretariat have key responsibilities in formulating forest policies, strategic, and action plans aligned with the Cancun decision and Warsaw framework on REDD+.

Cambodia MRV System for REDD+ is included into the National Forest Monitoring System under the overall coordination of the MAFF, with active participation of the MoE and guidance from the Cambodia REDD+ Taskforce, Technical Team, Consultation Group, and Gender Group.

Cambodia REDD+ Taskforce encompasses seven ministries, and the Cambodia REDD+ Consultation Group consists of 18 members representing constituents from nine different sectors (academia, international NGOs, local NGOs, community forestry, community fisheries, community protected areas, indigenous people, and private sector).

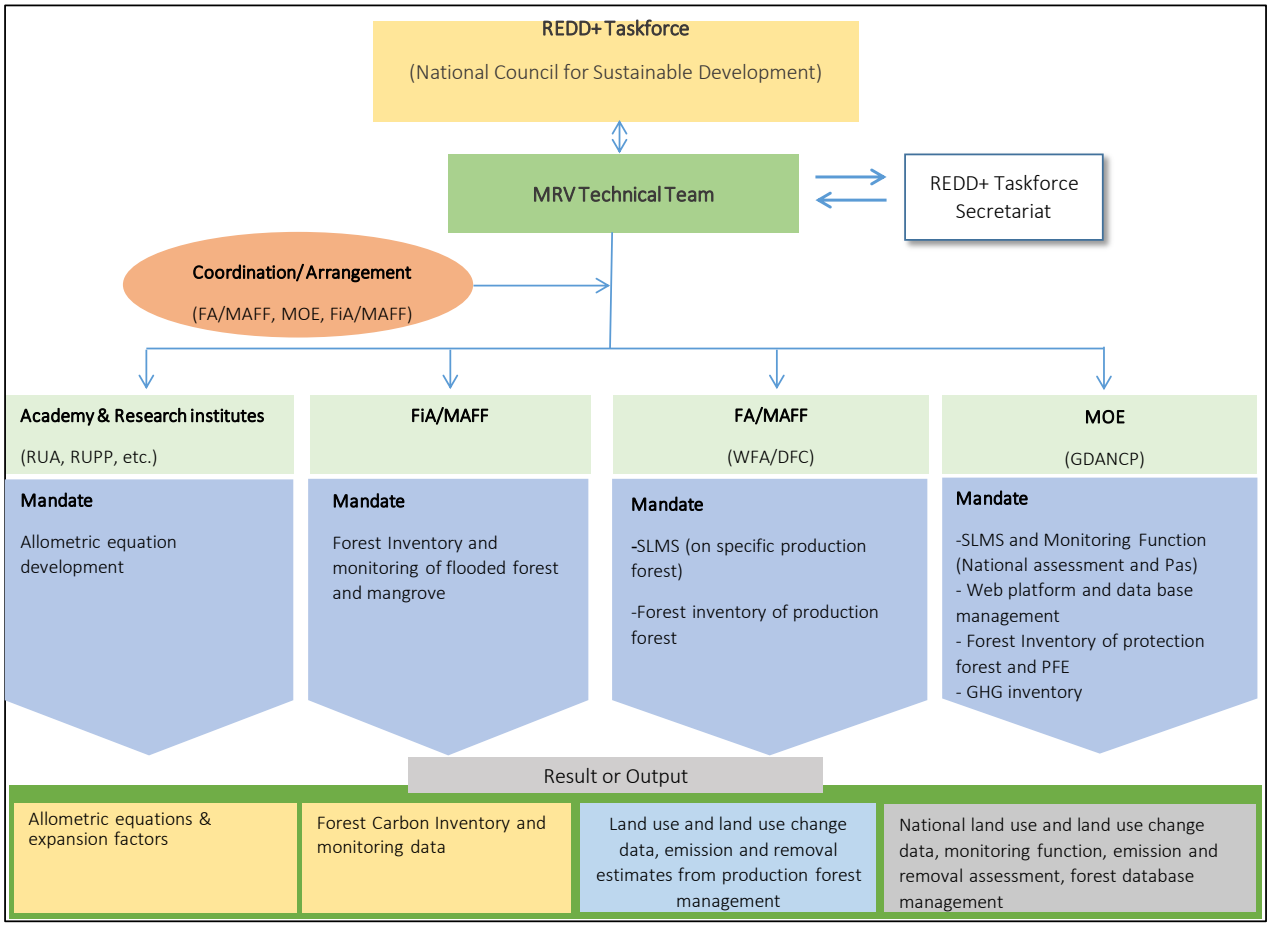


Figure 7. Institutional arrangements for REDD +

In Cambodia, three main government agencies are responsible for the management of forests: namely, the Forestry Administration (FA) and Fisheries Administration (FiA) of the MAFF and the General Department of Administration of Nature Conservation and Protection (GDANCP) of the MoE.

The MAFF (FA and FiA) has jurisdictional and regulatory authority over the Permanent Forest Estate (PFE) including flooded forests and mangroves. The MoE (GDANCP) has jurisdictional and regulatory authority over the management of Protected Areas (PAs).

The FA is responsible for reporting the assessment of forest cover conditions for the entire country, as well as producing nationwide wall to wall land use/cover maps. The FA, the MoE, and FiA, individually implement forest inventories assessment.

In 2014, the MRV/REL Technical Team was established and activated under Cambodia´s National REDD+ Taskforce.

The MRV/REL Technical Team is responsible for working with the REDD+ Taskforce to support the development of national MRV/REL framework for the REDD+ Taskforce to make decisions, including the following tasks:

- Develop the national forest classification;
- Develop a functional design of the Cambodia REDD+ Monitoring and Measurement Reporting and Verification system;

- Design the satellite forest monitoring system to support the generation of forest activity data;
- Design the National Forest Inventory to support the development of emission and removal factors for REDD+ related activities;
- Establish the reference period;
- Establish National reference levels (REL/RL) including submission of Forest Reference Level (FRL) to UNFCCC and corresponding to their technical assessment;
- Develop the REL/RL national and subnational carbon accounting framework (if required);
- Development of technical infrastructure to prepare for the implementation of Forest Monitoring and MRV systems;
- Determine institutional roles in the REDD+ monitoring and MRV systems;
- Establish and maintain the national Forest monitoring and MRV database;
- Facilitate data access and data sharing among relevant key actors for Quality Control /Quality Assurance and verification;
- Prepare GHG inventory data of the LULUCF sector and contribute for submission to the UNFCCC reports such as Biennial Update Report;
- Prepare annual implementation plans, as well as the improvement plan for database management; and
- Coordinate technical supports on MRV/REL with relevant institutions.

3.7. Institutional arrangements for financial support

Cambodia is making significant efforts on different elements of climate finance, mainly the streamlining of climate change into national and ministerial budgets, as well as the MRV of climate finance.

The lead entities of MRV support in Cambodia are the Ministry of Economy and Finance (MEF) and the Cambodian Rehabilitation and Development Board (CRDB) of the Council for the Development of Cambodia (CDC).

The MEF is the competent authority for budgetary issues and public finance management.

Figure 8. Key entities - support

Since 2017, the MEF has included guidance on climate change in annual budget circulars. Prior to this, key ministries also started integrating climate change in prioritising activities for the national budget.

Since 2012, using the ex-post expenditure data from previous fiscal years, and also using data from the Official Development Assistance (ODA) database, the MEF has performed Climate Change Public Expenditure Reviews (CPER), where expenditures used in projects related directly or indirectly to climate change are measured and reported. The NCSD and the Cambodia Climate Change Alliance (CCCA) provided technical support and verified the data on climate finance measured and monitored by the MEF. The CPER published in January 2018 was performed with data from fiscal year 2016 and the CPER published in 2019 with data from fiscal year 2017.

CHAPTER 2: NATIONAL GREENHOUSE GAS INVENTORY

This chapter presents the 2019 edition of the National Greenhouse Gas (GHG) emissions inventory of the Kingdom of Cambodia covering 1994 - 2016 GHG emissions. This inventory has been estimated following the 2006 IPCC Guidelines, and has been compiled with participation from a national inventory team and key actors in main line ministries of the country.

This inventory addresses the assessment of main direct greenhouse gases: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), and Hydrofluorocarbons (HFC).

Due to the limited information on their occurrence, the emissions of Perfluorocarbons (PFC), Sulphur hexafluoride (SF_6), and Nitrogen trifluoride (NF_3) have not been estimated. The gases considered ozone precursors: carbon monoxide (CO), oxides of nitrogen (NO_x), non-methane volatile organic compounds (NMVOCs), and Sulphur dioxide (SO_2), also reported in national GHG emissions inventories, have been estimated for the energy sector. Precursors were not estimated for the other sectors because they were considered less important in terms of emissions than the energy sector, the priority was given to the direct GHGs.

The nomenclature followed by the inventory is the one used by the 2006 IPCC Guidelines, as follow:

Table 20. Nomenclature used

Inventory sector	Code
Energy	1
Industrial Processes and Product Use (IPPU)	2
Agriculture, Forest and Other Land Use (AFOLU)	3
Waste	4

Each sector comprises individual categories (designed by the number and a capital letter such as 1A), sub-categories (designed by the number, the capital letter and a number such as 1A1) and sources/sinks (designed by the number, the capital letter, the number and a lowercase letter such as 1A1a).

1. Overview of inventory preparation and management

The 2006 IPCC Guidelines for the development of national GHG emission inventories recommend a set of steps to follow for inventory compilation. These steps are the *inventory development cycle*, which encompass all tasks needed to create a national GHG emission inventory in alignment with good practice.

The following figure illustrates the 2019 inventory development cycle for Cambodia, based on the steps proposed by 2006 IPCC Guidelines:

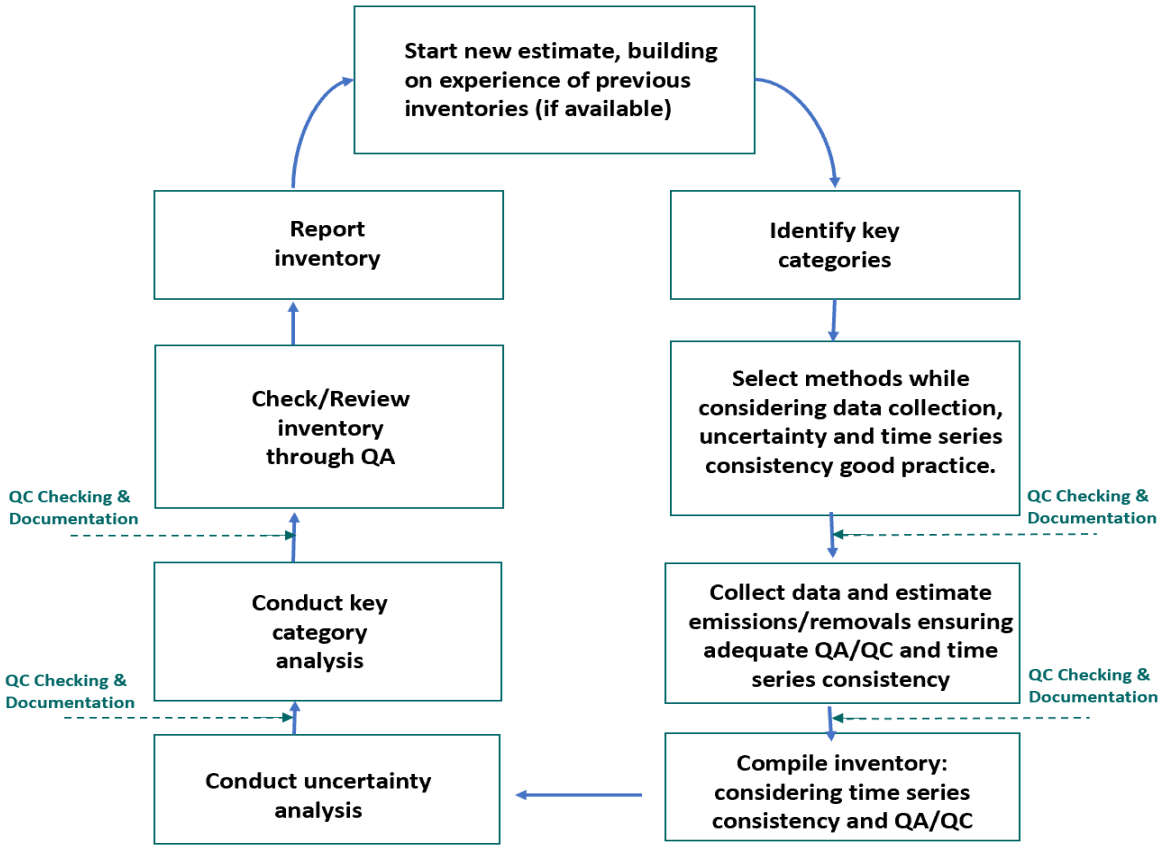


Figure 9. Inventory development cycle in Cambodia
Source: Adapted to Cambodia based on 2006 IPCC Guidelines, Volume 1, Chapter 1.

For the development of the 2019 edition of the inventory of Cambodia, all steps illustrated in the previous figure have been followed, including the preliminary identification of key categories, data collection, inventory compilation, key category and uncertainty assessment, QA/QC and documentation and archiving.

The following sections provide detailed information on methodologies and data used, results obtained, and key issues regarding the development of the Cambodian national GHG emissions inventory. This information has been extracted from the 2019 national inventory report (NIR) which presents more detailed information on the 2019 GHG inventory. The institutional arrangements in place in Cambodia for the inventory compilation are described in chapter 1 National Circumstances above.

2. GHG emissions in 2016

The following table shows the 2016 estimated emissions by gas and inventory sector. National total emissions are presented with and without the Forestry and Other Land Use (FOLU) sector to facilitate the understanding of national total emissions, and to avoid distortions produced by the magnitude of emissions in that sector.

Table 21. Emissions by sector and gas in mass unit, year 2016 (Gg)

Inventory Sector	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SOx
	Gg						
Energy	8 845.29	23.04	0.61	43.43	160.46	45.03	32.61
IPPU	1 449.46	NA	NA	NE, NA, NO	NE, NA, NO	NE, NA, NO	NE, NA, NO
Waste	524.56	79.7	0.82	NA	NA	NA	NA
Agriculture (3A + 3C)	17.42	645	7.56	NE, NA	NE, NA	NE, NA	NE, NA
Forest and Other Land Use (FOLU) (3B)	131 011.24	NA	NA	NA, NO	NA, NO	NA, NO	NA, NO
Total (without FOLU)	10 836.73	747.87	8.98	43.43	160.46	45.03	32.61
Total (With FOLU)	141 847.98	747.87	8.98	43.43	160.46	45.03	32.61

HFC emissions are provided in a separate table as they are only applicable for the IPPU sector. The following table shows HFC emissions by species and emission source within the IPPU sector category Product uses as substitutes for Ozone Depleting Substances ODS (2F).

Table 22. HFC emissions by gas in mass unit, year 2016

Gas	Emissions (Gg)
HFC-125	3.17
HFC143a	1.84
HFC134a	242.41
HFC-32	8.21
HFC-227ea	0.06

The occurrence of activities leading to PFCs and SF_6 emissions has not been ascertained in this inventory edition, so these emissions are excluded in the inventory.

National total GHG emissions calculated by multiplying the emissions by each gas by the corresponding global warming potential[6] (GWP) are **163 592 Gg. CO_2-eq**.

[6] The Government of Cambodia has chosen to use the GWPs presented in the IPCC AR4 instead of the SAR in order to be comparable with Annex I countries inventories. Non-Annex I countries are using both the 2006 IPCC and the revised 1996 IPCC Guidelines and the GWP of different IPCC Assessment reports for their GHG inventories and NDCs while all Annex I countries are using 2006 IPCC Guidelines and the GWP of the AR4.

The following figures show contribution of each gas and each sector to aggregated GHG emissions for year 2016.

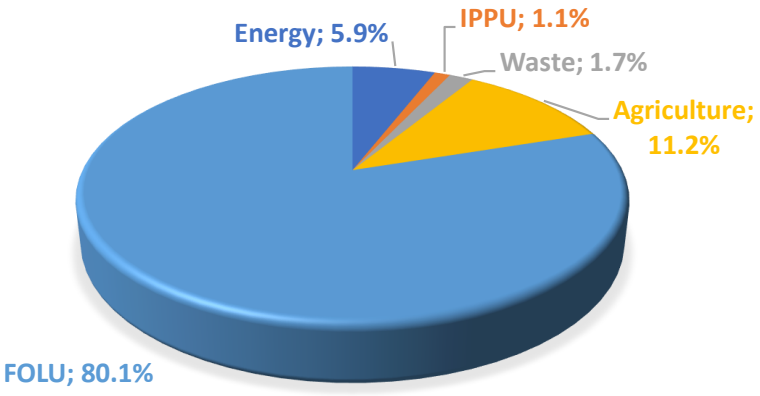


Figure 10. Distribution of GHG emissions by sector (%)

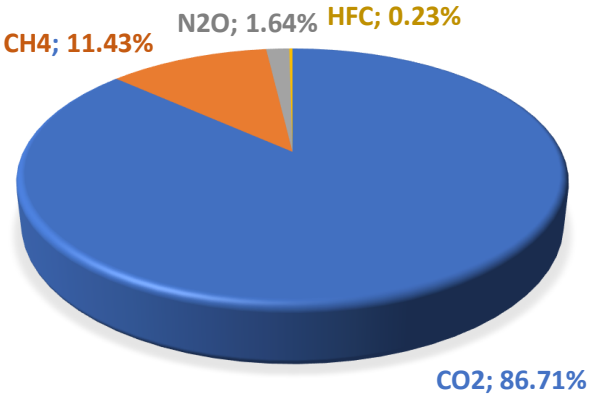


Figure 11. Distribution of GHG emissions by gas

Emissions distribution description and main drivers for emission trends are described in the following section.

As defined in BUR information provisions, non-Annex I Parties are encouraged to report tables 1 and 2 of the Annex to Decision 17/CP8. However, these tables are designed for 1996 IPCC guidelines, and so the inventory nomenclature used is not applicable to this inventory, which uses 2006 IPCC guidelines. Aiming at fulfilling the information provision, the following table (the short summary table suggested by chapter 8 volume I of 2006 IPCC Guidelines) is provided hereinafter. Detailed emissions by HFC species and source category are provided within the IPPU sector results below.

Similarly, non-Annex I parties are encouraged to include in the BUR, as appropriate and to the extent that capacities permit, the tables included in annex 3A.2 to the IPCC GPG for the LULUCF. To fulfil this information provision, detailed information of carbon stock changes is provided in the FOLU sector results below.

Notation keys have been used in cases where no emissions are reported. The reason for using the notation key NE is the lack of information on activity data for estimating the GHG emissions of the category and the priority given to GHGs in the case of precursors in other sectors than energy. The notation key NO has been used in cases where the non-occurrence of the activity is ascertained. Further, NA has been used when the gas is not applicable to the emissions of the category because it is not emitted.

Table 23. Table B - Short Summary table – year 2016

	Net CO2	CH4	N2O	HFC	PFC	SF6	NOx	CO	NMVOC	SO2
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gg			CO2 equivalents (Gg)			Gg			
Total national emissions and removals	141847.98	747.87	8.99	371.68	NA, NE, NO	NA, NE, NO	43.43	160.46	45.03	32.61
1. ENERGY	8845.29	23.04	0.61				43.43	160.46	45.03	32.61
1A. Fuel combustion (sectoral approach)	8845.29	23.04	0.61				43.43	160.46	45.03	32.61
1B. Fugitive emissions from fuels	NO	NO	NO				NO	NO	NO	NO
1C Carbon Dioxide Transport and Storage	NO						NO	NO	NO	NO
2. INDUSTRIAL PROCESSES AND PRODUCT USE	1449.46	NA, NE, NO	NA, NE, NO	371.68	NA, NE, NO	NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO
2A. Mineral products	1420.96	NA	NA				NA	NA	NA	NA
2B. Chemical industry	NO	NO	NO				NO	NO	NO	NO
2C. Metal industry	NE, NO	NE, NO	NE, NO				NE, NO	NE, NO	NE, NO	NE, NO
2D. Non-energy products from fuels and solvent use	28.50	NA	NA				NE, NA	NE, NA	NE, NA	NE, NA
2E. Electronics industry	NO		NO	NO	NO	NO	NO	NO	NO	NO
2F. Product uses as substitutes for ODS	NA, NO	NA, NO	NA, NO	371.68	NE, NO		NA	NA	NA	NA
2G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2H. Other (as specified in tables 2(I). A-H and 2(II))	NA, NO	NA, NO	NA, NO				NE, NO	NE, NO	NE, NO	NE, NO
3 AGRICULTURE, FORESTRY AND OTHER LAND USE	131028.66	645.15	7.56				NE, NA, NO	NE, NA, NO	NE, NA, NO	NE, NA, NO
3A Livestock		188.86	2.23				NE	NA	NE	NA
3B Land	131011.24	NE	NE				NA	NA	NA	NA
3C Aggregate Sources and Non-CO2 Emissions Sources on Land	17.42	456.29	5.33				NA	NA	NA	NA
3D Other	NE, NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 WASTE	524.56	79.678	0.82				NA	NA	NA	NA
4A Solid Waste Disposal		53.83	NA				NA	NA	NA	NA
4B Biological Treatment of Solid Waste		0.33	0.02				NA	NA	NA	NA
4C Incineration and Open Burning of Waste	524.56	9.46	0.14				NA	NA	NA	NA
4D Wastewater Treatment and Discharge		16.06	0.66				NA	NA	NA	NA
4E Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5 OTHER	NO	NO	NE, NO	NO	NO	NO	NE, NO	NE, NO	NE, NO	NE, NO
5A Indirect N2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3			NE				NE	NE	NE	NE
5B Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items										
International Bunkers	236.49	0.00	0.01				0.83	94.44	1.50	0.08
International Aviation (International Bunkers)	236.49	0.00	0.01				0.83	94.44	1.50	0.08
International Water-borne Transport (International Bunkers)	NE	NE	NE				NE	NE	NE	NE
Multilateral Operations	NE	NE	NE				NE	NE	NE	NE
CO2 emissions from biomass	13694.77									

NA – not applicable; NE – Not estimated; NO: not occurring. Categories with notation key NE in GHGs have not been estimated due to the lack of available information.

3. Description of emission trends

Greenhouse gas emissions estimated for the total inventory including Forestry and Other Land Use (FOLU) are 163 592 Gg.CO_2-eq for year 2016, which is 285 per cent higher than the 1994 emissions. Deforestation is the main driver for this increase, reflected in the FOLU sector emissions. Excluding FOLU sector emissions, 2016 GHG emissions are 32 871 Gg. CO_2-eq, which represents a 111 per cent increase from 1994 emissions.

The next table provides an overview of the emissions in each inventory sector for the years 1994, 2000, 2005, 2010, 2015, and 2016[7].

Table 24. Trend of emissions (Total GHG, Gg. CO_2-eq)

Inventory Sector	1994	2000	2005	2010	2015	2016
Energy	2 690.95	3 102.73	3 454.41	5 306.37	8 356.31	9 601.61
IPPU	3.81	6.04	12.73	492.84	1 001.38	1 821.15
Waste	1 534.32	1 859.50	2 146.20	2 365.29	2 688.19	2 760.68
Agriculture (3A + 3C)	11 202.58	13 032.31	15 336.38	18 136.08	18 068.35	18 397.67
Forest and Other Land Use (FOLU) (3B)	27 018.62	27 018.62	27 018.62	131 011.24	131 011.24	131 011.24
Total (without FOLU)	15 431.65	18 000.59	20 949.73	26 300.58	30 114.23	32 581.11
Total (with FOLU)	42 450.28	45 019.21	47 968.35	157 311.82	161 125.47	163 592.35

As illustrated in the following figure, emissions in all sectors demonstrate an increasing trend from 1994 to 2016.

[7] The GHG emissions of the inventories presented in previous national communications have been recalculated to ensure the time series consistency when applying the most recent 2006 IPCC Guidelines.

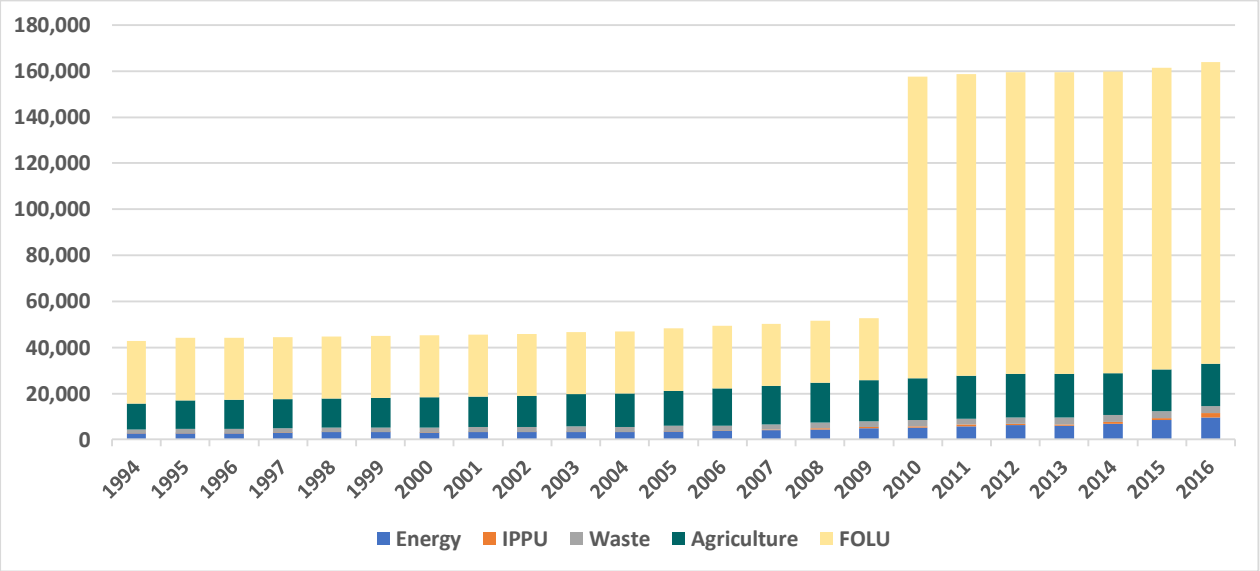


Figure 12. GHG emissions; Years 1994-2016 (Gg. CO2-eq)

The major contributor to the national GHG emissions during the entire period is the Forest and Other Land Use (FOLU) sector driven by the change in carbon stocks, primarily due to deforestation. Land use monitoring is based on three different maps related to 1994, 2009, and 2016, which gives two periods of land use changes[8]. The land use changes observed during the period 1994-2009 are much lower than the ones observed during the period 2010-2016. During this second period the loss of forest cover is very important (579 280 ha / year in average) compared to the previous period (132 733 ha /year in average). This loss of forest cover leads to high emissions.

The second largest emitter sector in the country is the Agriculture sector. Cambodia has an economy strongly marked by the contribution of agriculture to total GDP, which is also reflected in the emission pattern. The main driver for the GHG emissions increases in the agriculture sector is the development of rice cultivations, whose activity level and emissions increased by a rate of ~2.5% in the period 1994-2016.

In the time span covered by the inventory, Cambodian GDP has experienced significant expansion, along with its population. This is reflected in the increasing trend in emissions of the third and fourth largest emitter sectors in the country, the Energy and Waste sectors, respectively.

[8] By knowing only two periods of land conversions it is difficult to further elaborate on the trend. Consequently, it was chosen to keep the average value for all the years of the period covered by monitoring. It could be assessed that deforestation is increasing for the whole covered period but it cannot be confirmed that deforestation is still increasing for the very last years of each period. These data sets are consistent with the Forest Reference Level (FRL). It means that the activity data, emission factors and the methods to estimate the emissions used in the GHG inventory are the same used for the FRL (for the years 2006, 2010, 2014 using the mean values). Since there is no additional data available, the GHG inventory takes into consideration these official data. Consequently, the trend of reported emissions and removals keeps the shape of stairs.

Energy demand has experienced a significant increase due to the transport sector expansion and significant vehicle growth, and population migration to cities; these factors combined have led to increasing transport demand and fuel consumption and higher GHG emissions in the energy sector.

Increased population and changes in waste management and sanitation are the main drivers for waste sector emissions.

Lastly, the small size of the carbon intensive-industrial sector in the country makes the IPPU the fifth contributor to total national GHG emissions. Nevertheless, the IPPU sector emissions experienced a growing expansion in the last period of the series, due to an increasing contribution of cement production and the consumption of fluorinated gases.

Emissions per capita have increased from 4.00 to 10.42 tons CO_2-eq/capita/year[9]. This increase is mainly caused by the high deforestation experienced in the country. Conversely, GHG emissions per unit of the GDP have been reduced from a 15.41 to 8.24 tons CO_2-eq/thousand USD/year. This reduction is due to the expansion of the GDP being significantly higher than the increase of GHG emissions. Notably, the main sources of energy derived from renewable energy and import from neighbouring countries.

The following figure shows the percentage of emissions in each inventory sector for years 1994 and 2016.

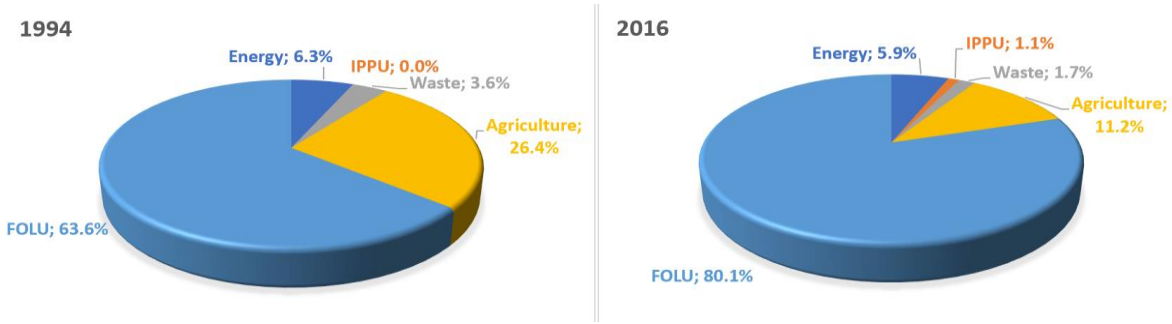


Figure 13. Percentage of emissions by sector 1994/2006 (as of % of CO_2-eq)

The previous figure shows the decreasing contribution to total national emissions in 2016 compared to 1994 in the sectors of energy, waste, and agriculture, and the increase in the contribution of the FOLU and the IPPU.

[9] This figure should not be compared with other countries figures because the methodologies used to elaborate the estimates differ. For a comparison please refer to the GHG (CO2, CH4, N2O, F-gases) emission time series 1990-2012 per capita for world countries estimated by the European Commission in its EDGAR database (https://edgar.jrc.ec.europa.eu/overview.php?v=GHGts_pc1990-2012).

In terms of each GHG contribution to national total emissions, CO_2 is the main gas emitted, driven by the large contribution of the FOLU sector to national total emissions, followed by CH_4, N_2O, and HFC.

Table 25. Contribution of each gas to national total emissions 1994 - 2016 (%)

Gas/year	1994	2000	2005	2010	2015	2016
CO_2	69.57%	66.31%	63.11%	86.79%	86.79%	86.71%
CH_4	25.65%	28.71%	31.75%	11.38%	11.32%	11.43%
N_2O	4.78%	4.99%	5.12%	1.76%	1.69%	1.64%
HFC	0.00%	0.00%	0.01%	0.07%	0.20%	0.23%

Note – This contribution is calculated converting first the emissions of each gas to CO_2-eq using global warming potentials of AR4

As mentioned above, the GHG inventory of the Kingdom of Cambodia includes estimates of greenhouse gases as CO_2, CH_4, N_2O, and HFC. Additional gases, known as precursors, have been estimated for the energy sector. The evolution of all gases estimated in the inventory is shown in the following table.

Table 26. Trend of Emissions by gas in mass unit 1994 – 2016 (Gg)

Inventory Sector	1994	2000	2005	2010	2015	2016
CO_2	29 532.09	29 850.31	30 274.54	136 528.00	139 839.37	141 847.98
CH_4	435.61	516.92	609.19	715.96	729.63	747.87
N_2O	6.80	7.54	8.25	9.30	9.14	8.98
HFC-125	NO	NO	0.04	0.79	2.70	3.17
HFC-143a	NO	NO	0.03	0.46	1.57	1.84
HFC-134a	NO	NO	4.20	75.74	209.25	242.41
HFC-32	NO	NO	0.07	1.35	6.48	8.21
HFC-227ea	NO	NO	0.00	0.02	0.05	0.06
NOx	14.46	16.70	17.27	31.80	39.20	43.43
CO	68.62	69.85	66.27	138.80	137.61	160.46
NMVOC	23.44	25.22	23.11	54.04	43.99	45.03
SO_2	2.51	3.15	4.08	14.71	27.40	32.61

4. Key Categories of Emissions and Uncertainty Assessment

Once the GHG inventory was compiled, improvement plans by sector and for the whole inventory were elaborated based on a key category analysis, an uncertainty assessment and the results of the QA/QC undertaken. The sectoral improvement plans are provided in BUR Annex IV.

This section presents main results of both key category analysis and the uncertainty assessment. More detailed information has been provided in in BUR Annex I and Annex II.

4.1. Key Category Analysis

The 2006 IPCC Guidelines define key category (KC) as "(…) one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals. Whenever the term key category is used, it includes both source and sink categories. (…)"

To the extent possible, key categories should receive special consideration in terms of three important inventory aspects:

- Firstly, identification of key categories in national inventories enables limited resources available for preparing inventories to be prioritised;
- Secondly, in general, more detailed higher tier methods should be selected for key categories; and
- Thirdly, it is good practice to give additional attention to key categories with respect to quality assurance and quality control (QA/QC).

The general approach for identifying key categories is to identify KC in terms of their contribution to the absolute level of national emissions and removals. For the inventories considering time series, the quantitative determination of key categories should include **an evaluation of both the absolute level and the trend of emissions and removals**.

The 2006 IPCC approach 1 has been used to identify key categories, for both level and trend.

The following table shows the key categories identified by methodological approach. The calculations were analysed twice: one with the FOLU and one without the FOLU. The rationale for this approach is to calculate alternative estimates avoiding distortions produced by the magnitude of the FOLU sector emissions. The methodology and detailed KCA results are provided in Annex I of the BUR.

Table 27. Summary of key categories identified by method

IPCC category	Name	Gas	With FOLU			Without FOLU		
			L2016	L1994	Trend	L2016	L1994	Trend
3B	Land	CO2	X	X	X			
3A1	Enteric Fermentation	CH4	X	X	X	X	X	X
1A1- Solid	Energy industries - solid fuels	CO2	X		X	X		X
3C7	Rice cultivations	CH4	X	X	X	X	X	X
2A1	Cement production	CO2	X		X	X		X
1A3b - liquid	Road transport - liquid fuels	CO2	X	X	X	X	X	X
3A2	Manure Management	N2O		X	X	X	X	X
3C4	Direct N2O Emissions from managed soils	N2O		X	X	X	X	X
3A2	Manure Management	CH4		X	X	X	X	X
2F1	Refrigeration and air conditioning	HFC				X		X
1A2 - Liquid	Manufacturing industries and construction - Liquid fuels	CO2				X		X
1A1- biomass	Energy industries – biomass	CH4			X		X	X
1A1 - liquid	Energy industries - liquid fuels	CO2				X		X
4A1	Solid waste disposal	CH4	X	X	X	X	X	X
4C2	Open burning	CO2		X	X	X	X	X
4D1	Domestic wastewater	CH4			X	X		X
3C5	Indirect N2O Emissions from managed soils	N2O			X	X	X	X
1A4 - biomass	Other sectors – biomass	CH4			X	X	X	X
4C2	Open burning	CH4					X	

4.2. Uncertainty Assessment

Inventory uncertainty has been assessed following the tier 1 method provided by 2006 IPCC Guidelines. The inventory team selected uncertainty values for the activity data and emission factors of each source/sink category estimated. For the selection of the uncertainty among those provided by the IPCC 2006, the criteria have been based on the conservative principle, using the upper values of the ranges provided by default. The coefficients used by sector and the results of the assessment are provided in the BUR Annex II.

5. Overall methodology for Greenhouse Gas Emissions Calculation

The 2006 edition of the IPCC Guidelines has been followed for estimating GHG emissions and removals. For estimating the emissions of precursors, the Guidelines of EMEP/EEA 2016[10] have been used, as proposed by the IPCC.

Due to limited available data and the absence of national specific emission factors, the emissions and removals estimates have been performed using a tier 1 methodology for most categories, gases, and years.

The categories, gases, and years for which a tier 2 methodology is applied are the followings:

- Cement production, CO_2 emissions for the years 2007-2015, as plant specific data on clinker production is available; and
- Land CO_2 emissions for the years 1994-2016, as the calculations for the lands are based on a comprehensive monitoring of the land use and a country specific estimate for each type of land.

The global warming potentials used for the calculation of the total GHG emissions are those of the AR4, as follows:

Table 28. Global Warming Potentials (GWP) used

Global Warming Potential	
Gas	**GWP**
CO_2	1
CH_4	25
N_2O	298
HFC134a	1 430
HFC125	3 500
HFC143a	4 470
HFC32	675
HFC-227ea	3 220

Source: IPCC Fourth Assessment Report (AR4)

The following table shows all the data sources by emission source as used for the 2019 GHG emission inventory edition.

[10] https://www.eea.europa.eu/publications/emep-eea-guidebook-2016

Table 29. Main sources of information used for the development of the inventory

Sector	Description of the data	Data Provider
Energy	Energy statistics for the period 2010-2015	Economic Research Institute for ASEAN and East Asia (ERIA)
	Energy balances 2010-2016	The Ministry of Mines and Energy
	Energy statistics for the period 1995-2012	The Association of South East Nations (ASEAN)
IPPU	Production data for years 2014-2017	The Ministry of Industry and Handicrafts
	Cement Production capacity and plant year of installation	Different sources online such as industrial papers and news on starting industrial operations
	Production data from one cement production plant	One producer company
	Fuel (Lubricant) consumption data	Cambodia Energy Statistics – ERIA and the Ministry of Mines and Energy
	Cambodia HFC inventory for the period 2012-2015	The National Ozone Unit of the Ministry of Environment
	Population and GDP data sources from period 1950-2016	CDB data, NCDD, Socio-economic survey and World bank data
AFOLU	Crops data	Animal populations, crop areas and productions from the Ministry of Agriculture, Forestry and Fisheries (MAFF).
	Livestock	
	Land activity data for period 2006-2010 and 2010-2014	Cartography matrix from the work developed under the preparation of the Forest Reference Level
	Biomass burning from rice cultivation	Vibol, S., & Towprayoon, S. (2010). Estimation of methane and nitrous oxide emissions from rice field with rice straw management in Cambodia. Environmental monitoring and assessment, 161(1-4), 301-313.
	Rice cultivation data period before 2004	MAFF publications for both wet and dry seasons
	Rice cultivation data period since 2005	FAOSTAT
Waste	Population data	Data from the National Committee for sub-national Democratic Development complemented with the world bank database
	GDP data	GDP from the MOP complemented with the world bank database
	Waste composition	Study "State of Waste Management in Phnom Penh, Cambodia", UNEP 2018.
	Waste generation	Ministry of Environment
	Amount of dung used for producing biogas	Hyman, J., & Bailis, R. (2018). Assessment of the Cambodian National Biodigester Programme. Energy for Sustainable Development, 46, 11-22.
		Energy balance of the Ministry of Mines and Energy
	Protein consumption	FAO data
	Percentage of people open burning waste	Yut S. and Seng B., 2018. KAP on waste management (data of 2012)

GHG emission inventory development was based on the information available at a national level that could be used for estimating the emissions of different emission sources of the 2006 IPCC Guidelines. The data gathered from official sources was complemented by international sources or expert judgement and assumptions.

The following sections provide further details on the calculations performed and results obtained for each of the inventory sectors.

6. Energy Sector

6.1. Characterization of the sector

The energy sector includes all the GHG emissions arising from combustion and fugitive releases of fuels. Based on the IPCC 2006 Guidelines, GHG emissions in the energy sector are split into three main categories: 1A Fuel Combustion Activities, 1B Fugitive emissions from fuels, and 1C CO_2 transport and storage.

As a result of the energy profile of Cambodia, only the emissions of fuel combustion activities (1A Fuel Combustion activities) are estimated in the current inventory. As Cambodia is mainly an importer of fuels and there is only production of charcoal, fugitive emissions are considered not occurring in the country. Emissions from charcoal production were allocated to the energy industries under stationary combustion (1A1c). CO2 transport and storage does not occur in the country.

The following figure shows the evolution of fuel consumption, which has been used for estimating inventory emissions. This time series has been estimated using official data from national stakeholders. The main data source used is from a study developed by the Economic Research Institute for ASEAN and East Asia (ERIA) on the energy statistics of Cambodia[11].

