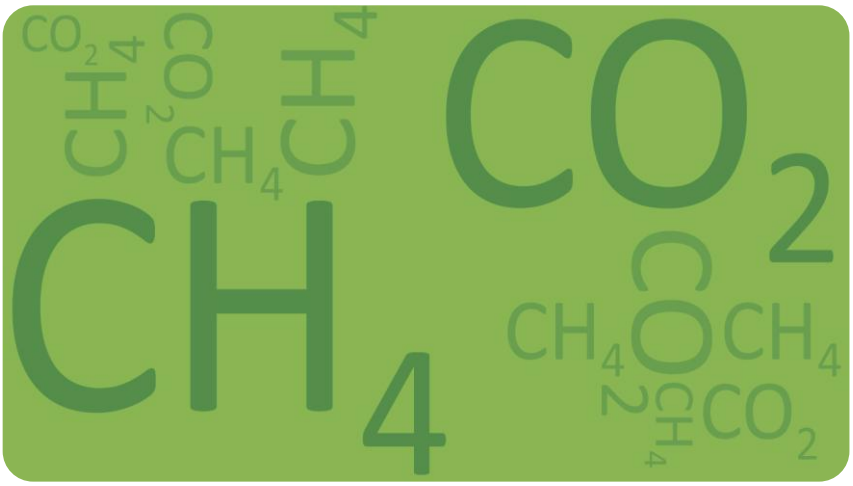
EMISSIONS REDUCTION PROFILE

Myanmar



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Contents

Brief Profile

Full name:	Republic of the Union of Myanmar (previously Union of Myanmar; Union of Burma)
Population:	50 million[1]
Capital:	Nay Pyi Taw
Area:	676,552 sq km (261,218 sq miles)
Major languages:	Burmese, indigenous ethnic languages
Life expectancy:	62 years (men), 67 years (women) (UN)
Monetary unit:	1 kyat = 100 pyas
Main exports	Teak, pulses and beans, prawns, fish, rice, opiates, oil and gas

Figure 1. Map of Myanmar[1]

1 http://upload.wikimedia.org/wikipedia/commons/4/4d/Un-myanmar.png

Economy, Growth and Emissions

Burma, officially the Union of Myanmar, is the second largest country by geographical area in Southeast Asia. Burma's diverse population has played a major role in defining its politics, history, and demographics in modern times. The military has dominated government since General Ne Win led a coup in 1962 that toppled the civilian government of U Nu. Burma remains under the tight control of the military-led State Peace and Development Council.

Burma is a resource-rich country. During World War II, the British destroyed the major oil wells, and mines for tungsten, tin, lead and silver to keep them from the Japanese. Under British administration, Burma was the second wealthiest country in Southeast Asia. It was the world's largest exporter of rice, and also had a wealth of natural and labour resources. It produced 75% of the world's teak, and had a highly literate population. However, since the reformations of 1962, the Burmese economy has become one of the least developed in the world -- suffering from decades of stagnation, mismanagement and isolation. Now, the lack of an educated workforce contributes to the growing problems of the economy.

Burma lacks adequate infrastructure. Energy shortages are common throughout the country, including in Yangon. Railways are old and rudimentary, with few repairs since their construction in the late 19th century. Highways are typically unpaved, except in the major cities. Burma's GDP stands at $42.953 billion and now grows at an average rate of 2.9% annually. The EU, United States and Canada, among others, have imposed economic sanctions on Burma.

Burma is among the least emitting countries in the world, with 0.3 tCO_2e per capita per year, and total annual GHG emissions of 12 million tCO_2 -- excluding any methane emissions from agriculture, which has not been estimated (World Bank). In the WRI assessment, however, Myanmar has been attributed annual GHG emissions of 265 million tCO_2e/year[2], including all greenhouse gasses. This indicated significant emissions from agriculture.

The growth in economy and emissions can be seen in the graphs below.

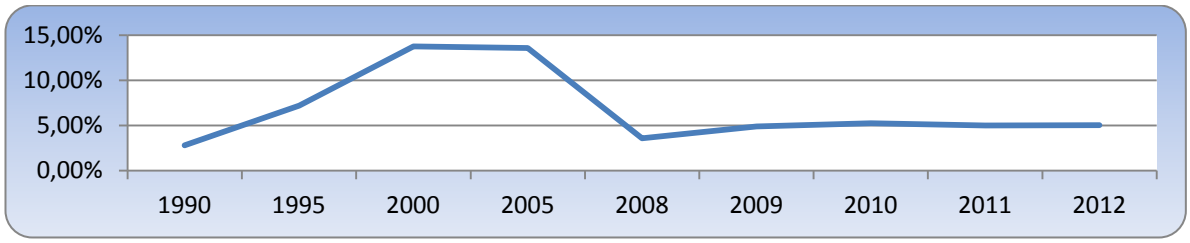

Figure 2: Economic growth since 1990 (GDP percent change)

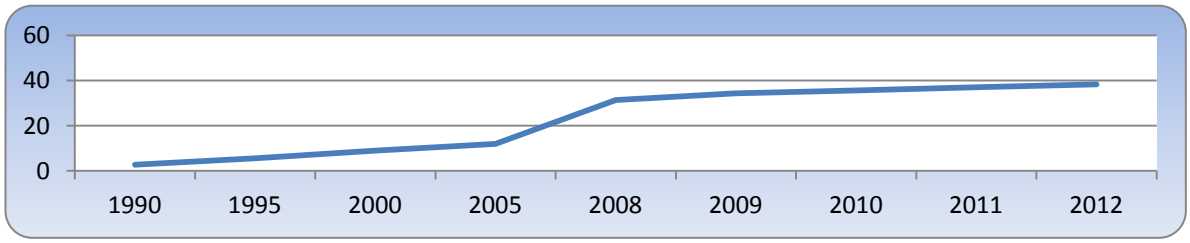

Figure 3: GPD current prices (Billions USD)

2 Climate Analysis Indicators Tool (CAIT) Version 9.0. (Washington, DC: World Resources Institute, 2011) World Resources Institute.

