平成25年度
アジアの低炭素社会実現のための
JCM大規模案件形成可能性調査事業

「二国間オフセットクレジット制度(JCM)案件形成を通したヤンゴン市における低炭素社会実現支援事業」

報告書

平成26年3月

公益財団法人地球環境戦略研究機関

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― 目　次 ―

サマリー

「二国間オフセット・クレジット制度（JCM）案件形成を通したヤンゴン市における低炭素社会実現支援」事業（以下、本事業）は、ミャンマー、ヤンゴン市における二国間クレジット（JCM）大規模案件の形成を通して、ヤンゴン市の持続可能な発展に貢献すると共に、日本の民間企業や事業者のミャンマーにおける案件発掘及び形成の強化、日本側自治体の温暖化対策や低炭素施策及びその実施経験を展開することを通じて、ヤンゴン市の低炭素社会実現及び JCM の案件形成に資することを目的とした。具体的には後述の通り、３つの活動を行った。

・ミャンマー低炭素都市連絡会の設置と運営

日本側でミャンマーとの協力関係及び事業に関心の高い自治体、民間企業、研究機関等からなる連絡会を設置し、定期的な情報共有、現地の技術調査や政策動向、JCM の案件開発に向けた意見交換等を行った。本連絡会は、案件開発へ向けた日本側自治体、企業等との連携の強化に貢献した。2013 年 7 月、12 月及び 2014 年 2 月において、合計三回開催された。第三回においては、ヤンゴン市職員を招聘し、連絡会において議論を行った。

加えて、連絡会参加機関と連携し、2013 年 11 月 20 日から 22 日にかけてミャンマーで開催された「第三回グリーン経済成長フォーラム」に参加した。本会議を日本の優れた技術や制度の認知を高めることができる場として位置づけ、JFE エンジニアリング社、北九州市、国際協力機構、及び IGES 研究員が登壇するセッションを企画。日本の優れた低炭素技術、国際支援、自治体の取り組み等の紹介を行った。

・低炭素技術調査の実施

本調査は、インドエネルギ―資源研究所（TERI）を外注先とし、無電化地域におけるオフグリッド再生可能エネルギーの導入可能性についての調査を行った。主に文献調査とミャンマーでの政府関係者、NGO 等への聞き取り調査を主な調査手法とした。現地調査は 11 月のグリーン経済成長フォーラム（GEGG）と繋げる形で行われ、2014 年 3 月 4 日にはヤンゴンにて関係者でのワークショップも実施した。

再生可能エネルギーは主に太陽光、風力、バイオマス、小規模水力の 4 つを検討。ミャンマーの各州におけるこれらの資源の利用可能性を検討すると共に、無電化地域における電源導入モデルを検討した。また、政府機関や NGO への聞き取りを通して、関連する政策や関係政府機関の整理も行った。

・政策支援・能力構築の実施

ヤンゴン市開発委員会、ミャンマー環境保全森林省（Ministry of Environmental Conservation and Forestry）等の政府関係機関に対して、「持続可能な廃棄物管理に関する国際ワークショップ」の開催を通した政策支援を行った。廃棄物分野における日本企業の技術や日本の都市の経験を共有すると共に、JCM の情報普及を図った。

また、2014 年 2 月 24 日～31 日にかけてヤンゴン市開発委員会汚染管理清掃局から職員を日本へ招聘し、日本自治体との政策対話、先進施設の見学、連絡会への参加等を行った。これにより日本の政策、技術に対する理解を深めた。訪日プログラムでは、東京都練馬区の廃棄物回収現場の視察、川崎市の PET ボトルリサイクル及び有害廃棄物処理施設の視察、国内連絡会への参加等を行った。

事業化へ向けた検討

本年度事業においては主に下記 2 つの案件の事業化についての検討を行った。

小型焼却炉の導入（JFE エンジニアリング社）：JFE エンジニアリング社は環境省 FS を 2012—2013 年度にかけて実施。メタン排出回避、発電による燃料代替等による GHG 削減が見込める。ただし詳細な GHG 削減量の算定はこれからであり、これについては IGES が支援する用意がある。