[11] http://www.eria.org/RPR_FY2015_08.pdf

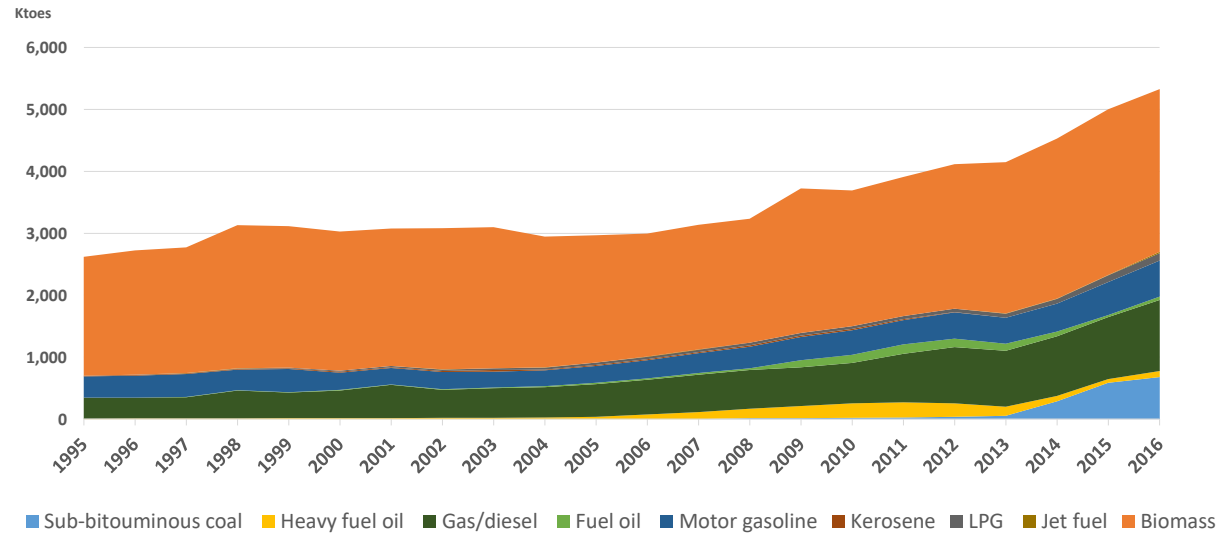


Figure 14. Fuel consumption of Cambodia 1994-2016 (ktoe)

The previous figure shows that fuel consumption is driven by the consumption of biomass, the fuel with higher contribution to national total fuel consumption. Biomass consumption occurs in the residential sector, in the energy industries (production of electricity and charcoal), and manufacturing industry. Biomass is followed by gas/diesel and motor gasoline, primarily used in the transport sector.

6.2. Methodology and emissions by category

Regarding methodologies, the most detailed data available in the country has been used to estimate a sectoral approach for emissions of category 1A Fuel Combustion activities.

In the sectoral approach, emissions are estimated using a bottom-up procedure - from the most disaggregated data available by sector. The data is available in ktoe of fuel consumed and transformed to GJ using the conversion factors provided by the international energy agency[12].

Biomass CO_2 emissions are not included in national total emissions. Besides, non-energy consumption is not considered in the energy sector, but instead in the IPPU sector.

The emission of the sectoral approach of the energy sector has been estimated using a tier 1 approach for all categories of the energy sector, using fuel-specific emission factors provided by 2006 IPCC guidelines (also EMEP/EEA 2016 Guidelines were used for estimating precursors emissions).

[12] Available at https://www.iea.org/statistics/resources/unitconverter/

The following tables provide the emission factors used for estimating the emissions of category 1A fuel consumption activities at sub-category level.

Table 30. Emission factors of category 1A1 Energy industries

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
	Kg/TJ			g/GJ			
Fuel							
Coal	96 100	1	1.5	209	8.7	1	820
Heavy fuel oil	77 400	3	0.6	142	15.1	2.3	495
Diesel	74 100	3	0.6	65	16.2	0.8	46.5
Biomass	112 000	30	4	81	90	7.31	10.8
Charcoal*	NA	1000	NA	NA	NA	NA	NA

Source for GHG: Table 2.2. Chapter 2 Stationary combustion
Source for other gases: Tables 3.2 - 3.7, EMEP/EEA 2016 Chapter 1A1
*Source for charcoal: Table I-14 IPCC 1996; volume III for energy

CH_4 emissions from the production of charcoal has been estimated using an emission factor from the Revised 1996 Guidelines, as no emission factor specific for charcoal production exists in the 2006 IPCC Guidelines. The emission factor is applied to the amount of charcoal produced.

The CO_2 emissions of biomass are not included in total sector emissions. CO_2 emissions from the consumption of biomass for electricity production are estimated by applying the biomass emission factor of the previous table to the amount of biomass consumed. Nevertheless, the CO_2 emissions occurring in charcoal production cannot be estimated by applying a biomass emission factor to the total amount of firewood used for the production of charcoal, as not all the carbon is combusted in the process. Instead, the carbon content of the biomass is transformed into charcoal. For this reason, the activity data used for calculating CO_2 emissions from charcoal is estimated by subtracting the amount of charcoal produced to the total amount of biomass, which is used for charcoal production. A CO_2 emission factor is applied to this biomass amount calculated as a differential. CO_2 emissions from biomass are reported as a memo item. Non-CO2 emissions from biomass as well as the remaining emissions for the other fuels are estimated by applying the emission factors to the corresponding activity data.

Table 31. Emissions factors of category 1A2 Manufacturing industries and construction

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
	Kg/TJ			g/GJ			
Fuel							
Heavy fuel oil	77 400	3	0.6	513	66	25	47
Diesel	74 100	3	0.6	513	66	25	47
Biomass	112 000	30	4	91	570	300	11
Coal	96 100	10	1.5	173	931	88.8	900
LPG	63 100	1	0.1	513	66	25	47

Source for GHG: Table 2.2. Chapter 2 Stationary combustion
Source for other gases: Tables 3.2 - 3.7, EMEP/EEA 2016 Chapter 1A2

Table 32. Emission factor of category 1A3 Transport

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
	Kg/TJ						
Fuel							
Jet fuel	71 500	0,5	2	250	28 553	452	24
Motor gasoline	69 300	33	3.2	200	1 937	230	47
Gas/diesel	74 100	3.9	3.9	306	79	17	47
LPG	63 100	62	0.2	547	3 049	491	47

Source for jet fuel GHG: Table 3.6.4 and 3.6.5. Chapter Mobile Combustion
Source for motor gasoline GHG: Tables 3.2.1 and 3.2. from Chapter 3 Mobile Combustion
Source for other gases: Tables 3.2 - 3.7, EMEP/EEA 2016 Chapter 1A3

Table 33. Emission factors used for the Commercial and institutional sub-sectors

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
	Kg/TJ						
Fuel							
Kerosene	71 900	10	0.6	51	57	0.7	70
Fuel oil	77 400	10	0.6	51	57	0.7	70
LPG	63 100	5	0.1	51	57	0.7	70

Source for jet fuel GHG: Table 3.6.4 and 3.6.5. Chapter Mobile Combustion
Source for GHG: Table 2.2. Chapter 2 Stationary combustion
Source for other gases: Tables 3.1 - 3.5, EMEP/EEA 2016 Chapter 1A4

Table 34. Emission factors used for the Residential and agricultural sub-sectors

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
	Kg/TJ						
Fuel							
Kerosene	71 900	10	0.6	51	57	0.7	70
LPG	77 400	5	0.1	51	57	0.7	70
Gas/diesel	74 100	10	0.6	51	57	0.7	70
Firewood	112 000	300	4	91	570	300	11
Charcoal	112 000	200	1	91	570	300	11
Biogas	54 600	5	0.1	74	29	23	0.67

Source for GHG: Table 2.2. Chapter 2 Stationary combustion
Source for other gases: Tables 3.1 - 3.5, EMEP/EEA 2016 Chapter 1A4
Air quality gases EFs for firewood and charcoal extracted from table 3.10
Air quality gases EFs for biogas extracted from table 3.8

6.3. Comparison between the Reference and Sectoral Methods

The IPPC guidelines recommends applying a Sectoral approach and a Reference approach to estimate CO_2 emissions from fuel combustion and to compare the results of these two independent estimates. The Sectoral approach uses values bounded to each category that together add up the national total of the Energy sector, while the Reference approach uses the total values of the national energy statistics.

The Reference approach is a top-down approach, using a country's energy supply data to calculate CO_2 emissions mainly from fossil fuels combustion. Therefore, the Reference approach is designed to calculate the emissions of CO_2 from fuel combustion, starting from high level energy supply data.

The assumption is that carbon is conserved so that, for example, carbon in crude oil is equal to the total carbon content of all the derived products.

The Reference approach does not distinguish between different source categories within the energy sector and only estimates total CO_2 emissions from Source category 1A Fuel Combustion.

For estimating CO_2 emissions using the reference approach, the following five methodological steps were followed:

- Step 1: Estimate Apparent Fuel Consumption in Original Units;
- Step 2: Convert to a Common Energy Unit;
- Step 3: Multiply by Carbon Content to Compute the Total Carbon;
- Step 4: Compute the Excluded Carbon; and
- Step 5: Correct for Carbon Unoxidized and Convert to CO_2 Emissions.

These steps are expressed in the following equation:

$$\boldsymbol{CO_2} = \sum_{\boldsymbol{all\ fuels}} \left[\left(\left(\boldsymbol{AC_{fuel}} * \boldsymbol{CFactor_{fuel}} * \boldsymbol{CC_{fuel}} \right) * \boldsymbol{10^{-3}} - \boldsymbol{ECarbon_{fuel}} \right) * \boldsymbol{COF_{fuel}} * \boldsymbol{44/12} \right]$$

Where:

AC= Apparent Consumption = production + imports – exports – international bunkers – stock change
CFactor = conversion factor for the fuel to energy units (TJ) on a net calorific value basis
CC = carbon content (tonne C/TJ (= kg C/GJ))
ECarbon = carbon in feedstocks and non-energy use excluded from fuel combustion emissions (Gg C)

The data used for calculating the reference approach is the energy balance provided by the Ministry of Mines and Energy.

The differences between the sectoral and reference approach are the following:

Table 35. Differences between the sectoral and reference approaches (%)

2010	2011	2012	2013	2014	2015	2016
6.01	3.41	6.05	0.88	0.57	7.34	7.73

For years 2010 and 2012, the difference is found in solid fuels, while for years 2015 and 2016 the difference is encountered in liquid fuels.

The sectoral approach uses data from a study developed by the Economic Research Institute for ASEAN and East Asia (ERIA). National stakeholders consider ERIA statistics the most exhaustive and complete source of energy data in the country. These statistics were produced as a result of surveys developed to fill the existent data gaps; and were developed by a team of international and national experts. National stakeholders validated the ERIA dataset. Data sources used in both approaches (the energy balance from the Ministry of Mines and Energy and the data from the ERIA) are official. Nevertheless, information is unavailable to explain these differences between data sources. In the future, Cambodia will need to address the improvement of its official energy statistics and ensure the consistency of fuel consumption data.

6.4. Energy emissions trend

In the time span covered by the inventory, Cambodian GDP has experienced a significant expansion, along with its population. This is reflected in the increasing trend in the Energy sector emissions.

Energy demand has experienced a significant increase due to the transport sector expansion, economic and population growth; these factors combined has led to increasing fuel consumption and higher GHG emissions in the energy sector.

Table 36. Trend of emissions (GHG, Gg. CO_2-eq)

Inventory Sector	1994	2000	2005	2010	2015	2016
1A1. Energy Industries	298.87	450.75	512.49	1 120.27	2 766.58	3 255.58
1A2. Manufacturing Industry	186.38	236.5	287.03	682.46	458.28	746.189
1A3. Transport	1 892.04	2 003.53	2 205.42	2 897.00	4 625.81	5 094.21
1A4. Other	313.66	411.87	449.47	606.64	505.64	505.64
Total	2 690.95	3 102.73	3 454.41	5 306.37	8 356.31	9 601.61

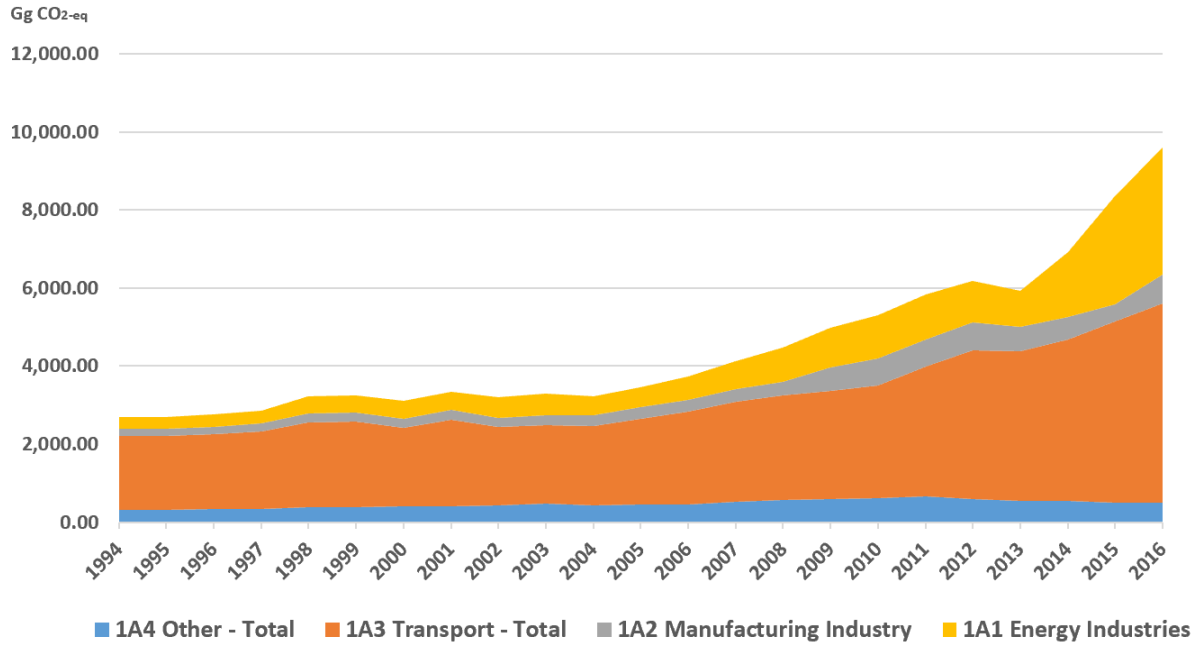


Figure 15. GHG emissions in the energy sector - 1994-2016 (Gg. CO_2-eq)

As illustrated in the previous figure, the main contributor to the energy sector emissions is transport (category 1A3), with a contribution that ranges from 70.3% in 1994, to 53.1% in 2016. However, the contribution from this sector had decreased between 1994 and 2016. The second contributor to GHG emissions in the energy sector is energy industries (category 1A1), with a contribution that ranges from 11.1% in 1994 to 33.9% in 2016. The third emissions contributor is the other sectors (category 1A4), with a contribution that ranges from 11.7% in 1994 to 5.3% in 2016. Lastly, the manufacturing and construction industry contributed 6.9% of total emissions in 1994, increasing up to 7.8% in year 2016.

The following table shows the contribution of each category to the total GHG emissions from the energy sector for the entire time period.

Table 37. Percentage of contribution to energy GHG emissions by category (%)

Inventory category	1994	2000	2005	2010	2015	2016
1A1. Energy Industries	11.1%	14.5%	14.8%	21.1%	33.1%	33.9%
1A2. Manufacturing Industry	6.9%	7.6%	8.3%	12.9%	5.5%	7.8%
1A3. Transport	70.3%	64.6%	63.8%	54.6%	55.4%	53.1%
1A4. Other	11.7%	13.3%	13.0%	11.4%	6.1%	5.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Regarding the contribution of each gas to total GHG emissions, the following table shows the detailed contribution by gas each year.

Table 38. Percentage of emissions by gas 1994 – 2016 (%)

Gas	1994	2000	2005	2010	2015	2016
CO_2	78.3%	76.3%	79.9%	87.1%	91.1%	92.1%
CH_4	18.1%	20.3%	17.2%	10.2%	6.9%	6.0%
N_2O	3.6%	3.4%	2.9%	2.7%	2.1%	1.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note – This contribution is calculated converting the emissions of each gas to CO_2-eq using global warming potentials

CO_2 is predominant, followed by CH_4. The lower contribution of CH_4 can be explained by the decreasing contribution of biomass to total energy consumption. The increase in the contribution of CO_2 is intensified in the last period of the series by the increase of coal consumption for electricity production.

Apart from GHGs, the estimates of the energy sector included precursors, which have been calculated using the EMEP/EEA guidelines. The following table shows the temporal evolution of the emissions estimated for all gases, including precursors.

Table 39. Trends in Emissions by gas in mass unit 1994 – 2016 (Gg)

Gas	1994	2000	2005	2010	2015	2016
CO_2	2 106.72	2 367.98	2 760.03	4 622.74	7 611.62	8 845.29
CH_4	19.46	25.21	23.78	21.72	22.92	23.04
N_2O	0.33	0.351	0.34	0.47	0.58	0.61
NOx	14.46	16.70	17.69	31.80	39.20	43.43
CO	68.62	69.85	68.25	138.80	137.61	160.46
NMVOC	23.44	25.22	24.82	54.04	43.99	45.03
SO_2	2.51	3.15	3.26	14.71	27.40	32.61

7. Industrial Processes and Product Use Sector

7.1. Characterization of the sector

The industrial Processes and Product Use (IPPU) sector includes emissions occurring in the production and the consumption of products, excluding those due to fuel combustion (included in the energy sector), and the generation and treatment of waste (included in the waste sector). Considering that exclusion, GHG emissions are produced from a wide variety of industrial activities. Main emission sources include releases from industrial processes that chemically or physically transform materials where many different GHG, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) are released during these processes.

Based on the 2006 IPCC Guidelines, the IPPU sector comprises eight categories:

- 2.A - Mineral Industry
- 2.B - Chemical Industry
- 2.C - Metal Industry
- 2.D - Non-Energy Products from Fuels and Solvent Use
- 2.E - Electronics Industry
- 2.F - Product Uses as Substitutes for Ozone Depleting Substances

- 2.G - Other Product Manufacture and Use
- 2.H - Other

Nevertheless, the available information reveals that in Cambodia only the production of cement, the consumption of lubricants, and the use of fluorinated gases occur. Consequently, the inventory includes emissions estimates for 2.A.1 Cement Production, 2.D.1 Lubricant Use, 2.F.1 Refrigeration and Air Conditioning, and 2.F.3 Fire Protection.

7.2. Methodology and emissions by category

The IPPU emission sources reported in this edition are 2.A.1 Cement Production, 2.D.1 Lubricant Use, 2.F.1 Refrigeration and Air Conditioning, and 2.F.3 Fire Protection.

Cement production has been estimated following a hybrid tier 1/tier2 approach, while the rest of categories are estimated following a tier 1 approach.

Cement production

In cement manufacture, CO_2 is produced during the production of clinker, a nodular intermediate product that is then finely ground, along with a small proportion of calcium sulphate [gypsum ($CaSO_4 \cdot 2H_2O$) or anhydrite ($CaSO_4$)], into hydraulic (typically Portland) cement. During the production of clinker, limestone, which is mainly calcium carbonate ($CaCO_3$), is heated, or calcined, to produce lime (CaO) and CO_2 as a by-product.

Additionally, cement kiln dust (CKD) is generated during the manufacture of clinker. Emission estimates should account for emissions associated with the CKD.

The data used for the cement production emissions estimate consist of:

i) national total cement production; and
ii) clinker and cement production from the largest producer company in the country. The information of the production plant is not presented in this report due to confidentiality reasons.

It is worth highlighting that 100% of national cement production is covered by the production plant which provided information for the period 2007-2015. In 2016, however, not all cement production is covered by the production in this plant. According to the information provided by the cement plant, clinker was not produced in the country prior to 2007.

The methodology followed is a combination of the tier 1 and tier 2 approaches of 2006 IPCC Guidelines. First, the clinker production provided by the largest production plant is used for calculating CO_2 emissions using the tier 2 approach. The following equation illustrates the method used:

$$CO_2\ Emissions = M_{cl} * EF_{cl} * CF_{ckd}$$

Where:

M_{cl} = weight (mass) of clinker produced, tonnes

EF_{cl} = emission factor for clinker, tonnes CO_2/tonne clinker

CF_{ckd} = emissions correction factor for CKD, dimensionless

Then, as the information provided by the production plant included both cement and clinker production, the amount of cement not covered by the production plant for year 2016 was calculated by subtracting the production of the plant from the total national production. Using this quantity as activity data, the CO_2 emissions of the production of clinker not covered by the production plant were estimated following the tier 1 method, as follows:

$$CO_2\ Emissions = \left[\sum_i (M_{ci} * C_{cli}) - Im + E_x\right] * EF_{clc}$$

Where:

Mcl = weight (mass) of cement produced by type i, tonnes

Ccli = clinker fraction of cement of type i, tonnes

Im = imports for consumption of clinker, tonnes

Ex = exports of clinker, tonnes

EFclc = emission factor for clinker in the particular cement, tonnes CO2/tonne clinker. The default EFclc is corrected for CKD

CFckd = emissions correction factor for CKD, dimensionless

The clinker fraction used for the cement production not covered by the production plant which provided information on clinker was the default provided by the IPCC, 95%. The emission factor used in both equations was the default tier 1 emission factor, which is already corrected for CKD: 0.52 tonnes CO_2/tonne clinker.

Lubricants use

All lubricants consumed in the country are considered as non-energy consumption and reported in the IPPU sector, consistently with the information provided in the energy balances of the country and according to the 2006 IPCC Guidelines.

The data used for the lubricant emissions estimate consist of total national lubricant consumption from the energy balance.

The tier 1 approach of 2006 IPCC guidelines has been used, as follows:

$$CO_2\ Emissions = LC * CC_{Lubricant} * ODU_{Lubricant} * 44/12$$

Where:

LC = total lubricant consumption, TJ

CCLubricant = carbon content of lubricants (default), tonne C/TJ (=kg C/GJ)

ODULubricant = ODU factor (based on default composition of oil and grease), fraction 44/12 = mass ratio of CO_2/C

This equation has been applied using a Lubricant Carbon Content (tonne-C/TJ) of 20, and a Fraction Oxidized During Use (ODU factor) of 0.2.

Substitutes for Ozone Depleting Substances (F-gases)

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and other fluorinated gases serve as alternatives to ozone depleting substances (ODS) being phased out under the Montreal Protocol.

The sectors in which HFC, PFC, and other fluorinated gases are used are followings:

- refrigeration and air conditioning;
- fire suppression and explosion protection;
- aerosols;
- solvent cleaning;
- foam blowing; and
- other applications.

HFCs and PFCs have high global warming potentials and are gaining importance at the international level due to their increasing contribution to total national GHG emission inventories. In this edition of the inventory, HFC emissions of refrigeration and air conditioning and fire protection categories have been estimated.

The activity data of this category is obtained from a study carried out by the National Ozone Unit of the Ministry of Environment on Hydrofluorocarbons (HFC) consumed in the country. The information is limited to the imports of gases.

The tier 1 approach provided by the 2006 IPCC Guidelines has been followed by using the guidelines along with the worksheets available at: https://www.ipcc-nggip.iges.or.jp /public/2006gl/vol3.html.The main assumptions and default coefficients used for the estimation of the emissions are illustrated in the following table:

Table 40. Main assumptions taken and coefficients used

Year of Introduction of the gases	**2005**
Growth Rate in New Equipment Sales	**2.5%**
Assumed Equipment Lifetime (years)	**10**
Emission Factor from installed base	**15%**
% of gas destroyed at End-of-Life	**25%**

The data availability consists in imports of refrigerant products (blends). To obtain activity data of each gas by category, the gas composition of blends provided by the 2006 IPCC Guidelines has been used to convert the data, as follows:

Table 41. Gas composition of blends

Gas blend	HFC-125	HFC143a	HFC134a	HFC-32	Total
R-404A	44%	52%	4%		1
R-507A	50%	50%			1
R-410A	50%			50%	1
R-407C	25%		52%	23%	1

Source : Table 7.8 Chapter 7, volume 2 IPPU, IPCC 2006

7.3. IPPU emissions trends

Table 42. Trend of emissions 1994 - 2016 (GHG, Gg. CO_2-eq)

Emission source	1994	2000	2005	2010	2015	2016
2A1. Cement production	NO	NO	NO	370.14	653.89	1,421.96
2D1. Lubricants	3.81	6.04	6.41	8.60	28.25	28.50
2F. Subst. for ODS (F-gases)	NO	NO	6.32	114.10	320.24	371.68
Total	3.81	6.04	12.73	492.84	1 001.38	1 821.15

Table 43. HFC emissions in mass unit by gas and emission source 1994 - 2016 (tonnes)

Emission source	Gas	1994	2000	2005	2010	2015	2016
2F1 - Refrigeration	HFC-125	NO	NO	0.02	0.39	1.35	1.58
	HFC143a	NO	NO	0.03	0.46	1.57	1.84
	HFC134a	NO	NO	0.09	1.59	5.38	6.53
	HFC-32	NO	NO	0.00	0.00	0.00	0.00
2F1 – Air conditioning	HFC-125	NO	NO	0.02	0.39	1.35	1.58
	HFC143a	NO	NO	0.00	0.00	0.00	0.00
	HFC134a	NO	NO	4.11	74.15	203.86	235.88
	HFC-32	NO	NO	0.07	1.35	6.48	8.21
2F3 - fire protection	HFC-227ea	NO	NO	0.00	0.02	0.05	0.06

Table 44. HFC emissions by gas and emission source 1994 - 2016 (Gg. CO_2-eq)

Emission source	Gas	1994	2000	2005	2010	2015	2016
2F1 - Refrigeration	HFC-125	NO	NO	0.08	1.38	4.73	5.54
	HFC143a	NO	NO	0.12	2.08	7.02	8.22
	HFC134a	NO	NO	0.13	2.27	7.70	9.34
	HFC-32	NO	NO	0.00	0.00	0.00	0.00
2F1 – Air conditioning	HFC-125	NO	NO	0.08	1.38	4.73	5.54
	HFC143a	NO	NO	0.00	0.00	0.00	0.00
	HFC134a	NO	NO	5.88	106.04	291.53	337.31
	HFC-32	NO	NO	0.05	0.91	4.38	5.54
2F3 - fire protection	HFC-227ea	NO	NO	0.00	0.06	0.16	0.19

Table 45. Emissions by gas in mass unit 1994 - 2016 (Gg)

Gas	1994	2000	2005	2010	2015	2016
CO_2	3.81	6.04	6.41	378.74	681.14	1 449.46
CH_4	NA	NA	NA	NA	NA	NA
N_2O	NA	NA	NA	NA	NA	NA
HFC-125	NO	NO	0.04	0.79	2.70	3.17
HFC143a	NO	NO	0.03	0.46	1.57	1.84
HFC134a	NO	NO	4.20	75.74	209.25	242.41
HFC-32	NO	NO	0.07	1.35	6.48	8.21
HFC-227ea	NO	NO	0.00	0.02	0.05	0.06
NOx	NA	NA	NA	NA	NA	NA
CO	NA	NA	NA	NA	NA	NA
NMVOC	NE	NE	NE	NE	NE	NE
SO_2	NA	NA	NA	NA	NA	NA
SF_6	NA	NA	NA	NA	NA	NA

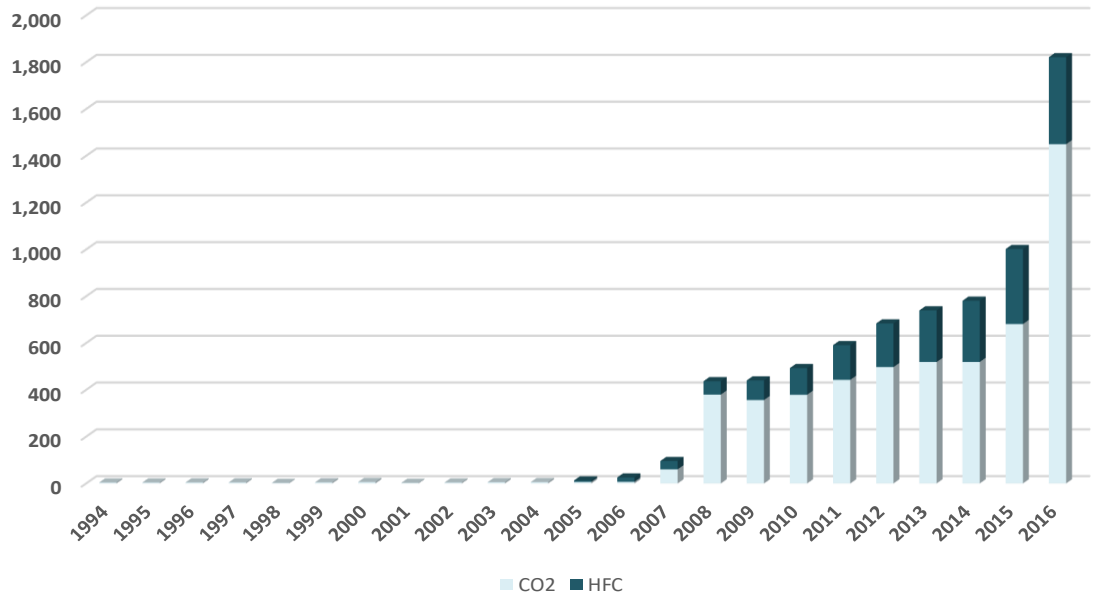


Figure 16. GHG emissions in the IPPU sector 1994 - 2016 (Gg. CO_2-eq)

8. AFOLU

8.1. Characterization of the sector

The AFOLU sector (Agriculture, Forestry and Other Land Uses) in Cambodia is very impacted by the land use category (3.B). Especially after 2008 (due to data availability the data in 2008 and 2009 was missed and we assumed the trend was same as previous years; hence, the result of the calculation found the drastic change between 2008-09 and 2010), large emissions (131 011 Gg.CO_2eq/year) have been estimated based on changes measured between 2010 and 2014. Emissions largely exceed removals for this category.

In the agriculture sector, rice cultivations and enteric fermentation are the main sources with 9 856 kt CO_2eq/year and 3 554 kt CO_2eq/year, respectively.

National statistics from the Ministry of Agriculture, Forestry and Fisheries (MAFF) provide most data needed to elaborate the estimates concerning animal populations, crop areas, and productions.

Data on fertilizers is estimated using the Ministry of Commerce (MoC) statistics. This data was completed with data estimated by the FAO and provided on the FAOSTAT.

For land use categories all data used is from the report on forest reference level (FRL) provided by Cambodia to the UNFCCC within the REDD+ framework. Expert judgement was also made to make the data more reliable and reflect the country situation.

8.2. Methodology and emissions by category

Livestock

All livestock emissions are based on animal populations, which are estimated based on different national information sources. It is worth highlighting that the category of poultry only includes chicken and ducks, which are the main poultry production in Cambodia (pigeons, quails, and geese are not estimated due to lack of data but the emissions are also considered to be very small).

Enteric Fermentation

Enteric fermentation emissions are estimated using the tier 1 methodology from the 2006 IPCC guidelines according to these equations:

$$Emissions = EF_{(T)} * \left(\frac{N_{(T)}}{10^6}\right)$$

Where:

Emissions = methane emissions from Enteric Fermentation, Gg CH_4 yr^{-1}

$EF_{(T)}$ = emission factor for the defined livestock population, kg CH_4 $head^{-1}$ yr^{-1}

$N_{(T)}$ = the number of head of livestock species / category *T* in the country

T = species / category of livestock

$$Total\ CH_{4Enteric} = \sum_i E_i$$

Where:

Total $CH_{4Enteric}$ = total methane emissions from Enteric Fermentation, Gg CH_4 yr^{-1}

E_i = is the emissions for the i^{th} livestock categories and subcategories

Emission factors used are the default values proposed by the 2006 IPCC guidelines for Asia and developing countries in tables 10.10 and 10.11.

Table 46. Emission factors for enteric fermentation – kg CH_4/head/year

Cattle	Buffaloes	Pigs	Poultry	Horses	Sheep	Goats
47	55	1	0	18	5	5

Manure Management

CH_4 emissions from manure management are estimated with the tier 1 methodology from the 2006 IPCC guidelines according to this equation:

$$CH_{4Manure} = \sum_{(T)} \left(\frac{EF_{(T)} * N_{(T)}}{10^6}\right)$$

Where:

$CH_{4Manure}$ = CH_4 emissions from a manure management, for a defined population, Gg $CH_4 yr^{-1}$
$EF_{(T)}$ = emission factor for the defined livestock population, kg CH_4 $head^{-1}$ yr^{-1}
$N_{(T)}$ = the number of head of livestock species / category *T* in the country
T = species / category of livestock

CH_4 emission factors used are default values proposed by the 2006 IPCC guidelines for Asia and developing countries with a warm climate in tables 10.14 and 10.15.

Table 47. Emission factors for manure management – kg CH_4/head/year

Cattle	Buffaloes	Pigs	Poultry	Horses	Sheep	Goats	Elephants
1	2	7	0.02	2.19	0.2	0.22	0

The equations for tier 2 methodology proposed in the 2006 IPCC guidelines were also implemented with default values proposed for manure management systems.

N_2O emissions from manure management are estimated with the tier 1 methodology from the 2006 IPCC guidelines according to this equation:

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_{(T)} \left(N_{(T)} * Nex_{(T)} * MS_{(T,S)}\right)\right] * EF_{3(S)}\right] * \frac{44}{28}$$

Where:

$N_2O_{D(mm)}$ = direct N_2O emissions from a manure management in the country, Kg N_2O yr^{-1}
$N_{(T)}$ = number of head of livestock species/category *T* in the country Kg N animal yr^{-1}
$MS_{(T,S)}$ = fraction of total amount nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* in the country, dimensionless
$EF_{3(S)}$ = emission factor for the direct N_2O emissions from manure management system S in the country, Kg N_2O-N/kg N in manure management system *S*
S = manure management system
T = species / category of livestock
44/28 = conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions

All parameters used in the calculations are default values proposed by the 2006 IPCC guidelines for Asia: animal weights (TAM), nitrogen excretion rates (Nrate), and manure management systems.

Table 48. Nitrogen excretion rates and animal weights

Variable\Animal	Cattle	Buffaloes	Pigs	Poultry	Horses	Sheep	Goats
Nrate (kg N/1000 kg animal/day)	0.34	0.32	0.5	0.82	0.46	1.17	1.37
TAM (kg/animal)	319	380	28	1.8	238	28	30
Nex (kg N/animal/year)	39.6	44.4	5.1	0.5	40.0	12.0	15.0

Table 49. Manure management systems used for the entire time series

Variable\Animal	Cattle	Buffaloes	Pigs	Poultry	Horses	Sheep	Goats
Lagoon							
Liquid/Slurry			40%				
Solid storage							
Dry lot	46%	41%	54%				
Pasture range	50%	50%			100%	100%	100%
Daily spread	2%	4%					
Digester			6%				
Burned for fuel	2%	5%					
Pit <1 month							
Pit >1 month							
Poultry manure with litter				100%			

Emission factors used are the default values proposed by the 2006 IPCC guidelines in tables 10.21.

Table 50. N_2O emission factors for manure management - kg N_2O-N/kg Nex

Lagoon	Liquid/ Slurry	Solid storage	Dry lot	Daily spread	Digester	Pit <1 month	Pit >1 month	Poultry manure
0	0.005	0.005	0.02	0	0	0.002	0.002	0.001

Land

Land calculations are based on a comprehensive monitoring of land use and a country specific estimate for each type of land.

The activity data used is the set of land use matrixes implemented from the comparison of different cartographies for 2006, 2010, and 2014. These matrixes are mostly focusing on forest areas because they were elaborated in the framework of the REDD+ program to define the forest reference level for Cambodia.

Table 51. Activity data – Aggregated area land and land use changes (1-year matrixes) – ha or ha/Year

Year	Forest becoming other land	Other land becoming forest	Forest remaining forest	Other land remaining other land	Total forest	Total other land
2000	132 733	37 780	11 363 669	6 626 492	11 401 449	6 759 225
2001	132 733	37 780	11 268 715	6 721 446	11 306 495	6 854 179
2002	132 733	37 780	11 173 762	6 816 399	11 211 541	6 949 132
2003	132 733	37 780	11 078 808	6 911 353	11 116 587	7 044 086
2004	132 733	37 780	10 983 854	7 006 307	11 021 634	7 139 040
2005	132 733	37 780	10 888 901	7 101 260	10 926 680	7 233 994
2006	132 733	37 780	10 793 947	7 196 214	10 831 727	7 328 947
2007	132 733	37 780	10 698 993	7 291 168	10 736 773	7 423 901
2008	132 733	37 780	10 604 039	7 386 121	10 641 819	7 518 855

2009	132 733	37 780	10 509 086	7 481 075	10 546 865	7 613 808
2010	579 280	95 845	10 356 066	7 129 482	10 451 912	7 708 762
2011	579 280	95 845	9 872 632	7 612 917	9 968 477	8 192 197
2012	579 280	95 845	9 389 197	8 096 351	9 485 043	8 675 631
2013	579 280	95 845	8 905 763	8 579 786	9 001 608	9 159 066
2014	579 280	95 845	8 422 328	9 063 220	8 518 173	9 642 501
2015	579 280	95 845	7 938 894	9 546 655	8 034 739	10 125 935
2016	579 280	95 845	7 455 459	10 030 089	7 551 305	10 609 369

For this inventory, all the fluxes are calculated by stock variation using the following equation of the 2006 IPPC guidelines (2.5):

$$\Delta C = \frac{(C_{t2} - C_{t1})}{(t_2 - t_1)}$$

Where:

ΔC = annual carbon stock change in the pool, tonnes C yr^{-1}
C_{t1} = carbon stock in the pool at time t_1, tonnes C
C_{t2} = carbon stock in the pool at time t_2, tonnes C

The different stocks are estimated based on different scientific references and national expertise. They are estimated for above ground and below ground biomass.

Table 52. Parameter – Biomass content of forestlands

Land use/cover			Above ground biomass (t)*	Below ground biomass (t)**
Category		Sub-category		
Forest	Natural forest	Evergreen	163	31
		Semi-evergreen	243	44
		Deciduous	85	18
		Pine forest	100	20
		Bamboo	0	0
		Mangrove	150	29
		Rear mangrove	165	32
		Flooded forest	70	15
		Forest regrowth	75	16
	Planted forest	Pine plantation	100	20
		Other plantation	100	20

* Above ground biomass is estimated from various sources (UN-REDD, UNDP, IPCC, etc.) as presented in the Forest Reference Level (FRL)
** Below ground biomass is estimated based on above ground biomass from equations proposed by Cairns et al (1997) in the IPCC (2003)

These sub-sector emissions have not been disaggregated into more detailed categories because all unforested lands were aggregated in the baseline data used by the inventory.

In the current inventory, all GHG estimates are related to forest, concerning afforestation, deforestation, or changes in forests. Nevertheless, deforestation should not be reported under the forest category, but rather under the final use category, which is unknown. For this reason, it was preferred to keeping only one aggregated value for all land use estimates (category 3.B) in the nomenclature.

Table 53. Carbon Stock changes in land

AGB + BGB Fluxes (tC/yr)	2000	2005	2010	2015	2016
Forest becoming other land*	-9 165 575	-9 165 575	-40 230 160	-40 230 160	-40 230 160
Other land* becoming forest	1 933 497	1 933 497	5 339 125	5 339 125	5 339 125
Forest remaining forest	-136 636	-136 636	-839 303	-839 303	-839 303
Other land* remaining other land*	0	0	0	0	0
Total forest	1 796 860	1 796 860	4 499 822	4 499 822	4 499 822
Total other land*	-9 165 575	-9 165 575	-40 230 160	-40 230 160	-40 230 160
Total (tC/yr)	-7 368 715	-7 368 715	-35 730 339	-35 730 339	-35 730 339

*Other lands encompass all lands which are not forests (croplands, grasslands, etc.)

Emissions from biomass burning

There is limited information available on biomass burning in Cambodia. For crop residue burning, relevant and accurate data has been found in a scientific publication (San et al, 2009[13]). This publication was used to estimate biomass burning from rice cultivation.

For grassland burning, estimates from the first and second national communication showing that 50% of grassland was burnt (1996 IPCC guidelines) have been used for the entire time series.

Activity data shows the area concerned by biomass burning. For crop residues, biomass burning was considered for rice crops and sugar cane cultivation. For rice crops, it was estimated that straw is removed on 100% of rice fields; however, remaining stubble is burnt in some cases (stubble is supposed to be burnt on 30% in rainfed areas and 20% in irrigated areas). For sugar cane, burning before harvest is very common because harvest is difficult without burning when there is no mechanisation, so it was estimated that 100% of the area of sugar cane is burnt. For other crops, information is unavailable; however, it was assumed that residues are not burnt.

Greenhouse gas emissions estimate from fire were calculated according to the following equation:

$$L_{fire} = A * M_B * C_f * G_{ef} * 10^{-3}$$

[13] Estimation of methane and nitrous oxide emissions from rice field with rice straw management in Cambodia. Vibol San, Sirintornthep Towprayoon. Article in Environmental Monitoring and Assessment · April 2009

Where:

Lf_{ire} = amount of greenhouse gas emissions from fire, tonnes of each GHG e.g., CH_4, N_2O, etc.

A = area burnt, ha

M_B = mass of fuel available for combustion, tons ha-1. This includes biomass, ground litter and dead wood. When Tier 1 methods are used the litter and dead wood pools are assumed zero, except where there is a land-use change

C_f = combustion factor, dimensionless

G_{ef} = emissions factor, g kg-1 dry matter burnt. Note: Where data for MB and Cf are not available, a default value for the amount of fuel actually burnt (the product of MB and Cf) can be used from IPCC guidelines.

Emission factors used are the default values proposed by the IPCC 2006 guidelines in table 2.5.

Liming

No data on liming were available so CO_2 emissions from liming are not estimated. However, this activity is assumed to be very small in Cambodia.