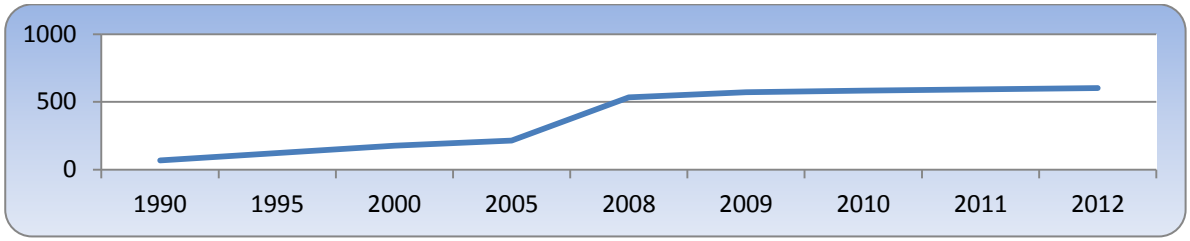

Figure 4: GDP per capita, current prices (USD)

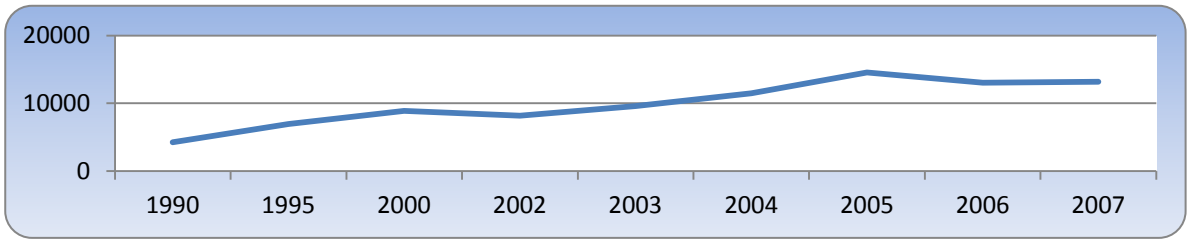

Figure 5: Total carbon emissions since 1990

Status of CDM Development and Capacity Building in Myanmar

Myanmar has established a DNA, which is based at the Ministry of Forestry, Planning & Statistics Department. There is currently a single CDM project from Myanmar in the pipeline.

Title	Status	Type	tCO2 reduction/year	Date of submission
Dapein(1) Hydropower Project in Union of Myanmar	At Validation	Hydro	677,937	05-02-2011

In addition, Myanmar has been included amongst the host countries in four Programmes of Activities.

Title	Status	Type	tCO2 reduction/year	Date of submission
International water purification programme	At Validation	Water purification	12,488	29-07-2011
PoA for the reduction of emissions from non-renewable fuel from cooking at household level	At Validation	Efficient cook stoves	22,797	13-12-2011
CarbonSoft Open Source PoA, LED Lighting Distribution: Emerging Markets	At Validation	Lighting	29,321	23-12-2011
Solar LED Lamp Project in Developing Asia	At Validation	Lighting	7,772	29-03-2012

All of these have yet to include a CPA specific for Myanmar.

Overview of CDM Opportunities in Myanmar

Agriculture and Forests

The population and economy of Burma are greatly dependent on agriculture and forestry. Deforestation in Myanmar corresponds to approximately 116 million ton of CO_2 per year, and the country has one of the highest rates of forest loss on earth[3]. Deforestation and forest degradation in Myanmar is primarily attributed to agriculture, logging and fuelwood collection, and to a lesser extent, development for energy infrastructure.

Forest Carbon Options

According to recent FAO estimates, Myanmar's forests cover an area of 32,082,600 ha, which translates into approximately 49% of the country's total surface land area.[4] Estimates of deforestation and change in forest cover show that between 1990-2010, Myanmar lost an average of 372,250 ha or 0.95% per year. In total, this amounted to approximately 19% of the country's forest cover (7,445,000 ha). About 10% of Myanmar's forests are classified as primary forest, the most biodiverse and carbon-dense type, while 87% consist of naturally regenerated forest and the remaining 3% are planted forest.[5]

Afforestation and reforestation of degraded forest lands, and mangrove restoration, present a potential for climate change mitigation in Myanmar, while generating financial flows from forest carbon activities under the CDM. However, A/R CDM activities have generally remained underdeveloped, compared to other CDM sectors, mainly as a result of the complexity of the A/R CDM procedure, and the limited market demand for A/R CDM credits. Moreover, CERs from these projects are not eligible in the European Emission Trading System, and only tCERs are issued to A/R CDM projects. While there are currently no A/R CDM activities in Myanmar, the country has potential for generating additional income from forest carbon activities under the CDM.

3 http://rainforests.mongabay.com/deforestation/archive/Myanmar.htm (forest cover divided by carbon stock)

4 http://faostat.fao.org/site/377/DesktopDefault.aspx?PageID=377#ancor

5 http://rainforests.mongabay.com/deforestation/2000/Myanmar.htm

REDD+ also presents an opportunity for creating financial flows for Myanmar's efforts to mitigate GHG emissions, through forest carbon activities. However, in order for the country to prepare and become 'ready for REDD+', Myanmar will have to clearly define rules on land tenure and carbon rights, and set up institutions for REDD+ governance. Altogether, for REDD+ to become successful, the outcome will have to secure clear, tangible benefits, and access to land for forest dwellers and local communities, while conserving Myanmar's forests and biodiversity.