オフグリッド再エネ案件：本調査はプレ FS に近い位置づけであり、オフグリッド再エネに関する政策、既存のプログラム、導入モデル等の検討を行った。次のステップとしてはより詳細な場所、技術、日本企業等を特定したより詳細な FS の実施が必要である。ミャンマーにおいてはアジア開発銀行もオフグリッド再エネ開発に取り組んでいる。環境省が設立を予定している ADB 信託基金の利用の可能性も高いと思われる。

これらに加えて、ヤンゴン近郊のミンガラドン工業団地における省エネ案件を検討している。本団地は日系企業が運営しており、特に縫製業の工場が入居している。労働集約型の縫製業は日本企業などにとって最も進出が進んでいる分野であるため、大規模展開の可能性が大きい。

ミャンマーは JCM では署名国ではないため、ミャンマー環境保全森林省（MOECAF）に対して JCM の早期署名を働きかけている。これに応える形で、MOECAF 側では環境保全局(Environmental Conservation Department -ECD)が JCM におけるフォーカルポイントになる動きとなっている。また、IGES は MOECAF と協力へ向けた MoU を 2014 年 3 月に締結予定であり、ミャンマーにおける JCM の推進にも有用と思われる。加えて、ミャンマーにおいては JICA、ADB 等も活発に活動しているため、JICA 基金、ADB 信託基金等との連携の可能性も高い。

1.本事業のねらい

日本が推進をしている二国間クレジット制度（以下 JCM：Joint Crediting Mechanism）は、アジア等の途上国に対して低炭素技術・製品・システム・サービス・インフラ等の普及や対策実施を促進し、低炭素社会の構築及び持続可能な発展に対して貢献することを目的としている。

アジア各国における低炭素社会の構築を実現していくためには、個別のプロジェクト毎の案件発掘と形成のみならず、日本の自治体や都市間の協力を通じたより広範囲な分野における技術移転や制度輸出、経験やノウハウの共有を通じた案件の発掘・形成を実現していくことが望ましい。このためには途上国に移行が可能な政策や制度のパッケージ化、そして実際に計画策定や具体的案件を実行していく関係者の人材育成や社会基盤整備が不可欠であり、我が国の関係者のみならず、途上国側関係者及び国際機関等の協働を通じてより包括的にアジアの低炭素化を進めることで JCM 大規模案件の発掘・形成を包括的に支援していく必要がある。

ミャンマーは豊かな環境や資源、民主化を背景とした社会経済基盤の発展を通じて急速に開発が進められている。ミャンマー最大の都市であるヤンゴン市は 500 万人の人口を有し、多くの日本企業もヤンゴン市に事務所を構える。長期的なエネルギー消費量の増大やモノや製品の消費増大に伴う廃棄物の増加、また温室効果ガス（GHG）の排出量についても経済成長に伴い増加が見込まれている。

環境配慮・低炭素型の制度づくりを行うことは、急務となっているが、ミャンマーに対する海外からの支援は再開したばかりである。そのため国際支援へのニーズは高い。さらに、東南アジア諸国連合（ASEAN）諸国と比較して各種インフラの整備も遅れている事から、既存の設備にとらわれずに低炭素型インフラ・技術を導入できる可能性が高い。

本事業は、ヤンゴン市における JCM 大規模案件の形成を通して、ヤンゴン市の持続可能な発展に貢献すると共に、日本の民間企業や事業者のミャンマーにおける案件発掘及び形成の強化、日本側自治体の温暖化対策や低炭素施策及びその実施経験を展開することを通じて、ヤンゴン市の低炭素社会実現及び JCM の案件形成に資することを目的とした。具体的には後述の通り、３つの活動を行った。