Urea application

Activity data shows the amount of urea spread in fields. Data on fertilizers are difficult to use and data treatment was necessary to elaborate a relevant estimate of fertilizer use in Cambodia. For this source only, urea must be considered among fertilizers (mostly included in urea and urea ammonium nitrate). The form of nitrogen fertilizer is provided by FAOSTAT (even if this data fluctuates considerably during the time series). Gaps in the data sets are fulfilled through extrapolation.

CO_2 emissions from urea application are estimated using the tier 1 methodology from the 2006 IPCC guidelines. The emission factor is 0.2 tC/t urea. The fertilizer named "Urea ammonium nitrate" (UAN) contains approximately 50% of urea, the emission factor is thus 0.1 tC/t UAN.

$$CO_2 - C\ Emission = M * EF$$

Where:

CO_2-C Emission = annual C emissions from urea application, tonnes C yr^{-1}

M = annual amount of urea fertilization, tonnes urea yr^{-1}

EF = emission factor, tonne of C (tonne of urea)$^{-1}$

Direct N_2O emissions from managed soils

Direct N_2O emissions are based on different nitrogen inputs. Mineral fertilizers, organic fertilisers, pasture, and crop residues are considered for this calculation.

N_2O emissions from nitrogen inputs are estimated with the tier 1 methodology from the 2006 IPCC guidelines.

$$N_2O_{Direct} - N = N_2O - N_{Nimputs} + N_2O - N_{OS} + N_2O - N_{PRP}$$

Where

$$N_2O - N_{Nimputs} = \left[\left[(F_{SN} + F_{ON} + F_{CR} + F_{SOM}) * EF_1\right] + \left[(F_{SN} + F_{ON} + F_{CR} + F_{SOM})_{FR} * EF_{1FR}\right]\right]$$

$$N_2O - N_{OS} = \left[\left(F_{OS,CG,Temp} * EF_{2CG,Temp}\right) + \left(F_{OS,CG,Trop} * EF_{2CG,Trop}\right) + \left(F_{OS,F,Temp,NR} * EF_{2F,Temp,NR}\right) + \left(F_{OS,F,Temp,NP} * EF_{2F,Temp,NP}\right) + \left(F_{OS,F,Trop} * EF_{2F,Trop}\right)\right]$$

$$N_2O - N_{PRP} = \left[\left(F_{PRP,CPP} * EF_{3PRP,CPP}\right) + \left(F_{PRP,SO} * EF_{3PRP,SO}\right)\right]$$

Where:

N_2ODirect –N = annual direct N_2O–N emissions produced from managed soils, kg N_2O–N yr^{-1}

N_2O–NN inputs = annual direct N_2O–N emissions from N inputs to managed soils, kg N_2O–N yr^{-1}

N_2O–NOS = annual direct N_2O–N emissions from managed organic soils, kg N_2O–N yr^{-1}

N_2O–NPRP = annual direct N_2O–N emissions from urine and dung inputs to grazed soils, kg N_2O–N yr^{-1}

F_{SN} = annual amount of synthetic fertiliser N applied to soils, kg N yr^{-1}

F_{ON} = annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soils (Note: If including sewage sludge, cross-check with Waste Sector to ensure there is no double counting of N_2O emissions from the N in sewage sludge), kg N yr^{-1}

F_{CR} = annual amount of N in crop residues (above-ground and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils, kg N yr^{-1}

F_{SOM} = annual amount of N in mineral soils that is mineralised, in association with loss of soil C from soil organic matter as a result of changes to land use or management, kg N yr^{-1}

F_{OS} = annual area of managed/drained organic soils, ha (Note: the subscripts CG, F, Temp, Trop, NR and NP refer to Cropland and Grassland, Forest Land, Temperate, Tropical, Nutrient Rich, and Nutrient Poor, respectively)

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1} (Note: the subscripts CPP and SO refer to Cattle, Poultry and Pigs, and Sheep and Other animals, respectively)

EF_1 = emission factor for N_2O emissions from N inputs, kg N_2O–N (kg N input)$^{-1}$(Table 11.1)

EF_{1FR} is the emission factor for N_2O emissions from N inputs to flooded rice, kg N_2O–N (kg N input)$^{-1}$ (Table 11.1) 5

EF_2 = emission factor for N_2O emissions from drained/managed organic soils, kg N_2O–N ha^{-1} yr^{-1}; (Table 11.1) (Note: the subscripts CG, F, Temp, Trop, NR and NP refer to Cropland and Grassland, Forest Land, Temperate, Tropical, Nutrient Rich, and Nutrient Poor, respectively)

EF_{3PRP} = emission factor for N_2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals, kg N_2O–N (kg N input)$^{-1}$; (Table 11.1) (Note: the subscripts CPP and SO refer to Cattle, Poultry and Pigs, and Sheep and Other animals, respectively)

Emission factors used are the default values proposed by the IPCC 2006 guidelines in table 11.1.

Table 54. N_2O emission factors for managed soils

Variable	Inorganic fertilizers	Organic fertilizer applied to soils	Urine and dung deposited by cattle, poultry and pigs	Urine and dung deposited by sheep and others	Crop residues	EF for flooded rice fields
Emission Factor (Kg N_2O-N /(kg N)	0.01	0.01	0.02	0.01	0.01	0.003

Indirect N_2O emissions from managed soils

Indirect N_2O emissions are due to both volatilization and nitrogen leaching. These activities are calculated based on data available in the estimation of direct N_2O emissions and specific parameters provided by the IPCC 2006 guidelines.

The N_2O emissions from atmospheric deposition of N volatilised from managed soil are estimated using the equation 11.9 from the 2006 IPCC guidelines:

$$N_2O_{(ATD)} - N = [(F_{SN} * Frac_{GASF}) + (F_{ON} + F_{PRP}) * Frac_{GASM}] * EF_4$$

Where

$N_2O_{(ATD)}$–N = annual amount of N_2O–N produced from atmospheric deposition of N volatilised from managed soils, kg N_2O–N yr^{-1}

F_{SN} = annual amount of synthetic fertiliser N applied to soils, kg N yr^{-1}

$Frac_{GASF}$ = fraction of synthetic fertiliser N that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied)-1 (Table 11.3)

F_{ON} = annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1}

$Frac_{GASM}$ = fraction of applied organic N fertiliser materials (F_{ON}) and of urine and dung N deposited by grazing animals (F_{PRP}) that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied or deposited)$^{-1}$ (Table 11.3)

EF_4 = emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N–N_2O (kg NH_3–N + NO_x–N volatilised)-1] (Table 11.3)

Conversion of N_2O(ATD)-N emissions to N_2O emissions for reporting purposes is performed by using the following equation:

$$N_2O_{(ATD)} = N_2O_{(ATD)} - N * 44/28$$

The N_2O emissions from leaching and runoff in regions where leaching and runoff occurs are estimated using Equation 11.10 from the 2006 IPCC guidelines:

$$N_2O_{(L)} - N = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) * Frac_{LEACH-(H)} * EF_5$$

Where

$N_2O_{(L)}$–N = annual amount of N_2O–N produced from leaching and runoff of N additions to managed soils in regions where leaching/runoff occurs, kg N_2O–N yr^{-1}

F_{SN} = annual amount of synthetic fertiliser N applied to soils in regions where leaching/runoff occurs, kg N yr^{-1}

F_{ON} = annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils in regions where leaching/runoff occurs, kg N yr^{-1}

F_{PRP} = annual amount of urine and dung N deposited by grazing animals in regions where leaching/runoff occurs, kg N yr^{-1}

F_{CR} = amount of N in crop residues (above- and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually in regions where leaching/runoff occurs, kg N yr^{-1}

F_{SOM} = annual amount of N mineralised in mineral soils associated with loss of soil C from soil organic matter as a result of changes to land use or management in regions where leaching/runoff occurs, kg N yr^{-1} (from Equation 11.8)

$Frac_{LEACH-(H)}$ = fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff, kg N (kg of N additions)$^{-1}$ (Table 11.3)

EF_5 = emission factor for N_2O emissions from N leaching and runoff, kg N–N_2O (kg N leached and runoff)$^{-1}$] (Table 11.3)

Conversion of N_2O(ATD)-N emissions to N_2O emissions for reporting purposes is performed by using the following equation:

$$N_2O_{(L)} = N_2O_{(L)} - N * 44/28$$

Parameters and emission factors used are the default values proposed by the IPCC 2006 guidelines in table 11.3.

Table 55. Parameters and emission factors for indirect N_2O emissions for managed soils

Parameters and emission factors	Value
Frac leach (kg N/kg of N additions)	0.3
Frac gasm (kg N volatilized/kg of N applied or deposited) for organic fertilizer	0.2
Frac gasf (kg N volatilized/kg of N applied) for synthetic fertilizer	0.1
Atmospheric deposition (kg N2O-N/kg NH3-N+NOx-N volatilized)	0.01
Nitrogen Leaching and runoff (kg N2O-N/kg N leaching/runoff)	0.0075

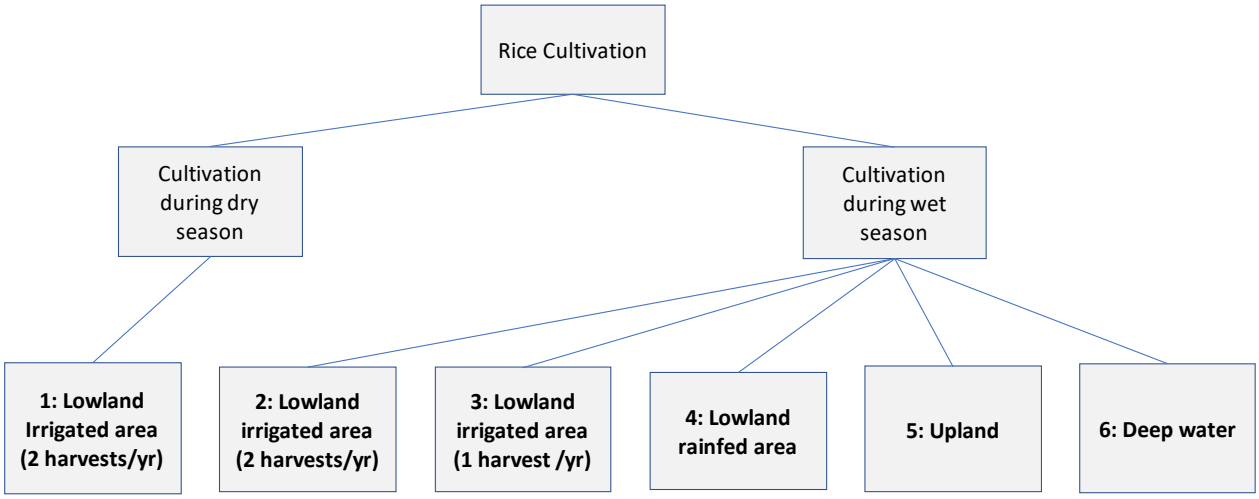
Indirect N_2O emissions from manure management

On the same basis as nitrogen in managed soils, indirect N_2O emissions may occur during storage of manure management. The methodologies are similar and based on the IPCC 2006 guidelines. Loss percentages due to volatilization are based on default values provided in Table 10.22 of the IPCC 2006 guidelines and the rates of leaching are obtained by the difference between the total losses presented in Table 10.23 and volatilization losses.

The methodology and emission factors are the same as those used in managed soils.

Rice cultivation

Rice cultivation areas are estimated based on different national datasets. For this inventory, the 2006 IPCC guidelines were implemented, and six types of rice cultivation were defined in relation with the IPCC requirements.



Type 1 (dry season - lowland irrigated area - 2 harvests/yr): The area is estimated based on the area harvested in dry season (MAFF statistics since 2004 and for the following years 1993, 1994, 1995, 2000).

Type 2 (wet season - lowland irrigated area - 2 harvests/yr): the area is the same as type 1. It is estimated based on rice area harvested during dry season because it is considered that these areas are also irrigated (when necessary) during the wet season.

Type 3 (wet season - lowland irrigated area - 1 harvest/yr): Cambodia developed a great deal of its irrigation during the covered period. It is estimated by the International Rice Research Institute (IRRI) that irrigated area was around 15% in 2005 and 25% in 2010-14. 25% of rice area represents more than the area harvested in dry season which means that some areas are irrigated to produce rice only in wet season. The area of type 3 is estimated by the difference between total irrigated area and the irrigated areas which allows 2 harvests/yr (types 1 and 2).

Type 4 (wet season - lowland rain-fed area): this area is obtained by the difference between total harvested area and all other types of rice cultivation.

Type 5 (wet season - upland area): this area (35 000 ha) is estimated based on the area estimated in 1993 (MAFF) and maintained for the entire times series.

[14] GRiSP (Global Rice Science Partnership). 2013. Rice almanac, 4th edition. Los Baños Philippines): International Rice Research Institute. 283 p.

Type 6 (wet season - deep water): this area (108 500 ha) is estimated based on the area estimated in 1993 (Bulletin of agriculture statistics, 1993) and maintained for the entire times series.

CH_4 emissions from rice cultivation are estimated using the tier 1 methodology from the 2006 IPCC guidelines. Equations for rice cultivation is equation 5.1:

$$CH4Rice = \sum_{i,j,k} \left(EF_{i,j,k} * t_{i,j,k} * A_{i,j,k} * 10^{-6} \right)$$

Where:

CH_4 Rice = annual methane emissions from rice cultivation, Gg CH_4 yr^{-1}

EF_{ijk} = a daily emission factor for i, j, and k conditions, kg CH_4 ha-1 day^{-1}

t_{ijk} = cultivation period of rice for i, j, and k conditions, day

A_{ijk} = annual harvested area of rice for i, j, and k conditions, ha yr-1

i, j, and k = represent different ecosystems, water regimes, type and amount of organic amendments, and other conditions under which CH_4 emissions from rice may vary

Emission factors are based on the equations 5.2 and 5.3 and different assumptions relative to rice management.

The six types of rice cultivation defined previously were subdivided into four subcategories dependent on residue management and manure application. This subdivision was made based on a scientific publication (San et al, 2009[15]).

- Subcategory A: Manure application and stubble incorporation
- Subcategory B: Manure application and stubble burning
- Subcategory C: No manure application and stubble incorporation
- Subcategory D: No manure application and stubble burning

Table 56. Rice cultivation subdivision

Variable	Wet season	Dry season
A: Manure + Stubble incorporation	53%	48%
B: Manure + Stubble burning	23%	12%
C: No manure + Stubble incorporation	18%	32%
D: No manure + Stubble burning	8%	8%

These values are estimated for the years 2005-2006 but applied for the entire time series.

The amount of manure and stubble incorporated are calculated consistently with the rest of the GHG inventory for livestock and crop residues.

[15] Estimation of methane and nitrous oxide emissions from rice field with rice straw management in Cambodia. Vibol San, Sirintornthep Towprayoon. Article in Environmental Monitoring and Assessment · April 2009

Parameters and emission factor - kg CH_4/ha/day

$$EF_i = EF_c * SF_w * SF_p * SF_o * SF_{s,y}$$

Where:

EF_i = adjusted daily emission factor for a particular harvested area
EF_c = baseline emission factor for continuously flooded fields without organic amendments
SF_w = scaling factor to account for the differences in water regime during the cultivation period (from Table 5.12)
SF_p = scaling factor to account for the differences in water regime in the pre-season before the cultivation period (from Table 5.13)
SF_o = scaling factor should vary for both type and amount of organic amendment applied (from Equation 5.3 and Table 5.14)
$SF_{s,r}$ = scaling factor for soil type, rice cultivar, etc., if available

$$SF_o = \left(1 + \sum_i ROA_i * CFOA_i\right)^{0.59}$$

Where:

SF_o = scaling factor for both type and amount of organic amendment applied
ROA_i = application rate of organic amendment i, in dry weight for straw and fresh weight for others, tonne ha^{-1}
$CFOA_i$ = conversion factor for organic amendment i (in terms of its relative effect with respect to straw applied shortly before cultivation) as shown in Table 5.14.

Considering the types (1 to 6) and the subdivision (A, B, C, D), 24 categories were defined with specific emission factors. Emission factors are changing along the time series because of changes in crop residues and manure availability.

Considering expert judgement used in the first national communication, cultivation length is fixed at 115 days for the dry season and 165 days for the wet season. This value could be improved by considering the changes in rice varieties leading to shorter cultivation periods.

Table 57. Rice cultivation emission factors

kg CH_4/ha/yr	1994	2000	2005	2010	2015	2016
Type 1A	307	297	288	284	275	275
Type 1B	256	245	235	230	220	220
Type 1C	233	233	233	233	233	233
Type 1D	214	214	214	214	214	214
Type 2A	440	425	413	407	395	394
Type 2B	368	351	337	330	316	316
Type 2C	335	335	335	335	335	335
Type 2D	307	307	307	307	307	307
Type 3A	255	244	235	230	221	220
Type 3B	250	239	229	224	215	215
Type 3C	172	172	172	172	172	172
Type 3D	166	166	166	166	166	166
Type 4A	71	68	66	64	62	62
Type 4B	70	67	64	63	60	60
Type 4C	48	48	48	48	48	48
Type 4D	46	46	46	46	46	46
Type 5A	0	0	0	0	0	0
Type 5B	0	0	0	0	0	0
Type 5C	0	0	0	0	0	0
Type 5D	0	0	0	0	0	0
Type 6A	79	76	73	71	68	68
Type 6B	78	74	71	70	67	67
Type 6C	53	53	53	53	53	53
Type 6D	51	51	51	51	51	51

Harvested wood products

This category is not currently estimated in the inventory.

8.3. AFOLU emissions trends

Table 58. Trend of emissions 1994 - 2016 (GHG, Gg. CO_2-eq)

Inventory Sector	1994	2000	2005	2010	2015	2016
3A. Livestock	5 370.57	5 678.87	6 100.43	6 399.75	5 362.78	5 384.54
3B. Land	27 019	27 019	27 019	131 011	131 011	131 011
3C. Crop cultivation	5 832.01	7 353.45	9 235.95	11 736.33	12 705.57	13 013.13
Total	38 221.2	40 050.9	42 355.0	149 147.3	149 079.6	149 408.9

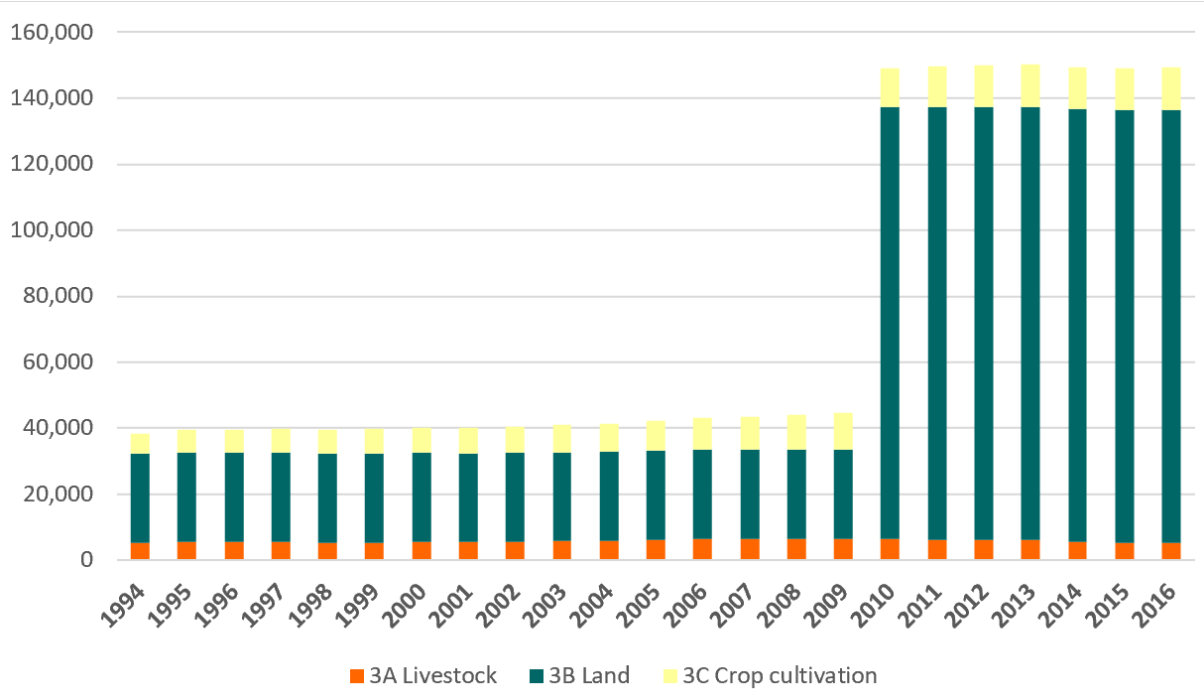


Figure 17. Trend of emissions 1994 - 2016 (GHG, Gg. CO_2-eq)

Table 59. Emissions by gas in mass unit 1994 - 2016 (Gg)

Gas	1994	2000	2005	2010	2015	2016
CO_2	27 020.23	27 020.26	27 020.26	131 041.14	131 028.66	131 028.66
CH_4	375.69	442.23	526.79	627.28	629.41	645.15
N_2O	6.07	6.63	7.27	8.13	7.77	7.56

9. Waste

9.1. Characterization of the sector

The waste sector includes emissions occurring in the generation and management of waste. Based on the 2006 IPCC Guidelines, waste sector emissions are broken down into the following categories:

- 4A. Solid Waste Disposal
- 4B. Biological treatment of solid waste
- 4C. Incineration and open burning of waste
- 4D. Wastewater treatment and discharge

Typically, the most important sources of emissions in this sector are the CH_4 emissions from solid waste disposal, CH_4 emissions from wastewater treatment and discharge and CO_2 emissions which occur in incineration and open burning of waste.

This edition of the inventory includes estimates for all the categories defined by the 2006 IPCC Guidelines.

9.2. Methodology and emissions by category

Data available at the national level on waste generation and management has been used to derive a complete characterization of the overall management of waste in the country and its temporal evolution.

Analogously, the data available was used to characterize the typology of wastewater discharges needed for estimating the GHG emissions of the wastewater sector.

The following tables show the evolution of the country profile regarding waste generation and management, as well as wastewater discharges.

Table 60. Waste management practices in Cambodia – 1990 -2016

Year	Total MSW generated (Gg)	% of waste burned	% of waste compo sted	% of waste used as animal food	% of waste recycled	% wastes going to landfills	Columns in grey are not summed. These figures are the breakdowns of the % of wastes going to landfill					Total
							% of waste going to managed landfills	% of waste going to un-managed landfills	% of waste to unmanaged landfills - shallow	% of waste to unmanaged landfills - deep	% of waste going to Unspecified landfills	
Before 1990	…	66%	2%	0.302%	0.000%	32%	0%	11.28%	11.28%	0%	21%	100%
1990	2 508	66%	2%	0.302%	0.000%	32%	2%	11.28%	11.28%	0%	19%	100%
1991	2 596	65%	2%	0.300%	0.000%	33%	2%	11.30%	11.30%	0%	19%	100%
1992	2 689	65%	2%	0.299%	0.000%	33%	2%	11.32%	11.32%	0%	20%	100%
1993	2 786	65%	2%	0.298%	0.000%	33%	2%	11.34%	11.34%	0%	20%	100%
1994	2 883	64%	2%	0.297%	0.000%	34%	2%	11.36%	11.36%	0%	20%	100%
1995	2 977	64%	2%	0.295%	0.000%	34%	2%	11.38%	11.38%	0%	21%	100%
1996	3 069	64%	2%	0.294%	0.000%	34%	2%	11.40%	11.40%	0%	21%	100%
1997	3 157	63%	2%	0.293%	0.000%	35%	2%	11.42%	11.42%	0%	21%	100%
1998	3 241	63%	2%	0.292%	0.000%	35%	2%	11.44%	11.44%	0%	22%	100%
1999	3 321	62%	2%	0.291%	0.000%	35%	2%	11.45%	11.45%	0%	22%	100%
2000	3 396	62%	2%	0.291%	0.000%	36%	2%	11.45%	11.45%	0%	22%	100%
2001	3 550	62%	2%	0.290%	0.000%	36%	2%	11.46%	11.46%	0%	23%	100%
2002	3 638	61%	2%	0.290%	0.000%	37%	3%	11.47%	11.47%	0%	22%	100%
2003	3 726	61%	2%	0.290%	0.000%	37%	5%	11.48%	11.48%	0%	20%	100%
2004	3 661	61%	2%	0.289%	0.000%	37%	9%	11.48%	11.48%	0%	17%	100%
2005	3 745	60%	2%	0.289%	0.000%	38%	9%	11.49%	11.49%	0%	18%	100%
2006	3 532	60%	2%	0.288%	0.000%	38%	11%	11.50%	11.50%	0%	15%	100%
2007	3 601	59%	2%	0.288%	0.000%	38%	13%	11.50%	11.50%	0%	13%	100%
2008	3 738	59%	2%	0.287%	0.000%	39%	14%	11.51%	11.51%	0%	13%	100%
2009	3 780	59%	2%	0.287%	0.000%	39%	15%	11.52%	11.52%	0%	13%	100%
2010	3 847	58%	2%	0.286%	3.197%	36%	15%	11.53%	11.53%	0%	10%	100%
2011	3 906	58%	2%	0.286%	3.512%	36%	16%	11.54%	11.54%	0%	9%	100%
2012	3 991	58%	2%	0.285%	1.949%	38%	23%	11.55%	11.55%	0%	3%	100%
2013	4 086	57%	2%	0.285%	1.824%	39%	24%	11.56%	11.56%	0%	3%	100%
2014	4 156	57%	2%	0.284%	2.379%	38%	26%	11.57%	11.57%	0%	0.3%	100%
2015	4 179	57%	2%	0.283%	2.379%	38%	28%	9.60%	9.60%	0%	0.3%	100%
2016	4 239	57%	2%	0.282%	2.379%	38%	30%	7.90%	7.90%	0%	0.3%	100%

Year	Total MSW generated (Gg)	% of waste burned	% of waste composted	% of waste used as animal food	% of waste recycled	% wastes going to landfills	Columns in grey are not summed. These figures are the breakdowns of the % of wastes going to landfill					Total
							% of waste going to managed landfills	% of waste going to un-managed landfills	% of waste to unmanaged landfills - shallow	% of waste to unmanaged landfills - deep	% of waste going to Unspecified landfills	
Source	2006 IPCC defaults*population	Estimate based on Yut S. and Seng B., 2018. KAP on waste management			MoE	MoE + Yut S. and Seng B., 2018. KAP on waste management	MoE	Estimate based on Yut S. and Seng B., 2018. KAP on waste management				

Table 61. Wastewater discharges typology – Assumption on the temporal evolution

	Degree of utilization of treatment or discharge pathway or method for each income group									
	U=rural					U=urban low income				
	Septic Tank	Latrine	Other	Sewer	None	Septic Tank	Latrine	Other	Sewer	None
Default IPCC	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
1990	0%	9%	0%	2%	89%	14%	10%	3%	53%	20%
1991	0%	10%	0%	2%	87%	14%	10%	3%	53%	20%
1992	0%	12%	0%	2%	86%	14%	10%	3%	53%	20%
1993	0%	13%	0%	3%	84%	14%	10%	3%	53%	20%
1994	0%	14%	0%	3%	83%	14%	10%	3%	53%	20%
1995	0%	16%	0%	3%	81%	14%	10%	3%	53%	20%
1996	0%	17%	0%	4%	79%	14%	10%	3%	53%	20%
1997	0%	18%	0%	4%	78%	14%	10%	3%	53%	20%
1998	0%	20%	0%	4%	76%	14%	10%	3%	53%	20%
1999	0%	21%	0%	4%	74%	14%	10%	3%	53%	20%
2000	0%	22%	0%	5%	73%	14%	10%	3%	53%	20%
2001	0%	24%	0%	5%	71%	14%	10%	3%	53%	20%
2002	0%	25%	0%	5%	70%	14%	10%	3%	53%	20%
2003	0%	26%	0%	6%	68%	14%	10%	3%	53%	20%
2004	0%	28%	0%	6%	66%	14%	10%	3%	53%	20%
2005	0%	29%	0%	6%	65%	14%	10%	3%	53%	20%
2006	0%	30%	0%	6%	63%	14%	10%	3%	53%	20%
2007	0%	32%	0%	7%	62%	14%	10%	3%	53%	20%
2008	0%	33%	0%	7%	60%	14%	10%	3%	53%	20%
2009	0%	34%	0%	7%	58%	14%	10%	3%	53%	20%
2010	0%	36%	0%	8%	57%	14%	10%	3%	53%	20%
2011	0%	37%	0%	8%	55%	14%	10%	3%	53%	20%
2012	0%	38%	0%	8%	53%	14%	10%	3%	53%	20%
2013	0%	40%	0%	8%	52%	14%	10%	3%	53%	20%
2014	0%	41%	0%	9%	50%	14%	10%	3%	53%	20%
2015	0%	44%	0%	9%	49%	14%	10%	3%	53%	20%
2016	0%	44%	0%	9%	47%	14%	10%	3%	53%	20%

Solid waste disposal

Category 4A Solid waste disposal includes emissions that occur in the treatment and disposal of municipal, industrial, and other solid waste.

GHG emissions have been calculated using tier 1 methodology provided by the 2006 IPCC Guidelines using the default values provided by the guidelines, as well as with national specific information.

The IPCC methodology for estimating CH_4 emissions from Solid Waste Disposal Sites (SWDP) is based on the First Order Decay (FOD) method. This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed.

Table 62. Waste composition used

Food	Garden	Paper	Wood	Textile	Nappies	Plastics, other inert
55%	**0%**	**10%**	**2%**	**2%**	**0%**	**30%**

Source: The study "State of Waste Management in Phnom Penh, Cambodia" carried out by the UNEP in 2018. This study is available at:
https://www.researchgate.net/publication/326293569_State_of_Waste_Management_in_Phnom_Penh_Cambodia

The parameters used in the estimation are those provided by the 2006 IPCC guidelines for Asia-southeast, "Moist and wet tropical" weather. The starting year for the estimation is 1950.

The following tables show the key parameters used in the emissions estimate:

Table 63. Key parameters used

Parameters	Value used
Methane generation rate constant (k)	
Food waste	0.4
Garden	0.17
Paper	0.07
Wood and Straw	0.035
Textiles	0.07
Disposable nappies	0.17
Sewage sludge	0.4
Industrial waste	0.17
Delay time (months)	6
Fraction of methane (F) in developed gas	0.5
Conversion factor c to CH4	1.33

Regarding the Methane correction factor (MCF), for municipal solid waste the MCF value is calculated using the distribution of waste disposal sites types shown in table *Waste management practices in Cambodia* above.

For industrial wastes, the MCF used corresponds to 100% of wastes going to uncategorized landfill sites.

Table 64. Weighted average methane correction factor

Year	Municipal Solid Waste	Industrial Waste
	Weighted average MCF for MSW	Weighted average MCF for Industrial Waste
1994	0.66	0.60
2000	0.66	0.60
2010	0.80	0.60
2015	0.93	0.60
2016	0.96	0.60

Biological treatment of waste

Category 4B *Biological treatment of waste* includes the emissions from composting and anaerobic digestion in biogas facilities. Both activities occurred in the country during the inventory period.

The total amount of waste composted has been calculated by applying to total national waste generated and the percentage of waste composted (see table on Waste management practices in Cambodia above).

The total amount of waste treated by biological treatment facilities has been calculated using data from the energy balance on amount of biogas produced and a conversion rate (m^3/kg) calculated using data from the "Assessment of the Cambodian National Biodigester Programme". Through this program, household biodigesters are built and maintained in the residential sector. The emissions due to the energy use of biogas are allocated within the energy sector.

The following tables show the data used for the calculation and the results obtained.

Table 65. Activity data – Calculation of conversion rate

Variable	Type 1	Type 2	Type 3	Type 4	Type 5
Dung requirements (kg/day)	30	50	70	90	125
Estimated gas production (m^3/day)	1.2	2	2.8	3.6	5
Conversion rate (m^3/kg)	0.04	0.04	0.04	0.04	0.04

Source: Extracted from https://www.sciencedirect.com/science/article/pii/S0973082618302588#bb0185

Table 66. Activity data – Calculation of the amount of waste (animal dung) treated

Variable	2010	2011	2012	2013	2014	2015	2016
Amount of biogas produced and consumed from the Energy Balance (tonnes)	2 024	2 608	2 271	603	882	882	882
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.2	1.2	1.2
m^3	1 686 333	2 173 675	1 892 175	5 022 08	7 346 17	7 346 17	7 346 17
Dung (Gg)	42.16	54.34	47.30	12.56	18.37	18.37	18.37

The tier 1 methodology proposed by the 2006 IPCC Guidelines has been applied using an emission factor of 4 g CH_4/kg waste treated and 0.24 g N_2O/kg waste treated for calculating the emissions from compost and an emission factor of 0.8 g/kg waste treated for calculating the emissions from anaerobic digestion. There is no recovery of methane.

Incineration and open burning

Category 4C2 *Incineration and open burning of waste* includes combustion of waste emissions stemming from controlled facilities or open dumps. Incineration of waste does not occur in Cambodia and therefore it is not included in the inventory.

The percentage of the population burning waste has been estimated based on the information available in Yut S. and Seng B., 2018. KAP on waste management. Activity data has been calculated using the following equation:

$$MSW_B = P * P_{frac} * MSW_p * B_{frac} * 365 * 10^{-6}$$

Where:

MSW_B = Total amount of municipal solid waste open-burned, Gg/yr
P = population (capita)
P_{frac} = fraction of population burning waste, (fraction)
MSW_p = per capita waste generation, Kg waste/capita/day
B_{frac} = fraction of the waste amount that is burned relative to the total amount of waste treated, (fraction)
365 = number of days by year
10^{-6} = conversion factor from kilogram to gigagram

The per capita waste generation used corresponds to category 4A solid waste disposal. The default value for Bfrac used is 0.6 as provided in the corresponding chapter of the 2006 IPCC Guidelines.

Once the amount of total waste open burning is calculated, the emissions are calculated by applying an emission factor to the amount of waste burned in wet basis, for the case of CH_4 and N_2O, and by estimating the waste amount burned in dry basis for CO_2 emissions as follows:

$$CO_2\ Emissions = \sum_i (SW_i * dm_i * CF_i * FCF_i * OF_i) * 44/12$$

Where:

SW_i = total amount of solid waste of type *i* (wet weight) incinerated or open-burned, Gg/yr
dm_i = dry matter content in the waste (wet weight) incinerated or open-burned, (fraction)
CF_i = fraction of carbon in the dry matter (total carbon content), (fraction)
FCF_i = fraction of fossil carbon in the total carbon, (fraction)
OF_i = oxidation factor, (fraction)
44/12 = conversion factor from C to CO_2
i = type of waste incinerated/open-burned specified as follows: MSW: municipal solid waste; ISW: industrial solid waste

The parameters used in the calculation are the followings:

- Oxidation factor: 0.58; and

- The coefficients provided by the 2006 IPCC of Dry Matter Content, Fraction of Carbon in Dry Matter and Fraction of Fossil Carbon in Total Carbon, which are specific to each component of the waste.

Emission factors used are those proposed by the 2006 IPCC guidelines for the tier 1 method: 6.5 g CH_4/kg and 0.15 g N_2O/kg.

Wastewater treatment and discharge

Category 4D *Wastewater treatment and discharge* includes emissions of CH_4 and N_2O occurring when wastewater is treated or disposed anaerobically.

Wastewater arises from a variety of domestic, commercial, and industrial sources and may be treated on site (uncollected), brought to a centralized plant (collected), or disposed untreated nearby or via an outfall.

Organically degradable material in wastewater (TOW) has been calculated using the value "collected" for the adjustment of industrial wastewater and the BOD value provided for "Asia":

$$TOW = P * BOD * 0.001 * I * 365$$

Where:

TOW = total organics in wastewater in inventory year, kg BOD/yr
P = country population in inventory year, (person)
BOD = country-specific per capita BOD in inventory year, g/person/day
0.001 = conversion from grams BOD to kg BOD
I = correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00)

The default factor for BOD used is 40 kg BOD/cap/day extracted from Table 6.4 of the 2006 IPCC Guidelines, Value for Asia.

Data on average annual per capita protein generation is provided by the FAO for years 1990-1992, 1995-1997, 2000-2002 and 2005-2007. Intermediate years have been interpolated. The years 2007-2016 have been extrapolated using the expression of trend of the time series:

$$Y_t = 0.3745X - 730.7$$

The tier 1 methodology provided by the 2006 IPCC Guidelines has been followed for estimating emissions of both CH_4 and N_2O.

For the emissions of CH_4, the following equation has been used:

$$CH_4\ Emissions = \left[\sum_{i,j}\left(U_i * T_{i,j} * EF_j\right)\right](TOW - S) - R$$

Where:

TOW = total organics in wastewater in inventory year, kg BOD/yr

S = organic component removed as sludge in inventory year, kg BOD/yr
U_i = fraction of population in income group *i* in inventory year
$T_{i,j}$ = degree of utilisation of treatment/discharge pathway or system, *j*, for each income group fraction *i* in inventory year
i = income group: rural, urban high income and urban low income
j = each treatment/discharge pathway or system
$EF_{i,j}$ = emission factor, kg CH_4/kg BOD
R = amount of CH_4 recovered in inventory year, kg CH_4/yr

The previous equation is complemented with the following expression for estimating the emission factor:

$$EF_j = B_o * MCF_j$$

Where:

j = each treatment/discharge pathway or system
Bo = maximum CH_4 producing capacity, Kg CH_4/kg BOD
MCF_j = methane correction factor

For the CH_4 emissions calculation, the assumptions made regarding the split of type of discharges for rural and urban population are contained in table *Wastewater discharges typology* above, so the corresponding coefficients of the 2006 IPCC Guidelines have been used for calculating the emission factor by treatment.

Final emission factors used for estimating CH_4 emissions are the following:

Table 67. Emission factors used – CH_4 emissions in domestic wastewater

Type of treatment	Methane correction factor for each treatment system (MCF)	Maximum methane producing capacity (BoD) (kg CH4/kg BOD)	Emission factor (EF) (kg CH4/kg BOD)
Untreated-sea, river, lake	0.1	0.6	0.060
Untreated-flowing sewer	0	0.6	0
Treated-septic system	0.5	0.6	0.3
Treated-Latrine with sediments removal	0.1	0.6	0.060

For the case of N_2O, the following equation has been used:

$$N_{EFFLUENT} = (P * Protein * F_{NPR} * F_{NON-CON} * F_{IND-COM}) - N_{SLUDGE}$$

Where:

NEFFLUENT = total annual amount of nitrogen in the wastewater effluent, kg N/yr
P = human population
Protein = annual per capita protein consumption, kg/person/yr
F_{NPR} = fraction of nitrogen in protein, default = 0.16, kg N/kg protein
$F_{NON-CON}$ = factor for non-consumed protein added to the wastewater
$F_{IND-COM}$ = factor for industrial and commercial co-discharged protein into the sewer system
N_{SLUDGE} = nitrogen removed with sludge (default = zero), kg N/yr

9.3. Waste emissions trends

GHG emissions of the waste sector are driven by the increase in urban population, along with improvements in sanitation and waste management.

Table 68. Trend of emissions 1994 – 2016 (GHG, Gg. CO_2-eq)

Inventory Sector	1994	2000	2005	2010	2015	2016
4A1 Solid waste disposal	539.20	693.44	875.61	1 077.14	1 288.36	1 345.77
4B2 Biological treatment	8.81	10.57	11.74	12.99	13.69	13.92
4C2 Open Burning	614.40	698.14	746.83	743.07	792.95	803.06
4D1 Domestic wastewater	371.91	457.35	512.02	532.09	593.18	597.93
Total	1 534.32	1 859.50	2 146.20	2 365.29	2 688.19	2 760.68

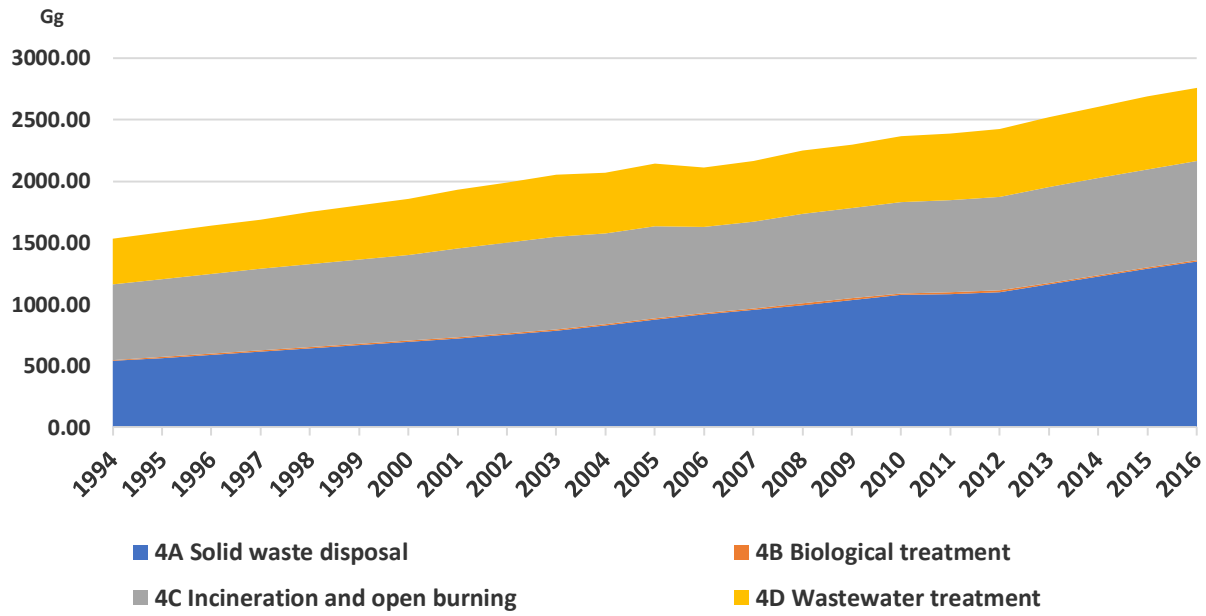


Figure 18. GHG emissions in the waste sector - 1994-2016 (Gg. CO_2-eq)

As illustrated in the previous figure, waste GHG emissions show an increasing trend in all categories driven by the increase of population.