Calculating the potential emission reductions from REDD+ activities in Myanmar demonstrates that there is mitigation potential if deforestation is avoided completely. Assuming that the baseline is entirely based on historical emissions, avoided emissions are calculated by multiplying the annual deforestation in Myanmar, estimated to be 372,250 ha per year, with 98 tC/ha, which is the approximate amount of tons of carbon stored per ha in the country's forests annually.[6] Based on this data, and the conversion of 1 ton of biomass carbon to the equivalent of 3.67 tCO_2[7], avoiding deforestation, alone, in Myanmar has the potential to contribute to approximately 133 million tons in CO_2 emission reductions every year. Reversing the trend and adding reforestation to these estimates would increase this number even more. Afforestation/reforestation initiatives aiming to replant 50% of the loss in forest cover during 2000-2005 (-2,332,000 ha), would require the regeneration of 1,166,000 ha of forest land, which could generate more than 400 million tCO_2e reductions annually.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
REDD+ / Avoided deforestation	133,883,430	Historical baseline
Afforestation/ Reforestation	419,363,560	AR-AM1, AR-AM3, AR-AM4, AR-AM5, AR-AM9, AR-AM10, AR-AMS1, AR-ACM1, AR-ACM2

Fuelwood

Fuelwood remains the most important source of energy for cooking, due to inadequate electric power supply and limited provision of household fuel gas. Moreover, while the per capita consumption of fuelwood has been slightly decreasing, the absolute consumption of the country has been steadily increasing.[8]

Firewood

Biomass consumption (wood-energy and agricultural residues) remains the main source of domestic energy in rural households. Reducing the demand for firewood is, therefore, a strategy to reduce drivers of deforestation and an exhaustion of Myanmar's forests. Such strategies include improved fuel-efficient cook stoves, and alternative fuels and techniques for cooking and baking, which altogether might have a significant impact on GHG emissions.

6 ftp://ftp.fao.org/docrep/fao/011/i0350e/i0350e04c.pdf

7 http://aciar.gov.au/files/node/8864/TR68%20part%202.pdf

8 http://www.fao.org/docrep/014/am252e/am252e00.pdf

Charcoal

Charcoal constitutes the second most important fuel after firewood, and is a source of income as well as environmental degradation in rural areas.

Charcoal production releases methane – especially in the traditional open pits process. There are three phases in the carbonization process: 1) ignition, 2) carbonization, and 3) cooling. CDM projects are implemented in two different processes: 1) improving the kiln design for better temperature control and greater control of carbonization variables, which reduce methane emissions, and 2) capturing the methane released from the charcoaling plant, and combusting it to generate electricity (e.g. in a gas engine).

Since charcoal production involves tree removal from forests, sustainable wood supply is an important concern. Therefore, any introduction of efficient charcoal production technologies should only be approved if facilities have allocated dedicated woodlots for sustainable fuelwood plantations. If charcoal is sustainably produced through plantations, and methane emissions are eliminated, charcoal production becomes carbon neutral, since all emitted carbon would subsequently be sequestered in replanted trees.

The annual charcoal production in Myanmar for 2011 was estimated to be 164,634 t.[9] According to a recently registered CDM project, using renewable charcoal from forest plantations, shifting from traditional open kilns to efficient kilns employing methodology AM0041[10], the anticipated methane emissions reduction per ton of produced charcoal is 0.037 tons[11]. This corresponds to 0.777 tons of carbon emissions reduced per ton of produced charcoal, based on the global warming factor of 21. Assuming that project emissions are zero, and that fuelwood is supplied from sustainable plantations, transforming the country's entire charcoal production from a 100% open kiln production in the baseline would potentially result in an emissions reduction of 127,920 tCO_2e/year. Such a project might be viable, but significant uncertainties are associated with this calculation, if not on the actual emissions reduction potential and project emissions, then on the current production methods and the outlook for including the entire charcoal production under one CDM activity.

Type of Technology	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Charcoal production	127,920	AMS-I.C., AMS-III.K., ACM00021, AM0041

Waste

Waste management has a great GHG emissions reduction potential. The potential for reductions lies in two different areas of waste handling: proper disposal of organic matter that would otherwise emit methane (CH_4), and waste incineration, that can serve to replace energy (both thermal and electric) that would have been produced from fossil fuels.

9http://siteresources.worldbank.org/INTCARFINASS/Resources/MainReportLowCarbonEnergyprojectsforDevelopmentofSubSaharanAfrica8.18.08.pdf

10http://cdm.unfccc.int/filestorage/A/P/Q/APQY8M2DU796JH10G3SKEW5ZR4TBXN/05072010_PDD_Charcole.pdf?t=V298bTZrcmtxfDCc85eDOxwk3EIdOherlYZR

11 http://www.fao.org/docrep/x2740E/x2740e60.pdf

Organic matter, for instance in the form of waste, emits large quantities of greenhouse gasses, primarily methane (CH_4), if not disposed of properly. The potential for the reduction of these emissions lies in various sectors.
Waste in the domestic sector, e.g. from small household livestock units, as well as in the industrial sector and municipalities, is most often left unutilized, to decay, or rarely used for the purposes of fertilizer or burning in open pits. The waste is, therefore, both harmful to the surrounding environment, and often a health hazard. Consequently, a waste management project will be greatly beneficial to local sustainable development.

Waste management projects can be implemented in various sectors in Myanmar. The challenge of mitigating GHG emissions from waste lies in the lack of existing incentives, as the proper handling of waste does not present an opportunity to generate revenue for the stakeholders.

Agricultural Waste

Agricultural production leaves considerable amounts of agricultural waste, in the form of biomass and animal waste in particular. Some of it is recycled into the agricultural production as fertilizer, while large amounts remain unutilized – and in many instances pose a disposal problem. Uncontrolled burning in the fields is not only a hazardous disposal solution, it is also a waste of a potential energy source. With efficient collection systems in place, waste from agricultural production can be utilized as fuel for power and heat production. In the sugar industry, significant amounts of bagasse – the waste after extraction of sugar – is an excellent fuel. Rice production may also be industrialized, to the extent that rice husks are available in amounts sufficient for incineration in a boiler, thereby securing a basis for power and heat production. In the forest industry, large concentrations of biomass waste can be utilized for power and heat production, e.g. at sawmills. The forest industry also supplies raw material for briquettes production, where sawdust, charcoal dust, degradable waste paper and dust from agricultural production may constitute a final utilization of waste materials from agriculture related production.