・ミャンマー低炭素都市連絡会の開催

・低炭素技術調査の実施

・政策支援・能力構築の実施

2. ミャンマー及びヤンゴンの政策・事業環境

ミャンマーの経済は今注目を集めているものの、現時点では最貧国（LDC）である。もともとミャンマー経済は東南アジアでは優等生とされ、大きな期待を寄せられていた。しかし、政治の不安定性や、欧米諸国からの経済制裁などが影響を及ぼし、経済成長は今まで伸び悩んでいた。

1997 年に米国はミャンマーに対して経済制裁を発動し、米国からミャンマーへの新規投資、輸入の禁止を行った。理由は、国内の弾圧や、1990 年の総選挙結果（NLD の圧勝）の無視などであった。欧州もこれに同調し、この制裁は 10 年以上続いた。この制裁の間に、ミャンマーは隣国中国やタイとの経済的結びつきを強めることとなった。

しかし 2012 年以降、米国と欧州が事実上経済制裁を解除し、日本の働きかけにより同国の負債を一部解消し、日本、世界銀行、アジア開発銀行も支援を再開する運びとなった。これを機に、ミャンマー経済はさらに成長を加速させると考えられる。

ミャンマー経済は、自然資源に強く依存している。ミャンマーの主要輸出品目は大半が資源及び農産物であり、中でも天然ガスは 2011 年度輸出の 38%を占める。輸入もこれに関連しており、資源採掘に必要なディーゼル油を主とした石油製品や、天然ガスや鉱物採掘に使われる機材・機械が多い（JETRO　2012）。2010 年度のミャンマーに向けての対外直接投資（認可額）は、200 億ドルと過去最高を記録したが、その 99%は資源・エネルギー及び鉱物関係の投資であり、主に天然ガス開発と水力発電ダムに向けられた。2013 年においても、電力と石油・ガス部門への投資が 75%以上を占めている。国別投資額では中国が群を抜いており、タイ、香港、韓国、英国、シンガポール等の存在も大きい。日本は投資額では 9 位である（国家計画経済開発省　2014 年 3 月時点）

ミャンマーにおける海外直接投資の部門別比率

No	Sector	Number of Enterprises	Approved amount of investment (USD million)	Share
1	Power	7	19284.432	43.93
2	Oil and Gas	115	14372.272	32.74
3	Mining	68	2833.734	6.45
4	Manufacturing	287	3456.306	7.87
5	Hotel and Tourism	50	1599.711	3.64
6	Real Estate	22	1229.15	2.8
7	Livestock & Fisheries	26	347.474	0.79

8	Transport & Communication	16	313.906	0.72
9	Industrial Estate	3	193.113	0.44
10	Agriculture	12	191.961	0.44
11	Construction	2	37.767	0.09
12	Other Services	12	41.892	0.1
	Total	**620**	**43901.72**	**100**

Source: Ministry of National Planning and Economic Development, Myanmar (2013) As of September 30 2013

環境政策

ミャンマーにおいて、環境に関する法律、政策はすでにある程度存在している。例えば2008年に軍政主導で制定された憲法 においては「国家は、自然環境を保護・保全する義務がある」と規定している。また、2009年には国連環境計画の支援により、モニタリング指標を含む包括的な国家持続可能な開発戦略を策定している。そして2012年6月には環境保護法が策定され、同時に既存の組織を統合する形で「環境保護森林省」が発足している。また、環境影響評価に関する法律も策定されており、2014年の早い段階で承認される予定である。

その一方で、環境影響評価を適切に実施する人材や技術がミャンマーには不足していると考えられる。また、大気質や水質に関する環境基準も制定されておらず、これらの汚染を管理する体制が整っていない。アジア開発銀行、ノルウェー、韓国、UNEP等を始めとする援助機関が関連分野での支援を実施もしくは検討している。

気候変動政策

ミャンマーにおいて気候変動政策自体は存在しないが、2013年3月に政府内のハイレベル委員会である「Myanmar Climate Change Alliance Committee」が設立された。この委員会は月1回のペースで会合を開催予定 しており、環境保全大臣が議長を務め、関連する28の省庁、政府機関がメンバーとなっている。この委員会は、気候変動に関する国家行動計画等を策定する予定である。