The main contributor to sectors of emissions is category 4A Solid waste disposal, with a contribution that ranges from 35.1% in 1994 to 48.7% in 2016. Increasing emissions in this category are determined by the waste generation associated with population and economic increase, along with the rising percentage of waste going to landfill.

The second contributor to waste emissions is open burning of waste, a contribution ranging from 40.0% in 1994 to 29.1% in 2016. The contribution has been reduced mainly due to population migration from rural to urban areas, where open burning is less widespread.

The third contributor to waste GHG emissions is 4D Wastewater treatment, with a contribution ranging from 24.2% in 1994 to 21.7% in 2016.

Finally, biological treatment of waste has a very low contribution to waste emissions, with a contribution that ranges from 0.6% in 1994 to 0.5% in 2016.

Regarding the contribution of each gas to total GHG emissions, the following table shows the detailed evolution of their contribution for the entire time period.

Table 69. Percentage of emissions by gas 1994 - 2016 (%)

Inventory Sector	1994	2000	2005	2010	2015	2016
CH_4	65.9%	66.5%	68.3%	70.8%	71.9%	72.2%
CO_2	26.2%	24.5%	22.7%	20.5%	19.3%	19.0%
N_2O	7.9%	8.9%	9.0%	8.7%	8.8%	8.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note – This contribution is calculated converting first the emissions of each gas to CO_2-eq using global warming potentials

The predominant gas in the sector is CH_4 followed by CO_2.

The following table shows the emissions for the entire time series, in terms of mass of emissions of each gas:

Table 70. Emissions by gas in mass unit 1994 – 2016 (Gg)

Gas	1994	2000	2005	2010	2015	2016
CO_2	401.33	456.03	487.83	485.38	517.96	524.56
CH_4	40.5	49.5	58.6	67.0	77.3	79.7
N_2O	0.41	0.56	0.65	0.69	0.80	0.82
HFC	NA	NA	NA	NA	NA	NA
NO_x	NA	NA	NA	NA	NA	NA
CO	NA	NA	NA	NA	NA	NA
NMVOC	NA	NA	NA	NA	NA	NA
SO_2	NA	NA	NA	NA	NA	NA
SF_6	NA	NA	NA	NA	NA	NA

10. Comparison of GHG Emission/removal estimated in 1994 and 2000 in previous inventories with the recalculated GHG Emissions/removal using the 2006 IPCC Guidelines

The Kingdom of Cambodia has submitted two National Communications along with their respective Greenhouse Gas Inventories, the first one in 2002 with 1994 data, and the second one in 2016 with 2000 data.

Table 71. Comparison with the GHG emissions reported in previous inventories

Inventory Sector/(Gg.CO2-eq/year)	Inventory submitted in the NC1 (1994)	2019 inventory edition (2016)	Inventory submitted in the NC2 (2000)	2019 inventory edition (2016)
Energy	1 881	2 691	2 767	3 103
IPPU	50[16]	4	0	6
Agriculture	10 560	11 203	21 112	13 032
Forestry and other land Use	-17 907	27 019	-24 566	27 019
Waste	273	1 534	229	1 859

The main difference with previous inventories is found in the Forestry and Other Land Use, where a net sink was estimated for the sector. The new information gathered within the framework of the Forest Reference Level has permitted an improvement in the data of this sector. Additionally, the methodology used now corresponds to the 2006 IPCC methodology when the 1996 IPCC Guidelines were used in previous inventories.

[16] According to the national cement producers, clinker production started in the country in 2007. Consequently, 1994 estimates wrongly include CO_2 emissions from the production of the imported clinker for the cement production in the national estimates.

11. Quality Assurance and Quality Control of the Greenhouse Gas Inventory

In its 2019 edition of the GHG emission inventory, Cambodia developed two types of quality control procedures: general QC procedures and category specific QC procedures, as proposed by 2016 IPCC Guidelines. In addition, QA was implemented through peer reviews of the inventory and consultation workshops.

General QC procedures include generic quality checks related to calculations, data processing, completeness, and documentation that are applicable to all inventory source and sink categories.

For the general QC procedures, a QC template was used by national compilers for reviewing the GHG emission compilation of all sectors.

QA consisted in three main steps:

- In the international team a peer reviewer expert was assigned by sector to undertake checks, propose improvements, and ensure inventory quality;
- Additionally, a cross-cutting international expert undertook a review of the GHG inventory to check its adherence to the UNFCCC Guidelines and the Decisions Provisions on GHG inventories reporting in National Communications and Biennial Update Reports; and
- Finally, official approval consisted in a one-month period of interactions between the technical international consultants and the national team who held meetings by sector with the most relevant key national stakeholders. During this period, the international team revised the inventory according to observations and recommendations of the competent authority. Based on this interactive process, the final version of the inventory was compiled and presented in a validation workshop.

The QA/QC Plan is presented in Annex III.

CHAPTER 3: MITIGATION ACTIONS AND THEIR EFFECTS

1. National Policy and Planning Framework

Cambodia´s greenhouse gas emissions are low compared to most countries; however, it is one of the most vulnerable countries affected by climate change. Thus, climate change is being considered in the development, economic, and social agenda.

Cambodia is proud of its progress on climate change policy. Explicit efforts have been made in mainstreaming climate change into national, sectoral, and sub-national planning.

As described in previous sections, the National Council for Sustainable Development, Climate Change Technical Working Group and the General Secretariat have been established with a mandate to coordinate the national climate change response. The detailed description of the institutional arrangements in place in Cambodia for mitigation are described in chapter 1: National Circumstances above.

Cambodia has developed and implemented a series of National Policies (containing policy target definitions), National Strategies (containing steps in achieving policy targets), and Action Plans (containing implementation strategies).

Table 72. Climate change policy and planning framework

Policy	Main climate change related objectives
Policy on Green Growth	Balance economic development with environment, society, culture and sustainable use of national resources.
Strategic Plan for Green Growth	To guide the economy towards a greener economy, focusing on effective use of natural resources, environmental sustainability, green jobs, green technologies, green finance, green credit and green investment. It also refers to the reduction of greenhouse gas emissions under the third pillar, Blue Economy Development with Sustainability.
National and Sectoral Strategic Development Plans	Climate change as a priority development issue due to its major threat to the country's economic growth. Include indicators to track implementation of climate change actions.
National Environmental Strategy and Action Plan	Aims to ensure that environmental protection and sustainable natural resources management are pillars of the country's socioeconomic development.
Climate Change Strategic Plan and Sectoral Action Plans	Aim to integrate climate change into national, sectoral, and sub-national level planning.

The Cambodia National Policy on Green Growth, the National Green Growth Strategy, National Strategic Development Plans, Sectoral Strategic Plans, the National Forest Program, the National Environmental Strategy and Action Plan and climate change strategic plan are meant to guide future development towards low-carbon and climate-resilient development and sustainable development.

1.1. National and Sectoral Strategic Development Plans

1.1.1. National Strategic Development Plans

The National Strategic Development Plans (NSDP) provide a broad framework aimed at harmonizing development efforts and the effectiveness of aid to implement these strategies.

The NSDP 2006-2010 was Cambodia's medium-term development plan, which linked the vision of the Government's Rectangular Strategy for growth, employment, equity and efficiency to concrete goals, targets and strategies. It contained a statement about the impacts of climate change, and it acknowledged that natural hazards could affect progress, but there was no systematic assessment of climate risks to achieving its goals, strategies and targets.

The NSDP 2009-2013identified climate change as a priority development issue due to its major threat to the country's economic and growth prospects. It identified key priority actions to be undertaken in response to climate change impacts that have negative implications on national development efforts. On this basis, climate change was considered as a cross-cutting issue in the planning process of the NSDP 2014 – 2018. The NSDP 2009-2013 enshrines the commitment of the Royal Government of Cambodia to mitigate adverse effects of energy consumption on the environment and society through energy project implementation, while safeguarding economic efficiency and environmental sustainability of each project.

1.1.2. Sectoral Strategic Plans

Table 73. Sectoral instruments by sector

Sector	Instruments
Agriculture	Agricultural Sector Strategic Development Plan (ASDP) Agricultural Sector Master Plan towards 2030
Livestock	National Strategic Planning Framework for Livestock (2016-2025) Law on animal health and production
Forestry and ecosystems	National Forest Programme (NFP) REDD± Strategy 2017-2026 National Protected Area Strategic Management Plan (NPASMP) 2017-2031
Energy	National Energy Efficiency Policy
Transport	Strategy on Environmentally Sustainable Transport Development (ESTD) Climate Change Strategic Plan for the Transport Sector (CCSPTS) Urban Transport Master Plan
Waste and Wastewater	Draft National Waste Management Strategy and Action Plan 2018-2030 Sub-decree on municipal solid waste management Sub-decree on solid and water pollution control

The **Agricultural Sector Strategic Development Plan** (ASDP) has been established to reduce poverty, assure food security and safety through Cambodian agricultural

modernization at faster speeds and with new scope approaches, to promote the development of agriculture and exportation of agricultural products, along with natural resource conservation in a sustainable manner. Additionally, the Agricultural Sector Master Plan towards 2030 is prepared with a vision of "a modern Agriculture Sector, which is competitive, inclusive, resilient and sustainable to contribute to food security, safety, and nutrition for the prosperity and wellbeing of the Cambodian people". It is intended to increase agricultural growth and expand agricultural exports with high quality and safety through enhancing agricultural productivity, value added and enabling competition, while considering sustainable land use and ensuring sustainable fisheries and forestry resource management.

The Government has established a goal to ensure food security, increase incomes, create employment, and improve nutrition status for all people. Based on this goal, the **National Strategic Planning Framework for Livestock** (2016-2025) was prepared with the objective to improve the livelihoods of small producers, household income, and food security and to provide a safe and sufficient supply of livestock products to consumers, as well as for export.

The law on animal health and production was promulgated and several notifications and circulars to all stakeholders have been issued to implement in accordance with the law.

In the forestry sector, the Government prepared the **National Forest Programme** (NFP) (2010 to 2030) with the main objective of implementing the REDD-plus scheme (reduce emissions from deforestation and forest degradation, forest conservation, sustainable forest management, and enhancement of carbon sinks). The NFP is the main national forestry sector plan. Protected areas are not included in this plan.

The Forestry Administration is primarily responsible for development and implementation of the NFP, although NGOs are also involved in the development and monitoring of the Programme.

The **National REDD+ Strategy** 2017-2026 was also developed with a vision to contribute to national and global climate change mitigation through improving resources and forest land management and sustainable biodiversity conservation.

Additionally, the **National Protected Area Strategic Management Plan** (NPASMP) 2017-2031 was approved with a vision to contribute to the country's economy and sustainable development, including poverty reduction, through the conservation and sustainable use of its biological, natural, and cultural resources and other ecosystem services.

In the energy sector, the **National Energy Efficiency Policy** prepared in 2018 and currently pending approval contains two main goals:

1) Improve the management and maintenance of existing infrastructure (e.g. buildings) and industrial processes (e.g. for the use of fuel wood) for increased energy efficiency; and
2) Increase the transfer and adoption of energy efficient technology (e.g. fuel-efficient vehicles and light bulbs) to reduce energy intensity.

Transport sector emissions are expected to increase considerably since the Government plans to invest in transportation infrastructures and to improve trade facilitation through developing a multi-modal transportation network to ensure connectivity within the country and the whole region. During the increase in traffic demand, the country did not ignore environmental stresses, and the **Strategy on Environmental Sustainable Transport Development** (ESTD) was formulated to ensure stable economic growth and environmental sustainability.

In addition, the Ministry of Public Works and Transport (MPWT) developed a **Climate Change Strategic Plan for Transport Sector** (CCSPTS) in 2012, which covered both transport adaptation and mitigation to climate change. The strategic framework for climate change adaptation in transport infrastructure envisions that the transport infrastructure will be in good condition to adapt to extreme climate events, while the objective of this framework is to improve the quality of road infrastructure to deal with the impact of climate change.

While the strategic framework for GHGs mitigation in the transport sector includes a vision to significantly reduce the amount of GHG emissions, the strategic plan covers objectives to: develop efficient, comfortable and a safe transport system; introduce a modern public transport system; reduce traffic congestion; enhance inspection and maintenance of vehicles; enhance traffic management; and enhance fuel quality.

At the local level, the government prepared an **Urban Transport Master Plan** targeting 2035 to solve the current transport problems/issues and support the 2035 Urban Vision and Urban Structure, which will maintain the people-environment-friendly urban conditions and revitalize the urban activities in Phnom Penh City. Two important directions were included (1) to shift from a private-oriented urban transport system to a well-balanced system of public and private transport, and a combination of road, public transport and traffic management for improving the mobility of citizens; and (2) to materialize the urban potential of Phnom Penh City.

Concerning the waste sector, a **Waste Management Strategy and Action Plan 2018 - 2030** of Cambodia has been under development since 2018. The core principles of the draft strategy are illustrated below.

Vision	**The Kingdom of Cambodia becomes clean and beautiful city and towns with improved public health, social security, and environmental quality by 2030**
Mission	☐ To optimize the exploitation of useful resources from solid waste through waste separation according to its type and promote the use of recycled products resulting from waste. ☐ To improve and optimize the waste collection service based on the type of waste separation. ☐ To create infrastructure for waste disposal facility and improve the current existing dumping sites in compliance with environmentally sound management of waste disposal.
National Goal	Development of environmentally sound management of solid waste, ensuring a balance between economic development and environmental protection
Objective A:	To improve waste collection coverage at urban area and minimize the amount of waste, disposed at landfill by promoting segregation of organic and plastic waste at source for recycle.
Objective B:	To nurture recycling business sector by promoting recycling of recyclable waste for sustainable resource management and economy development.
Objective C:	To promote multi-benefits on the improvement of water and air pollution through establishing sound management of solid waste.
Objective D:	To improve data collection and estimation methods on waste management situation for monitoring and evaluation of waste management.

The Government approved the **Sub-decree on municipal solid waste management** on August 27, 2015 with the objective to improve municipal solid waste management in an efficient, transparent, and accountable manner to ensure the protection of aesthetics, public health, and environment.

Similarly, the Government adopted the **Sub-decree on water pollution control** in 1999 with the main objective to regulate water pollution control to prevent and reduce water pollution of public water areas so that the protection of human health and the conservation of bio-diversity could be ensured. The MoE has encouraged the implementation of its surveillance on major pollution sources, e.g. factories and large enterprises, by encouraging the installation of liquid waste treatment plants at the source, air purification devices before emitting, and noise reduction equipment.

1.2. National Environmental Strategy and Action Plan

Cambodia's National Environment Strategy and Action Plan, 2016–2023 (NESAP)[17] can be considered a roadmap for environmental and natural resources management and

[17] Work on the NESAP and on a national environment code to strengthen legal frameworks for environmental management began in 2015. The NESAP was endorsed by the National Council for Sustainable Development in October 2017 and then by the Government of Cambodia in December 2017. The NESAP development process was overseen by a task force comprising of 16 line ministries and institutions, and involved other relevant stakeholders. The Greater Mekong Subregion Core Environment Program provided extensive support to the process. Consultations with stakeholders on the NESAP were held across Cambodia, and involved hundreds of representatives from government ministries, civil society, and development organizations.

sustainable development. The NESAP identifies priority policy tools and financing options for sustainable natural resources management and environmental protection. The NESAP aims to ensure that environmental protection and sustainable natural resources management are pillars of the country's socioeconomic development. The NESAP is a strategy for all government ministries, as well as the private sector, civil society, and development partners, to integrate environmental concerns into economic policies and investments.

The NESAP provides a detailed analysis of the state of the environment in Cambodia, and outlines priority policy and governance improvements and financing mechanisms that can assist the country achieve environmentally sustainable economic development.

The NESAP is based on what it calls the "three Hs," which are essential for achieving balanced and long-term development. The three Hs include:

- Head: All administration levels have strong political will and the commitment to contribute to cross-sector coordination and inclusive and sustainable development;
- Heart: All key actors and decision-makers are committed and devoted to common goals for moving towards pro-green and equitable development; and
- Hands: Human and financial resources as well as science and technology resources are available for informing decisions and sustaining actions to achieve the NESAP vision, mission, and objectives.

1.3. Climate Change Strategic Plan

The Cambodia **Climate Change Strategic Plan 2014-2023** (CCCSP)[18] aims to support building a greener, low-carbon and climate-resilient, equitable, sustainable and knowledge-based society to contribute to global efforts addressing climate change. The development of the CCCSP was a significant step towards embedding climate change in the NSDP 2014-2018 and in the sectoral development plans of all relevant ministries.

The CCCSP sets objectives for national entities and assists non-governmental organizations and development partners in developing concrete and appropriate measures and actions related to climate change adaptation and mitigation of GHG emissions, which are the supportive pillars for the achievement of the Rectangular Strategy and Cambodia Millennium Development Goals. The CCCSP thus reflects the country´s political will, firm

[18] The CCCSP was developed under the overall coordination of the Ministry of Environment, with the active participation of the Climate Change Technical Team (CCTT) and guidance from the National Climate Change Committee (previously called NCCC and currently the National Council for Sustainable Development (NCSD)). A wide range of technical support was provided by several national and international experts for the development of the CCCSP. The development of the CCCSP was made possible with financial support from development partners, namely the European Union (EU), the Swedish International Development Cooperation Agency (Sida), the Danish International Development Agency (DANIDA), and the United Nations Development Programme (UNDP), through the Cambodia Climate Change Alliance (CCCA).

commitment and readiness for reducing climate change impacts on national development, and contributing, with the international community, to global efforts for mitigating GHG emissions under the UNFCCC.

The main CCCSP strategic objectives are to:

- Promote climate resilience through improving food, water, and energy security;
- Reduce sectoral, regional, gender vulnerability, and health risks to climate change impacts;
- Ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands, etc.), biodiversity, protected areas and cultural heritage sites;
- Promote low-carbon planning and technologies to support sustainable development;
- Improve capacities, knowledge and awareness for climate change responses;
- Promote adaptive social protection and participatory approaches in reducing loss and damage due to climate change;
- Strengthen institutions and coordination frameworks for national climate change responses; and
- Strengthen collaboration and active participation in regional and global climate change processes.

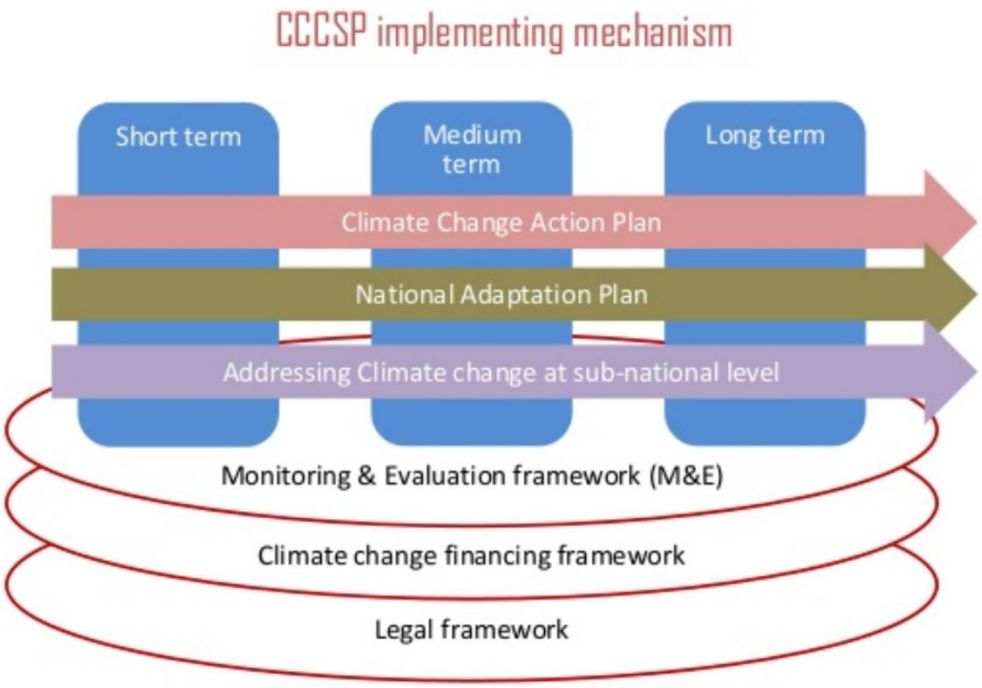


Figure 19. CCCSP implementing mechanism

The CCCSP sets out strategies and actions for different phases:

- In the immediate term: establish institutional and financial arrangements for CCCSP implementation, development of national monitoring and evaluation (M&E) frameworks and indicators, and development of climate change action plans by line ministries;

- In the medium term: launch of high priority programmes with an initial focus on adaptation and gradual increase in mitigation actions, and accreditation of the Adaptation Fund and Green Climate Fund (GCF); and
- In the long term: the focus will be on research and learning, but its main objective will be to scale up successful initiatives and to continue mainstreaming climate change into national and sub-national programmes.

Cambodia has made progress integrating climate change in budgeting through the development of a climate change financing framework (CCFF), in addition to producing regular climate public expenditure reviews and having improved tracking of climate finance in the Official Development Assistance (ODA) database.

At the sub-national level, climate change is being integrated into provincial policy, planning and budgeting processes. In particular, the National Programme for Sub-National Democratic Development (NPSNDD) is expected to enhance opportunities for sub-national governments to integrate climate resilience in their actual local development activities.

1.4. Sectoral Climate Change Action Plans

Climate Change Action Plans (CCAPs) have been prepared for fourteen ministries and institutions (the Ministry of Agriculture, Forestry and Fisheries; the Ministry of Education, Youth and Sport; the Ministry of Environment; the Ministry of Health; the Ministry of Industry and Handicraft; the Ministry of Information; the Ministry of Land Management, Urban Planning and Construction; the Ministry of Mines and Energy; the Ministry of Public Works and Transport; the Ministry of Tourism; the Ministry of Water Resources and Meteorology; the Ministry of Women's Affairs and the Ministry of Rural Development) plus the National Committee for Disaster Management (NCDM) for the period 2014-2018.

CCAPs include a planning matrix identifying priority actions required to deliver climate change strategies and priorities.

Table 74. Priority mitigation actions by institution

Institution	Main priority mitigation actions
Ministry of Industry and Handicraft	Development of resource and energy efficiency guidelines for the industry and handicraft sectors Resource and energy efficiency assessment of industries and SMEs Development of best resource and energy efficiency practices for industries and SMEs Development of a green industry policy and green industry award program Development of Nationally Appropriate Mitigation Actions (NAMAs) Development of a compendium of renewable energy technology for the industrial sector Promotion of renewable energy generation on site and co-generation for industrial sector as well as special economic zone Development of a compendium of low carbon technology for industrial production processes Development of a policy to promote the use path-breaking technologies for low-carbon production industries
Ministry of Agriculture, Forestry and Fisheries	Promote appropriate technologies to reduce GHGs Enhance animal waste management to reduce GHGs Promote sustainable forest management Promote reforestation and afforestation Develop/implement REDD mechanisms Establish GHG inventory for fisheries
Ministry of Mines and Energy	Promote energy efficiency to reduce GHGs Integrate renewable energy in energy systems Develop low carbon policies Promote small scale low carbon development
Ministry of Public Works and Transport	Raise public awareness of GHGs from transport Promote integrated public transport in cities Green belts along major roads for mitigation Mass transit and cycle systems in cities Promote efficient and proven transport technology
Ministry of Tourism	Pilot Pattern of District, Clean City, in 4 main tourism destination (PP, SR, SHV, BTB) Promote "One Tourist One Tree" campaign through tourism parks development
Ministry of Education, Youth and Sport	Develop education policy for Climate Change Strengthen capacity in the MoEYS for Climate Change planning Promote university capacity in Climate Change
Ministry of Women's Affairs	Strengthen gender Climate Change capacities Piloting gender-based Climate Change adaptation/mitigation
Ministry of Rural Development	Scale up micro-finance in local business opportunities for mitigation and adaptation
Ministry of Land Management, Urban Planning and Construction	Integrating climate change response measures to the commune land use planning

Institution	Main priority mitigation actions
Ministry of Information	Human resource development and enhancing human capacity on climate change in information sector
Ministry of Health	All actions focused on adaptation and natural disasters
Ministry of Water Resources and Meteorology	All actions focused on adaptation

2. Mitigation actions and their effects

This chapter presents a summary of Cambodia's Nationally Determined Contribution (NDC) submitted to the UNFCCC in 2015, the main mitigation sectoral instruments in the country, the main mitigation projects by sector and the market-based mechanisms. Information on the main mitigation projects in Cambodia in tabular format is provided in BUR Annex IV.

2.1. Nationally Determined Contribution under the Paris Climate Agreement

Cambodia's Nationally Determined Contribution (NDC) was submitted to the UNFCCC in 2015, outlining the actions planned to reduce greenhouse gas emissions (a maximum of 27% of GHG emissions by 2030 compared to the Business as Usual) and adapt to climate change, and describing plan financing and tracking. Cambodia´s first NDC is summarised in the following two tables.

Table 75. NDC - mitigation

Cambodia Nationally Determined Contribution	Mitigation	Target	Unconditional	Reduce GHG emissions by 27% from BAU levels in 2030 in energy, manufacturing, and transportation sectors.
			Conditional	Additional LULUCF contribution of 4.7 tCO_2eq/ha/year (equivalent to 10.6 $MtCO_2eq$ of additional sequestration compared to BAU). Note: The conditional contribution from the LULUCF was calculated using data from the 2000 GHG inventory, which has been updated with new GHG estimates found in Cambodia's FRL submission to the UNFCCC in 2017 and the 2019 GHG inventory covering the time series 2000-2016 for the FBUR and the TNC.
		Basis of Target	Analytical Basis	Mitigation potential evaluated based on sectoral reductions and "previous needs analyses, experience from successful projects, pilot projects, feasibility studies, literature reviews, and expert judgement".
				BAU projections developed using the LEAP model for energy sector and COMAP for LULUCF sector.
			Existing Policies	Cambodia Climate Change Strategic Plan 2014-2023
				Green Growth Policy, Strategic Plan, and Roadmap
				National Forest Programme (2010-2029)
				National Energy Efficiency Policy 2018 (Not approved yet)
			Mitigation actions	16% reduction in energy emissions (1.8 $MtCO_{2eq}$). National grid connected to renewables energy generation. Promoting energy efficiency by end users.
				7% reduction in manufacturing emissions (0.727 $MtCO_{2eq}$). Includes renewable energy and energy efficiency for factories and brick kilns.
				1% reduction from other sources (0.155 $MtCO_{2eq}$). Includes energy efficient buildings, cook stoves, and biodigesters.

				Increase forest cover to 60% of total land through the implementation of the National Forest Programme (2010-2029) and the Forest Law Enforcement, Governance and Trade programme.
				3% reduction in transportation emissions (0.39 $MtCO_{2eq}$). Promoting mass public transport and improving motor vehicle inspections.

Table 76. NDC - adaptation

Cambodia Nationally Determined Contribution	Adaptation	Included in the NDC	Yes
		Implementation Strategies	Climate change adaption mainstreamed in national and subnational planning, including through the National Adaptation Plan.
		Priority Sectors	Agriculture; Infrastructure; Forestry; Health; Coastal Zones.
		Priority Actions	Promoting and improving the adaptive capacity of communities and restoring the natural ecology system to respond to climate change.
			Implementing measures of management and protection of areas to adapt to climate change.
			Strengthening climate information and early warning systems.
			Developing and rehabilitating the flood protection dykes for agricultural/urban development.
			Increasing the use of mobile pumping stations and permanent stations in responding to mini-droughts and promoting groundwater research in response to drought and climate risk.
			Developing climate-proof tertiary-community irrigation to enhance the yields from agricultural production of paddy fields.
			Promoting the climate resilience of agriculture through building sea dykes in coastal areas and scaling-up of climate-smart farming systems.
			Developing crop varieties suitable to Agro-Ecological Zones (AEZ) and resilient to climate change (include coastal zones).
			Promoting aquaculture production systems and practices that are adaptive to climate change.
			Repairing and rehabilitating existing road infrastructure and ensuring effective operation and maintenance, taking into account climate change impacts.
			Up-scaling of national programmes on different diseases (malaria, respiratory infection, diarrhoeal disease, etc.)
			Strengthening technical and institutional capacity to conduct climate change impact assessments, climate change projections, and mainstreaming of climate change into sector and sub-sector development plans.
		Data Quality & Transparency	The INDC includes qualitative actions to incorporate adaption into Cambodia's priority sectors.
	Participation		The INDC developed under the National Council for Sustainable Development, which has representatives in relevant ministries.
	Financial Assistance		US$ 1.27 billion for implementation of the INDC activities (to 2018).
	Technical Needs Identified in the INDC		Technical support to develop MRV and M&E systems.
			Technical support for a detailed technology needs assessment.

Table 77. Mitigation potential by sector

Mitigation Potential by Sector of the NDC		
Sector	Priority actions	% reduction in 2030 compared to BAU
Energy Industries	Grid connected renewable energy generation (solar energy, hydropower, biomass and biogas) and connecting decentralised renewable generation to the grid.	16%
	Off-grid electricity such as solar home systems, hydro (pico, mini and micro).	
	Promoting energy efficiency by end users.	
Manufacturing Industries	Promoting use of renewable energy and adopting energy efficiency for garment factory, rice mills, and brick kilns.	7%
Transport	Promoting mass public transport.	3%
	Improving operation and maintenance of vehicles through motor vehicle inspection and eco-driving, and the increased use of hybrid cars, electric vehicles and bicycles.	
Others	Promoting energy efficiency for buildings and more efficient cook stoves.	1%
	Reducing emissions from waste through use of biodigesters and water filters.	
	Use of renewable energy for irrigation and solar lamps.	
Total Savings		27%
In accordance with the National Forest Programme (2010-2029), Cambodia is striving to increase and maintain the forest cover at 60% of the total land area, from an estimate of 57% in 2010. This will be achieved in particular through:		4.7 tCO_2eq/ha/year for up to 5 million hectares. In absence of any actions the net sequestration from the LULUCF is expected to reduce to sequestration of 7,897 $Gg.CO_2$-eq in 2030 compared to projected sequestration of 18,492 $Gg.CO_2$-eq in 2010.
Reclassification of forest areas to avoid deforestation: - Protected areas: 2.8 million hectares; - Protected forest: 3 million hectares; - Community forest: 2 million hectares; - Forest concessions reclassified to protected and production forest: 0.3 million hectares; and - Production forest: 2.5 million hectares. Implementation of the FLEGT[19] programme in Cambodia		
The objective is to improve forest governance and promote international trade in verified legal timber.		

[19] FLEGT stands for Forest Law Enforcement, Governance and Trade. It aims to reduce illegal logging by strengthening sustainable and legal forest management, improving governance and promoting trade in legally produced timber.

2.2. Main mitigation sectoral instruments

2.2.1. Main mitigation instrument in the AFOLU sector

The main mitigation instrument recently developed in this sector is the National REDD+ Strategy 2017 – 2026.

It provides a roadmap for the implementation of policies and measures to address deforestation drivers and forest degradation. It is evidence of the country´s continued commitment to sustainable forest resource management in an era of climate change.

The NRS goal is to reduce deforestation and forest degradation while promoting sustainable management, conservation of natural resources, and contribute to poverty alleviation.

The scope of Cambodia's REDD+ Strategy will prioritize addressing deforestation and build capacity alongside to later address forest degradation. Cambodia will implement REDD+ at the national level under the results-based payment mechanism of the UNFCCC. Cambodia will consider implementation of sub- national and voluntary market-based REDD+ projects subject to specific criteria.

The three strategic objectives that have been identified to achieve the vision, mission and goal of the Strategy are to:

(1) Improve management and monitoring of forest resources and forest land use:

- Strengthen management of forest conservation areas, such as protected areas and flooded and mangrove conservation areas;
- Promote forest land tenure security through forest land classification, zoning, demarcation, and registration;
- Strengthen law enforcement activities to address unauthorized logging, and encroachment;
- Monitor the status of Economic Land Concessions (ELCs) and social land concessions (SLCs) for compliance with regulations;
- Support harmonization of legal frameworks for effective management of forest resources;
- Strengthen regulatory framework and capacity for social and environmental impact assessment and compliance; and
- Strengthen capacity for data management and establish decision support systems for forest and land use sector.

(2) Strengthen implementation of sustainable forest management:

- Strengthen and scale up community-based forest management;
- Engage and encourage the private sector to implement alternative and sustainable supply chains from agro industrial plantations, and to reduce emissions;
- Expand afforestation, reforestation and restoration activities;
- Enhance timber supply and wood-based energy sourced from community-based forest management areas and private plantations to reduce pressure on forest areas;

- Promote effective, equitable, sustainable management and use of forests, forest lands and non-timber forest products; and
- Identify and implement alternative and sustainable livelihood development programmes for local communities most dependent on forest resources.

(3) Mainstream approaches to reduce deforestation, build capacity, and engage stakeholders:

- Support mechanisms to mainstream policies and measures that reduce deforestation in relevant government ministries and agencies;
- Strengthen national and sub national capacity for improved coordination mechanisms for national land use policy and planning;
- Strengthen capacity, knowledge and awareness of stakeholders to enhance their contribution to reducing deforestation and forest degradation;
- Encourage public engagement, participation and consultations in forestry and land use planning, and promote the involvement of multiple stakeholders;
- Strengthen capacity of academic and research institutions in training, research and technology development associated with forestry and land use; and
- Establish partnerships with development partners in building knowledge and human resources related to forestry, land use, and climate change.

The NRS will be implemented in two phases:

- During Phase I (2017-2021), an action plan will be developed and institutional arrangements for NRS implementation will be finalized. Drivers will be addressed through improved implementation of existing forest management frameworks such as National Forest Programme (NFP), National Protected Areas Strategic Management Plan (NPASMP). These frameworks include policies and measures related to strengthening forest law enforcement, providing tenure security and implementing community-based nature resource management. Implementation is however hindered by inadequate financial and technical resources. The NRS will prioritize mobilisation of upfront non-results-based finance that will address these challenges and alongside build capacity for field-based implementation and results. Steps will be taken to improve existing versions of the Forest Reference Level (FRL) and the National Forest Monitoring System (NFMS) and a Safeguards Information System (SIS) will be established to complete the requirements of the Warsaw Framework. A mid-term assessment of the NRS will be undertaken to identify lessons, challenges, and to address these during the next phase.
- During Phase II (2022-2026), the transition from readiness to implementation will be completed. The achievement of measurable results will be prioritised. Phase I assessment findings will be reviewed, and appropriate steps taken accordingly. An assessment will also be completed of forest and land cover change results of 2016, 2018, and 2020 to measure the effectiveness of the NRS. A key milestone during this phase will be the establishment of a rigorous forest monitoring mechanism that can review policies and measures to address drivers of deforestation and forest degradation for effectiveness and efficiency. In addition, the SIS will

continue to monitor and strengthen as required to ensure compliance with UNFCCC requirements for safeguards. This phase will also establish a functioning disclosure mechanism of the information, data, and results of FRL, NFMS, studies and analytical work through a web-based platform and other communication media and tools. This phase will also see improved and accurate data and results that will lead to revised versions of the FRL and the NFMS.

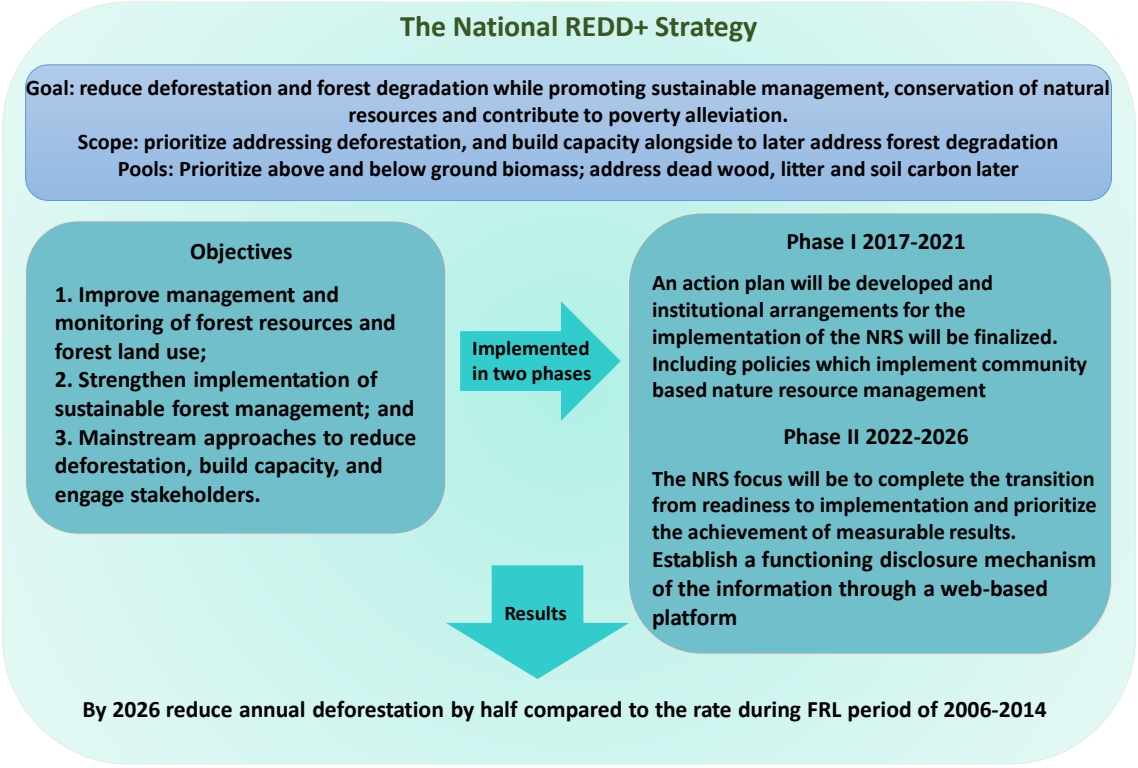


Figure 20. The Cambodian REDD+ Strategy

2.2.2. Main mitigation instruments in the energy, industry and waste sectors

The main mitigation instrument recently developed (although it has not yet been approved) is the National Energy Efficiency Policy 2018 – 2035.

It was prepared in 2018 with two main goals:

- Improve the management and maintenance of existing infrastructure (e.g. buildings) and industrial processes (e.g. for the use of fuel wood) for increased energy efficiency; and
- Increase the transfer and adoption of energy efficient technology (e.g. fuel-efficient vehicles and light bulbs) to reduce energy intensity.

The overall objective of the National Energy Efficiency Policy is to reduce future national energy demand by 20 per cent in 2035 compared to the Business as Usual (BaU) projections. If effectively implemented, the result will be:

- Energy consumption of 1 million tonnes of oil equivalent (toe) by 2035 relative to the business as usual scenario;
- Energy intensity of 65% in 2035, relative to 2014; and
- CO2 emissions of 3 million tons in 2035, or 28.5 cumulative million tonnes between 2017 and 2035, relative to the BAU scenario.

The five sectors identified as priority areas for the energy efficiency policy are represented in the figure below.

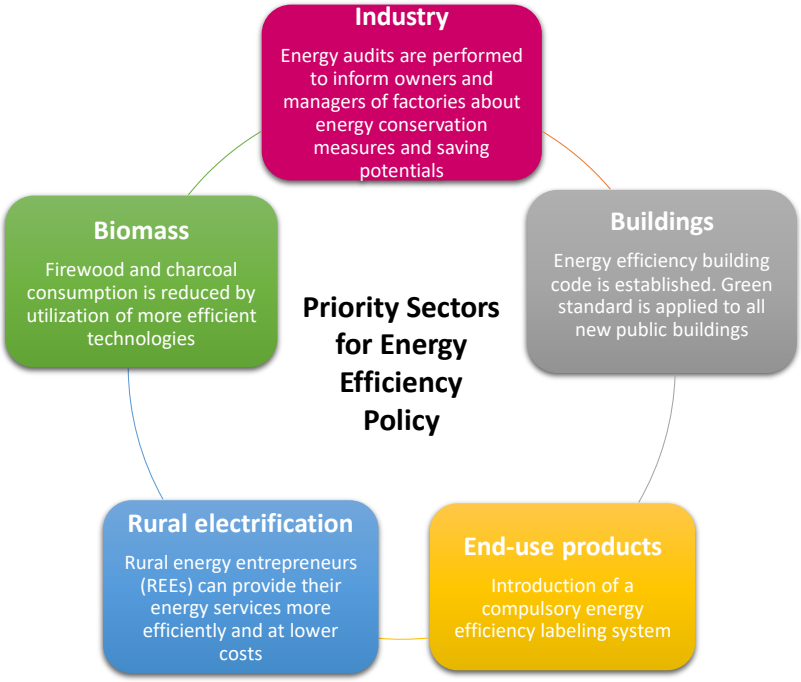


Figure 21. Priority sectors for energy efficiency policy

Priorities, action plans, and targets are summarised in the table below.