Biomass energy projects can be built in a wide range of sizes and for broad applications. Such projects are also cost-efficient solutions for waste generated by the sugar industry. They can be as large as 100 MW power stations generating both electricity and heat, but are typically 15-30 MW in size. Biomass energy projects are also technically feasible in much smaller sizes, but are rarely commercially viable below 8-10 MW, depending on availability and pricing of biomass residues.

Bagasse and Rice Husk Energy Generation

In 2009 there was an abundance of agricultural waste in Myanmar, mainly from rice and sugarcane production, which is the most common source for biomass waste to energy projects. The total amount of sugarcane bagasse in 2009 was 1.35 million tons[12]. Assuming that 25% was already used for energy or other purposes, there would be about 1 million tons left. If 20% of this resource could be gathered for a single power plant (approximately 100 MW), and the electricity would be displacing grid electricity, the potential emissions reduction would be 900,000 MWh * 0.2623 tCO_2e/MWh = 236,000 tCO_2e/year.

12 "Myanmar to Use Agricultural Waste and Biogas to Prevent the Destruction of Forests", Asia Biomass Office 2009.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Bagasse power	236,000	AM36, ACM6, ACM2, AMS-I.D., AMS-I.C.

Biomass Energy Generation

In Myanmar there is a significant production of rice and, therefore, also the residue rice husks. It is already common practise to utilize the rice husks for energy purposes in the country[13], but there is still a significant surplus from the rice production every year. If it is assumed that 25% of all the rice husks are already utilized for energy, the remaining 75% are still available for energy production. Furthermore, assuming that 20% of this resource was available for collection and in turn made available for a single biomass power plant (approximately 100 MW), the potential emissions reduction would be 800,000 MWh * 0.2623 tCO_2e/MWh = 210,000 tCO_2e/year.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Rice husk energy	210,000	AM36, ACM6, ACM3, ACM2, ACM18, AMS-III.E., AMS-I.D., AMS-I.C.

Animal Waste

Manure from livestock can also be utilized for energy purposes. This is a suitable solution particularly for rural areas where the population often does not have access to modern energy sources, and mainly relies on agricultural activities. With regard to this kind of energy technology, there have been some past experiences to build on in Myanmar, as 105 biogas digesters were installed in 2005 and contributed to a capacity of 945 kW[14]. In 2007 an Indian company installed a biomass power plant, supplying 200 rural households with energy.

It is estimated that there are about 103 million head of livestock in Myanmar. Of these, cows are an important fraction, particularly in Mandalay, Sagaing, and Magway divisions[15]. In urban areas, electricity or kerosene is most often used as fuel for cooking, whereas firewood still remains, by far, the most common source of energy for cooking in rural areas. If a project similar to the one implemented by the Indian company was scaled-up to cover 20,000 households, and the baseline scenario used was 0.5 litres of kerosene per day, the potential emissions reduction would then be 20,000 households * 365 days * 0.5 litres/day * 2.58 $kgCO_2$/litre = 9,400 tCO_2e/year.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Domestic biogas	9,400	ACM6., AMS-I.C., AMS-I.D., AMS-III.E., AM36

13 knowledgebank.irri.org

14 "Myanmar to Use Agricultural Waste and Biogas to Prevent the Destruction of Forests", Asia Biomass Office 2009.

15 "Myanmar: Country Assessment on Biofuels and Renewable Energy", Ministry of Agriculture and Irrigation, 2009.

Wastewater

Municipal wastewater can also be a source of energy if a biogas collection system is installed at the sewage treatment plant. The treatment plant in Yangon (Yangon City Development Committee Wastewater Treatment Plant) has been operating since 2005 and serves approximately 325,000 people in six townships, downtown Yangon. The installation of a gas-collecting system at this plant could have a potential emissions reduction effect, if the gas was utilized in a gas engine, and the electricity was supplied to the grid. Using the same flow/power ratio from a registered Chinese CDM project, the emissions reduction would then be 53,000 MWh/year[16] * 0.2623 tCO_2e/year = 14,000 tCO_2/year.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Wastewater	14,000	M36, ACM6, ACM2, AMS-I.C., AM36, ACM6, ACM2, AMS-I.D., AMS-I.C., ACM6, ACM2, AMS-I.D. and AMS-I.C.

Landfill Gas

The municipal solid waste management systems in Myanmar are functioning well in the two largest cities: Yangon and Mandalay. By 2004, the daily solid waste collected in Yangon was 1,150 tons. If a landfill gas project were implemented to collect the methane generated at the landfill, and the gas was utilized in gas engines, supplying the national grid with electricity, the potential would be about 120,000 tCO_2/year[17].

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Landfill gas	120,000	AM36, ACM6, ACM2, AMS-I.C., AM36, ACM6, ACM2, AMS-I.D., AMS-I.C., ACM6, ACM2, AMS-I.D. and AMS-I.C.

Conventional Power Production

Power consumption per capita in Myanmar is amongst the lowest in the region – the estimated consumption for 2010/2011 was 160 kWh per capita and the electrification rate was only 22%. There is a considerable gap between supply and demand of electricity, despite power production experiencing a steady growth rate of about 15% over the past few years[18]. This is partly due to the high level of exports to the neighbouring China and Thailand, and the drought that has been preventing the hydroelectric plants from working at their full capacity.

In 2010/2011 a total of 7543.06 million kWh[19] was generated by the Myanmar Electric Power Enterprise. Of the total production, 8.9% was thermal power generation, 0.4% was diesel-generated electricity, 67.7% was hydropower, and the remaining 23% was production from gas power plants. According to data from the Central Statistical

16 "Tianjin TEDA Sewage Methane Recovery Project".