なお、ミャンマーにおいて温室効果ガス（GHG）の排出量は低く、森林の吸収が大きい。2000年のインベントリによれば、森林の吸収は経済全体の排出量を大きく上回っているこれは。すでに10年以上前のデータであるため現在はGHGの排出量が増加していると考えられるが、依然として低い水準にあると考えられる。

エネルギー政策

ミャンマー政府は現在、エネルギー管理委員会(Energy Management Committee)において、包括的なエネルギー戦略を策定している。これとは別に、電化率を 2030 年までに 80%へ引き上げ、天然ガスの国内利用の促進、省エネの推進等を掲げている。ヤンゴン付近には、石炭火力発電の建設が予定されており、温室効果ガスの排出増加が懸念される。

日本企業にとっての事業環境

ミャンマーへの日本企業の興味は非常に高く、「アジア最後のフロンティア」とも言われる。JICA 日本の援助機関も精力的に活動を展開している。その一方で、ミャンマーは法整備やインフラ、金融部門の遅れが目立ち、進出に足踏みをする企業も多い。二国間クレジット制度を利用した事業案件を実施する場合も、これらの課題が影響を与えてくるものと考えられる。

3. 「ミャンマー低炭素都市連絡会」の設置と運営

日本側でミャンマーとの協力関係及び事業に関心の高い自治体、民間企業、研究機関等からなる連絡会を設置し、定期的な情報共有、現地の技術調査や政策動向、JCM の案件開発に向けた意見交換等を行った。本連絡会は、案件開発へ向けた日本側自治体、企業等との連携を強化に貢献した。2013 年 7 月、12 月及び 2014 年 2 月において、合計三回開催された。

加えて、連絡会参加機関と連携し、2013 年 11 月 20 日から 22 日にかけてミャンマーで開催された「第三回グリーン経済成長フォーラム」に参加した。本会議を日本の優れた技術や制度の認知を高めることができる場として位置づけ、JFE エンジニアリング社、北九州市、国際協力機構、及び IGES 研究員が登壇するセッションを企画。日本の優れた低炭素技術、国際支援、自治体の取り組み等の紹介を行った。

3.1 第 1 回　ミャンマー低炭素都市連絡会　7 月 31 日

第 1 回連絡会は、本事業及び連絡会の趣旨の説明、及び今年度の焦点であるヤンゴン市の廃棄物管理、及びミャンマーにおける環境政策全般に関する情報共有と議論を行った。

日時：7 月 31 日（水） 14:00～17:30 （懇親会 18:00~） 場所：東京都千代田区内幸町 2-2-1 日本プレスセンター4 階会議室 言語：原則として日本語（一部英語発表あり）

アジェンダ

司会：地球環境戦略研究機関　気候変動とエネルギー領域　小圷一久エリアリーダー

14:00 - 14:15	**挨拶** - IGES　森秀行所長 - 環境省国際協力室　植松朋樹環境専門調査員
14:15 - 14:20	**参加者の紹介**
14:20 - 14:50	**JCM 大規模案件形成事業概要と本連絡会の目的について** - 発表：IGES　気候変動とエネルギー領域　小圷一久エリアリーダー・碓井健太研究員 - 質疑応答
14:50 - 15:20	**ミャンマーにおける環境政策の現況について** - 発表：IGES　持続可能な社会のための統合政策領域　宮澤郁穂研究員 - 質疑応答

15 :20 - 15:30	**休憩**
15:30 - 16:30	**ヤンゴン市における廃棄物管理の現況について** - 発表:IGES　持続可能な消費と生産領域　ニルマラ・メニプラ研究員 - ディスカッサント：JFEエンジニアリング海外本部東南アジア事業部営業統括部営業グループ　高橋元部長代理 - ディスカッサント：東京都環境局廃棄物対策部資源循環推進課　中村幸子様 - 質疑応答
16:30 -17:30	**全体議論・情報交換**
17:30	**閉会**