Table 78. Energy efficiency priorities, action plans, and targets

Energy access priorities
Improve overall electricity supply particularly all villages not yet electrified and promote an equal level of electricity services in cities and rural areas of Cambodia. Promotion of biomass use for decentralized production of energy (thermal or electrical) through gasification or bio digestion.
Energy access action plan
In 2020 the high-tension transmission line will cover over 24 cities and provinces of Cambodia. And these cities and provinces will have at least one sub- station each to receive electricity supply from the national grid. Since 2015, the national grid has sufficient capacity to support consumer demand already connected to the national grid and in 2018 the national grid will provide 25% reserve capacity for the system. In 2020, 80% of villages will be connected to the national grid and another 20% will be supplied by other energy sources such as electricity imported from neighbouring countries or single supply systems. In 2030, 95% of villages will be connected to the national grid while another 5% of the villages will be connected to single supply systems with a quality of supply similar to the national grid. In 2020, at least 50% of households in Cambodia will be grid-connected with the same quality of supply as those connected to the national grid and 70% of households will follow up to 2030. In 2020, the gap of electricity selling prices between urban and rural areas will be reduced and the price difference should not exceed 15%.

Develop alternative electricity sources and improve electrical transmission lines to satisfy the demand for electricity services under close consideration of safety, quality and security of supply aspects at reasonable costs.

Continuous support to social affairs in rural electrification fund program of EDC by contribution of RGC's direct fund and business support of EDC.

Clean cooking solutions: Promotion of improved and efficient cookstoves for urban households; Promotion of improved and efficient cookstoves for household scale industries in rural areas.

Energy Efficiency priorities

Encouraging the efficient use of energy with minimal impact on the environment despite the energy efficiency concept being included in NSDP 2009-2013, no specific sector is mentioned.

The energy efficiency of the industrial sector is improved; The energy intensity per unit of production is reduced by means of reducing the specific energy consumption of industrial production processes.

Increase knowledge around rural electrification efficiency: Government, private organisations, and rural households are better informed and prepared to tackle energy efficiency in rural electrification.

Establish an energy manager program.

Energy Efficiency targets

Reduce the future National Energy demand by 20% through 2035, compared to business as usual projections.

Energy Efficiency action plans

Implementation of voluntary standards on energy efficiency in industrial enterprises consuming more than a certain amount (to be determined) of energy per year.

Implementation of energy efficiency/conservation laws/ regulations on industrial energy use.

Support the development of energy service companies (ESCO's).

Technical training for engineers and technicians in the field of energy efficiency, preforming energy audits, establishing EMS and implementing energy saving measures in the industry.

Support the local development and manufacturing of energy efficient equipment.

A compulsory national energy efficiency labelling system for household appliances is being elaborated and promulgated by government.

Energy Efficiency standards for appliances

Energy efficiency of end-user products has increased, and residential electricity consumption is reduced. Energy efficiency of end user products is improved. At present there are no energy efficiency standards available in Cambodia and the end user does not receive any information on the energy efficiency of household appliances available in the market. It is therefore recommended that the energy consumption of energy consuming household appliances is tested by certified testing laboratories and labelled according to an approved labelling system. According to experiences in other Association of Southeast Asian Nations (ASEAN) countries and in Europe, by means of these measures, energy savings of up to 50% can be achieved in residential energy consumption.

Energy Efficiency industry standards

Capacity building in the field of energy efficiency and conservation (EE&C) in industry is strengthened.

Owners and managers of factories are trained in energy management and apply its principles.

Energy Efficiency building standards

An energy efficiency building code for new buildings is established.

Energy efficiency of new buildings is improved. An energy efficiency building code for new buildings is established. An energy efficiency building code is widely regarded as the most effective way to reduce energy consumption in buildings. There is relatively little to no cost to improve the design of new buildings, to make them inherently more energy efficient, before they are built. Once a building is built, changes become more difficult and expensive. An energy efficiency building code specifies these energy efficient designs.

Energy efficiency in existing buildings is improved. An Energy Manager Certification program is established. Energy efficiency of existing buildings can be improved in the most cost-effective manner by careful attention to building operation. An onsite energy manager can both monitor building equipment, such as air-conditioners and boilers, and manage the habits of building occupants e.g. turning off lights when not in use. Furthermore, the building energy manager can report energy data and energy saving strategies that are valuable for policy making.

Energy efficiency in public buildings is improved. A green standard is applied to all new public buildings. A green standard is chosen for government buildings because it is in government's power to subscribe to a higher standard than energy efficiency codes and lead the way for Cambodia. An added benefit is addressing wider environmental

concerns, such as building waste in landfills and water consumption. Also, these standards are already written, such the LOTUS in Viet Nam, and thus can be implemented relatively quickly. A model program is the United States' Government Service Administration (GSA) which has made the Green Building Council's LED green standard a requirement for all federal government buildings.

Energy Service Companies (ESCOs)

Rural energy entrepreneurs (REEs) operate more efficient businesses. Rural energy entrepreneurs (REEs) can provide their energy services more efficiently and at lower costs. To improve energy efficiency of rural electricity supply, the two most urgent priorities are introducing and enforcing standards on electricity generation and distribution and training of REEs in operating their systems more effectively. REEs generate and/or distribute electricity across much of Cambodia. Although some guideline standards apply to licensed REEs, they are not properly enforced. On top of this, a large number remain unlicensed. REEs in operation with electrical losses of up to 40%. These unlicensed REEs represent the greatest potential for efficiency savings in rural electrification and can be tackled through better training, stricter standards, and improved technology (including renewable energy). Increasing efficiency will lead to lower electricity costs for the end users. Support the development of ESCO's.

Energy Efficiency public awareness/promotional programmes

To increase public awareness and create a platform for cooperation and networking, it is proposed to establish an "Energy Efficiency Information Resources Centre" (EEIRC) at MIME. This EEIRC should comprise: (a) A physical desk at MIME accessible by phone or in person and (b) A web portal via internet offering information and services about EE products, regulations, standards, reports and governmental publications.

End users are aware of the concept of energy efficiency and behave accordingly - (a) End users change their behaviour and use their electrical appliances in a more efficient way; (i) At present there is a lack of knowledge about energy efficiency on all levels. Education programs must therefore be developed and implemented into school curricula. Publicity campaigns must be broadcasted by radio and TV and be published in newspapers to inform the greater public about the concept of energy efficiency and the saving potentials that can be realized by the appropriate utilization of electrical appliances, avoiding any wasteful consumption of electricity.

Organize awareness raising campaigns about energy efficiency in industry.

Education programs in energy efficient behaviour are performed in schools.

Renewable Energy action plans

Promotion of biomass use for decentralized production of energy (thermal or electrical) through gasification or bio digestion.

GHG emissions reduction targets

Reduce National CO_2 emissions in 2035 by 3 million tons of CO_2.

Biomass for energy production purposes

The National forest resources are protected by the sustainable and efficient use of biomass. Firewood and charcoal consumption is reduced by utilization of more efficient technologies. Community based sustainable forest management is being implemented effectively within a context of province, distinct and commune level planning and delivering concrete benefits to local communities. A strong demand and supply chain of energy efficient cook stoves is established. The most urgent issues as discussed in the working group on energy efficiency in biomass utilization concern the targeting of the sector with the largest efficiency potential, to make the improved technology competitive by smart and innovative mechanisms and to conduct public awareness campaigns about these technologies via mass media to raise public awareness, especially of biomass users on the availability of EE technologies in the market and their comparative advantages.

Energy sector investment priorities

Attract private participation in energy infrastructure investment including production, transmission and distribution focusing strongly on modern technology, economic efficiency and on reducing negative social and environmental impacts.

Provide financial incentives to interested companies to implement energy efficiency strategies and measures.

Governance

Energy management principles:

Developing a policy and a legal and regulatory framework for the energy sector in order to ensure efficient management and resources utilization for the economic development and improvement in livelihoods of the Cambodia people.

Promotion of good energy management practice in industrial enterprises.

Public database availability: Improve energy data collection and processing in the industry.

2.3. Main mitigation projects by sector

Over the past few years, in parallel to development of the climate change policy framework, the Royal Government of Cambodia has developed and implemented a range of projects aimed specifically at mitigating GHG emissions.

Information on the main mitigation projects in Cambodia (excluding JCM projects, addressed below) in tabular format is provided in BUR Annex IV. Complementary, the following two sections provide detailed descriptive information on the characteristics, scope and main features of the mitigation projects being implemented, planned or finalised in Cambodia, separated into the energy, industry, and waste sectors; and agriculture, forestry and other land uses sectors.

2.3.1. Agriculture, Forestry and other land uses sector

This section summarizes existing forest carbon projects. In some instances, the project's own emission reduction estimates—both past (i.e. prior to 2017) and future (for the lifetime of the project, which may be from 30 to 60 years)—are provided. It is worth noting that such projects use different methodologies and underlying data sources than the national forest monitoring system. There is currently an ongoing effort to align the GHG estimation and accounting for forest carbon due to a recognition of such mismatches. Therefore, estimated GHG emissions by projects should be considered within this context.

Southern Cardamom REDD+ Project

The Southern Cardamom REDD+ Project (SCRP) is an initiative designed to promote climate change mitigation and adaptation, maintain biodiversity and create alternative livelihoods under the United Nations scheme of Reducing Emissions from Deforestation and Forest Degradation (REDD+).

The SCRP encompasses 445,339 ha of forest within parts of Southern Cardamom National Park and Tatai Wildlife Sanctuary. It intends to protect a critical part of the Cardamom Mountains Rainforest Ecoregion – one of the 200 most important locations for biodiversity conservation on the planet. The Project will directly support the livelihoods of 21 villages in nine communities around the perimeter of the project area. Eight additional villages in four communities are eligible to receive educational scholarships. These communities represent approximately 3,957 families and 16,495 individuals.

The project's climate benefits are currently estimated using a Verified Carbon Standard (VCS) methodology not yet aligned with national GHG estimation and accounting for the forest sector. Through use of VCS methodology, the project estimated (and had verified) avoided emission of approximately 12 million t CO2eq during a first monitoring period of 2015 to 2017 (3 years total). Project lifetime is 30 years, i.e. to 2045, and is expected to generate not only emission reductions, but also substantial community and biodiversity co-benefits.

New and sustainable livelihood opportunities, such as direct employment, alternative income generating activities (IGAs) and initiatives to stimulate investment in businesses will be designed to reduce pressure on the environment while significantly increasing

community well-being. Additional programs will address food security, improve health and education facilities, as well as raise environmental awareness. Biodiversity co-benefits will be achieved through greater protection of the ecosystem predominantly by means of increased security and improved monitoring.

The project will also protect critical habitat for significant populations of many IUCN listed species, including Asian elephant, Asiatic black bear, sun bear, large spotted civet, clouded leopard, and dhole, as well as the critically endangered reptiles Siamese crocodile and Southern river terrapin.

Reduced Emissions from Deforestation and Degradation in Keo Seima Wildlife Sanctuary

The Keo Seima Wildlife Sanctuary (KSWS) REDD+ Project aims to support demonstration activities and development of REDD+ strategies in the KSWS.

The KSWS, formerly known as the Seima Protection Forest, is home to more than 60 species of animal and plants on the global Red List threatened with extinction, according to the criteria of the IUCN, the International Union for Conservation of Nature. The project goal aims to support the Royal Government of Cambodia through planning, project development, adaptive management, and capacity building for enhancing REDD+ implementation. The KSWS located in eastern Cambodia covers an area of 292,690 ha, predominantly in the Mondulkiri Province with a small area extending into Kratie Province. The project accounting area covers 166,983 ha of forest in the KSWS.

The Ministry of Environment, Provincial Authorities and WCS provided local communities from 20 villages with Community Development Agreements under the Keo Seima Wildlife Sanctuary's (KSWS) REDD+ project. This agreement will provide them with a large revenue share from KSWS's carbon credit sales for use in implementing their prioritized village development plans, with typical activities including improving access to clean water and providing community meeting buildings.

The KSWS project also uses a VCS methodology that is not currently consistent with national GHG estimation and accounting for the forest sector. Using VCS methodology, the project is projected to avoid emissions of more than 14 million metric tons of CO2 eq. over the first 10-year period between 2010 and 2019. During the period 2010/2017 the estimated, reported and verified emissions reduction under VCS reached nearly 15 million metric tons of CO2.

In 2016, the Royal Government of Cambodia through the MoE, in partnership with the WCS, sold KSWS's first carbon credits to an American company.

The KSWS is an example of GHG mitigation that the RGC has achieved through partnership with conservation NGOs and other stakeholders to protect Cambodia's natural resources. Local communities have played a very important role in safeguarding KSWS's forests and biodiversity for many generations. They have sacrificed time and risked lives, alongside the MoE rangers, to combat illegal logging and poaching activities.

Currently, only voluntary carbon markets transact internationally forest carbon credits. Such markets enable companies, organizations and individuals to pay for a range of actions that reduce carbon emissions. The KSWS project is verified against both the Verified Carbon Standard (VCS) and the Climate, Community and Biodiversity Standards (CCBA).

Tumring REDD+ Project

The Tumring REDD+ Project (TRP) is a multi-partner initiative designed to promote climate change mitigation and adaptation, restore biodiversity and create alternative livelihoods.

Despite its global importance, uncontrolled small-scale land conversion of forest to agricultural land by migrants and conversion to agro-industrial plantations by the private sector make the Tumring area one of most threatened forest landscapes in Cambodia. Deforestation drivers in this area consist of a high demand for new agricultural and cash crop land. The population in the province and the area around the project has significantly increased over the last several decades. This is both due to migration and an increase in childbirth rates.

In response to the threats to the project area, the MAFF, in consultation with the Korean government, is making attempts to protect the southwestern edge of the Prey Long landscape. TRP protection will be achieved by both increasing the level of protection of the Project Area, and also providing project activities to the communities that are designed to mitigate these drivers of deforestation.

One project activity includes employing additional rangers and a community member force. The current ranger/community member force suffers from inadequate equipment and training. This project will provide invaluable support to this program. Two very important project activities are assisting local communities with promoting effective land use planning and granting secure land tenure.

Through these activities, the TRP will generate substantial community and biodiversity co-benefits. Additional programs will address food security, improve health and education facilities, as well as raise environmental awareness. Biodiversity co-benefits will be achieved through greater protection of the ecosystem predominantly by means of increased security and improved monitoring.

The 66,645 ha TRP lies on the southwestern edge of the recently declared Prey Long Wildlife Sanctuary (PLWS) in central Cambodia. The Prey Long Wildlife Sanctuary contains the largest remaining area of lowland evergreen forest in Cambodia and forms part of the Indo-Burma Hotspot, one of the world's 34 biodiversity hotspots.

The PLWS is the primary watershed of central Cambodia that regulates water and sediment flow to the Mekong River and Tonle Sap Lake. An estimated 700,000 Cambodians depend on these watersheds for irrigation and fisheries. Its forests are also recognized for their importance in securing rural livelihoods, with more than 250,000 people, mostly indigenous Kuy, living in and or adjacent to them.

The TRP is an important buffer area for the PLWS. It houses important biodiversity including the endangered pileated gibbon (Hylobates piletus) and sunda pangolin (Manis javanica),

as well as a host of other threatened species. It also stores carbon, whose release in the atmosphere through deforestation results in the emission of large quantities of greenhouse gases. Thus, protecting the TRP forests is critical for mitigating global climate change, conserving biodiversity, and ensuring the provision of ecosystem services to a marginalized indigenous community.

Similarly, the Tumring REDD+ Project is also currently using a VCS methodology not aligned with national GHG estimations. Nevertheless, the project using a VCS methodology, estimates that by reducing the deforestation in the TRP Project Area, it will result in a reduction of [2.8 million] tCO_2eq. emissions over a 10-year timeframe.

REDD in Community Forests – Oddar Meanchey

Cambodia's Forestry Administration, along with Pact and Terra Global Capital developed this first Cambodian REDD carbon offset project.

The project took place in the northwest Cambodian province of Oddar Meanchey. In recent years, the province's forests were under constant and intense pressure from commercial and illegal logging, forest fires, economic land concessions, and encroachment. These issues, coupled with rapid economic growth, population expansion, migration, and land speculation, accelerated deforestation throughout the province. Between 2002 and 2006, Oddar Meanchey lost 2% of its forests annually.

This project was specifically approved by the Council of Ministers (Decision no. 699 signed May 2008), with the principle that the project would ensure that carbon revenues were used to: (1) improve forest quality, (2) provide maximum benefits to local communities participating in project activities, and (3) study the potential area for new REDD projects in Cambodia.

The project was one of the country's REDD demonstration projects for Cambodia's National REDD Roadmap. The project area consisted of 13 discrete community forest areas managed by 58 villages over a total project area of 67,783 hectares of forest land in the North western province of Oddar Meanchey.

The project was one of the first to use a new methodology and to be submitted under both the Voluntary Carbon Standard (VCS) and the Climate Community and Biodiversity Alliance (CCBA) guidelines.

No longer in effect, the project was expected to sequester 7.1 million metric tons of CO2 over 30 years.

2.3.2. Energy, industry and waste sectors

At its sixteenth session, the Conference of Parties (COP) decided to create a registry to record nationally appropriate mitigation actions (NAMAs) seeking international support, and to facilitate the matching of finance, technology and capacity-building support with these actions. NAMAs are diverse, ranging from project based mitigation actions to national or sectoral programmes or policies, and exist in preparation (in the conceptual or drafting phase towards a formal proposal that describes the activities, costs, support needs,

potential GHG emission reductions and time frame) or in implementation (approved by the national government and ready to begin operation/awaiting the resources needed).

NAMAs that have been submitted to the NAMA Registry are publicly available in this platform https://www4.unfccc.int/sites/PublicNAMA/SitePages/Country.aspx?CountryId=29.

There are two NAMAs under development in Cambodia, summarised below.

NAMA on Energy Efficiency in the Garment Industry

The Ministry of Industry & Handicraft and UNDP MDG Carbon have issued the NAMA on Energy Efficiency in the Garment Industry in Cambodia.

NAMA´s overall objective is to support Cambodia´s energy efficiency policy by improving efficiency in the industrial sector and building capacity in the field of energy efficiency. Efficient biomass boilers using agricultural waste streams as fuel input will decrease GHG emissions by displacing the use of non-renewable biomass. The introduction of efficient sewing, washing, drying machines and compressors will improve energy efficiency in motor driven systems and will decrease GHG emissions by reducing the use of electricity. The most important sustainable benefits of the NAMA will be improvements in energy security, income generation and asset accumulation. Therefore, the NAMA for Energy Efficiency in the garment industry is designed to support the country to improve energy efficiency and energy security while reducing GHG emissions.

The NAMA will be implemented over a period of 6.5 years. Initial efforts will focus on securing national and international funding as well as establishing the institutional structure. There will be a five-year period for investment in new energy efficient equipment.

NAMA on Sustainable Charcoal Value-Chains

Since May 2015, the General Secretariat of the National Council for Sustainable Development (GSSD) and GERES have been collaborating together to develop a NAMA on sustainable charcoal and solid biomass fuels to leverage private sector investment, support forest restoration in protected areas, and invest in a shift towards sustainable practices for traditional producers.

In Cambodia, charcoal consumption by households and restaurants represents an annual market of 85 million USD, as well as one of the main drivers of forest degradation. Each year, more than 1.6 million tonnes of wood are overharvested, representing the emission of 3 million tCO_2eq.

With socio-economic projections indicating no decreases in consumption in the next decades, charcoal pressure on protected areas will continue to increase, threatening the achievement of the first NDC that aims to increase and maintain forest cover at 60%.

Currently, several economic and regulatory barriers prevent the shift to sustainable charcoal production. Besides non-sustainable charcoal producers not paying for the environmental cost of forest degradation, they also benefit from an indirect subsidy

through a de facto VAT exemption making sustainable charcoal non-competitive on the market without a direct or indirect external subsidy.

The Ministry of Environment (MoE), responsible for both coordinating the climate change response of Cambodia and the management of protected areas, is willing to tackle this issue by leveraging private sector investment in sustainable charcoal production and supporting the conversion of existing producers to sustainable practices.

Through this NAMA, the MoE strives to tackle the current informal subsidy on non-sustainable charcoal by exempting sustainable producers from VAT, and to progressively increase sustainable charcoal competitiveness by collecting fees on non-sustainable charcoal trade. This domestic financing stream will provide the MoE with the long-term means to accompany the conversion of traditional producers to more sustainable technologies and practices. In the meantime, the protected areas buffer-zone will need to be restored to enable the development of sustainable charcoal centres with high-efficiency charcoal kiln technologies. The NAMA will accelerate this transformation by bridging the profitability gap of sustainable charcoal initiatives through a result-based subsidy during the transition period.

National Bio-digester Programme

In January 2006, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and SNV Cambodia agreed on the joint development of a National Biodigester Programme (NBP) to create an indigenous, sustainable energy source in Cambodia and to utilize the potential of biogas in the country.

Most households with technical potential for a biodigester rely primarily on wood for cooking causing substantial exposure to hazardous household air pollution (with related health hazards) and contributing to deforestation.

The overall objective of the NBP is the dissemination of domestic biodigesters as an indigenous, sustainable energy source through the development of a commercial, market oriented, biodigester sector in eight selected provinces of Cambodia. Project activities aimed to resolve the issues sketched in the baseline scenario above, by hygienically treating animal and human waste in a biodigester to produce a clean renewable cooking fuel, biogas, whereas the treated waste is to be used as a potent and safe organic fertilizer. Exploiting the potential of biogas enables rural households to switch to clean cooking from relying on wood, reduce deforestation and improve agricultural yields through use of bio-slurry.

Locally constructed biogas plants convert animal manure and human excrement into combustible methane gas, which can be used in simple gas stoves, rice cookers, and lamps. Due to a reduced need for gathering or buying traditional fuels, biogas users save time and money while reducing deforestation and greenhouse gas emissions.

The first phase of the National Biodigester Programme (2005-2012) concentrated on the introduction, promotion and dissemination of the technology and on setting up sector infrastructure.

The second phase (2013-2016) had a strong focus on strengthening all actors to ensure long-term sustainability.

The current phase (2019-2025) aims at contributing to:

- increasing the number of family sized, quality biodigesters with the total 8,600 biodigesters during 2019-2025 in selected provinces;
- ensuring the continued operation of all biodigesters installed;
- maximising the benefits of biodigesters, particularly optimum use of digester effluent; and
- promoting stakeholder technical capacity development within the NBP for wider scale deployment of biodigester technology.

The NBP has already covered 10,000 family-sized bio-digesters with the expected annual emissions reduction of around 59 $ktCO_2$ eq./year. During the period 2012/2016, the total emission reduction estimated, reported, and validated by the Project reach the 487 $ktCO_2$ eq.

Fuelwood Saving Project

The Cambodian fuelwood saving project (CFSP) has been working on the improvement of cook stoves that consume about 20.0% less charcoal than traditional ones and could reduce GHG emissions by about 160 $ktCO_2$eq./year over the period of 2003-2012.

The objectives of the CFSP were to disseminate improved cook stoves and other wood energy saving devices to critical and highly populated areas of the country, to perform research on improved cook stoves and wood energy saving related matters, to promote the importance of wood energy issue in Cambodia, to facilitate technology exchange with other countries in Asia and to support the government of Cambodia to establish a "national wood energy policy".

Outputs included selling charcoal & wood burning stoves, disseminating own built stoves and training technicians to disseminate own built stoves and producers to produce commercialized improved cook stoves. The project provided credits to encourage producers to manufacture additional improved cook stoves.

Det Norske Veritas Certification AS was therefore able to certify that emission reductions reported from the project during May 10, 2003 – January 9, 2007 amount to 182.4 $ktCO_2$ eq. Additional verifications were carried out yearly from 2008 to 2013 resulting in an amount of emission reduction of 288.3 $ktCO_2$ eq per year. The total estimated, reported, and verified emission reduction of the project during May 10, 2003 to May 9, 2013 reach to 1,912.2 $ktCO_2$eq.

3. Market based mechanisms

3.1. Clean Development Mechanism (CDM)

The Royal Government of Cambodia is strongly committed to the Kyoto Protocol and views CDM as an opportunity to achieve national sustainable development and poverty reduction objectives, while at the same time reducing greenhouse gas emissions.

A leader among least developed countries (LDCs) for CDM awareness and Designated National Authority (DNA) capacity, Cambodia has several CDM projects. Due to low electrification rates and national power system efficiency, Cambodia has made strident efforts to implement a sustainable energy efficiency programme aimed at meeting its domestic energy needs. Therefore, the CDM projects portfolio can complement the Government´s aim to achieve these goals, as well as improve individual well-being.

The following table summarizes the CDM projects registered in Cambodia.

Table 79. CDM projects in Cambodia

Name of CDM project activity	Type of Project	Information on technology	Registration Date	Annual emission reduction estimated (tCO_2/year)	Emission reduction reported (tCO_2/year)
Kamchay Hydroelectric BOT Project	Hydro	New reservoir	08/10/2013	281,348	-
Cambodia Stung Atay Hydropower Project	Hydro	New reservoir	19/12/2012	266,472	-
Stung Tatay Hydroelectric Project	Hydro	New reservoir	14/12/2012	563,074	2,414,369
Lower Stung Russei Chrum Hydro-Electric Project	Hydro	New reservoir	21/08/2012	701,199	3,120,080
Biogas Project at MH Bio-Ethanol Distillery, Cambodia	Biogas	Agricultural waste	16/02/2012	58,146	145,159
W2E Siang Phong Biogas Project Cambodia	Biogas	Agricultural waste	07/04/2011	26,592	-
Kampot Cement Waste Heat Power Generation Project (KCC-WHG)	Waste heat/gas utilization	Cement production line	17/04/2009	17,107	21,810
Methane-fired power generation plant in Samrong Thom Animal Husbandry, Cambodia	Biogas	Animal waste	03/12/2008	5,593	-
TTY Cambodia Biogas Project	Biogas	Agricultural waste	03/09/2008	50,036	-

Name of CDM project activity	Type of Project	Information on technology	Registration Date	Annual emission reduction estimated (tCO_2/year)	Emission reduction reported (tCO_2/year)
Angkor Bio Cogen Rice Husk Power Project	Biomass	Rice Husk	10/08/2006	51,620	152,113
PoA Waste to energy using biomass gasification in South East Asia LDCs programme of activities in Cambodia	Biomass	Waste gasification	14/03/2016	549	-
PoA Water Kiosks in Cambodia– CPA 4	Small-scale water treatment stations	Water Purification	05/12/2016	7,321	-

3.2. Joint Crediting Mechanism (JCM)

The Japanese and Cambodian governments signed the Low Carbon Growth Partnership on April 11, 2014.

A Joint Crediting Mechanism (JCM) was established to promote investment and deployment of low carbon technologies, products, systems, services, infrastructure and capacity building leading to low carbon and sustainable growth in Cambodia.

Verified reductions or removals from mitigation projects including the forestry sector under the JCM can be used as a part of Japan's internationally pledged greenhouse gases mitigation efforts and Cambodia's nationally appropriate mitigation actions.

Both parties ensure utilizing the JCM´s robust methodologies, transparency and environmental integrity and maintain the JCM simple and practical to promote concrete actions for global greenhouse gases emissions reductions or removals.

The JCM starts its operation as a non-tradable credit type mechanism. Both sides continue discussions towards the transition to a tradable credit type mechanism and reach a conclusion at the earliest possible date, while considering the JCM implementation timeframe.

This partnership covers the period from the signing of the document for verified emission reductions or removals from the JCM projects to be made until 2030. Both sides consider a possible extension of the above-mentioned period and reach a conclusion by 2030.

The JCM has the following purposes:

- To facilitate diffusion of leading low carbon technologies, products, systems, services, and infrastructures as well as implementation of mitigation actions, and contributing to sustainable development of the Kingdom of Cambodia;
- To appropriately evaluate contributions to GHG emission reductions or removals from Japan in a quantitative manner, through mitigation actions implemented in the Kingdom of Cambodia and use those emission reductions or removals to achieve emission reduction targets of the countries involved; and

- To contribute to the ultimate objective of the UNFCCC by facilitating global actions for emission reductions or removals.

Both parties aim for concrete contributions to assist in Cambodia´s adaptation efforts through the JCM after it is converted to the tradable credit type mechanism.

Project participants may allocate part of the credits to their respective side. Each side checks the status of the issuance and use of credits and assures that no double counting is discovered.

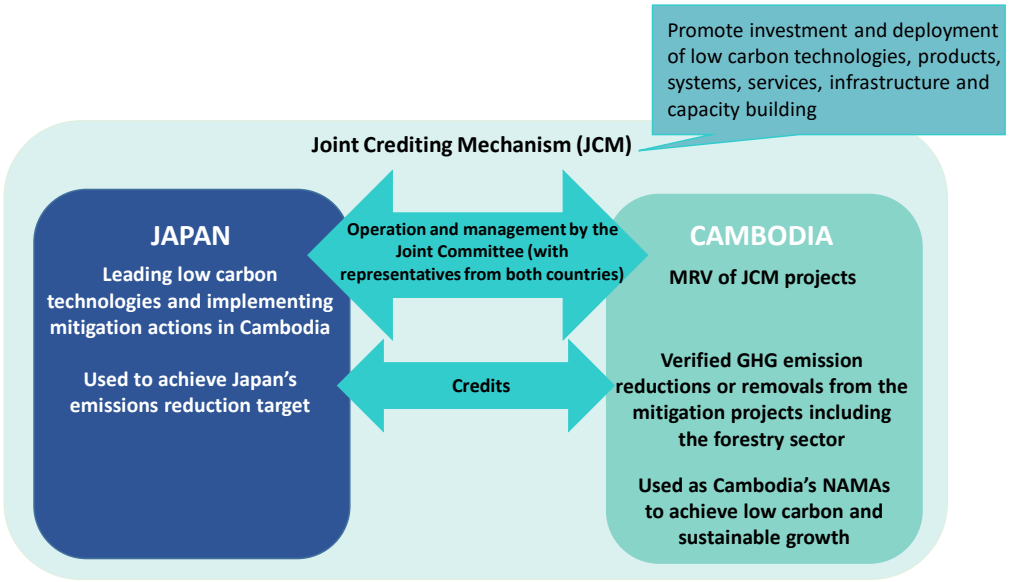


Figure 22. The JCM

The following table summarises the JCM projects planned, started and completed and the expected annual GHG emission reductions.

Table 80. JCM projects

Mitigation Action	Implementing Institution	Project Status	Duration	Sectors	Expected emission reductions (tCO2/year)	Gas Covered
Introduction of High Efficiency LED Lighting Utilizing Wireless Network	Minebea Co., Ltd. Overseas Cambodian Investment Corporation (OCIC) Siem Reap Provincial Hall APSARA	Completed	Jan 2016 – Dec 2018	Energy Sector	3,590	CO2
Introduction of Ultra-lightweight Solar Panels for Power Generation at International School Project	Asian Gateway Corporation International School of Phnom Penh	Completed	Feb 2016 – Sep 2016	Energy sector	149	CO2

Mitigation Action	Implementing Institution	Project Status	Duration	Sectors	Expected emission reductions (tCO2/year)	Gas Covered
Introduction of 1MW Solar Power System and High Efficiency Centrifugal Chiller in Large Shopping Mall	AEON MALL Co., Ltd. AEON MALL (CAMBODIA) CO., LTD.	Completed	Nov 2016 – May 2018	Energy sector	1,688	CO2
Energy Saving by Inverters for Distribution Pumps in Water Treatment Plant	METAWATER Co., Ltd. Phnom Penh Water Supply Authority	Completed	Apr 2016 – Aug 2018	Energy sector	407	CH4
Provincial Water Supply and Sanitation Project	ADB	Not Started	Planned: Jul 2019 – Jun 2021	Energy sector	6,371	CO2
JCM – REDD+ Prey Lang	Mitsui&CO. Ltd.	Installation Phase		Forestry	1,136,158	CO2

3.3. Voluntary Emission Reductions (VERs)

A few local organizations have implemented voluntary carbon standards as viable alternatives to the CDM.

There are six Voluntary Emission Reductions (VERs) projects, including four REDD+ projects and two energy projects (for a more extensive description of these projects please refer to the mitigation projects section of this chapter). Five of the six projects are registered on Verra´s VCS standard and one on Gold Standard.

Table 81. VERs projects

Name of VER project activity	Implementing Institution	Standard	Sector	Duration	Ex-ante estimation annual emission reduction (tCO_2/year)	Reporting Period	Annual emission reduction reported [20](tCO_2/year)
Southern Cardamon REDD+ Project	The RGC, the Ministry of Environment	VCS	Agriculture, Forestry, Land Use	01 January 2015 – 31 December 2044	3,867,568	2015/2017	3,982,378[21]
Tumring REDD+ Project	The RGC, the Forestry Administration	VCS	Agriculture, Forestry, Land Use	01 January 2015 – 31 December 2044	378,434	-	-
Reduced Emissions from Deforestation and Degradation in Keo Seima Wildlife Sanctuary	The RGC, the Forestry Administration	VCS	Agriculture, Forestry, Land Use	01 January 2010 – 31 December 2069	1,426,648	2010/2017	1,842,174[22]
Reduced Emissions from Deforestation and Degradation in Community Forest – Oddar Meanchey, Cambodia	The RGC, the Forestry Administration	VCS	Agriculture, Forestry, Land Use	28 February 2008 – 28 February 2037	204,792	-	-
Fuel Wood Saving with improved Cookstoves in Cambodia	GERES (Groupe Energies Renouvelables & Environnement)	VCS	Energy	01 January 2003 – 09 May 2013	192,600	2003/2013	191,215[23]
Bio-digester Programme	The RGC, the Ministry of Agriculture, Forestry and Fisheries	Gold Standard	Energy	13 March 2006 – 25 February 2023	10,000	2012/2016	97,321[24]

[20] It considers the total emissions reduction estimated by Project in the monitoring report.
[21] https://mer.markit.com/br-reg/public/project.jsp?project_id=104000000014152
[22] https://mer.markit.com/br-reg/public/project.jsp?project_id=104000000012424
[23] https://mer.markit.com/br-reg/public/project.jsp?project_id=100000000000387
[24] https://mer.markit.com/br-reg/public/project.jsp?project_id=103000000002177

CHAPTER 4: DOMESTIC MEASUREMENT, REPORTING, AND VERIFICATION

The Royal Government of Cambodia's approach to develop and operationalize its domestic measurement, reporting, and verification (MRV) systems focuses on integration into the existing climate change monitoring and evaluation (M&E) framework structure of the CCCSP rather than setting up new layer institutional structures.

Cambodia considers this approach as an efficient and cost-effective way of mobilizing institutions and setting up processes for performing MRV functions on a sustainable basis at all levels (project, sector, and national levels) and for all MRV types (GHG emissions, Impacts of mitigation actions and Support received).

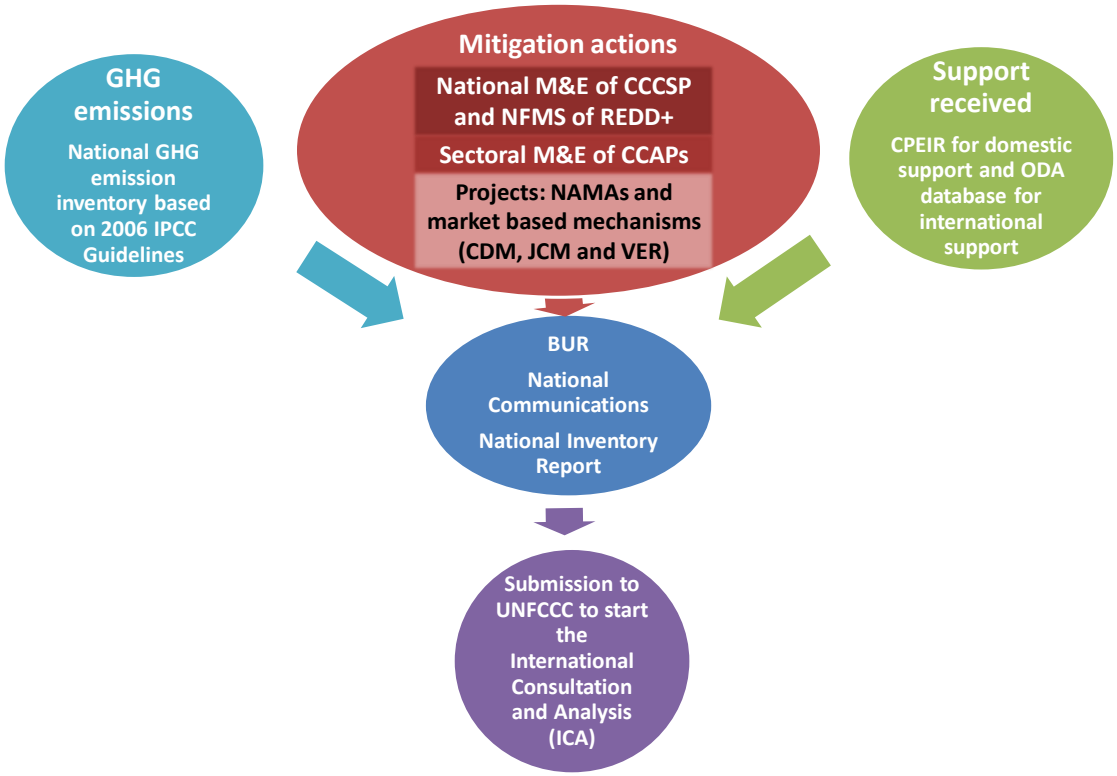


Figure 23. Cambodia existing MRV types

Cambodia's focus has been on designing a simple-to-integrate MRV structure that is acceptable and less burdensome to identified institutions, while it meets the essential ingredients for MRV.

Because the MRV is seeking to integrate into the existing climate change M & E framework, performing any additional MRV function will not require new legislation. The institutions would rather draw their authority to perform their MRV functions from the existing legal framework that mandates them to carry out the development of M & E framework for their climate change action plans (CCAPs).

The domestic MRV system aims to:

- Report on (a) GHG Inventories, (b) mitigation actions and their effects and (c) support needed and received in a complete, transparent and timely manner;
- Assure that the existing sectoral and national climate change M&E systems integrate all MRVs at all levels in order to measure and monitor:

iv. greenhouse gas (GHG) emissions trends,
v. GHG emissions or reductions attributed to a specific mitigation action (policy, programme, measure or project) including the sustainable development benefits; and
vi. climate-related support provided by the Royal Government of Cambodia or received from donors or the market in a form of finance to enable implementation of a certain action or as a result of an action taken in a specific sector of the economy.

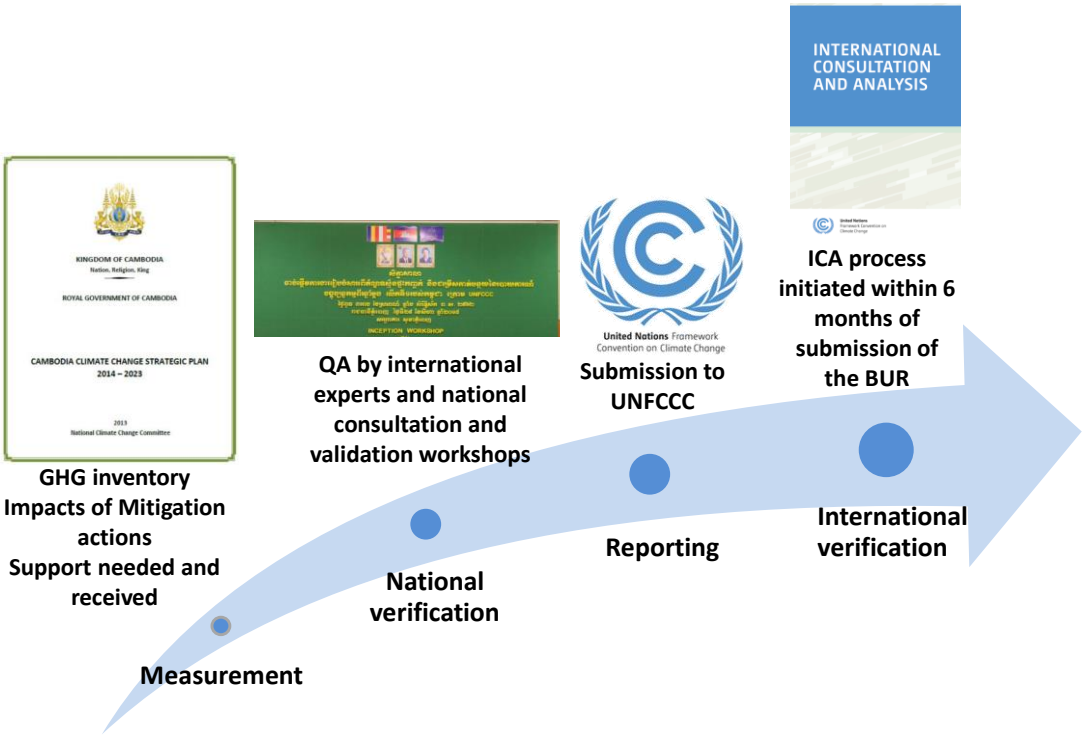


Figure 24. Cambodian GHG emissions MRV procedure

All this information is reported partly in the National Inventory Report (NIR) and the National Communications and completely in the BUR and communicated to the UNFCCC in order to start the International Consultation and Analysis (ICA) process, constituting the second verification layer. The first verification layer of information on GHG emissions, impacts of mitigation actions and support has been performed by QA (quality assurance) international experts and through national consultation and validation workshops.