17 Calculated in an internal potential calculation model.

18 Dapice D., Electricity in Myanmar: The Missing Prerequisite for Development, May 31, 2012.

19 http://www.csostat.gov.mm/S09MA02.asp

Organization, the total installed power production capacity in 2010/2011 was 2,544 MW, although the actual generation was estimated to be only 1,340 MW, in contrast to the demand of 1,850 MW. Myanmar has been struggling to provide adequate power supply to its inhabitants. Blackouts and unreliable supply have become frequent throughout the country, especially in the Mandalay and Rangoon provinces. The answer for many businesses and households has been the use of diesel generators.

A 500 MW gas power plant is currently being planned—the initial plan was to build a 4,000 MW coal power plant--and is expected to be operational by 2015[20]. Additional plans for coal are also in the works, including a 600 MW coal fired plant in Yangon. Since Myanmar has considerable natural gas reserves, an option for emission reductions would be fossil fuel switch projects switching from coal use to the less carbon intensive natural gas.

Switching the current thermal production from coal to natural gas would result in emission reductions of about 251,053 tons of CO_2[21], if fully replacing coal with natural gas for the production of the same amount of MWh. Replacing the 600 MW of power production currently planned as coal power with natural gas, would give another 1,455,300 tons of CO_2 emission reductions[22]. Additional options could also exist in co-firing coal plants with biomass.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Fossil fuel switch	1,706,353	ACM3, AM8, ACM9, AMS-I.C., AMS-II.D., AMS-III.B.

Renewable Energy

Hydro

Myanmar hosts considerable hydropower potential, amounting to 100,000 MW. The Myanmar Electric Power Enterprise has identified more than 200 potential hydropower development locations throughout the country, with a total capacity of approximately 38,000 MW[23].

There are 36 hydropower projects that have been identified for future implementation, with a total installed capacity of 36,524 MW. The average annual generating hours are calculated based on the installed capacity and power generation of existing hydropower plants, which are about 5,000 hours[24]. Based on this number and the assumption that plants would operate an average of 5,000 hours annually, the potential power production from hydropower is 182,62 GWh. Calculated using Myanmar's grid emission factor[25], this equals emissions savings of 47,900 tons of CO_2. It is important to note that with continuous installation of large-scale hydro, all things equal, the grid emission factor would be diluted with time, as larger proportions of electricity would be produced using

20 http://gastopowerjournal.com/index.php/projectsafinance/item/129-myanmar-abandons-plans-to-build-dawai-coal-power-plant-favours-gas-fired-plants

21 Calculated using IPCC guidelines regarding emission factors for natural gas and plant efficiency.

22 Calculated using IPCC guidelines regarding emission factors and plant efficiency, for plants built after 2000.

23 REEGLE, 2012, http://www.reegle.info/countries/myanmar-energy-profile/MM

24 Myanmar Country Report, 2011, The Republic of Union of Myanmar, http://nrec.mn/data/uploads/Nom%20setguul%20xicheel/Water/badrakh%20china/Myanmar.pdf

25 Emissions reductions are calculated using grid emission factor of 0.2623 (Pedro Carqueija, 2012, UNEP Risoe).

renewable energy sources. Therefore, the real emissions savings would most likely be lower for the later installed hydropower stations.

Solar

Use of solar energy is still at an early stage in Myanmar, even though radiation intensity is measured at more than 5 KWh/m2/day[26] during the dry season. Sunlight is especially abundant in the central region of the country. The solar energy potential in Myanmar is estimated at 51,973.8 terawatt hours per year[27]. The highest potential for solar power applications in Myanmar is observed in rural areas that are not grid-connected, in particular for rural small-scale solar PV installations.

Several types of solar installations have been identified as being especially beneficial for rural inhabitants. These include solar cookers; solar water heating systems for industrial application; solar distillation units for battery charging; solar photovoltaic systems for water pumping, battery charging, and power supply to children's hospitals for operating vital equipment; solar lighting. Use of solar air driers can also be beneficial for agricultural and industrial products[28]. There are a number of small solar installations across the country so far, most of which are well under the capacity of 0.5 MW[29]. This suggests that for application of small-scale solar activities, bundling several projects together, or implementing them as a Programme of Activities, would be more viable. The exact amount of emissions savings is highly dependent on the technology chosen, as well as the number of households/businesses involved, therefore, exact calculations are not made within the scope of this report. As the number of rural households is close to 7 million[30], the options for emission reductions are vast.

Wind

Wind potential in Myanmar is estimated to be 365.1 terawatt hours per year[31]. It is still at an early, experimental stage of development, and so far only for research purposes. This is mainly due to the high initial investment needed for wind projects, and the lack of sufficient data to determine the exact practically exploitable potential.

Recently, however, a private company from Thailand has signed a memorandum of understanding with the government of Myanmar to develop 1,000 MW of wind power in the country[32]. This is a good indication of the potential that might exist within wind power in the country. Implementation of 1,000 MW of wind power could potentially replace about 2,500 GWh of power from the grid (calculated based on 2,500 hours of annual operation). Calculated with the grid emission factor of 0.2623, this corresponds to approximately 655,750 tons of CO_2 in emissions savings.

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26 REEGLE, 2012, http://www.reegle.info/countries/myanmar-energy-profile/MM

27 http://eneken.ieej.or.jp/data/2594.pdf

28 Yee, T.T.H. Win, S.S. and Soe N.N., Solar energy potential and applications in Myanmar, World Academy of Science, Engineering and Technology 42 2008.

29 Ibid.

30 Yapp, J., CDM Potential for commercialization of the integrated biogas system, http://unapcaem.org/Activities%20Files/A01/CDM%20Potential%20for%20the%20Commercialization%20of%20the%20Integrated%20Biogas%20System.pdf

31 REEGLE, 2012, http://www.reegle.info/countries/myanmar-energy-profile/MM

32 Allchin,J., Thai firm to explore wind energy in Burma, 9.12.2011., http://www.dvb.no/news/thai-firm-to-explore-wind-energy-in-burma/19127

Geothermal

Myanmar has abundant geothermal resources. The Myanmar Office of Geological and Mineral Resources has identified a total of 93 geothermal sites, most of which are located around the igneous belt of Myanmar[33]. The exploration, however, is at its early stages, and further investigations would be necessary in order to determine the exact potential for geothermal power, and hence emission reductions.