18:00～	懇親会（参加者負担） 富国生命ビル内「PAVILLON」

議事録

開会挨拶

-IGES 森秀行所長による挨拶。

参加者に歓迎の意を表明。ミャンマーに三回ほど訪問したことがある。ミャンマー産業省大臣と会った事があるが、彼のスローガンは「資源は有限であるが、イノベーションは無尽蔵」だった。また、資源は発展を阻害することがあることにも留意。ミャンマーは巨大な国であり、教育水準も高く、英語も出来る人が多い。米国、欧州、中国、韓国、他タイやマレーシア等の国がミャンマーへの投資を行うようになってきており、日本も彼らと競争をしていく必要がある。この連絡会がそのような動きの一助になればと思っている。ミャンマーグリーン経済成長フォーラムは11月20―23日の開催を予定しており、IGESもセッションを企画している。参加機関の皆様とも協力していきたい。

- 環境省国際協力室 植松朋樹環境専門調査員による挨拶

環境省では17のFSを実施しており、ミャンマー案件に関しては、IGESが受託している。

大阪市―ホーチミン市、北九州市―スラバヤの都市間協力や、イスカンダルでのFS事業を行なっている。単体だけでなく、都市まるごと低炭素化を掲げ、低炭素技術の大規模な国際展開支援、またJICA等と連携した活動も考えている。良い案件があれば是非紹介して欲しい。また、国横断的な事業として、自治体プラットフォーム、企業プラットフォーム、研究プラットフォーム等を立ち上げている。10月21―25日のスマ

ートシティウィークにおいても、セミナーを実施する予定。これらを使って、情報共有、マッチングなどを進めていきたい。

国際展開を考えた資金支援。特に、低炭素技術の支援を考えている。

自治体、企業、研究のそれぞれのプラットフォームを立ち上げることを考えている。１７のFSの情報共有を行い、大規模案件の形成へと繋げていく。横浜で、各自治体に集ってもらい情報共有することも考えている。

参加者の紹介

参加各機関が簡単な自己紹介を行った。

JCM 大規模案件形成事業概要と本連絡会の目的について

- 発表：IGES 気候変動とエネルギー領域 小圷一久エリアリーダー・碓井健太研究員

JCM 大規模案件形成事業概要について

二国間クレジット制度（JCM）案件の大規模形成を狙っている。ミャンマーでは、まだJCMでの締結は行われていないが、検討はされている。この連絡会には、すでにミャンマーで事業を行っている企業も参加。政策面での経験の共有、技術移転、それに伴うキャパビル教育も実施。特に公害などに対応した日本の自治体の経験は非常に重要であり、都市間協力の意義がある。また、都市においては、バイオマス利用、風力発電、都市のインフラとしての上下水道といった様々な分野において低炭素化の余地がある。今年は、１つの都市で様々なセクターを対象に展開していくことを目指している。

今後の具体的な支援ツールとして、NAMA/MRVのガイドブックを作成。JCMはGHGの削減量を把握し、第３者認証を行う。３つの支援プラットフォーム（自治体、企業、研究）を考え、連携協力を促進できるように考えている。企業プラットフォームでは、将来的なマッチング情報等の提供も行うことを考えており、将来的に案件形成へと繋ぐことを考えている。研究プラットフォームでは、研究者と政策決定者との交流や連携を促進することを考えている。低炭素の政策について、具体的な行動へと繋げて行きたい。

ヤンゴン市事業について

本年度は、ヤンゴン市をカウンターパートとして、持続可能な発展を目指す。主な中身として、連絡会議、技術調査、政策支援及び能力開発を予定しており、ヤンゴン市

でのワークショップの開催も考えている。このワークショップへは、連絡会参加者からの参加も期待している。

特に、廃棄物管理をターゲットとし、GHG と廃棄物管理の関係についての能力構築。加えて、ヤンゴン市の職員を日本へ招聘し、研修を行うことも考えている。技術導入可能性調査については、TERI の協力のもと実施。未電化地域への技術支援を考えている。ヤンゴン市での廃棄物分野の関心は高い。また、IGES-環境保全森林省で協力についての MOU を締結する予定である。今後の連絡会では、廃棄物関連とエネルギー分野を考えている。第３回の開催では、ヤンゴン市の職員を含めての開催を予定している。