MRV systems in Cambodia

Measurement, reporting, and verification of mitigation in Cambodia includes a set of information systems covering different areas of Cambodian climate change management. The following paragraphs provide an overview of the main features of all MRV systems in place or in development focusing on the elements measured/monitored, reported and verified, as well as the institutional arrangements and operational procedures in place within each of them.

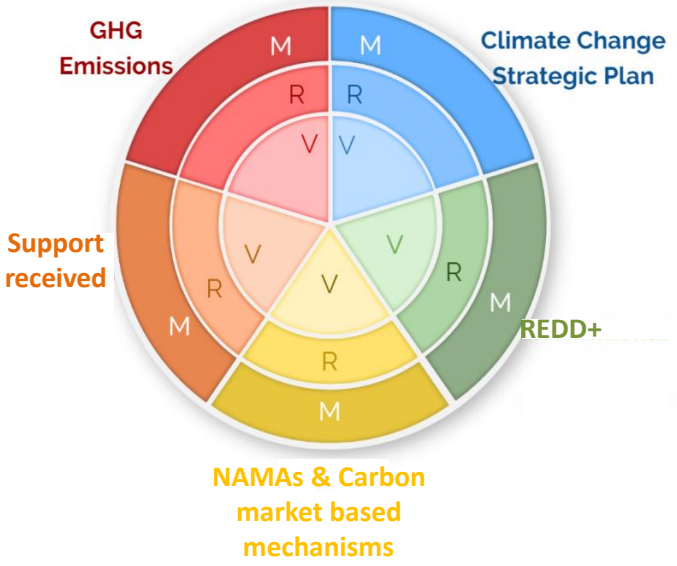


Figure 25. MRV systems in Cambodia

The following describes the main characteristics of the five MRV systems in place in Cambodia.

MRV of GHG emissions

Cambodia´s MRV on GHG emissions

The MRV of GHG emissions is performed through the national GHG emissions inventory which presents GHG emissions by sources and removals by sinks for the time series 1994-2016. The gases included in the inventory are CO2, CH4, N2O, HFCs, PFCs, CO, NOx, NMVOCs, and SO2. Estimates of these gases are performed by sector following the nomenclature and methodologies provided by the 2006 IPCC Guidelines.

The data, methodology, and results of the inventory including other key areas of national GHG emission inventories such as key category assessment and uncertainty analysis are presented in the National Inventory Report (NIR) and reported in the specific chapters of the Third National Communication and the First Biennial Update Report.

The Department of Climate Change of the GSSD has the overall responsibility for the inventory preparation, reporting and verification.

For the 2020 inventory edition, Cambodia has drafted and followed procedures that will be formalized for the update of the GHG inventory on a continuous basis. These procedures are data gathering, estimation of emission/removals, uncertainty assessment, key category analysis, QA/QC plan development and implementation, development of an Improvement plan, archiving, next inventory cycle planning.

MRV of Cambodian Climate Change Strategic Plan

Cambodia´s MRV of CCCSP

The MRV of Cambodia Climate Change Strategic Plan (CCCSP), called climate change Monitoring and Evaluation (M&E) framework, evaluates success of the country's climate change response by measuring how well its institutions do in managing climate risks, and how successful climate interventions are in reducing vulnerability and encouraging low carbon development. Two sets of indicators are used: Five Indicators on institutional readiness to understand how the country is integrating climate resilience across sectors and all segments of society and is responding to climate change and five impact indicators to measure the extent to which Cambodia's efforts in implementing CCCSP have resulted in reducing vulnerability and encouraging low carbon development. Using 2014 as a baseline, they measure at different period intervals the status of climate policy and strategies, climate integration into development planning, coordination, climate information and climate integration into financing; percentage of communes vulnerable to climate change; amilies affected due to floods, storms and droughts and GHG emissions trend.

The GSSD through the Department of Climate Change and its Policy and Coordination Office is responsible for the quality analysis and validation checks.

The NCSD and its Secretariat (GSSD), and the Climate Change Technical Working Group (CCTWG), have key roles and responsibilities regarding the development and management of the national M&E framework for climate change response.

MRV of REDD+

Cambodia´s MRV of REDD+

The MRV for REDD+ is included into the National Forest Monitoring System (NFMS) which provides information about the forest condition and changes, focusing on emissions by deforestation and forest degradation and the enhancement of forest carbon stock. The NFMS registers and updates Activity Data generated from the Satellite Land Monitoring System (SLMS) and Emissions Factors from the National Forest Inventory (NFI) to contribute to the GHG inventory (see MRV of GHG emissions).

In a first stage, the baseline of REDD + activities and actions, called forest reference emission level and/or forest reference level (FREL), was measured and submitted to the UNFCCC for a technical assessment by two Land Use, Land Use Change and Forestry (LULUCF) experts.

In a second stage, the actual results of REDD + actions compared to the assessed FREL are submitted in the technical annex of the current first Biennial Update Report to the UNFCCC. The LULUCF experts undertaking the technical analysis will check whether data and information provided in the technical annex is transparent, consistent, complete and accurate; consistent with the assessed FREL and guidelines for technical annexes with REDD+ results; and that results are accurate, to the extent possible.

The MRV System for REDD+ is under the overall coordination of the General Directorate of Administration for Nature Conservation and Protection (GDANCP) of the MoE with the active participation of the MAFF, and guidance from the Cambodia REDD+ Taskforce, Technical Team, Consultation Group and Gender Group.

MRV of NAMAs

Cambodia´s MRV of NAMAs

The baseline or 'business as usual' (BAU) scenario defines the emissions that would have occurred in the absence of the NAMA action. This includes the total amount of current emissions along with the emissions assumed to occur in a certain period. The estimated emission reductions are the amount of reduced CO_2 that occur as a result of the NAMA. They are measured quantitatively against the baseline emissions/BAU scenario. In addition to emission reductions, NAMAs also aim at generating co-benefits. They include sustainable development effects, such as economic benefits (e.g. increase in number of employed persons), environmental benefits (e.g. cleaner water), and social benefits (e.g. improved living conditions).

The key objective of the MRV system of NAMAs is to ensure accurate and reliable estimates of GHG emission reductions that occur due to the implementation of the activities of each NAMA. From a national perspective, one of the key objectives of the MRV is related to sustainable development co-benefits. From an international perspective, the objective of the NAMA MRV is focused on the increase of transparency on implementing mitigation actions, as well as the assessment of impact of mitigation efforts in reducing emissions below the BAU scenario.

For each country the designated NAMA focal point (or NAMA approver), is the responsible for approving all individual NAMAs before they are recorded in the UNFCCC Registry. In the case of Cambodia, the NAMA focal point is the Director of Department of Climate Change of the GSSD.

The NAMA implementer is responsible for ensuring that data are measured, stored, and reported in accordance with pre-established procedures depending on the type of action.

The verification uses objective evidence to confirm that the goals or targets of a NAMA are being achieved. Thus, verification includes independent checking of the implementation of the activities, the impacts and the process and procedures for collecting and reporting information, in order to increase the completeness and transparency of the information. Verification also involves a technical review of the appropriateness of the estimation methodology, the use of emissions factors (in the case of GHG estimates), information gathering systems and provisions for public and/or relevant stakeholder input and review.

Two NAMAs are in development in Cambodia, one of them has already developed a MRV plan (namely Energy Efficiency NAMA in the Garment Industry).

MRV of international carbon market-based mechanisms

Cambodia´s MRV of carbon market-based mechanisms projects

In the case of Clean Development Mechanisms (CDM), Joint Credit Mechanisms (JCM) or other voluntary market-based emission reductions (VERs), only pre-approved baseline and measurement methodologies are used. The objective of the MRV system in the case of CDM, JCM or VERs is to measure the GHG emissions reduction achieved from the implementation of project activities. Official guidelines and procedures are used for the development of projects, measurement/monitoring, reporting and verification, as needed in the framework of each mechanism. Overall the MRV starts with the validation of the project activities to ensure additionality and that "actual" reductions are confirmed through the monitoring of the relevant data for estimating GHG emissions, and more importantly verification of the data, data collection systems and records.

For Joint Crediting Mechanism (JCM), a Joint Committee of the JCM was established for the overall management of JCM. Currently there are six JCM projects operating in Cambodia, all the projects are developed by the private sector.

Lastly, regarding voluntary emission reduction projects, currently six projects are being implemented in Cambodia. Five of these projects are developed under the Verified Carbon Standard (VCS) program and the remaining one under the Gold Standard. Four projects, which were proposed by the Royal Government of Cambodia, are related to REDD+, and the other two (one proposed by the Royal Government of Cambodia and the other by GERES) are in the Energy sector. The Ministry of Environment and the Forestry Administration are implementing these projects.

MRV of Support

Cambodia´s MRV of Support received

Key elements of the Cambodian MRV of support are the Official Development Assistance (ODA) database and the Climate Expenditure and Institutional Review (CPEIR). Through these elements, Cambodia measures, reports and verifies data on climate finance and the ODA. The identification of constraints, gaps and needs is currently performed ad hoc by national stakeholders.

The lead entities of the MRV of support in Cambodia are the Ministry of Economy and Finance (MEF) and the Cambodian Rehabilitation and Development Board (CRDB) of the Council for the Development of Cambodia (CDC). The MEF is the competent authority for budgetary issues and public finance management in Cambodia. Since 2017, the MEF included guidance on climate change in annual budget circulars. Prior to this, key ministries have also started to integrate climate change in the way they prioritize activities for the national budget. Using the ex-post expenditure data provided by line ministries, and also using the data from the ODA database, the MEF performed in years 2017, 2018 and 2019 three annuals Climate Expenditure Review (CPER) of the country for the fiscal years 2015, 2016 and 2017 respectively, where the expenditure carried out in the country in projects related directly or indirectly to climate change was measured and reported.

The National Council for Sustainable Development (NCSD) and the Cambodian Climate Change Alliance (CCCA) provided technical support and verified the data on climate finance measured and monitored by the MEF.

The ODA database is maintained by the CRDB. While the ODA Database is Government owned and managed, the responsibility for entering data lies with development partners.

Regarding climate change expenditure, the NCSD and the CCCA provide guidance to the MEF on how to identify climate change- related expenditure in the budget of the country.

The NCSD, the CDC, CCCA and the MEF agreed on the definition of climate change relevance weights to public expenditure, depending on the objectives and scope of the different expenditure items. Using these climate change relevance weights, the expenditure of the country is split in three categories. The calculations are made by the MEF with the collaboration of the National Institute of Statistics. The measurements are validated by the CRBD and the NCSD.

Regarding the ODA data, the measurement and data entry in the ODA database is made by the different multilateral and bilateral agencies with activity in Cambodia. A Manual has been developed by the CRDB for enabling users to understand how to fill-in the data and using the database.

Both the expenditure and the ODA data are used for producing reports to inform the international community and donors as well as national stakeholders.

The expenditure data is used mainly for policy making purposes, but also for providing information to donors and the public about the efforts made in Cambodia to address climate change.

The ODA database data is used for producing tailored reports for donors, development partners, and others.

In the ODA database, the information is also publicly available. Visitors can make searches by sector, donor, province, type of assistance, implementing agency, among other variables. One of the sectors is named "cross- sectoral programmes", within which climate change is found as one of the main items.

The information is reported in the corresponding chapters on support received in the National Communication and Biennial Update Report of the country.

Both climate change expenditure and ODA measurements are validated by the CRBD and the NCSD. The content of the BUR and NC is validated in multi-stakeholder processes, involving validation workshops and online consultations.

The extend of information provided on support needed and received and its transparency is also verified under the ICA process.

Cambodian NDC implementation roadmap

Cambodia has made significant efforts in addressing the establishment of robust information systems for the measurement/monitoring, reporting and verification of climate-change related data. During preparation of the first BUR, Cambodia had in place five well-established MRV systems (GHG emissions, CCCSP which includes adaptation and mitigation, REDD+, Project level MRVs for two planned NAMAs, 12 CDMs, 6 JCMs, and 6 VERs, and Support received). Cambodia is placing great emphasis in the development of an integrated and detailed MRV system aimed at achieving the implementation of the NDC.

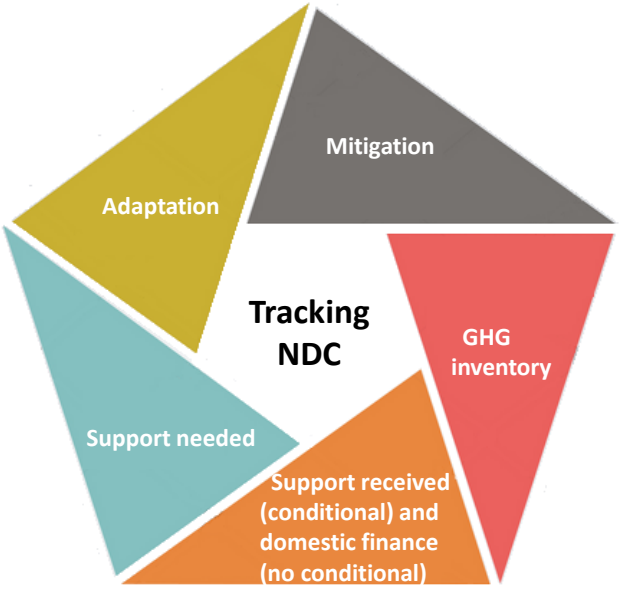


Figure 26. MRV for NDC tracking

The systems in place have enabled information gathering and reporting in the First BUR of the country and Third National Communication. Nonetheless, Cambodia acknowledges continuous improvement as one of the key guiding principles of national MRV systems, and therefore the country will address the reinforcement of the standardization, operability and reinforcement of institutional arrangements of all national measurement, reporting and verification systems.

In this context, the following are the priority areas identified by Cambodia for guiding future MRV developments:

- Reinforcing the institutional arrangements to ensure smooth functioning of MRV systems;
- Providing capacity building to all institutions involved in MRV systems;
- Developing methodologies to estimate the support needed for NDC implementation; and
- Addressing the linkages between MRV systems.

CHAPTER 5: NEEDS AND SUPPORT

Cambodia has placed special emphasis in ensuring the transparency of use of funds received from international sources, as well as illustrating its national effort to implement climate change activities. The previous section described the MRV system in place for tracking support and expenditures on climate change activities.

1. Support Received

Cambodia has received support from different sources for climate change related activities, including the preparation of the INC, the SNC, and the BUR, the NAPA, the CCCSP (2014-2023), Sectoral Climate Change Action Plans (CCAP) or the INDC. Many human resources development programmes and institutional capacity arrangement and enhancements have been awarded.

The CCCSP was developed under the overall coordination of the Ministry of Environment, with the active participation of the Climate Change Technical Team (CCTT) and guidance from the National Climate Change Committee (previously called NCCC and currently the NCSD). A wide range of technical support was provided by several national and international experts for the development of the CCCSP. The development of the CCCSP was made possible with financial support from development partners, namely the European Union (EU), the Swedish International Development Cooperation Agency (SIDA), the Danish International Development Agency (DANIDA), and the United Nations Development Programme (UNDP), through the Cambodia Climate Change Alliance (CCCA).

The main international donors for climate change activities in 2017 are ADB (35%), China (29%), Japan (7%), IFAD (4%), USA (4%), Republic of Korea (4%), and EU (3%), while other donors are below 2%. This includes both projects where climate action was the main objective (dedicated climate change projects), and projects which delivered climate change benefits but where climate action was not the main objective.

International support received in 2017 represents 86% for adaptation and cross-cutting activities and 14% for mitigation.

Table 82. International support received per donor from 2015 to 2017 (in Billions of KHR)

Donor	2015	2016	2017	Share in total (2017)	Adaptation (2017)	Mitigation (2017)
ADB	149	136	172	35%	170	2
China	197	122	144	29%	128	16
Japan	26	18	36	7%	32	4
Republic of Korea	73	18	22	4%	21	0
France	33	11	20	4%	20	1
IFAD	9	18	19	4%	19	0
USA	25	26	18	4%	17	0
EU	16	19	15	3%	14	2
Germany	6	13	11	2%	11	0
Australia	8	9	11	2%	11	0
UNDP	6	4	8	2%	8	1
Global Fund	5	4	5	1%	5	0
World Bank	0	4	4	1%	4	0
Sweden	7	8	4	1%	4	0
Switzerland	3	3	3	1%	3	0
Canada	1	1	1	0%	1	0
Czech Republic	0	0	1	0%	0	0
UK	0	0	1	0%	1	0
FAO	0	3	1	0%	0	0
UNIDO	1	0	0	0%	0	0
GAVI	1	1	0	0%	0	0
Total	566	418	496	100%	470	26

Source: MEF (2019) – CPER 2017

Information on financial support received for implementing key climate change projects in Cambodia is shown in the following table (only for projects where climate action was the main objective).

Table 83. List of projects implemented with international support received (projects with climate action as main objective only)

No.	Project Name	Financing (USD)	Donors	Project Period
1	Cambodia Climate Change Alliance Phase 1	10,848,784	UNDP, EU, Sida, Danida	2010-2014
2	Cambodia Climate Change Alliance Phase 2	12,397,600	UNDP, EU, Sida	2014-2019
3	Southeast Asia Knowledge Network of Climate Change Offices	100,000	UNEP	2013-2014
4	Vulnerability Assessment and Adaptation Program to Climate Change within the Coastal Zone of Cambodia Considering Ecosystem and Livelihood Improvement	1,635,000	UNEP/GEF	2011-2016
5	Strategic Program for Climate Resilience	86,000,000	Climate Investment Funds	2013-2019
6	Cambodia Climate Change Alliance Phase 2	12,397,600	UNDP, EU, Sida	2014-2019
7	Preparation of the intended nationally determined contribution (INDC) in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC)	136,000	UNEP	2015-2017
8	Cambodia's Initial Biennial Update Report	352,000	UNEP	2015-2019
9	Reducing the vulnerability of Cambodian rural livelihoods through enhanced sub-national climate change planning and execution of priority actions	4,567,500	UNDP/GEF	2016-2019
10	Enabling Activities for the Preparation of Third National Communications under theUNFCCC	480,000	UNEP	2016-2019
11	Enhancing Climate Resilience of Rural Communities Living in Protected Areas of Cambodia	4,900,000	Adaptation Fund	2013-2018
12	Building climate resilience of urban systems through Ecosystem-Based Adaptation (EBA) in the Asia-Pacific region	1,000,000	UNEP/GEF	In pipeline
13	Readiness and Prepatory Support Proposal for Green Climate Fund	272,338	GCF	In pipeline
14	Strengthening Climate Information and Early Warning Systems in Cambodia to Support Climate Resilient Development and Adaptation to Climate Change	4,900,000	LDC-F	
15	Strengthening the Adaptive Capacity and Resilience of Rural Communities Using Micro Watershed Approaches to Climate Change and Variability to Attain Sustainable Food Security	5,200,000	LDC-F	
16	Building Adaptive Capacity through the Scaling-up of Renewable Energy Technologies in Rural Cambodia	4,600,000	SCC-F	
	Total	**137,489,222**		

In addition to the above list, Cambodia received support for the implementation of sectoral mitigation projects. These projects are described in the chapter on mitigation above. Furthermore, many capacity building assistance projects have been supported by Japan, Korea, the Netherlands, Denmark, UNDP, UNEP, ADB, EU, World Bank, and other bilateral and multilateral donors, and include:

- Capacity Development for the Clean Development Mechanism (CD4CDM) with the support from the Netherlands' Ministry of Foreign Affairs via UNEP;
- The Institute for Global Environmental Strategies (IGES) of Japan supported the capacity building programme for the CDM, and the new market mechanism in Cambodia;
- Danida and Oxfam America provided support to the Climate Change Capacity Strengthening and Awareness Raising Programme in Cambodia;
- Climate Change - Mitigation and Adaptation training in Sweden with the support of the SIDA;
- Region-Focused Training Course on the Capacity-Building for Officers dealing with AR-CDM Project for Asia-Pacific Region and South and Central America in Japan with the support of JICA;
- Training on IPCC 2006 Methodology on GHG Inventory for Energy Sector and Industrial Processes, and Quality Assurance & Verification in Kuala Lumpur, Malaysia with the support from United Nations Environment Programme (UNEP);
- Training on the Development of Forest Degradation Index and the Carbon Emission Estimation Method Using PALSAR Data in Japan with the support from Forestry and Forest Product Research Institute of Japan; and
- Training workshop on the application of the Asian Pacific Integrated Model (AIM) in Japan with support from the IGES;
- Training workshops on mitigation analysis for Cambodia National Communication;
- The International Training Course on Environmental Policies (ITCEP) in Incheon, Korea; supported by national institute of environmental human resource development, the Ministry of Environment, the Republic of Korea; and
- Several long-term trainings for Master programs in Korea and Ph.D. in Japan and Singapore related to climate change, etc.

2. Constraints and Gaps

Although many policies and strategies addressing climate change impacts have been developed, their implementation remains limited due to insufficient financial support. For instance, despite the approval of the NAMA on Energy Efficiency in the garment industry, the proposed action has not been implemented. Additionally, only 14 out of the proposed 171 projects under the NAP received full financial support, while 16 of them are partially supported (GSSD, 2017). This indicates that not all climate finance provided to Cambodia has been aligned with national priorities and actions. There is also a lack of institutional and technical capacity on climate action.

The following sections provide further detail on contraints and gaps.

2.1. Gaps on capacity building

Many officers have been assigned to participate in numerous climate change related short-term trainings both in the country and abroad since 2000 (GSSD, 2015). Long-term scholarships on climate change related majors have also been awarded ranging from Master to Doctor of Philosophy. However, Cambodia retains limited experts and researchers in the fields of GHG inventory and mitigation, climate vulnerability assessment and adaptation measures, climate change and energy, climate agronomists, climate economists, etc. Capacity building of climate change national experts, as well as expertise retention remain key challenges in achieving the succesfull implementation of climate change projects.

2.2. Financial gaps

Cambodia has received both grants and loans from development partners and donor countries to design and implement climate change projects. However, Cambodia still faces financial constraints to ensure effective implementation of adaptation and mitigation actions. Climate change financing remains a key barrier, although significant milestones have been achieved.

Public support for climate change activities is important. In 2017, one third of public expenditure, or 30.2%, was either fully or partially delivering climate change benefits. This share of public expenditures with some degree of climate change benefits has remained relatively stable since 2009, around 30.6% in average.

Public climate change expenditure constituted 3.2% of total public expenditure. It has remained also relatively stable since 2009, around 3.8% in average, of total public expenditure. In absolute terms, climate change expenditure has risen around 23%, from KHR 770 billion in 2016 to KHR 912 billion in 2017.

Table 84. Proportion of climate change expenditure to the total public expenditure and the GDP

	2012	2013	2014	2015	2016	2017
Public expenditure with climate change benefits vs. total public expenditure	31.9%	29.7%	34.4%	29.1%	30.6%	30.2%
Climate change public expenditure (weighted) vs. total public expenditure	3.4%	3.9%	4.7%	4.3%	3.2%	3.2%
Climate change public expenditure (weighted) vs. GDP	0.9%	1.2%	1.5%	1.3%	0.9%	1.0%

Source: MEF (2019) – CPER 2017

The proportion of climate change expenditure to GDP is of 1.1% in average during the period 2009-2017. The amounts allocated from domestic resources (national budget) for climate change expenditure continued to increase steadily to KHR 331 billion in 2017, an increase of KHR 49 billion from 2016.

Around 95% of domestic climate change expenditure was spent in adaptation and cross-cutting activities and 5% in mitigation in 2017.

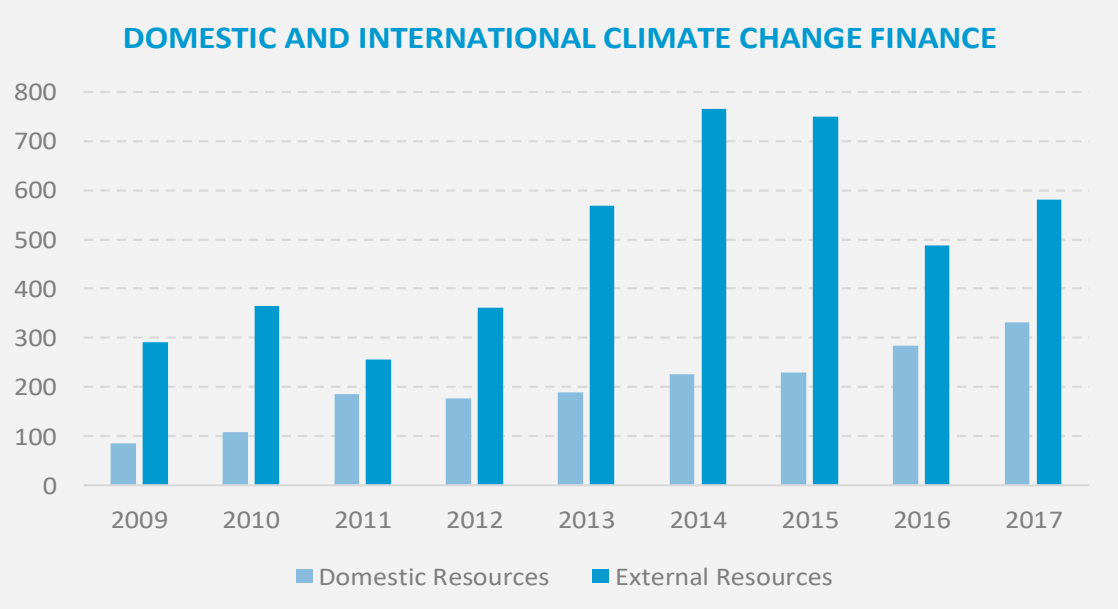


Figure 27. Domestic and international support for climate action in billions of KHR (2009 – 2017)

Source: MEF (2019) – CPER 2017

Development partners remain the largest source of funding for climate change responses (64% in 2017), and fluctuations in external climate change financing are affecting Cambodia's capacity to implement actions on mitigation and adaption to climate change.

The National Adaptation Plan (NAP) Financing Implementation Plan was also developed in 2017 to expedite the implementation of the NAP process. Fifteen sectoral climate change action plans were identified covering 171 actions, which require a total budget of around USD 865.5 million for their implementation; only 7% of the proposed budget has been made available (GSSD, 2017).

The results of a financial needs analysis carried out to assess the existent financial gap to implement climate change adaption plans (CCAPs) proposed by 15 sectoral line ministries/institutions are presented below.

Table 85. Financing gap analysis to implement climate change adaption plans

No.	Ministry	# of CCAP Projects	# of Priority Actions	Funded projects	Partially Funded	Non-Funded	CCAP Cost (USD Million)	Financing Gap (USD Million)	Gap %
1	MAFF	29	17	0	1	28	187.6	187.1	100%
2	MIH	17	0	0	1	16	11	10.75	98%
3	MLMUPC	8	2	0	1	7	9.1	8.8	97%
4	MME	9	0	0	1	8	5	4.8	96%
5	MOE	17	2	8	4	5	27.7	6.9	>25%
6	MOEYS	7	2	0	1	6	10.6	10.2	97%
7	MOH	11	1	0	1	10	46.8	46.4	99%
8	MOINFO	5	0	0	1	4	4.3	4.2	97%
9	MOT	8	1	0	1	7	3.4	3.2	96%
10	MoWAs	6	0	1	1	4	3.6	3.3	93%
11	MoWRAM	16	8	0	1	15	272.5	272.1	100%
12	MPTC	6	0	0	0	6	4.6	4.6	100%
13	MPWT	11	1	1	0	10	211	210	100%
14	MRD	10	5	4	1	5	56.7	17.9	32%
15	NCDM	11	1	0	1	10	11.8	11.7	99%
	Total	**171**	**40**	**14**	**16**	**141**	**865.5**	**802.6**	**92.70%**

Source: GSSD (2017)

2.3. Gaps on technology transfer

Some mitigation technologies have been transferred to Cambodia through various mechanisms (including the Clean Development Mechanisms under the Kyoto Protocol), yet substantial gaps remain. As an initial step to fill the gaps, a Technology Needs Assessment (TNA) for climate change mitigation technologies was conducted, while the associated Technology Action Plans (TAP) were prepared in 2013 (RGC, 2013a). Two prioritized sectors were covered in the analysis, the transport sector and the energy sector. Fourteen technologies in the transport sector and 12 in energy efficiency were proposed, but only two for each sector were selected, namely: energy efficient urban mass transport and vehicle emission standards for the transport sector; and energy efficient lighting (Compact Fluorescent Lamps-CFL) and energy efficient household appliances for the energy sector. Although the TAP was developed in 2013, the determined priority sectors remain valid and are addressed by the Ministry of Public, Works, and Transport (MPWT), the Ministry of Mines and Energy (MME), and the Ministry of Industry and Handicraft (MIH).

Several barriers are identified for CFL diffusion and household energy efficient appliances: higher price of product compared to standard technology, absence of regulations to mandate or encourage public use, and limited public awareness. Although these technologies are generally available in Cambodia, they have had limited success with end consumers who cannot yet discern their economic, social, and environmental benefits. At the same time, the transfer and diffusion of technologies in the transport sector face significant barriers in terms of capital and investment requirements.

Renewable energy has significant potential, but still faces a shortage of facilities and appropriate regulations, slowing down the uptake. The promotion of solar energy is challenging because the facilities to test photovoltaic (PV) systems or PV panels for solar system are currently unavailable. Biomass gasification is an appropriate technology for the rural area, but hands-on-training is needed to increase capacity in operation and maintenance.

2.4. Gaps for the continuous development of the GHG Inventory

Cambodia has conducted two national GHG emission inventories under the national communications submitted in 1994 and in 2000, and the methodology used was primarily based on the 1996 IPCC Guidelines and IPCC Good Practice Guidance (MoE, 2002 and GSSD, 2015). These inventories relied mainly on assumptions, expert judgment, and default IPCC values. The emissions estimate was only conducted for three gases (carbon dioxide, methane, and nitrous oxide) and the completeness of the inventory was limited. Cambodia acknowledges its limitations to obtain reliable data and information as well as the lack of national expertise to develop the national GHG inventory on a continous basis. The constraints identified regarding the development of the national GHG emissions inventory include:

- Limited activity data and national emission factors;
- The scope of the data and its categorization is not aligned with IPCC methodologies, particularly for the AFOLU sector;
- The absence of an inventory system in place to develop the compilation of the inventory;
- Limited financial support for regular inventory preparation; and
- Limited national experts on GHG emission inventories and IPCC Guildeines and good practices.

2.5. Gaps on Mitigation

Thus far, the country has developed only two Nationally Appropriate Mitigation Action (NAMA), covering the NAMA on Energy Efficiency in the Garment Industry in 2015, which aims to improve efficiency in the industrial sector and to build capacity in the field of energy efficiency (MIH, 2015), and the NAMA on Sustainable Charcoal Value-Chains of the Groupe Energies Renouvela Bles, Environment et Solidarités (GERES). Under the NAMA framework, additional sectors should be considered, such as: transport, energy, waste, etc. Cambodia has faced a number of challenges for implementing and extending to other sectors due to the following constraints:

- Limited understanding of the NAMAs framework;
- Inadequate national and sectoral policies to develop and implement the NAMA;
- Line ministries, academia, research institutes, and private sectors faced limited capacity in applying environmentally sound technologies and implementing the NAMA;
- Limited effective coordination mechanism among line ministries and other key stakeholders to develop and implement inter-sectoral NAMAs; and
- NAMA developers face difficulties in accessing financial sources from both domestic and international donors.

3. Financial, technology, and capacity building needs

As discussed earlier, Cambodia has received substantial support from development partners and donor countries in the form of funding, technology, and capacity development. Furthermore, over the past several years Cambodia has placed great emphasis on integrating climate change into the development planning process at the national, sectoral and sub-national level, as well as piloting potential approaches, mostly

in adaptation (RGC, 2013 and 2014a). The government is shifting towards full-scale implementation of climate change response, including mitigation aspects. Therefore, Cambodia has financial, technological, and capacity needs to streamline climate change into all development areas of the country. The following sections provide a description of the main financial, technology, and capacity building needs identified.

3.1. Financial needs

As discussed previously, Cambodia has to mobilize around 92% (USD802.63 million) of the total climate change expenditure (USD865.47 million) from international funding sources to implement the actions identified by line ministries in their climate change adaptation plans for a five year period. Therefore, Cambodia needs to mobilize further financial support both from development partners and donor countries and the national budget to address climate change concerns.

By the end of 2017, fourteen ministries and agencies approved Climate Change Action Plans (CCAP). Expenditure requirements from these fourteen institutions plus the Ministry of Posts and Telecommunications is around 692 billion KHR, with KHR 645 billion allocated to adaptation and cross-cutting activities (93%) and KHR 47 billion allocated to mitigation (7%).

Further, additional financial support should be mobilized and secured in the longer term as climate change impacts are likely to reduce GDP by 0.4%, 2.5%, 6.0%, and 9.8% in 2020, 2030, 2040, and 2050, respectively, (MEF and NCSD, 2018). The government should increase its effort to raise government revenues or mobilize additional support from international communities to ensure stable GDP growth of 7% through 2050 to achieve development targets: achieve high-middle income country status by 2030 and high income country status by 2050.

3.2. Technology needs

Besides the Technology Action Plan of 2013, the country has not developed national policies or strategies to meet technology needs addressing climate change. The country needs to promote and mobilize resources to implement the proposed seven project ideas raised in the TAP (see below). Moreover, since the previous Technology Needs Assessment was carried out in 2012, the identification of additional technology needs by sector would be required to reflect the changes that have occurred.

Table 86. Seven project ideas of the TAP

No.	Project ideas	Budget required (USD)	Project duration (Year)
1	Promoting energy efficient lighting through demonstration and outreach	600,000	3
2	Mainstreaming energy efficient lighting into sub-national and national development plans	600,000	2
3	Energy efficiency labeling in Cambodia	600,000	2
4	Promoting research and development in low cost energy efficient household appliances	1 million	3
5	Promoting urban public transport in Phnom Penh	30 million	5
6	Public transport planning and travel demand management	1 million	3
7	Enhancing vehicle emissions control and inspection & maintenance in large cities	3 million	3

Source: RGC (2013a)

3.3. Capacity needs

Although the country has been participating in many capacity building programmes, Cambodia still seeks additional technical and human resources support to increase and enhance its capacity to respond to climate change. The programmes should be extended to research institutes and academia on specific topics such as climate change impact assessments, GHG inventory and mitigation, REDD+, etc.

Annex I - Detailed Results of the KCA

The 2006 IPCC approach 1 has been used to identify key categories, for both level and trend. The following is a description of the methodology followed.

Level assessment

The contribution of each source or sink category to the total national inventory level is calculated according to the following equation:

$$L_{x,t} = \frac{|E_{x,t}|}{\sum_y |E_{y,t}|}$$

$Where$:

$L_{x,t} = level\ assessment\ for\ source\ or\ sink\ x\ in\ latest\ inventory\ year$
$|E_{x,t}| = absolute\ value\ of\ emission\ or\ removal\ estimate\ of\ source\ or\ sink\ cateogy\ x\ in\ year\ t$
$\sum_y |E_{y,t}|$
$= total\ contribution, which\ is\ the\ sum\ of\ the\ absolute\ values\ of\ emissions\ and\ removals\ in\ year\ t$

Trend assessment

The Trend Assessment is calculated according to the following equation:

$$T_{x,t} = \frac{|E_{x,0}|}{\sum_y |E_{y,0}|} \cdot \left| \frac{|E_{x,t} - E_{x,0}|}{|E_{x,0}|} - \frac{(\sum_y |E_{y,t}| - \sum_y |E_{y,0}|)}{\sum_y |E_{y,0}|} \right|$$

$Where$:

$T_{x,t} = trend\ assessment\ for\ source\ or\ sink\ x\ in\ year\ t\ as\ compared\ to\ the\ base\ year\ (year\ 0)$
$|E_{x,0}| = absolute\ value\ of\ emission\ or\ removal\ estimate\ of\ source\ or\ sink\ cateogy\ x\ in\ year\ 0$
$E_{x,t}\ and\ E_{x,0} = real\ values\ of\ estimate\ of\ source\ or\ sink\ category\ X\ in\ years\ t\ and\ 0, respectively.$
$\sum_y |E_{y,t}|\ and\ \sum_y |E_{y,0}| = Total\ incventoy\ estimates\ in\ years\ t\ and\ 0, respectively.$

Disaggregation level

To the extent possible, the assessment performed has followed the suggested aggregation level for approach 1 provided by 2006 IPCC Guidelines. The exception is the Forestry and Other Land Uses subsector. In this sector, the break-down in additional disaggregated categories has not been possible due to a lack of data.

Results

Key category analysis with FOLU – Level (2016)

IPCC category	Name	Gas	Emissions year 2016	Assessment for year 2016	Cumulative total 2016	KCA order 2016
3B	Land	CO2	131011.24	0.79	0.79	1
3C7	Rice cultivations	CH4	11323.14	0.07	0.86	2
1A3b – liquid	Road transport - liquid fuels	CO2	4933.16	0.03	0.89	3
3A1	Enteric Fermentation	CH4	4188.38	0.03	0.92	4
1A1-Solid	Energy industries - solid fuels	CO2	2663.57	0.02	0.93	5
2A1	Cement production	CO2	1420.96	0.01	0.95	6
4A1	Solid waste disposal	CH4	1345.77	0.01	0.957	7

Key category analysis with FOLU– Level (1994)

IPCC category	Name	Gas	Emissions year 1994	Assessment for year 1994	Cumulative total 2016	KCA order 1994
3B	Land	CO2	27018.62	0.63	0.626	1
3C7	Rice cultivations	CH4	4602.85	0.11	0.733	2
3A1	Enteric Fermentation	CH4	4249.36	0.10	0.831	3
1A3b – liquid	Road transport - liquid fuels	CO2	1849.58	0.04	0.874	4
3C4	Direct N2O Emissions from managed soils	N2O	684.01	0.02	0.900	5
3A2	Manure Management	N2O	649.45	0.02	0.915	6
4A1	Solid waste disposal	CH4	539.20	0.01	0.933	7
3A2	Manure Management	CH4	471.76	0.01	0.944	8
4C2	Open burning	CO2	401.33	0.01	0.953	9

Key category analysis with FOLU– Trend (1994-2016)

IPCC category	Name	Gas	Trend assessment	% Contribution to the trend	Total cumulative trend	Order trend
3B	Land	CO2	0.64	0.42	0.424	1
3A1	Enteric Fermentation	CH4	0.28	0.19	0.610	2
3C7	Rice cultivations	CH4	0.15	0.10	0.707	3
1A1- Solid	Energy industries - solid fuels	CO2	0.06	0.04	0.748	4
1A3b – liquid	Road transport - liquid fuels	CO2	0.05	0.03	0.786	5
3A2	Manure Management	N2O	0.04	0.03	0.814	6
3C4	Direct N2O Emissions from managed soils	N2O	0.04	0.03	0.841	7
2A1	Cement production	CO2	0.03	0.02	0.869	8
3A2	Manure Management	CH4	0.03	0.02	0.890	9
4C2	Open Burning	CO2	0.04	0.02	0.906	10
4A1	Solid waste disposal	CH4	0.02	0.01	0.917	11
1A1	Energy industries – biomass	CH4	0.02	0.01	0.928	12
4D1	Domestic wastewater	CH4	0.02	0.01	0.939	13
3C5	Indirect N2O Emissions from managed soils	N2O	0.01	0.01	0.949	14
1A4 - biomass	Other sectors - biomass	CH4	0.01	0.01	0.957	15

Key category analysis without FOLU – Level (2016)

IPCC category	Name	Gas	Emissions year 2016	Assessment for year 2016	Cumulative total 2016	KCA order 2016
3C7	Rice cultivations	CH4	11323.14	0.34	0.34	1
1A3b - liquid	Road transport - liquid fuels	CO2	4933.16	0.15	0.49	2
3A1	Enteric Fermentation	CH4	4188.38	0.13	0.62	3
1A1- Solid	Energy industries - solid fuels	CO2	2663.57	0.08	0.70	4
2A1	Cement production	CO2	1420.96	0.04	0.75	5
4A1	Solid waste disposal	CH4	1345.77	0.04	0.79	6
3C4	Direct N2O Emissions from managed soils	N2O	943.80	0.03	0.82	7
3A2	Manure Management	N2O	663.06	0.02	0.84	8
1A2 - Liquid	Manufacturing industries and construction - Liquid fuels	CO2	603.88	0.02	0.86	9
3A2	Manure Management	CH4	533.10	0.02	0.88	10
4C2	Open burning	CO2	524.56	0.02	0.89	11

IPCC category	Name	Gas	Emissions year 2016	Assessment for year 2016	Cumulative total 2016	KCA order 2016
3C5	Indirect N2O Emissions from managed soils	N2O	404.22	0.01	0.91	12
4D1	Domestic wastewater	CH4	401.48	0.01	0.92	13
2F1	Refrigeration and air conditioning	HFC	371.95	0.01	0.93	14
1A1 - liquid	Energy industries - liquid fuels	CO2	326.84	0.01	0.94	15
1A4 - biomass	Other sectors - biomass	CH4	265.56	0.01	0.95	16

Key category analysis without FOLU– Level (1994)

IPCC category	Name	Gas	Emissions year 1994	Assessment for year 1994	Cumulative total 1994	KCA order 1994
3C7	Rice cultivations	CH4	11323.14	0.34	0.34	1
3A1	Enteric Fermentation	CH4	4,249.36	0.27	0.566	2
1A3b – liquid	Road transport - liquid fuels	CO2	1,849.58	0.12	0.684	3
3C4	Direct N2O Emissions from managed soils	N2O	684.01	0.04	0.727	4
3A2	Manure Management	N2O	649.45	0.04	0.769	5
4A1	Solid waste disposal	CH4	539.20	0.03	0.815	6
3A2	Manure Management	CH4	471.76	0.03	0.845	7
4C2	Open burning	CO2	401.33	0.03	0.871	8
4D1	Domestic wastewater	CH4	286.25	0.02	0.8900	9
3C5	Indirect N2O Emissions from managed soils	N2O	265.93	0.02	0.907	10
1A1-biomass	Energy industries - biomass	CH4	250.28	0.02	0.923	11
1A4 - biomass	Other sectors - biomass	CH4	195.49	0.01	0.936	12
4C2	Open burning	CH4	180.88	0.01	0.948	13
3C6	Indirect N2O Emissions from manure management	N2O	144.08	0.01	0.957	14

Key category analysis without FOLU– Trend (1994-2016)

IPCC category	Name	Gas	Trend assessment	% Contribution to the trend	Total cumulative trend	Order trend
3A1	Enteric Fermentation	CH4	0.30	0.29	0.290	1
1A1- Solid	Energy industries - solid fuels	CO2	0.17	0.16	0.453	2
3C7	Rice cultivations	CH4	0.11	0.10	0.554	3
2A1	Cement production	CO2	0.09	0.09	0.641	4
1A3b - liquid	Road transport - liquid fuels	CO2	0.07	0.06	0.705	5
3A2	Manure Management	N2O	0.04	0.04	0.748	6
3C4	Direct N2O Emissions from managed soils	N2O	0.03	0.03	0.786	7
3A2	Manure Management	CH4	0.03	0.03	0.814	8
2F1	Refrigeration and air conditioning	HFC	0.02	0.02	0.837	9
1A2 - Liquid	Manufacturing industries and construction - Liquid fuels	CO2	0.02	0.02	0.860	10
4C2	Open burning	CO2	0.02	0.02	0.879	11
1A1- biomass	Energy industries - biomass	CH4	0.02	0.02	0.897	12
1A1 - liquid	Energy industries - liquid fuels	CO2	0.01	0.01	0.911	13
4A1	Solid waste disposal	CH4	0.01	0.01	0.923	14
4D1	Domestic wastewater	CH4	0.01	0.01	0.936	15
3C5	Indirect N2O Emissions from managed soils	N2O	0.01	0.01	0.946	16
1A4 - biomass	Other sectors - biomass	CH4	0.01	0.01	0.955	17

Annex II – Uncertainty assessment results

The following table shows the uncertainty values estimated for the inventory. Specifically, the following table demonstrates:

- The uncertainty of the activity data and emission factor by IPCC category. The source of all the uncertainty values for the energy sector is IPCC 2006. For the selection of the uncertainty among those provided by IPCC 2006, the criteria have been based on the conservative principle, using the upper values of the ranges by default.
- The combined uncertainty calculated with the uncertainty of the activity data and emission factor and the emission level and trend, where appropriate,
- The calculation for the sensitivity type A and B, based on the equations provided in 2016 IPCC guidelines.
- The uncertainty in the total level and trend of the emissions of the inventory.