Biomass Power

Options for utilization of biomass exist both in using wastes such as rice husk and bagasse for power generation, and in utilization of manure. In addition, crops dedicated to biodiesel production can be grown. These options are discussed under the Waste and Agriculture chapters.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Hydro	47,900	ACM2, AMS-I.D., AM26, AMS-I.A., AM5, AM26, AMS-II.B., ACM11, ACM12, AM52
Wind	655,750	ACM2, AMS-I.D., AMS-I.F.

Energy Consumption

Greater efficiency in the consumption of energy is commonly an attractive option for emissions reduction, due to its dual benefit of reducing both emissions and the size of the energy bill. However, despite many years of promotion, it is also the most overlooked option. In CDMs, for instance, demand-side energy efficiency projects only make up 1% of the CER generation. Among the many reasons for this is the fact that most developing countries focus on energy access, rather than energy saving. In Myanmar, where only 13% of the population has access to the national grid, power consumption is averaging only 104 kWh per person, according to the World Bank and Asian Development Bank. [34] [35] This figure has grown rapidly over the past few years, to an estimated consumption of about 160 kWh per capita in 2011/12.[36] The population is estimated to be about 60 million, based on national statistics.[37] This may correspond to 13-14 million households.

The generally low level of power consumption does not mean that there is no scope for efficiency measures, although the reach will be limited. Moreover, the emissions from Myanmar's grid are relatively low, with two-thirds of power generation stemming from hydro and the remainder primarily based on gas. A rough estimate has the grid emission factor set at about 0.2 tCO_2e/MWh. Combined with this estimated low grid emission factor, the emission reductions from efficient grid electricity consumption will be relatively small. Conversely, small diesel generators are believed to be widespread in Myanmar for off-grid power generation. According to a Harvard study, a significant number of households are both willing and able to pay for grid connection, if the grid company would offer such a

33 The Asean geothermal outlook and future prospects of development and utilization, http://www.aseanenergy.info/Abstract/32009500.pdf

34 http://in.reuters.com/article/2012/04/16/myanmar-energy-power-electricity-idINDEE83F03X20120416

35 http://www.ash.harvard.edu/extension/ash/docs/electricity.pdf

36 http://www.ash.harvard.edu/extension/ash/docs/electricity.pdf

37 http://www.myanmararchives.com/myanmardata2006/2.htm

connection. These households may be as many as those that are grid connected, but must be assumed to be relying on diesel generators with an emission factor closer to 1 tCO_2e/MWh.[38]

Lighting

There is no information available on the extent of CFL usage in Myanmar. The close ties with China over the years could mean that the significant production and penetration rate of CFLs in China has spilled over to Myanmar – in which case emissions reduction options would be limited. If, however, CFLs are not common, a CFL bulb could theoretically reduce power consumption by 65 kWh per household – with a reduction from 60 W to 15 W, and an average usage of 4 hours per day. Potential emissions reduction from CFLs or other sources of consumption will, therefore, have relatively small emissions reduction effects. If, in theory, the approximately 1.8 million grid connected households could all exchange one 60 W incandescent bulb with a 15 W CFL that would operate 4 hours per day, the total emissions reduction could be calculated to be about 25,000 tCO_2e – assuming that incandescent bulbs are still widespread. Furthermore, if another 1.8 million households relying on diesel generators would also have the option to make the same exchange of bulbs, their potential emissions reduction would amount to about 5 times as much due to the higher emission factor, i.e. 125,000 tCO_2e.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
CFL distribution	150,000	AMS-II.E. AMS-II.J.

Efficient Cook Stoves

In most developing countries improved energy efficiency in households is a significant potential source of GHG emission reductions. The household sector is, by far, the largest energy user in Myanmar. According to the Global Alliance for Clean Cook Stoves, 88% of the urban population and more than 95% of the rural population depend on solid fuels for cooking, one-fourth of which is charcoal.[39] In addition to firewood, stems of cotton, sesame, pulse and beans, and other agricultural residuals are utilized for daily cooking in the villages. As urban households have more opportunity to substitute fuelwood with electricity and Liquefied Petroleum Gas (LPG), their use of firewood and charcoal is relatively lower than that of rural households. Average fuelwood consumption per household per annum for the last decade was estimated at about 1.4 cubic tons for urban households, and 2.5 cubic tons (about 2.8 tons) for rural households.[40] These figures indicate a high prevalence of traditional cook stoves, when compared to a Bangladesh study[41]where among improved cook stove users, 79% of households said they consumed approximately 3 kg of fuelwood per day. In contrast, 74% of the TCS users said they consumed about 10 kg of fuelwood per day. There are indications that some efficient cook stoves made of ceramics or clay are being used in Myanmar, but no data is available, and

38 http://www.ash.harvard.edu/extension/ash/docs/electricity.pdf

39 http://www.cleancookstoves.org/countries/asia/myanmar.html

40 http://www.fao.org/docrep/014/am252e/am252e00.pdf

41 http://www.worldenergy.org/documents/congresspapers/65.pdf

overall figures indicate that there is significant potential for uptake of efficient cook stoves among Burmese households. If 25% of Myanmar's approximately 13 million households shift from traditional to efficient cook stoves, assuming potential reductions of 2 tCO_2e/year/stove, the potential emissions reduction would amount to 6.5 million tCO_2e per year. Depending on the method of charcoal production, reduction potentials may even be higher.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Efficient stoves	6,500,000	AMS-I.E. AMS-II.G. AMS-I.C.