The methodology followed is the tier 1 provided by 2006 IPCC Guidelines. The following table and associated calculations are extracted from the table 3.2, volume 1, chapter 3 of 2006 IPCC Guidelines. A complete description of terms is available in the chapter on the 2006 IPCC Guidelines.

Uncertainty of the inventory

IPCC category	Gas	Base year emissions	2016 emissions	Activity data uncertainty	Emission factor Uncertainty	Combined uncertainty	Contribution to variance by category in year 2016	Type A sensitivity	Type B sensitivity	Uncertainty in trend by EF	Uncertainty in trend by AD	Uncertainty introduced into the trend in total national emissions
		Gg of CO2-eq		%	%	%		%	%	%	%	
1A1 -Energy industries– Solid	CO2	0.00	2663.57	5	7	9	0.020	0.062	0.062	0.437	0.312	0.288
1A1 -Energy industries – Solid	CH4	0.00	0.69	5	100	100	0.000	0.000	0.000	0.002	0.000	0.000
1A1 -Energy industries – Solid	N2O	0.00	12.39	5	75	75	0.000	0.000	0.000	0.022	0.001	0.000
1A1 -Energy industries – Liquid	CO2	48.28	326.84	5	7	9	0.000	0.003	0.008	0.023	0.038	0.002
1A1 -Energy industries – Liquid	CH4	0.05	0.32	5	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A1 -Energy industries – Liquid	N2O	0.11	0.76	5	75	75	0.000	0.000	0.000	0.001	0.000	0.000
1A1 -Energy industries – Biomass	CH4	250.28	250.32	60	100	117	0.032	-0.017	0.006	-1.666	0.352	2.899
1A1 -Energy industries – Biomass	N2O	0.15	0.70	60	75	96	0.000	0.000	0.000	0.000	0.001	0.000
1A2 -Manufacturing Industries– Solid	CO2	0.00	68.40	3	7	8	0.000	0.002	0.002	0.011	0.005	0.000
1A2 -Manufacturing Industries – Solid	CH4	0.00	0.02	3	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A2 -Manufacturing Industries – Solid	N2O	0.00	0.32	3	75	75	0.000	0.000	0.000	0.001	0.000	0.000
1A2 -Manufacturing Industries – Liquid	CO2	114.84	603.88	3	7	8	0.001	0.004	0.014	0.027	0.042	0.003
1A2 -Manufacturing Industries – Liquid	CH4	0.12	0.60	3	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A2 -Manufacturing Industries – Liquid	N2O	0.28	1.42	3	75	75	0.000	0.000	0.000	0.001	0.000	0.000
1A2 -Manufacturing Industries – Biomass	CH4	27.48	27.63	60	100	117	0.000	-0.002	0.001	-0.183	0.039	0.035

IPCC category	Gas	Base year emissions	2016 emissions	Activity data uncertainty	Emission factor Uncertainty	Combined uncertainty	Contribution to variance by category in year 2016	Type A sensitivity	Type B sensitivity	Uncertainty in trend by EF	Uncertainty in trend by AD	Uncertainty introduced into the trend in total national emissions
		Gg of CO2-eq		%	%	%		%	%	%	%	
1A2 -Manufacturing Industries – Biomass	N2O	43.67	43.92	60	75	96	0.001	-0.003	0.001	-0.218	0.062	0.051
1A3a - Domestic aviation– liquid	CO2	2.48	59.87	5	7	9	0.000	0.001	0.001	0.008	0.007	0.000
1A3a - Domestic aviation – liquid	CH4	0.00	0.01	5	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A3a - Domestic aviation – liquid	N2O	0.02	0.50	5	75	75	0.000	0.000	0.000	0.001	0.000	0.000
1A3b -Road transport– liquid	CO2	1849.58	4933.16	5	7	9	0.067	-0.051	0.116	-0.356	0.578	0.461
1A3b -Road transport – liquid	CH4	12.85	30.25	5	100	100	0.000	0.000	0.001	-0.045	0.004	0.002
1A3b -Road transport – liquid	N2O	27.11	70.42	5	75	75	0.001	-0.001	0.002	-0.059	0.008	0.004
1A4 -Others– liquid	CO2	91.55	189.57	15	7	17	0.000	-0.004	0.004	-0.027	0.067	0.005
1A4 -Others – liquid	CH4	0.30	0.56	15	100	101	0.000	0.000	0.000	-0.001	0.000	0.000
1A4 -Others – liquid	N2O	0.21	0.35	15	75	76	0.000	0.000	0.000	-0.001	0.000	0.000
1A4 -Others – biomass	CH4	195.49	265.56	60	100	117	0.036	-0.011	0.006	-1.137	0.373	1.432
1A4 -Others – biomass	N2O	26.10	49.60	60	75	96	0.001	-0.001	0.001	-0.089	0.070	0.013
2A1 – Cement	CO2	0.00	1420.96	10	10	14	0.015	0.033	0.033	0.333	0.333	0.222
2D1 - Lubricants	CO2	3.81	28.50	3	50	50	0.000	0.000	0.001	0.016	0.002	0.000
2F - F-gases	HFC	0.00	371.95	100	100	141	0.103	0.009	0.009	0.872	0.872	1.520
3A1 - Enteric Fermentation	CH4	4249.36	4188.38	20	30	36	0.849	-0.284	0.098	-8.520	1.963	76.448
3A2 - Manure Management	CH4	471.76	533.10	20	30	36	0.014	-0.030	0.012	-0.899	0.250	0.870
3A2 - Manure Management	N2O	649.45	663.06	20	50	54	0.047	-0.043	0.016	-2.145	0.311	4.699
3B – Land	CO2	27018.62	131011.24	20	100	102	6646	0.634	3.070	63.448	61.404	7796

IPCC category	Gas	Base year emissions	2016 emissions	Activity data uncertainty	Emission factor Uncertainty	Combined uncertainty	Contribution to variance by category in year 2016	Type A sensitivity	Type B sensitivity	Uncertainty in trend by EF	Uncertainty in trend by AD	Uncertainty introduced into the trend in total national emissions
		Gg of CO2-eq		%	%	%		%	%	%	%	
3C1 - Emissions from biomass burning	CH4	68.32	84.19	100	50	112	0.003	-0.004	0.002	-0.209	0.197	0.083
3C1 - Emissions from biomass burning	N2O	65.21	71.67	100	50	112	0.002	-0.004	0.002	-0.209	0.168	0.072
3C3 - Urea application	CO2	1.61	17.42	50	5	50	0.000	0.000	0.000	0.001	0.020	0.000
3C4 - Direct N2O Emissions from managed soils	N2O	684.01	943.80	50	100	112	0.415	-0.039	0.022	-3.944	1.106	16.776
3C5 - Indirect N2O Emissions from managed soils	N2O	265.93	404.22	50	100	112	0.076	-0.014	0.009	-1.446	0.474	2.315
3C6 - Indirect N2O Emissions from manure management	N2O	144.08	168.68	50	100	112	0.013	-0.009	0.004	-0.901	0.198	0.852
3C7 - Rice cultivations	CH4	4602.85	11323.14	10	75	76	27.330	-0.149	0.265	-11.156	2.654	131
4A1 - Solid waste disposal	CH4	539.20	1345.77	100	102	143	1.376	-0.017	0.032	-1.733	3.154	12.949
4B2 – Composting	CH4	5.13	7.90	100	5	100	0.000	0.000	0.000	-0.001	0.019	0.000
4B2 – Composting	N2O	3.67	5.65	100	5	100	0.000	0.000	0.000	-0.001	0.013	0.000
4B2 - Anaerobic digestion	CH4	0.00	0.37	100	100	141	0.000	0.000	0.000	0.001	0.001	0.000
4C2 - Open burning	CO2	401.33	524.56	100	100	141	0.206	-0.024	0.012	-2.407	1.236	7.323
4C2 - Open burning	N2O	32.19	42.08	100	100	141	0.001	-0.002	0.001	-0.191	0.099	0.046
4C2 - Open burning	CH4	180.88	236.42	100	100	141	0.042	-0.011	0.006	-1.074	0.554	1.460
4D1 – Domestic wastewater	CH4	286.25	401.48	59	117	131	0.103	-0.016	0.009	-1.913	0.555	3.969
4D1 – Domestic wastewater	N2O	85.66	196.45	20	8	22	0.001	-0.003	0.005	-0.025	0.092	0.009

National total emissions	42 450	163 592	Year uncertainty	81.86		Trend uncertainty	89.69

Energy sector

The following table shows a summary of the uncertainty values at category level*fuel*gas level for the energy sector:

Uncertainty in the energy sector

CRF category	Gas	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
1A1 -Energy industries– Solid	CO2	5	7	9
1A1 -Energy industries – Solid	CH4	5	100	100
1A1 -Energy industries – Solid	N2O	5	75	75
1A1 -Energy industries – Liquid	CO2	5	7	9
1A1 -Energy industries – Liquid	CH4	5	100	100
1A1 -Energy industries – Liquid	N2O	5	75	75
1A1 -Energy industries – Biomass	CO2	60	7	60
1A1 -Energy industries – Biomass	CH4	60	100	117
1A1 -Energy industries – Biomass	N2O	60	75	96
1A2 -Manufacturing Industries– Solid	CO2	3	7	8
1A2 -Manufacturing Industries – Solid	CH4	3	100	100
1A2 -Manufacturing Industries – Solid	N2O	3	75	75
1A2 -Manufacturing Industries – Liquid	CO2	3	7	8
1A2 -Manufacturing Industries – Liquid	CH4	3	100	100
1A2 -Manufacturing Industries – Liquid	N2O	3	75	75
1A2 -Manufacturing Industries – Biomass	CO2	60	7	60
1A2 -Manufacturing Industries – Biomass	CH4	60	100	117
1A2 -Manufacturing Industries – Biomass	N2O	60	75	96
1A3a - Domestic aviation– liquid	CO2	5	7	9
1A3a - Domestic aviation – liquid	CH4	5	100	100
1A3a - Domestic aviation – liquid	N2O	5	75	75
1A3b -Road transport– liquid	CO2	5	7	9
1A3b -Road transport – liquid	CH4	5	100	100
1A3b -Road transport – liquid	N2O	5	75	75
1A4 -Others– liquid	CO2	15	7	17
1A4 -Others – liquid	CH4	15	100	101
1A4 -Others – liquid	N2O	15	75	76
1A4 -Others – biomass	CO2	60	7	60
1A4 -Others – biomass	CH4	60	100	117
1A4 -Others – biomass	N2O	60	75	96

The source of all uncertainty values for the energy sector is the default values provided by the 2006 IPCC Guidelines. For the selection of the uncertainty among those provided by IPCC 2006, the criteria have been based on the conservative principle, using the upper values of the ranges by default.

IPPU sector

The following table shows a summary of the uncertainty values at category *gas level for the IPPU sector:

Uncertainty in the IPPU sector

Category	Gas	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
2A1 – Cement production	CO_2	10	10	14
2D1 – Lubricants	CO_2	3	50	50
2F - Subst. for ODS (F-gases)	HFC-125	100	100	141
2F - Subst. for ODS (F-gases)	HFC143a	100	100	141
2F - Subst. for ODS (F-gases)	HFC134a	100	100	141
2F - Subst. for ODS (F-gases)	HFC-32	100	100	141
2F - Subst. for ODS (F-gases)	HFC-227ea	100	100	141

The source of the uncertainty values for categories 2A1 and 2D1 is IPCC 2006. For category 2F, the uncertainty values allocated are mainly based on expert judgment (based on 2006 IPCC guidance) rather than default values due to limited guidance provided by 2006 IPCC Guidelines. The uncertainty of the activity data of this category is considered high, as data on blends apparent consumption is used instead of direct use of gases. Furthermore, the emission factor is composed (aggregated), which also leads to a high uncertainty.

Waste sector

The following table shows a summary of the uncertainty values at category*gas level for the waste sector:

Uncertainty in the waste sector

CRF category	Gas	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
4A1 - Solid waste disposal	CH4	100	102	143
4B2 – Composting	CH4	100	5	100
4B2 – Composting	N2O	100	5	100
4B2 - Anaerobic digestion	CH4	100	100	141
4C2 - Open burning	CO2	100	100	141
4C2 - Open burning	N2O	100	100	141
4C2 - Open burning	CH4	100	100	141
4D1 – Domestic wastewater	CH4	59	117	130
4D1 – Domestic wastewater	N2O	20	8	22

The source of all uncertainty values for the energy sector is IPCC 2006. For the selection of the uncertainty among those provided by IPCC 2006, the criteria have been based on the conservative principle, using the upper values of the ranges by default.

AFOLU sector

The following table shows a summary of the uncertainty values at category*gas level for the AFOLU sector:

Uncertainty in the waste sector

CRF category	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
Enteric fermentation			
3.A.1.a.i - Dairy Cows	20	30	36
3.A.1.a.ii - Other Cattle	20	30	36
3.A.1.b - Buffalo	20	30	36
3.A.1.c - Sheep	20	30	36
3.A.1.d - Goats	20	30	36
3.A.1.e - Camels	20	30	36
3.A.1.f - Horses	20	30	36
3.A.1.g - Mules and Asses	20	30	36
3.A.1.h - Swine	20	30	36
3.A.1.j – Other	20	30	36
Manure management – CH4			
3.A.2.a.i - Dairy cows	20	30	36
3.A.2.a.ii - Other cattle	20	30	36
3.A.2.b - Buffalo	20	30	36
3.A.2.c - Sheep	20	30	36
3.A.2.d - Goats	20	30	36
3.A.2.e - Camels	20	30	36
3.A.2.f - Horses	20	30	36
3.A.2.g - Mules and Asses	20	30	36
3.A.2.h - Swine	20	30	36
3.A.2.i - Poultry	20	30	36
Manure management – N2O			
3.A.2.a.i - Dairy cows	20	50	54
3.A.2.a.ii - Other cattle	20	50	54
3.A.2.b - Buffalo	20	50	54
3.A.2.c - Sheep	20	50	54
3.A.2.d - Goats	20	50	54
3.A.2.e - Camels	20	50	54
3.A.2.f - Horses	20	50	54
3.A.2.g - Mules and Asses	20	50	54
3.A.2.h - Swine	20	50	54
3.A.2.i - Poultry	20	50	54
3-B Land	20	100	
3.C - Aggregate sources and non-CO2 emissions sources on land – CH4			

CRF category	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
3.C.1.b - Biomass burning in croplands	50	50	71
3.C.1.c - Biomass burning in grasslands	100	50	112
3.C - Aggregate sources and non-CO2 emissions sources on land – N2O			
3.C.1.b - Biomass burning in croplands	50	50	71
3.C.1.c - Biomass burning in grasslands	100	50	112
3.C.3 - Urea application	50	5	50
3.C.4 - Direct N2O Emissions from managed soils	50	100	112
3.C.5 - Indirect N2O Emissions from managed soils	50	100	112
3.C.6 - Indirect N2O Emissions from manure management	50	100	112
3.C.7 - Rice cultivations	10	75	76

The source of all uncertainty values for categories included within 3A Livestock is IPCC 2006. For the selection of the uncertainty among those provided by IPCC 2006, the criteria have been based on the conservative principle, using the upper values of the ranges by default.

Conversely, the uncertainty values allocated in 3B Land and 3C Aggregate sources and non-CO2 emissions sources on land are mainly based on expert judgment (based on 2006 IPCC guidance) rather than default values due to limited guidance provided by 2006 IPCC Guidelines.

Annex III – QA/QC Plan

Quality Assurance and Quality Control Procedures for Greenhouse Gas Inventory

Quality Control

In its 2019 edition of the GHG emission inventory, Cambodia developed two types of quality control procedures: general QC procedures and category specific QC procedures, as proposed by 2016 IPCC Guidelines.

General QC procedures include generic quality checks related to calculations, data processing, completeness, and documentation that are applicable to all inventory source and sink categories.

For the general QC procedures, a QC template was used by national compilers for reviewing the GHG emission compilation of all sectors. The following table shows the QC procedures checked by national compilers.

General QC Procedures

QC activity	Procedures
Documentation	
Base information	Detailed description of the references of the base information used
Methodological coefficients	Detailed description of the references of the methodological coefficients used
Conversion coefficients	Detailed reference of all the conversion coefficients used
Units	Documentation of the units of the series
Data Transcription	
Base information	Errors in the transcription of the base information
Methodological coefficients	The methodological coefficients must coincide with the reference sources
Conversion coefficients	The conversion coefficients coincide with the reference sources (if possible)
Units	The units of the original data are correct
Emissions calculations	
Last inventory year	Check current year estimates against previous years (if available) and investigate unexplained departures from trend
Emission factor	Assess representativeness of emission factors, given national circumstances and analogous emissions data

QC activity	Procedures
Conversion factors	Check that conversion factors are correct
Time series	Review of the accuracy and temporal coherence of the time series. Check that there are no errors in the calculation, and examine the temporal coherence of the series, looking for anomalous data in the time series and comparing with indicators (if possible)
Uncertainty	
Assignment of uncertainties	The assigned uncertainties (tab "Uncertainty") are consistent with IPCC 2006

The template QC procedures were checked in all inventory categories, specifying errors found, proposing corrective actions and making observations, if appropriate.

The following issues were identified and corrected as a result of the general QC procedures:

i) The emission factors for category 1A4 were linked to those of category 1A1;
ii) There was an error in the conversion performed in the calculation of the biogas consumption;
iii) There was an error in the formula for the calculation of domestic wastewater; and
iv) There was an error in the amount of gases used as raw data for the calculation of emissions within category 2F.

An additional general QC procedure was carried out in the 2019 edition. The GHG emission calculations were performed in the 2006 IPCC software and the results were compared against the results obtained in the Excel worksheets. The differences between both approaches in terms of GHG emissions were below 2% in all cases.

Category specific QC procedures complements general inventory QC procedures and are directed at specific types of data used in the methods for individual source or sink categories. These procedures require knowledge of the specific category, the types of data available and the parameters associated with emissions or removals and are performed in addition to the general QC checks. The category specific procedures were carried out by international inventory compilers during inventory development. The main category specific procedures developed were the following:

Energy sector: reference vs sectoral approach; comparison of the data provided by the different sources of information. In the comparison of the reference approach, the differences for some years were above 5%. See methodological section for the energy sector for more detailed information.

IPPU sector: comparison of tier 1 and tier 2 estimates in cement production. As there are data on clinker production from one cement plant as well as data on cement production, it was verified that the differences between estimates are due to the different coefficients used (95% clinker content vs national specific clinker quantities).

Waste sector: Comparison of the default rate provided by 2006 IPCC for industrial waste generation against a national rate estimated using real data on industrial waste generated. Two conclusions were raised from this QC: i) the default value provided by IPCC is not adequate for the conditions of Cambodia as the results on emissions were higher than those of municipal solid waste; ii) The scope of the data on industrial waste generated is not 100% of the activity data. As a result of the QC, the rate estimated using national data was used, but this issue needs to be addressed in future editions of the inventory.

Quality Assurance

Quality assurance checks by an international team of experts

In the international team a peer reviewer expert was assigned by sector to undertake checks, propose improvements, and ensure inventory quality. These checks have been designed to verify the transparency, accuracy, consistency, comparability and completeness of the information submitted and include:

a) an assessment whether all emission source categories and gases are reported;
b) an assessment whether emissions data time series are consistent;
c) an assessment whether implied emission factors are comparable to the emissions factors of other countries with similar national circumstances such as Vietnam and considering IPCC default emission factors;
d) an assessment of the use of 'Not Estimated' notation keys where IPCC tier 1 methodologies exist;
e) an analysis of recalculations performed for the inventory submission, compared to the inventories presented in previous national communications;
f) a comparison of the national data using both different national data sources and international data sources when available;
g) a comparison of the results of the reference approach with the sectoral approach for the energy sector; and
h) an assessment whether there were potential overestimations or underestimations relating to a key category in the inventory.

In particular, the peer reviewers checked to see if the international team in charge of the inventory compilation had implemented the following activities:

- Source data received are traceable back to their source in the compilation system. The mechanisms for this are spreadsheet notes, and a common system of data referencing of activity data and emission factors in each sector.
- Checks are undertaken at each stage of the inventory compilation – on receipt of the data, after each calculation step and at the end of the process before dissemination.
- Calculations are also checked, and the checks applied are described in the QA/QC Plan.
- Checks are made on the inventory comparing the emissions of the whole time series and looking for explanations of the trend to ensure that large inter-annual variations have been investigated.
- Compare the reference and the sectoral approach in the energy sector and look for explanations in case of large discrepancies (the total emissions by fuel, must be consistent with the total emissions by source).

- All spreadsheets are subject to second person checking prior to data uploading to the IPCC software.
- As an additional quality check, the national emission estimates were also prepared via the IPCC software by introducing the activity data and emission factors.
- The national report provides full details of inventory estimation methodologies by source category. The report includes summaries of key data sources and significant revisions to methods and historic data, where appropriate. It also describes the assumptions used in the compilation.
- The uncertainty analysis and the key category analysis for the greenhouse gas inventory is detailed within the National Inventory Report.
- The national report includes a programme of continuous improvement.
- At the end of each reporting cycle it is planned that all the database files, spreadsheets, on-line manual, electronic source data, paper source data, output files, etc, are in effect frozen and archived. An annual report outlining the methodology of the inventory and data sources is produced. Electronic information is stored on hard disks that are regularly backed up.

Additionally, a cross-cutting international expert undertook a review of the GHG inventory to check its adherence to the UNFCCC Guidelines and the Decisions Provisions on GHG inventories reporting in National Communications and Biennial Update Reports.

Final quality assurance checks: Official consideration and approval of the inventory

Official approval consisted in a one-month period of interactions between the technical international consultants and the national team who held meetings by sector with the most relevant national stakeholders. During this period, the international team revised the inventory according to observations and recommendations of the competent authority. Based on this interactive process, the final version of the inventory was compiled and presented in a validation workshop.

Annex IV - Improvement plans by sector

Energy sector

The following are the main areas of improvement in the energy sector:

1) Consistency of the time series for future inventories. The data used regarding fuel consumption comes from different data sources (The Ministry of Mines and energy, the ERIA report and ASEAN database). The most complete, robust, and consistent data is available in the ERIA report, developed by a group of experts completing the raw data provided by the Ministry of Mines and Energy. Nevertheless, the Ministry of Mines and Energy has not followed the work made for the ERIA report for year 2016, issue that affects the consistency of the dataset, but is highlighted in the following sectors*fuels:

    - Evolution of biomass consumption in its distinct types, at least firewood, charcoal and biogas. The different aggregation levels provided by ASEAN, ERIA and the Ministry of Mines affects the consistency of the time series of biomass consumption of categories 1A1, 1A2 and 1A4.
    - The value of 2016 for transport jet fuel consumption is very high compared to 2015 of ERIA. The same issue occurs in category 1A4, regarding the consumption of oil products in the commerce and public services sector.
    - The figures for fuel consumption of oil products in the residential sector are not comparable between the Ministry of Mines and ERIA.

2) Sectoral disaggregation of the energy sector. Related to the previous point, the data of fuel consumption included in the ERIA report contained certain sectoral break down, which is useful for the inventory. In the future, additional data detailed at sectoral level is recommended. As a result of points 1) and 2) above, it is therefore recommended to the Cambodian Ministry of Mines and Energy to implement changes in the collection of energy data to provide more accurate and consistent data to the inventory.

3) Develop road transport estimates based on data of vehicles*km. This approach will enable comparing estimates performed using fuel consumption and will improve the quality of the inventory.

4) Develop estimates for railway (starting in May 2016), marine navigation and international marine bunkers.

IPPU sector

The following are the main areas of improvement in the IPPU sector:

1) Improvement of national statistics on production and consumption of products. The Ministry of Industry has provided limited data on production for years 2012-2016. It would be relevant for the country to address the need of having systematic and robust statistics.

2) Improvement of the estimates of cement production. In this edition, there is data available regarding cement and clinker production from the largest production plant in the country. This has enabled the inventory to apply a tier 2 methodology for this production. Nevertheless, this production plant accounts for 2/3 of the national production, so cement production is not applying a tier 2 in its entirety (for the whole category). Information gathered from the remaining production plants will enable Cambodia to have a full tier 2 methodology in the next inventory edition.

3) Continuation of the methodology of F-gases. Cambodia has made significant efforts in gathering data on HFC imports. Continuing this approach will be key for inventory quality in future editions.

4) Improving the completeness of the IPPU sector. The lack of reliable statistics in the country has hampered an appropriate assessment of the completeness of the inventory. Cambodia should address the identification of activities and launch processes for raising new raw data for the inventory.

AFOLU sector

3.A.1 - Enteric Fermentation

Emissions from enteric fermentation is estimated using tier 1 methodology. The main anticipated improvement for future inventories is a shift towards a tier 2 methodology. For this source, the **IPCC tier 2 is very detailed and leads to significant improvement** in the inventory. Of course, this methodology is based on additional requirements in terms of data collection. The main data needs concern the characterization of animal populations:

- Typical body weight,
- Meat yields,
- Milk yields,
- Type of feeding, etc.

This effort could be led for cattle, buffaloes and swine, which are the main output for Cambodia.

3.A.2 - Manure Management

For manure management, tier 1 and tier 2 are based on the same equations. Currently, the inventory corresponds to a tier 1 because only default IPCC parameters are used. However, it would be possible to implement a tier 2 by using **country-specific data for the distribution between the different manure management systems**. Specifically, data exist on the development of biogas production in small farms, this type of data could be used to modify the current estimate based on default value proposed by IPCC for Asia. Another key element is the grazing time spent by cattle and buffaloes. Emissions from grazing are significantly different from those in housing and manure storage. It would be a real improvement to use a country specific estimate for the percentage of manure disposed by grazing. For manure management, it would be useful to initiate additional cross checking between the amount of straw produced by rice crops, mostly used for livestock feeding and bedding, and the estimate of solid manure. In the short-term, it is unrealistic to propose country-specific emission factors for manure management because these emission factors are rather difficult to elaborate and present a very high level of uncertainty. Moreover, this source remains quite low compared to major key categories of agriculture (enteric fermentation, rice cultivation).

3.B - Land

The methodology used for this inventory is duplicated from the forest reference level (FRL) in the framework of REDD+ program. Indeed, it is beneficial to keep consistent methodologies and results. Nevertheless, it is possible to improve different elements of both publications in the future.

Completeness could be improved by adding estimates for the following categories:

- Carbon stock changes for **mineral soils**. This category was not estimated and may represent a burden for inventory teams, however, it would complete the reporting for this sector.
- Carbon stock change for **dead organic matter** (litter and dead wood). Lower impacts are expected from these pools compared to soil, but it is very dependent on forest types.

- Carbon stock changes for **harvested wood products**.
- Emissions from biomass burning in relation with land use conversions.
- Emissions from forest wildfires.
- Emissions from mineralization of organic matter in soils.
- Emissions from organic soils.

Accuracy, could be improved by collecting additional country specific data:

- **On areas**. Currently two periods (2006-2010 and 2010-2014) are monitored using 3 different maps (2006, 2010, 2014). This represents a positive baseline for calculating carbon stock changes, but the time period remains limited for analysing a complete view on land use changes. Indeed, in the IPCC it is common to use default periods of 20 years to apply to default parameters, such as for soils. Since the covered period is less than 20 years, conversion rates are extrapolated for more recent years and for the period before 2006.
- Many sources were collected to estimate **carbon stocks** on different land categories monitored by remote sensing. Although positive, it cannot be compared to real data originating for example from a national forest inventory. The collection of specific references on forest areas from Cambodia would represent a strong improvement.

Accuracy, could also be improved by applying IPCC tier 1 methodology for biomass in forest areas:

- Currently, a tier 2 is applied with the use of a stock change method for biomass in forests. But it would be possible to implement a tier 1 with the use of growth factors and harvested wood, at least for comparison.
- Currently, data were collected and offer the **possibility to make a complete approach 2 or even approach 3**. Currently, the calculation corresponds to an approach 1, which means that carbon stocks changes are fully symmetric in the calculations. For example, the losses observed in deforested areas are equivalent to the gains in afforested areas. Specific calculations could be developed according to the type of changes.

3.C.1 - Biomass burning

Burning of residues represents a real concern for rice cultivation. Currently, country-specific data was used to estimate the share of the **areas where burning of stubble occurs** (based on 2005-2006 data). It is already significant; however, it only provides a static estimate despite the high likelihood this type of practice will change overtime. A major improvement would be to monitor this practice with **a new survey** to estimate the changes since 2005-2006.

The current estimate on grassland is based on very scarce information. Specific monitoring would be necessary to improve the estimate of activity data for this source.

3.C.2 - Liming

Liming is not covered currently. It would be necessary to collect such information with a survey to estimate associated emissions.

3.C.3 - Urea application

Urea consumption is not monitored. Data on fertilizers are provided by the Ministry of Commerce since 2002, but this data only concerns the total amount of fertilizers and not the amounts by type of fertilizer. Currently, urea consumption was analysed using FAOSTAT data to estimate a proportion of urea in fertilizers. The monitoring of urea and other nitrogenous fertilizers is part of the improvement plan. The related emissions are currently rather low, but fertilizer consumption could increase substantially in the future.

3.C.4 - Direct N2O Emissions from managed soils

As mentioned for urea consumption, nitrogen consumption from mineral fertilizer data has low accuracy, and therefore this estimate could be improved. Nevertheless, the contribution of mineral fertilizers remains quite low compared to the contribution of organic amendments, pasture, and crop residues. It is certainly more important to focus on organic fertilizers and on the management of crop residues to improve the estimate of this source.

3.C.5 - Indirect N2O Emissions from managed soils

This source may represent large amounts of N_2O, but it is linked with other parameters used to estimate direct N_2O emission. The main improvement anticipated is the estimate of NH3 volatilisation.

3.C.6 - Indirect N2O Emissions from manure management

This source represents a minimal amount of emissions and is based on very uncertain parameters. It does not appear as a priority in the improvement plan.

3.C.7 - Rice cultivations

This category represents a major category for Cambodia. Currently, the calculation is based on tier 1 methodology from the IPCC, but the calculation is made for 24 different types of rice cultivation. It represents a very detailed calculation and could nearly be considered as a tier 2 (some country-specific parameters are used, and the categorization is high). The main improvements to be addressed include the **amount of residues** incorporated after harvest and the **amount of organic manure** brought to soils. It could prove interesting to collect additional data on the area with high irrigation since the current estimates are based on different sources, but not on dedicated statistics. Currently, the cultivation period is defined by type, but does not adjust. In practice, varieties of rice have improved, and cultivation periods are becoming shorter. It could be included in the calculations.

Waste sector

The following are the main areas of improvement of the inventory in the waste sector:

- Developing estimates for the rate of waste generation per capita for the entire time series. Currently, the rate used is constant for the entire time series. The rate is likely to be lower in the historical period, but it has not been estimated in this edition.

- Improving the information on waste composition. In this inventory edition, different studies have been considered for the choice of activity data. The differences between studies were found to be significant.

- Improving the data gathered on waste disposal, including industrial waste disposal. The information used has been gathered by the MoE and includes municipal and industrial waste disposal. Nevertheless, this information is only partial and does not cover 100% of the activity scope. This issue could be improved by obtaining additional data from the remaining landfills and improving the waste management sector image in the country.

- Raise data about waste incineration. This activity might occur in the country; however, it has not been estimated due to data unavailability.

- Estimate the amount of waste burned in landfills. This has not been estimated in the current edition and could raise significantly the emissions of category 4C3 open burning.

- Obtain direct information about composting. This activity occurs in the country, but it has been estimated using assumptions.

- Improve the data available from the national biodigesters programme. In the current edition of the inventory, the emissions estimate due to the production of biogas in the residential sector (which is happening due to the national biodigester program), has been estimated deriving the activity data (amount of wastes treated) from information on biogas produced. This information could be improved for future inventory editions.

- Improve the statistics on population for improving the estimates of open burning and domestic wastewater. The split between urban and rural population is needed for different areas of the inventory. National statistics has changed the definition of rural use, hampering the estimate of a consistent time series. This issue has been solved using the estimates provided by the World Bank. In the future, improvement of these statistics will enhance the quality of the inventory.

- Improve the data on discharge types by population fraction, to improve the calculation of domestic wastewater.

- Improving national statistics on industrial production. The quality of the IPPU and waste sectors are very affected by the lack of available information on industrial production. In the future, the improvement of these statistics will enhance the quality of the inventory.

Annex V – Mitigation actions in tabular format

Action 1 - Southern Cardamom REDD+ Project

Mitigation Action	**Southern Cardamom REDD+ Project**
Status	Ongoing
Implementing Institution	Royal Government of Cambodia (RGC), the Ministry of Environment
Duration	30 years (01 January 2015 – 31 December 2044)
Sectors (Sub-sector)	Agriculture, Forestry, Land Use
Gas(es) Covered	CO_2
Geographical Scope	Subnational. 445,339 ha encompasses parts of Southern Cardamom National Park and Tatai Wildlife Sanctuary
Quantitative Goal	Estimated emission reduced of 3.867.568-ton CO_2eq year
Methodology and Assumptions	The methodology used was the VCS methodology VM0009 Methodology for Avoided Ecosystem Conversion, v3.0. This methodology quantifies greenhouse gas emission reductions generated from avoiding either planned or unplanned (or both) deforestation as well as protection from native grassland conversion as initiated by a variety of agents and drivers. • The baseline scenario assumes that the entire Project Accounting Area would be converted to subsistence agriculture in the absence of the project. • All land within the project area has been forest for at least 10 years prior to the project start date; • Carbon dioxide (CO2) was determined to be the primary source of greenhouse gas emissions in the project. Methane (CH4) and nitrous oxide (N2O) are conservatively excluded from the project; and • Cambodia Forest Reference Emission Level (2017) was set as the reference scenario for reference area.
Objectives	To generate benefits in the areas of climate and biodiversity. To prevent the emission of an average of 3,867,568 t CO_2eq annually by stopping deforestation and forest degradation.
Steps undertaken and activities planned	Training on Agricultural Methods and Intensification Improve Health Facilities and Care Community-based Eco-Tourism Development Micro-finance Participatory Land Use Planning Strengthening Community Organizations Enhanced Security and Law Enforcement Sensitization and Awareness Raising Education Improvement Direct employment and Training on Income Generating Activities
Progress indicators	First assessment of GHG emissions accounting, climate adaptative capacity and resilience, community, and biodiversity covered the period 2015/2017; future assessments will be carried out biennially.
Estimated outcomes and emission reduction achieved	The main project achievements during the period 1 January 2015 - 31 December 2017 are: • 200 families trained on agricultural methods and intensification, • 9,929 international and domestic tourist visits, generating 396,282 USD for community members and 102,764 USD for the CBET fund. The amount of gross GHG emission reductions verified for the period, results on 13,384,794-ton CO_2eq.

Action 2 - Reduced Emissions from Deforestation and Degradation in Keo Seima Wildlife Sanctuary

Mitigation Action	**Reduced Emissions from Deforestation and Degradation in Keo Seima Wildlife Sanctuary**
Status	Ongoing
Implementing Institution	Royal Government of Cambodia (RGC), the Ministry of Environment
Duration	60 years (1 January 2010 – 31 December 2069)
Sectors (Sub-sector)	Agriculture, Forestry, Land Use
Gas(es) Covered	CO_2 and CH_4
Geographical Scope	Subnational. 166,983 ha of forest in the Seima Protection Forest, located in eastern Cambodia.
Quantitative Goal	Estimated emission reduced of 1,426,648-ton CO_2eq year
Methodology and Assumptions	The methodology used was the VCS methodology VM0015, version 1.1. "Methodology for avoided unplanned deforestation" • Baseline scenario for the Project area assumes that accelerating unplanned deforestation from small holder farmers partly mitigated by continued grant-funded conservation activities at declining levels; • The historical reference period runs for twelve years from 1 January 1998 to 31 December 2009; and • The first fixed baseline period is ten years and will start on 1 January 2010 and run until the end of December 2019.
Objectives	The general objective is to manage forest landscape that supports increasing wildlife populations and improve livelihoods for current residents. The specific objectives are: • To contribute to protection and conservation, to meet the goals of the National Millennium Development Plan of the Royal Government of Cambodia, and to maintain forest cover; • To maintain carbon stored in vegetation in order to reduce carbon dioxide (CO2) emissions into the atmosphere; • To conserve the culture and tradition of indigenous communities and local communities where they are living within the Protection Forest area; • To maintain the natural resources that these communities depend on for their livelihoods and to implement the program of poverty reduction of the Royal Government of Cambodia; • To contribute to sustainable socio-economic development through participation in the management of harvesting forest resources by the local communities, development of ecotourism and other similar activities which have very small impact to biological resources, forest and wildlife; • To prevent soil erosion, to protect soil fertility and to maintain the stability and quality of water sources; • To protect, conserve and rehabilitate genetic resources of globally threatened fauna and flora; • To maintain and rehabilitate important ecosystems as habitat for all forms of biodiversity; and • To support other activities including technical and scientific research, education, training, community development, and environmental studies related to sustainable development and conservation at local, national and international levels.
Steps undertaken and activities planned	• Develop the key legal and planning documents needed to manage Seima protection Forest and surrounding landscape; • Reduce forest and wildlife crime by direct law enforcement; • Establish sustainable community use of land and natural resources; and • Support alternative livelihoods that reduce pressure on forest and natural resources.

Mitigation Action	**Reduced Emissions from Deforestation and Degradation in Keo Seima Wildlife Sanctuary**
Progress indicators	Monitoring and verification took place at two points: • 2015 (covering 2010-2014) • 2017 (covering 215-2016) Project targets are: • Increase wildlife populations of conservation concern; • Maintain the variety, integrity and extent of all forest types; and • Increase security and productivity of natural resources to support local livelihoods. Enough farmland to support the livelihoods of current residents.
Estimated outcomes/emission reduction achieved	The main project achievement is: • 3 communities in process to get titles for land officially in the project area The amount of net GHG emission reductions verified for the period 2010-2015, results on 10,213,393-ton CO_2eq. For the period 2016-2017 results on 4,523,996-ton CO_2eq.