Industrial Production Processes

Industrial activities cover several industry sectors and reduction options related to energy efficiency, as well as change of processes and substitution of materials. In developing countries there are many cottage industries, such as small-scale brick production, or even household-based production, like textiles, which in most cases are not represented and do not constitute noteworthy emissions reduction options. In many countries, brick kilns are the exception, and may even represent considerable reduction potentials.

In neighbouring Bangladesh vertical brick kilns are being introduced, reducing emissions from brick production by more than 50%. Similar options may exist in Myanmar judging from videos published on youtube[42]. There are no figures for the total production of bricks in Myanmar. If figures available for Malawi, a country with a third of the inhabitants of Myanmar, are used as benchmark, the emissions reduction potential in Myanmar in shifting from traditional earthen kilns to vertical shaft kilns holds immense potential. If the demand in Malawi for about 170 million bricks per year would be shifted to vertical shaft kilns, the emissions reduction would be about 650,000 tCO_2e. In the event that this calculation can be paralleled to Myanmar, the reduction potential could amount to 2 million tCO_2e. On this basis, a conservative estimate for Myanmar for a programme promoting vertical shaft kilns for brick production could be approximately 500,000 tCO_2e. Fuel switch, e.g. to biomass residues, could add further reduction potentials.

In Myanmar, the principal industrial products with emissions reduction potential are cement, steel, bricks and tiles, and fertilizers. For many years, three separate old factories with a combined 0.45 Mta capacity met Myanmar's cement requirements. By 2005, a new 4,000 tpd dry-process plant was built by Kawasaki Heavy Industries in Hpa-an, in the south-eastern Karen State. There are also reports of a small 400 tpd wet-process plant built by the China National Constructional and Agricultural Import and Export Corporation. Continuing problems over power supplies, spare parts, and maintenance reduced the 2 Mta theoretical upper capacity limits to actual output levels of an estimated 1 Mt in 2006.[43] The combined emissions reduction potential (if benchmarked against the Philippines CDM project no. 4329[44] -- a WHR project at a 1 Mta cement plant that expects to generate 11,800 tCO_2e of emissions reduction per year) could be about 11-12,000 tCO_2e, but this depends on the grid emission factor, as the plants appear to be supplied

42 http://www.youtube.com/watch?v=YpsdJ4zzLfw

43 http://www.cemnet.com/members/gcr/intros/150.pdf

44 http://cdm.unfccc.int/filestorage/S/T/A/STAX2E8ZGJ5YLCB0VQPI96D1FUNM34/4329%20PDD.pdf?t=ZkJ8bTkzenlzfDBGPXfmebplRcSkZMwW6Zdz

with electricity from the grid. The grid emission factor in Myanmar is presumably low, with significant supplies of hydropower, and, therefore, emissions reduction would likely be minimal. Other options might exist, such as the replacement of ordinary pozzolana with rice husk, which is available in abundance -- but these options have not been assessed.

In addition, state-owned Indonesian cement producer PT Semen Gresik is reportedly expanding its operations into Myanmar by constructing a new 2.5 Mta cement plant.[45] There would be an estimated reduction potential of about 20,000 tCO_2e (benchmarking against other CDM cement WHR projects), though this would fully depend on the baseline.

Myanmar produces approximately 25,000 tons of steel per year[46], but apart from three small iron and steel mills operated as state enterprises, a modern copper cathode production plant at a mine near Monywa, and foundries attached to several state factories, the base metal casting industry is carried out in scores of small private workshops throughout the country. A directory issued by the Ministry of Industry in 2001 lists the products made in 300 of the larger small private base metal producers. Sheet iron, rolled iron and iron bars were being produced in 40 workshops and smelters, iron rods in 35, aluminium ware in 32, and nuts, bolts and nails in 24. Moreover, 140 shops are listed as producing spare parts and/or machinery, with a variety of metal products in the remainder.[47] With such disbursed manufacturing, emissions reduction is not possible.

Oil production in Myanmar stood at 18,000 bbl/day in 2009.[48] No information is available about the GOR (gas oil ratio), but if 500 scf per bbl is used (the figure recorded for onshore oil exploration in Trinidad and Tobago), and assuming that the bulk of the associated gas in Myanmar's oil production is vented into the atmosphere, then the 500 scf corresponds to just above 10 kg of methane with a global warming potential of 21. That is 217 kg of CO_2e, or 3,913 tCO_2e/day, which amounts to 1,428,000 tCO_2e/year. This is based on assumptions that the gas is not exploited, which may be challenged by the existence of 10 gas-fired power plants in Myanmar, and the $1.2 billion natural gas pipeline connecting to Thailand that began operations in 1999, as well as plans for a $1 billion Myanmar-Bangladesh-India gas pipeline.[49] The reduction potential has, therefore, not been included in the estimates.

Technology type	Emission Reduction Potential per year (tCO_2e)	Baseline Methodologies
Vertical shaft brick kilns	500,000	AMS-II.D

Transportation

In 2008, the emissions from combustion of liquid fuels in Myanmar were 4.4 million tCO_2e[50], constituting the theoretical upper limit of emissions reduction in the transport sector -- assuming that all fuel was used for transportation. There is, however, an amount of diesel generation going into back-up power, as well as limited diesel capacity in villages

45 http://www.cemnet.com/News/story/149207/semen-gresik-to-build-2-5mta-plant-in-myanmar.html

46 http://www.indexmundi.com/minerals/?country=mm&product=raw-steel&graph=production

47 http://www.ibiblio.org/obl/docs2/copperMetal.pdf

48 http://www.indexmundi.com/g/g.aspx?c=bm&v=88

49 http://www.nationsencyclopedia.com/Asia-and-Oceania/Myanmar-INDUSTRY.html

50 http://data.worldbank.org/indicator/EN.ATM.CO2E.LF.KT

providing very minimal electricity services. Myanmar diesel imports are on the rise since the government reformed the sector to facilitate imports by private companies, surging to $1.39 billion in fiscal 2010-11 from $673 million the year before[51]. This corresponds to about 2 billion litres of diesel, or 5.1 million tCO_2e – a significant increase from 2008, indicating that the most important fuel for transport, by far, is diesel.

In December 2005, Myanmar decided that its future lay in jatropha, and ordered millions of peasants to plant it[52] -- with a target of 3.2 million hectares of plantation (corresponding to 177 trees per inhabitant[53]). Generally, the programme was reported as being a failure, with unsuccessful crops later reversing to other crops. Had it been successful, the potential production would have been approximately 1 billion litres of biodiesel -- just enough for a 50% blending programme at the current level of consumption, or emission reductions of about 2.5 million tCO_2e. It is unclear how much of the crops were reversed. An account from 2012 presents a positive picture of a well functioning 40,000 hectare plantation in Maw[54], indicating that some of the initiative has been successful. The achievable emissions reduction, however, must be estimated somewhat lower than the indicated 2.5 million tCO_2e – perhaps closer to 500,000 tCO_2e.

Furthermore, there is potential for biofuels production in Myanmar's sugar industry. In 2011, Universal Robina Sugar Milling Corp started construction of a $27 million bioethanol plant in Manjuyod, which can produce 100,000 litres of fuel a day[55], potentially helping to reduce almost 100,000 tCO_2e/year.

In 2007, Yangon had about 4.1 million inhabitants, 6.7 million in the greater urban area, and growing at about 15% annually[56]. Approximately 84% of all transport is undertaken by bus, while only 6% is by rail.[57] There is almost no private car transport, and very few taxis. The public bus transport system is, therefore, an obvious target for increasing efficiency. Since 2005, a promotional programme for CNG conversion was initiated due to Myanmar's recent development of national natural gas fields[58]. There is government control of diesel consumption of buses, but no direct control of the CNG consumption. There are 2,000 city buses (50 passenger buses) and additionally about 5,000 smaller vehicles used for public transport in Yangon. Due to poor planning, many routes overlap and use the same transport corridors, with significant congestion despite the absence of private cars on the roads. BRT systems may, therefore, have significant potential, even based on the reorganization of existing buses. The emissions reduction potential, however, is not assessable due to the on-going conversion to CNG, the current biofuel mix, and the model for potential BRT implementation. An estimate could be 25,000 tCO_2e/year.

51 http://in.reuters.com/article/2012/04/16/myanmar-energy-power-electricity-idINDEE83F03X20120416

52 www.time.com/time/world/article/0,8599,1885050,00.html

53 http://www.arakanrivers.net/?page_id=141

54 http://blogs.straitstimes.com/2008/12/10/life-on-myanmar-s-biofuels-plantations/

55 http://business.inquirer.net/54581/urc-to-open-biofuel-plant-in-ph-factory-in-burma

56 http://www.trip.t.u-tokyo.ac.jp/kato/papers_e/2010TRB_Yangon.pdf

57 http://www.trip.t.u-tokyo.ac.jp/kato/papers_e/2010TRB_Yangon.pdf

58 http://www.trip.t.u-tokyo.ac.jp/kato/papers_e/2010TRB_Yangon.pdf

Technology type	Emission Reduction Potential per year (tCO2e)	Baseline Methodologies
Biodiesel for transport	500,000	ACM17, AMS-III.C., AMS-III.T.
Ethanol	100,000	
Bus Rapid Transit	25,000	AM31, ACM16

Summary

Myanmar has an overall abatement potential of 430,266,901 tCO_2e. The total investments needed to achieve these reductions can only be roughly assessed, as a sizeable share of the reductions relate to technologies for which no data currently exists -- in terms of their investment to CER-revenue ratio.

Technology type	Emission Reduction Potential per year (tCO_2e)
REDD+ / Avoided deforestation	133,883,430
Afforestation/ Reforestation	419,363,560
Charcoal production	127,920
Waste	589,400
Fossil fuel switch	1,706,353
Hydro	47,900
Wind	655,750
CFL distribution	150,000
Efficient stoves	6,500,000
Vertical shaft brick kilns	500,000
Biodiesel for transport	500,000
Ethanol	100,000
Bus Rapid Transit	25,000

These estimates should not be regarded as being precise. Rather, they represent a form of calculation that allows comparison among economies, and their relative attractiveness as destinations for carbon finance.

It should be emphasized that while attempting to be exhaustive, the estimates here do not claim to be all-inclusive. There may be unidentified sources of reductions not included in the technology overview, and not represented by existing methodologies, but in all likelihood these would be minor compared to the potentials identified.

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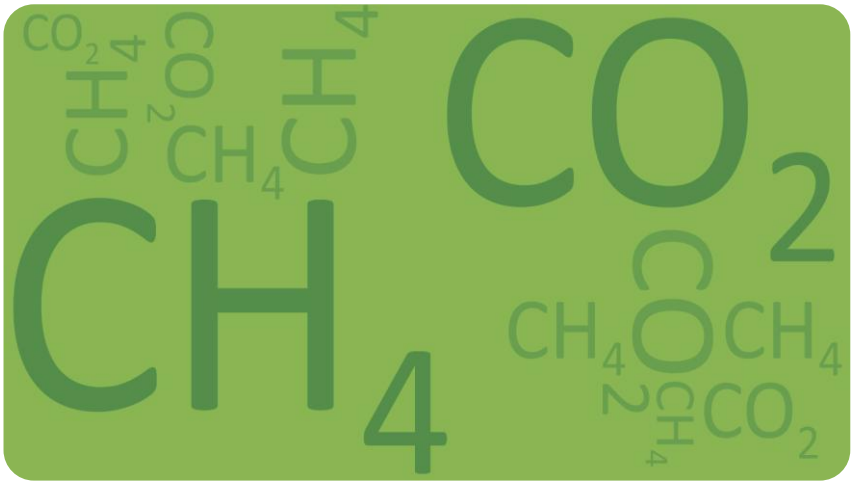

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