Action 3 - Tumring REDD+ Project

Mitigation Action	**Tumring REDD+ Project**
Status	Ongoing
Implementing Institution	Royal Government of Cambodia (RGC), the Forestry Administration
Duration	30 years (01 January 2015, 31 December 2045)
Sectors (Sub-sector)	Agriculture, Forestry, Land Use
Gas(es) Covered	CO_2 and CH_4
Geographical Scope	Subnational. 67,791.14 ha of forest in the Prey Long Wildlife Sanctuary in Central Cambodia.
Quantitative Goal	Estimated emission reduced of 378,434-ton CO_2eq year
Methodology and Assumptions	The methodology used was the VCS "VM0009 Methodology for Avoided Ecosystem Conversion, v3.0. This methodology quantifies greenhouse gas emission reductions generated from avoiding either planned or unplanned (or both) deforestation as well as protection from native grassland conversion as initiated by a variety of agents and drivers". • The baseline scenario assumes that the entire Project Accounting Area would be converted to subsistence agriculture in the absence of the project; • All land within the project area has been forest for at least 20 years prior to the project start date; and • Carbon dioxide (CO2) was determined to be the primary source of greenhouse gas emissions in the project. Methane (CH4) and nitrous oxide (N2O) are conservatively excluded from the project.
Objectives	• To conserve forest protection and livelihood development activities; • To reduce over 3 million tons CO_2eq emissions over a 10-year timeframe; • To increase forest protection by expanding the current government ranger and community protection force; • To assist local communities by promoting effective land-use planning and granting secure land tenure; • To protect the western edge of Prey Long Landscape for viable populations of threatened species, such as the clouded leopard, chole and bear; and • To contribute to fulfilling Cambodia´s commitments under the Convention of Biological Diversity.
Steps undertaken and activities planned	• Resin, Wild Honey Enterprise, and Forest Conservation based Micro-Finance; • Deforestation Free Commodities and Promote farmer production forestry; • Promoting Effective Forest Land Use Planning and Tenure Security; • Strengthening Community Organizations; • Training on Agricultural Methods and Intensification; • Employment and Motivation of a Larger Ranger Force; • Establish Micro-financing schemes; and • Improve Health Facilities and Care.
Progress indicators	• Estimate and control of carbon stock and carbon emissions by forest patrols and perimeter observation, plot measurements and identification of significant disturbance; • Number of households applying new agriculture techniques; • Number of key assets owned by households; • Number of illegal forests clearing and logging incidents; • Number of hectares of forest restored; • Percentage of community members with improved understanding of forest benefits; • Number of local-level rules and by-laws established and enforced in community forest; and • Ecosystem improvement and biodiversity improvements.
Estimated outcomes and emission reduction achieved	Monitoring Report is still unavailable

Action 4 - REDD in Community Forests – Oddar Meanchey

Mitigation Action	**REDD in Community Forests – Oddar Meanchey**
Status	Ongoing
Implementing Institution	• Royal Government of Cambodia (RGC), the Forestry Administration • Pact • Terra Global Capital • Children's Development Association
Duration	30 years (28 February 2008, 28 February 2037)
Sectors (Sub-sector)	Agriculture, Forestry, Land Use
Gas(es) Covered	CO_2, N_2O and CH_4
Geographical Scope	Subnational. 63,831 ha Oddar Meanchey province, northwest Cambodian.
Quantitative Goal	Estimated emission reduced of 204,792-ton CO_2eq year
Methodology and Assumptions	The methodology used was the VCS "VM0006 Carbon Accounting Methodology for Project Activities that Reduce Emissions from Mosaic Deforestation and Degradation", approved in December 2010. • The baseline scenario assumes that the project area would be deforested in absence of the REDD+ project activity; • Loss of forest is estimated in a 2.5% annual rate; • All land within the project area has been forest for at least 14 years prior to the project start date; • Historical reference period was set from November 1990 to June 2017; and • The baseline will be updated every 10 years.
Objectives	To support 13 Community Forestry Groups in reducing deforestation through the implementation of project activities designed to address key drivers of deforestation and improve livelihoods
Steps undertaken and activities planned	• Reinforcing land tenure status; • Land-use plans; • Forest Protection; • Assisted natural regeneration; • Fire prevention; • Fuel efficient Stoves; • Livestock Protection from Mosquitoes; • Agricultural Intensification; • Natural Resource Management; and • Non-Timber Forest Products development activities.
Progress indicators	• ΔGHG from avoided deforestation; • ΔGHG from avoided degradation; • ΔGHG from assisted natural regeneration; • ΔGHG from changes in long lived wood products; and • GHG from improved cookstoves.
Estimated outcomes and emission reduction achieved	• Facilitation of Community Forest Agreements; • Installation of boundary posts and signs; • Boundary conflict dispute resolution; • Trench digging along Community Forest boundaries; • Long-term land use plans develop; • Demarcation of assisted natural regeneration areas; • Planning for assisted natural regeneration activity implementation; • Establishment of tree nurseries; • Provision of monitoring equipment; • Forest patrolling; • Irrigation systems; and • Resin enterprise development. For the period 2008-2012 net GHG emission reduction were estimated in 745,712-ton CO_2eq.

Action 5 - NAMA on Energy Efficiency in the Garment Industry

Mitigation Action	NAMA on Energy Efficiency in the Garment Industry
Status	Planned (Under preparation)
Implementing Institution	Royal Government of Cambodia (RGC), the Ministry of Environment
Duration	7 years
Sectors (Sub-sector)	Energy
Gas(es) Covered	CO_2
Geographical Scope	National
Quantitative Goal	120,000 tonnes of CO_2eq emission reductions in the years 2016-2021.
Methodology and Assumptions	The MRV framework is based on Clean Development Mechanism (CDM) approved "Small-scale Methodology: AMS-I.E.: Switch from non-renewable biomass for thermal applications by the user, Version 06.0" (UNFCCC, 2014). • Baseline scenario for this NAMA assumes the continuous use of inefficient old equipment in the garment industry; • It is assumed that in the absence of the NAMA, the baseline scenario would be the projected use of fossil fuels to meet similar thermal energy needs as those provided by the devices installed through the NAMA; • Making financial incentives available will remove the barrier of limited funding for investments in energy efficiency; and • Capacity-building programme targeting the barriers of lack of awareness among industry decision makers; insufficient technical capacity within enterprises; lack of human and financial resources to effectively promote and support energy efficiency in industry; and the lack of qualified local suppliers of energy-efficient technologies and after-sales services.
Objectives	By supporting and complementing the implementation of Cambodia´s National Action Plan on Energy Efficiency, this NAMA will remove the barriers hindering effective investment in energy efficient processes and technologies in the garment industry and will have a substantial positive impact on Cambodia´s transformation to a low carbon economy.
Steps undertaken and activities planned	• Replacement of existing, less efficient, biomass fuel fired boilers with new biomass based, more efficient boilers; • Replacement/retrofit of existing, less efficient motors of sewing machines, washing machines, drying machines and compressor with new, more efficient motors and compressor; • Retrofitting of existing electric lighting fixtures, lamps and/or ballasts; and the permanent de-lamping of electric lighting fixtures with the use of reflectors; and • Installation of new, energy efficient equipment for the garment industry to replace old, inefficient equipment.
Progress indicators	• Emission reductions in Tonnes of CO_2eq; • Income generation, electricity payment reduction; and • Asset accumulation: investment biomass, sewing and lighting.
Estimated outcomes and emission reduction achieved	Monitoring report not available

Action 6 - NAMA on Sustainable Charcoal Value-Chains

Mitigation Action	**NAMA on Sustainable Charcoal Value-Chains**
Status	Planned (Under preparation)
Implementing Institution	Royal Government of Cambodia (RGC), the Ministry of Environment
Duration	5 years (2018-2022)
Sectors (Sub-sector)	Energy and Forestry
Gas(es) Covered	Information not available
Geographical Scope	Subnational. The project is carried out in Phnom Penh.
Quantitative Goal	Estimated 2,800,000 tonnes of CO_2e avoided in a 10-year impact period.
Methodology and Assumptions	Methodological information is not available. The project considers the following assumptions: • Currently, more than 1 million tonnes of wood are harvested annually in the Phnom rural area for charcoal production and, considering the urbanization trend and forecasted consumption patterns, this demand is not expected to decrease; and • Charcoal is expected to represent an increasing threat for Protected Areas which needs to be addressed by supporting existing charcoal producers' conversion to sustainable practices.
Objectives	• Reduce forest degradation in Protected Areas affected by charcoal production; • Leverage private sector investment in the sustainable charcoal sector to support Cambodian green economic growth; and • Invest in forest restoration and support switch to sustainable production for illegal charcoal producers in Protected Areas buffer-zones.
Steps undertaken and activities planned	• Certification and labelling of sustainable actors for market differentiation • Increase private investment profitability through financial and fiscal incentives • Invest in forest restoration and switch to sustainable production for non-sustainable actors in Protected Areas buffer-zones
Progress indicators	• % of the Phnom Penh charcoal demand covered by certified sustainable charcoal producers; • ha of degraded forest in Protected Areas buffer-zone restored and under sustainable forest management for sustainable charcoal production; • Sustainable livelihoods activities created; • USD of income generated from sustainable charcoal production by former non-sustainable charcoal producers; and • tonnes of CO_2-equivalent avoided.
Estimated outcomes and emission reduction achieved	Monitoring report not available

Action 7 - National Biodigester Programme

Mitigation Action	**National Biodigester Programme**
Status	Finalised
Implementing Institution	Royal Government of Cambodia (RGC), the Ministry of Agriculture, Forestry and Fisheries (MAFF)
Duration	4 years (January 2012 - December 2015)
Sectors (Sub-sector)	Energy
Gas(es) Covered	CO_2 - CH_4 - N_2O

Mitigation Action	National Biodigester Programme
Geographical Scope	Subnational, 16 provinces of Cambodia
Quantitative Goal	457,791 tCO_2 reduced
Methodology and Assumptions	The methodology applied is the Gold Standard methodology Technologies and Practices to Displace Decentralized Thermal Energy Consumption version 3.1. • The baseline scenario is defined by the typical baseline fuel consumption patterns in a population that is targeted for adoption of the project technology; and • The baseline for Animal Waste Management System is the emissions from animal manure management systems resulting from the anaerobic biodegradation of organic matter.
Objectives	To use funding from the private sector to create a permanent national domestic biodigester sector for the dissemination of high-quality household biodigesters that provide a clean, indigenous and sustainable energy source for cooking and lighting. The project also provides additional benefits with the bio-slurry providing a great means for fertilizing and improving local agricultural production.
Steps undertaken and activities planned	• Increase the number of family sized, quality biodigesters with the total 8,600 biodigesters in the period 2019-2025 in selected provinces; • Ensure the continued operation of all biodigesters installed under the biodigester programme; • Maximise the benefits of the operated biodigesters, particularly optimum use of digester effluent; and • Technical and promotional capacity development of the stakeholders within the NBP for further wide scale deployment of biodigester technology in Cambodia. This objective will particularly focus on the development of a capable and viable private sector responsible for marketing, construction and after-sales service of biodigesters.
Progress indicators	• Proportion of population with primary reliance on clean fuels and technology; • Proportion of agricultural area under productive and sustainable agriculture; and • Defined herein as Emissions Reductions or Removals and/or Adaptation to climate change.
Estimated outcomes and emission reduction achieved	• 25.000 biodigesters constructed from March 2006 to August 2016 / 122.500 direct beneficiaries; • 90% of constructed biodigesters still operational; i.e. 21,760 smoke-free kitchens (February 2016); • Biogas kitchen air pollution reduced 88% (Particulate Matter 2.5); • 29,5 averted deaths and 1,442 averted Disability Adjusted Life Years (ADALYs) realized from 2006 to 2014 with projection of 51 averted deaths and 2,519 ADALYs up to 2020; • 2,886 biodigester connected toilets; • 120 USD saving in expenditures on fuelwood and chemical fertilizer per household per year; • Employment creation; • 69 active private enterprises consolidated; • 604 trained masons; of whom 185 actives; • 162 trained supervisors; • 173,900 tonnes of wood saved; and • 457,791 tCO_2 reduced between May 2009 and December 2015.

Action 8 - Fuelwood Saving with Improved Cook Stoves in Cambodia

Mitigation Action	Fuelwood Saving with Improved Cookstoves in Cambodia
Status	Finalised
Implementing Institution	Groupe Energies Renouvelables & Environnement (GERES)
Duration	10 years (10 May 2003, 9 May 2013)
Sectors (Sub-sector)	Energy demand
Gas(es) Covered	CO_2
Geographical Scope	Subnational. The project is carried out in Phnom Penh, Kandal, Kompong Speu, Prey Veng, Takeo, Siem Reap, Battambang, Kampong Cham and Kompong Chhnang.
Quantitative Goal	Estimated emission reduction of 449,932-ton CO_2eq year

Mitigation Action	Fuelwood Saving with Improved Cookstoves in Cambodia
Methodology and Assumptions	The methodology used was Voluntary Emission Reductions - Improved Efficiency in Use of Non-Renewable Biomass. Reference: Climate Care Trust, derived from proposed methodology SSC.II.G., amended by the Johanneum Institute and approved by the community of practice (HEDON, Stove and Carbon Special Interest Group). • The baseline scenario assumes that without the project there will be more emissions of GHGs both by the activities of producing and consuming larger amounts of charcoal extracted from non-sustainably harvested wood; • The fuel wood collection and charcoal production area shift every season further away. The current rate of wood collected for energy use exceeds the re-growth rate of the forest. The charcoal production and consumption trends cannot reach sustainability in any foreseeable future; • The total wood fuel demand of Cambodia was estimated at 4.5 MT of wood in 2004, expected to cross 5 MT in 2009. Under prevailing conditions, properly managing the established forests or energy plantations cannot happen fast enough at the scale required for a sustainable supply of wood fuel. Undoubtedly, a sustainable charcoal supply will not take place in the current situation without proactive project intervention, possibly making use of Carbon Finance; and • For charcoal users, the average charcoal consumption is 2.118 kg / family /day using the traditional stove (or 773,60 kg charcoal per year); the charcoal saving when switching to New Lao Bucket Stove is 21.76 %; for wood users, the consumption is 2.775 kg/family/day (or 84.464 kg wood/family/month or 1,013.568 kg wood/family/year); the wood saving when switching to New Lao Bucket Stove is 21.49 %.
Objectives	To reduce charcoal and thereby fuel wood consumption by introducing improved Lao cook stoves in Cambodia. • avoidance overexploitation of forests; • improvement in social sustainability; and • lack of economic sustainability is tackled.
Steps undertaken and activities planned	• Elaborate stove design, trained producers and developed distribution networks; • Developing the commercialized distribution of the stove design; and • Scaling-up of the project to achieve large-scale dissemination.
Progress indicators	• Number of NLS Stoves sold; • Number of NLS Stoves in use; and • Number of NLS stoves producers.
Estimated outcomes and emission reduction achieved	• 155,249 NLS Stoves sold; • 579,149 NLS Stoves in use; and • 35 NLS stoves producers. For the period 2003-2013 net GHG emission reduction were estimated in 2,008,739-ton CO_2e.

Action 9 - Kamchay Hydroelectric BOT Project

Mitigation Action	Kamchay Hydroelectric BOT Project
Status	Ongoing
Implementing Institution	Sinohydro Kamchay Hydroelectric Project Co., Ltd. CF Carbon Fund II Limited from the Annex I party of The Netherlands
Duration	7 years (08/10/2013-07/10/2020)
Sectors (Sub-sector)	Energy industries (renewable sources)
Gas(es) Covered	CO_2 - CH_4
Geographical Scope	Subnational; The Kamchay Hydroelectric Project located in the Elephant Mountain Range in southwestern Cambodia on the Kamchay River
Quantitative Goal	281,348 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodology applied is the CDM methodology ACM0002 Consolidated baseline methodology for grid-connected electricity generation from renewable sources (version 13.0.0.) • The baseline scenario is the same amount power provided by Phnom Penh Grid yearly", which is the same as the scenario existing prior to the start of implementation of the proposed project; • The main emission source for the hydro power plants is the emissions of CH_4 from the reservoir; • No diesel Generator set will be used in the project activity; • The average annual electricity generation will gain totally 508.2 GWh; and • The total annual net grid-connected electricity delivered to Phnom Penh Grid will be about 498 GWh, which is calculated to be "508.2GWh*(1-2%)=498GWh", and 2% is the sum rate of the station auxiliaries, transformer losses and transmission losses.
Objectives	The overall purpose of the project is the generation of electricity based on renewable energy sources. The electricity generated by the project is connected through the Kampot Switching Station finally to the Phnom Penh Grid.
Steps undertaken and activities planned	• Utilise hydropower potential of the Kamchay River; • The electricity generated form the project activity will be sold to the grid; and • The Project is connected through the Kampot Switching Station to the Phnom Penh Grid.
Progress indicators	• Power houses installed; • Hydropower potential installed capacity; and • tCO2 annual average of GHG emission reduction.
Estimated outcomes and emission reduction achieved	Monitoring report not available.

Action 10 - Cambodia Stung Atay Hydropower Project

Mitigation Action	**Cambodia Stung Atay Hydropower Project**
Status	Ongoing
Implementing Institution	C.H.D (Cambodia) Hydropower Development Co., Ltd. Carbon Asset Management Sweden Pte Ltd
Duration	7 years (01/03/2013-29/02/2020)
Sectors (Sub-sector)	Energy industries (renewable sources)
Gas(es) Covered	CO_2
Geographical Scope	Subnational; Stung Atay, Stung Ruxeg Chrum, Pursat Province, Kingdom of Cambodia
Quantitative Goal	266,472 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodology applied is the CDM methodology ACM0002 Consolidated baseline methodology for grid-connected electricity generation from renewable sources (version 12.3.0.) • The electricity generated by the proposed project will be supplied to Phnom Penh Grid System; • The proposed project is planned to adopt imported technologies, which have been used worldwide and safe on environment and will not result in a negative damage to the ecosystem; • The baseline scenario assumes that electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources; and • Emissions from the reservoir can be neglected, as the power density of the project activity is 21.55W/m^2, greater than the threshold establish by the methodology applied of 10W/m^2.
Objectives	To achieve electricity generation by utilizing renewable water resources and to promote local sustainable development. • To add great benefit to the national economy and environmental sustainability while reducing CO_2 emissions; • To increase government revenue through tax, and stimulate the economic development of local area; • To substitute part of electricity in Phnom Penh Grid which is dominated by fossil fuel generated electricity; and • To create more job opportunities for local people. Rural labours could be arranged for on-site construction during the construction period, and some long-term job.
Steps undertaken and activities planned	• Install a newly built hydropower project with an installed capacity of 100 MW; • Installation of four set of 25 MV hydro turbine and generator unit; and • Supplied electricity generated to the Phnom Penh Grid System.
Progress indicators	• Estimated annual operational hours; • Annual electricity generated; • Annual electricity supplied to the Phnom Penh Grid System; and • GHG Emission reduction.
Estimated outcomes and emission reduction achieved	Not reported

Action 11 - Stung Tatay Hydroelectric Project

Mitigation Action	Stung Tatay Hydroelectric Project
Status	Ongoing
Implementing Institution	C.H.D (Cambodia) Hydropower Development Co., Ltd. Carbon Asset Management Sweden Pte Ltd
Duration	7 years (01/09/2013-31/08/2020)
Sectors (Sub-sector)	Energy industries (hydropower generation)
Gas(es) Covered	CO_2
Geographical Scope	Subnational; Tatay River in Koh Kong Province, The Kingdom of Cambodia
Quantitative Goal	563,074 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodology applied is the CDM methodology ACM0002 Consolidated baseline methodology for grid-connected electricity generation from renewable sources (version 12) • The electricity generated by the proposed project will be supplied to Phnom Penh Grid System; and • By displacing Heavy Fuel Oil and diesel fuel power generation with clean and renewable energy, the project leads to the reduction of CO2 emission into the atmosphere.
Objectives	To generate power from clean renewable hydro power in Koh Kong Province for the contribution to the sustainability of power generation of the Phnom Penh Power Grid. • To reduce the dependence on exhaustible fossil fuels for power generation; • To reduce the air pollution by displacing Heavy Fuel Oil power plants with clean, renewable power; • To reduce the adverse health impacts from the air pollution; • To reduce the emission of greenhouse gases, to combat the global climate change; and • To contribute to the electricity shortage and the local economic development through the employment creation.
Steps undertaken and activities planned	• Installation 3 sets of turbine and generators (3×82MW) which amount to a total capacity of 246MW; and • Supplied 857,300 MWh power to the Phnom Penh Grid System.
Progress indicators	• Estimated annual operational hours; • Annual electricity generated; • Annual electricity supplied to the Phnom Penh Grid System; and • GHG Emission reduction.

Estimated outcomes and emission reduction achieved	• 3 sets of turbine and generator installed with a total capacity of 246 MW
	• Emission reduction certified:
	  ○ 538,683 ton CO_2eq during the first monitoring period (01/09/2013-27/12/2015)
	  ○ 532,689 ton CO_2eq during the second monitoring period (28/12/2015-27/12/2016)
	• Emission reduction during the third monitoring period (27/12/2016-27/12/2018), estimated but not certified yet: 1,342,977 ton CO_2eq.

Action 12 - Lower Stung Russei Chrum Hydro-Electric Project

Mitigation Action	Lower Stung Russei Chrum Hydro-Electric Project
Status	Ongoing
Implementing Institution	China Huadian Lower Stung Russei Chrum Hydro-Electric Project
Duration	7 years (01/01/2013-31/12/2019)
Sectors (Sub-sector)	Energy industries (hydropower generation)
Gas(es) Covered	CO_2
Geographical Scope	Subnational; Stung Russei Chrum River in Koh Kong Province, Kingdom of Cambodia
Quantitative Goal	701,199 tCO_2 annual average of GHG emission reduction

Methodology and Assumptions	The methodology applied is the CDM methodology ACM0002 Consolidated baseline methodology for grid-connected electricity generation from renewable sources (version 12) • The scenario prior to the implementation of the project activity is that electricity delivered to the grid is generated by the operation of grid-connected power plants and by the addition of new generation sources; • Heavy Fuel Oil and diesel Oil power generation is currently the dominant power supply option within the Phnom Penh Power Grid; and • By displacing Heavy Fuel Oil and diesel fuel power generation with clean and renewable energy, the project leads to the reduction of CO2 emission into the atmosphere.
Objectives	To generate power from clean renewable hydro power in Koh Kong Province for the contribution to the sustainability of power generation of the Phnom Penh Power Grid; • To reduce the dependence on exhaustible fossil fuels for power generation; • To reduce the air pollution by displacing Heavy Fuel Oil power plants with clean, renewable power; • To reduce the adverse health impacts from the air pollution; • To reduce the emission of greenhouse gases, to combat the global climate change; and • To contribute to the electricity shortage and the local economic development through the employment creation.
Steps undertaken and activities planned	• Installation of an Upper Scheme Station with a capacity of 206 MW; • Installation of a Lower Scheme Station with a capacity of 132 MW; and • Supplied 1,067,600 MWh power to the Phnom Penh Grid System.
Progress indicators	• Estimated annual operational hours; • Annual electricity generated; • Annual electricity supplied to the Phnom Penh Grid System; and • GHG Emission reduction.
Estimated outcomes and emission reduction achieved	• 2 sets of the turbine/generator units with an individual capacity of 103MW at Upper Scheme Station installed ; • 2 sets of the turbine/generator units with an individual capacity of 66MW at Lower Scheme Station installed; and • Emission reduction certified during the first monitoring period (01/01/2013-27/09/2018) reach to 3,120,080 ton CO_2eq.

Action 13 - Biogas Project at MH Bio-Ethanol Distillery, Cambodia

Mitigation Action	**Biogas Project at MH Bio-Ethanol Distillery, Cambodia**
Status	Ongoing
Implementing Institution	MH Bio-Energy Co., Ltd
Duration	7 years (01/08/2012-31/07/2019)
Sectors (Sub-sector)	Biogas
Gas(es) Covered	CO_2
Geographical Scope	Subnational; Duong village, Preak Phnouv Commune, Pornhear Leu District, Phnom Penh Province, Kingdom of Cambodia
Quantitative Goal	58,146 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodologies applied are the CDM methodology AMS III.H "Methane recovery in wastewater treatment" version 16 and AMS-I.C. "Thermal Energy production with or without electricity" version 18; based on the installation of an anaerobic digestion system with methane recovery for the treatment organic wastewater generated by an existing ethanol manufacturing plant. The recovered methane will be used for steam generation onsite consumption that will displace fuel oil consumed in co-fired boilers. • The scenario prior to the implementation of the project activity is that electricity delivered to the grid is generated by the operation of grid-connected power plants and by the addition of new generation sources; • Baseline emission of the sludge treatment system affected by project activity shall be neglected since the sludge will be transported to their own plantation used for soil application; • Methane emissions from the baseline wastewater treatment systems affected by the project are determined using the methane generation potential of the wastewater treatment systems; and • The baseline of GHG emission of the thermal energy component, was calculated as the amount of displacement of fossil fuel consumed by boilers.
Objectives	To prevent the emission of methane to the atmosphere generated by the degradation of organic matter contained in the wastewater of bioethanol effluent which would be treated anaerobically open system. • To reduce methane that would have otherwise been allowed to dissipate into the atmosphere; and • To displace the use of fossil fuels for steam.
Steps undertaken and activities planned	• Involves a high temperature digester system contributes to better digestion of Chemical Oxygen Demand and thus a better removal of organic matter present in the wastewater. • Fed the recovered methane enriched biogas from the anaerobic to energy generation utilities, boilers and/or electricity generator, for the thermal energy generation and electricity generation respectively.
Progress indicators	• Treatment of the wastewater; • Capture of biogas; • Conduction of biogas; • Management of sludge; • Monitoring instruments; and • GHG Emission reduction.
Estimated outcomes and emission reduction achieved	• Implement a two phase of high temperature digestion system to wastewater treatment; • Implement a concrete building or bio-digester; • Implementation of 2 set of biogas blow-inverters; • Emission reduction certified during the first monitoring period (01/08/2012-31/12/2013) reach to 42,159 ton CO_2eq; and • Ex-post emission reduction estimated during the second monitoring period (01/01/2014-31/08/2017) reach to 103,000 ton CO_2eq.

Action 14 - W2E Siang Phong Biogas Project Cambodia

Mitigation Action	W2E Siang Phong Biogas Project Cambodia
Status	Ongoing
Implementing Institution	W2E Siang Phong Ltd
Duration	7 years (01/06/2011-31/05/2018)
Sectors (Sub-sector)	Energy industries and Waste handling and disposal
Gas(es) Covered	CO_2 , CH_4
Geographical Scope	Subnational; Kampong Cham Province, Kingdom of Cambodia
Quantitative Goal	26,592 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodologies applied are the CDM i) AMS-III.H. ver. 14 - Methane recovery in wastewater treatment; ii) AMS-I.F. - Renewable electricity generation for captive use and mini-grid, and; iii) AMS-I.C. ver. 17 - Thermal energy production with or without electricity • Prior to the implementation of the project, the wastewater treatment plant released methane and H_2S directly to the atmosphere; • The baseline situation involves the use of one anaerobic treatment system consisting of a sequential series of 7 ponds; • In the baseline situation, wastewater from the factory is directly discharged into this single treatment system; • After treatment, wastewater is discharge from the final pond into the local fields and watercourses; • The project activity will alter this baseline situation by introducing a sequential treatment step consisting of an anaerobic digester installed prior to the inlet of the baseline pond system and no change to the existing baseline pond system will occur; • In the baseline emissions for fossil fuel, heavy fuel oil is combusted in the burner to generate hot air and dry the starch, while in the project activity will be replaced and capable of burning both biogas and heavy fuel oil; and • In the baseline emission for electricity displaced, electricity is produced by the onsite diesel genset and electricity is purchased from the grid, while in the project activity the new biogas genset will produce electricity for use onsite.
Objectives	To reduce GHG emissions by capturing methane from the anaerobic treatment of the wastewater generated by processing cassava root to produce tapioca starch and combusting it to produce heat and electricity for use onsite. • To reduce methane that would have otherwise been allowed to dissipate into the atmosphere; • To generate renewable heat and electricity from biogas; and • To displace the use of fossil fuels for steam.
Steps undertaken and activities planned	• Implement a Covered In-Ground Anaerobic Reactor equipped with a system for the capture, collection and utilization of biogas; • The primary technology employed is designed to treat wastewater prior to discharge into the existing open pond system; • The digester is designed to optimize contact between the effluent and naturally occurring anaerobic bacteria which convert the organic material to biogas; and • In order to generate electricity, the project will use biogas genset is designed for biogas to ensure high efficiency of generation.
Progress indicators	• Methane emissions; and • CO_2 emissions.
Estimated outcomes and emission reduction achieved	• Monitoring report is not available

Action 15 - Kampot Cement Waste Heat Power Generation Project (KCC-WHG)

Mitigation Action	**Kampot Cement Waste Heat Power Generation Project (KCC-WHG)**
Status	Ongoing
Implementing Institution	Kampot Cement Company Co., Ltd
Duration	10 years (01/06/2009-31/05/2018)
Sectors (Sub-sector)	Energy industries and Waste handling and disposal
Gas(es) Covered	CO_2
Geographical Scope	Subnational; Kampong Cham Province, Kingdom of Cambodia
Quantitative Goal	17,107 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodology applied is the CDM AMS-III.Q. ver. 2 - Waste Energy Recovery (gas/heat/pressure) Projects • The project will not alter the production process of the cement factory or increase the factories fuel consumption per tonne of clinker; • Waste heat from the kiln will still be used to preheat raw materials prior to combustion in the rotating kiln and hot waste gases from the clinker cooler will still be used as combustion air in the clinkering process, as is the current practice; • Only energy that was otherwise wasted through venting to atmosphere will be utilised by the project activity; and • The baseline situation is the continued use of the captive Heavy Fuel Oil power plant.
Objectives	To utilise waste heat in the cement plant vent gas to produce electricity to offset the need for electricity from the on-site dedicated HFO fired power plan. • To contribute to sustainable development through the promotion of clean energy technology in Cambodia, the creation of skilled employment opportunities, reducing dependence on external fuel supplies and the reduction of air emissions; • To promote an awareness of the issues surrounding climate change, greenhouse gas emissions and sustainable development; • To help Cambodia reduce its dependency on foreign fuel sources; and • To reduce greenhouse gas emissions and contribute to improved air quality in the local region.
Steps undertaken and activities planned	• Install an air quenching cooler boiler to recover heat from the cooler vent gas; • Install a suspension pre-heater boiler to recover heat from the preheater vent gas; and • Install a steam turbine to generate 28.73 GWh per year of electricity.
Progress indicators	• Construction of the Waste Heat Power Generation Project; • Produce electricity; • Install equipment; and • Emissions reduction.
Estimated outcomes and emission reduction achieved	• Kampot Cement Waste Heat Power Generation Project constructed; • Electricity produced used within the cement factory; • Equipment installed; • During the first monitoring report, covering the period 01/07/2009 – 30/04/2010, the emission reductions are 10,758 ton CO_2eq.; and • During the second monitoring report, covering the period 01/05/2010-30/04/2011 the emission reduction area 11,052 ton CO_2eq.

Action 16 - Methane-fired power generation plant in Samrong Thom Animal Husbandry, Cambodia

Mitigation Action	**Methane-fired power generation plant in Samrong Thom Animal Husbandry, Cambodia**
Status	Ongoing
Implementing Institution	Samrong Thom Animal Husbandry Clean Energy Finance Committee, Mitsubishi UFJ Securities Co., Ltd.
Duration	7 years (03/12/2008 – 02/12/2015)
Sectors (Sub-sector)	Energy industries and Waste handling and disposal
Gas(es) Covered	CO_2
Geographical Scope	Subnational; Phum Prek Treng, Khum Samrong Thom, Kien Svay District, Kandal province, Kingdom of Cambodia
Quantitative Goal	5,593 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodologies applied are the CDM AMS-III.D. ver. 13 - Methane recovery in agricultural and agro industrial activities and the AMS-I.A. ver. 12 - Electricity generation by the user- • The methane capture and destroy would otherwise be emitted to the atmosphere in the absence of the project; • The Project will produce electricity using renewable generating units, which will replace existing fossil fuel fired generators; and • The energy baseline is the fuel consumption of the technology in use or that would have been used in the absence of the project activity.
Objectives	To recover the methane generated from the wastewater of Samrong Thom Animal Husbandry (STAH) piggery farm in Kien Svay district, Kandal province, Cambodia. To contribute to Cambodia Sustainable Development.
Steps undertaken and activities planned	• Install an anaerobic reactor digestion system to capture the methane generated from their wastewater; and • Use the recovered methane to fuel a gas engine driven generator to supply the electricity requirements of the farm and to other local user via a rural electricity enterprise.
Progress indicators	• Install capacity of 200kW, to generate 1,314,000 kWh of electricity per annum, which will supply the electricity demand of STAH piggery farm; and • Recover and destroy methane from swine wastes from STAH pig farm equivalent to 5,281 ton CO_2eq per annum.
Estimated outcomes and emission reduction achieved	• Monitoring report not available

Action 17 - TTY Cambodia Biogas Project

Mitigation Action	TTY Cambodia Biogas Project
Status	Ongoing
Implementing Institution	T.T.Y Agricultural Plant Development and IMEX Co. Ltd ; Carbon Bridge Pte Ltd
Duration	7 years (03/09/2008-02/09/2015)
Sectors (Sub-sector)	Waste handling and disposal
Gas(es) Covered	CO_2 , CH_4
Geographical Scope	Subnational; Phum Prek Treng, Khum Samrong Thom, Kien Svay District, Kandal province, Kingdom of Cambodia
Quantitative Goal	50.036 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodology applied is the CDM Methodology AM0022 ver. 4 - Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector. • The baseline scenario of the project will be the continued use of the existing deep lagoon wastewater treatment process, which currently emits methane to the atmosphere; • In the project scenario, the project will capture and burn the methane, thus reducing the potent greenhouse gas. The renewable biogas burned in the heaters will displace the need to burn fossil fuel HFO and the associated emissions; and • The Project is implemented in existing lagoon-based industrial wastewater treatment facilities for wastewater with high organic loading.
Objectives	• Build a Biogas Project at the T.T.Y Tapioca Starch Factory in Memot, Cambodia; • Capture biogas emitted from the anaerobic digestion of organic matter in wastewater that is currently discharged from the tapioca starch factory into large deep lagoons; • Create and use renewable biogas energy to replace the heavy fuel oil (HFO) currently used in the heaters to dry the starch in the factory; and • Create Certified Emission Reductions from the project.
Steps undertaken and activities planned	• Installation of a CIGAR (Covered In-Ground Anaerobic Reactor); • The CIGAR creates an enclosed and anaerobic environment which enables bacteria to convert organic matter into biogas; • The captured biogas will be sent to a heater (InPlan 4.05 MW) which will run on the biogas and displace around 2,700m3 of Heavy Fuel Oil per year; • Biogas electricity generators will be installed; and • Any excess biogas will be flared in an enclosed flare.
Progress indicators	• Fugitive methane, through the assessment of organic material flows through the project and the baseline system; • On-site heat generated from the biogas collected in the anaerobic treatment facility; • Inefficient biogas combustion emissions in project: emissions arising though inefficient destruction of biogas in the heating systems and electricity generation sets; • Biogas leakage in project: through leaks in the pipeline during transportation of biogas, or its production in anaerobic digesters; and • Aerobic disposal of sludge for land application.
Estimated outcomes and emission reduction achieved	• Monitoring report not available

Action 18 - Angkor Bio Cogen Rice Husk Power Project

Mitigation Action	Angkor Bio Cogen Rice Husk Power Project
Status	Ongoing
Implementing Institution	Angkor Bio Cogen Co., Ltd; Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.; Asian Development Bank as Trustee of the Future Carbon Fund; Swedish Energy Agency.
Duration	7 years (19/04/2009-0 18/04/2016)
Sectors (Sub-sector)	Energy industries, Waste handling and disposal, Agriculture
Gas(es) Covered	CO_2 , CH_4
Geographical Scope	Subnational, Phum Ang Snoul, Ang Snoul District, the Kingdom of Cambodia.
Quantitative Goal	51,620 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodologies applied are the CDM AMS-I.A. ver. 7 - Electricity generation by the user; AMS-III.E. ver. 7 - Avoidance of methane production from biomass decay through controlled combustion; and AMS-I.D. ver. 18 - Grid connected renewable electricity generation • The baseline scenario in the absence of project activity continues to use high carbon intensive (diesel oil) for electricity generation; • Baseline emissions are calculated based on baseline emissions for electricity generation plus baseline emissions for methane avoidance; • Project emissions are calculated based on project emissions from combustion of biomass plus project emissions from combustion of fossil fuels due to the project activity; and • Emission reductions of the project activity are determined by subtracting the project emissions from the baseline emissions.
Objectives	• To use for electricity generation rice husk that would otherwise be left to decay
Steps undertaken and activities planned	• Construction and operation of a 2 MWh new rice husk power generation plant • Sell the electricity to Angkor Rice Mill in bulk under a power purchasing agreement
Progress indicators	• Main equipment installed and operated; • Gross electricity generated; • Electricity exported; • Electricity imported form the grid; and • Emission reduced.

Estimated outcomes and emission reduction achieved	• Equipment are installed and operating: 16,848 hours;
	• Gross electricity generated:28,876.165 MWh;
	• Electricity exported:21.226.378 MWh;
	• Electricity imported form the grid: 748.581 MWh;
	• Emission reduction verified:
	  ○ During the first monitoring period (20/04/2011-31/05/2012): 3,753 ton CO_2eq.
	  ○ During the second monitoring period (01/05/2012-31/12/2012): 937 ton CO_2eq.
	  ○ During the third monitoring period (01/01/2013-31/07/2015): 27,859 ton CO_2eq.
	  ○ During the fourth monitoring period (01/08/2015-19/08/2018): 119,564 ton CO_2eq.

Action 19 - PoA Waste to energy using biomass Gasification in South East Asia LDCs programme of activities

Mitigation Action	PoA Waste to energy using biomass Gasification in South East Asia LDCs programme of activities
Status	Ongoing
Implementing Institution	Nexus Carbon for Development Ltd
Duration	28 years (30/09/2013-19/09/2041)
Sectors (Sub-sector)	Energy industries
Gas(es) Covered	CO_2
Geographical Scope	National, Kingdom of Cambodia.
Quantitative Goal	549 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodologies applied are the CDM AMS-I.A. ver. 16 - Electricity generation by the user; AMS-I.B. ver. 12 - Mechanical energy for the user with or without electrical energy; and AMS-I.D. ver. 18 - Grid connected renewable electricity generation • Currently, the rice mills or small power plants use diesel powered systems to generate mechanical or electrical energy; • The energy baseline is the fuel consumption of the technology in use or that would have been used in the absence of the project activity to generate the equivalent quantity of energy. The electricity would continue to be generated by the diesel-based generators as in the business as usual scenario. Baseline emissions from electricity generation are calculated based on the amount of diesel used and the emission factor of diesel; and • The grid connected baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid.
Objectives	• To support the application of gasification technology for mechanical and electrical energy generation in rice milling facilities and other industrial sectors such as rural electrification. • To alleviate poverty of local people and to mitigate climate change through reducing dependence on diesel for energy generation or the carbon intensive grid.
Steps undertaken and activities planned	• Implement 3 micro scale Rice Husk Gasification (RHG) units operating at different locations in Cambodia with a total capacity of 360 kW; • Collect, manage and archive the ER data; and • Distributing the sales income from carbon credit.
Progress indicators	• Number of installed units; • Type of technology of installed units; • Manufacturer of installed units; • Model of installed units; • Installation addresses/locations; • Installed capacity of installed units; and • GHG Emission reduction.
Estimated outcomes and emission reduction achieved	• Monitoring report not available

Action 20 - PoA Waste to energy using biomass Gasification in South East Asia LDCs programme of activities

Mitigation Action	**PoA Waste to energy using biomass Gasification in South East Asia LDCs programme of activities**
Status	Ongoing
Implementing Institution	Nexus Carbon for Development Ltd.
Duration	28 years (30/09/2013-19/09/2041)
Sectors (Sub-sector)	Energy industries
Gas(es) Covered	CO_2
Geographical Scope	National, Kingdom of Cambodia.
Quantitative Goal	601 tCO_2 annual average of GHG emission reduction
Methodology and Assumptions	The methodologies applied are the CDM AMS-I.A. ver. 16 - Electricity generation by the user; AMS-I.B. ver. 12 - Mechanical energy for the user with or without electrical energy; and AMS-I.D. ver. 18 - Grid connected renewable electricity generation • Currently, the rice mills or small power plants use diesel powered systems to generate mechanical or electrical energy; • The energy baseline is the fuel consumption of the technology in use or that would have been used in the absence of the project activity to generate the equivalent quantity of energy. The electricity would continue to be generated by the diesel-based generators as in the business as usual scenario. Baseline emissions from electricity generation are calculated based on the amount of diesel used and the emission factor of diesel; and • The grid connected baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid.
Objectives	• To support the application of gasification technology for mechanical and electrical energy generation in rice milling facilities and other industrial sectors such as rural electrification; and • To alleviate poverty of local people and to mitigate climate change through reducing dependence on diesel for energy generation or the carbon intensive grid.
Steps undertaken and activities planned	• Implement 3 micro scale Rice Husk Gasification (RHG) units operating at different locations in Cambodia with a total capacity of 360 kW; • Collect, manage and archive the ER data; and • Distributing the sales income from carbon credit.
Progress indicators	• Number of installed units; • Type of technology of installed units; • Manufacturer of installed units; • Model of installed units; • Installation addresses/locations; • Installed capacity of installed units; and • GHG Emission reduction.
Estimated outcomes and emission reduction achieved	• Monitoring report not available

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