質疑応答

本連絡会と、３つのプラットフォームは同じものなのか。

→（環境省植松氏）プラットフォームは、17 事業に関わっていただいた方、入っていない方も含めて参加できる。その各プラットフォームに各国のテーマグループ＝連絡会が作られているイメージ。

ミャンマーにおける環境政策の現況について

- 発表：IGES 持続可能な社会のための統合政策領域 宮澤郁穂　研究員

ミャンマーの基礎情報、環境の状況、環境政策、関連組織等について説明。ミャンマーは ASEAN の中でも２番目に国土が大きい国である。首都がヤンゴンからネピトーへ遷都。ヤンゴンからネピドへは陸路で５時間程度かかる。外国からの投資の規制が緩和されつつある。中国・香港からの投資を筆頭に、増加している。

その中で、消費や都市化の問題が顕在化。外国投資も増加しつつあり、大気汚染、GHG 排出量の増加につながっている。

環境の優先課題：、森林、水、土地、気候変動、廃棄物、生物多様性、鉱山等の課題がある。森林は 1975 年には 61%＝＞47%（2010）へと変化。水力が一番発達したエネルギー源であるが、３０%程度の人口しか電気へアクセスできない。交通セクターに伴う、大気汚染もあり、車の所有台数が急激に増加している。

環境関連制度：1990 年は、外交政策の一部として、National Commission for Environment が設置された。しかし、民主化が行われた後、２０１２年３月に、環境保護法が成立し、環境保護省が設置された。環境保護省が作られたことにより各セクターでの環境関連施策が活発化すると想定される。

環境保護法の中身：環境管理基金を設置し、課金制度を作っている。特別会計等を通じて、環境管理を行う。　環境基準は基本的に他の省庁が基準を作っている場合は、厳しい方を取る。環境保護法は、国益のためであれば適用されない可能性がある。

環境保全森林省（MOECAF）は、もともと既存の森林省をベースに作っている。2012 年の統合で、環境保護局が作られた。現状 50 名がいる。環境保護局の中で、４つの部署（保護と EIA、環境汚染管理、政策および国際協力、事務）がある。国際協力室へのコンタクトをしても職員が少なく、対応が難しい場合もあるのが現状である。地域事務所として、５箇所に設置予定。しかし何人増員されるかは不明。ヤンゴン市では、環境基準、EIA 等の基準の設置に向けて、隣国の基準を参考にしながら進めている。

課題として、森林や水、エネルギーアクセスなど様々な課題があるが、データの不足が非常に深刻。隣国の ASEAN からの教訓を生かしつつリープ・フロッグの可能性が大いにある。日本は、南-南協力を推進を促進していくうえでも重要な役割を担っていけるのでないか。

質疑応答：

・ヤンゴン市とヤンゴン地域の違いは。

→行政的に異なる。2011 年 3 月時点で, 7 つの州がある。市街化したところには行政区を設置した。

・制度的な能力、政策担当者の能力が不足している状況。こういった点を考えると自治体の協力の重要性もでてくる。しかし、現状まだまだ国内の体制ができておらず、国のデータも不足している。データ整備の支援や政策面での貢献も重要になるだろう。ミャンマーの環境に関する意欲も高いことにも留意。

ヤンゴン市における廃棄物管理の現況について

-発表: IGES 持続可能な消費と生産領域 ニルマラ・メニプラ研究員

汚染管理清掃局（PCCD）が廃棄物管理の責任を持つ。廃棄物回収、運搬、最終処分場での処理を行なっている。1690 トン/日の廃棄物排出があり、1550 トン/日が回収されている。76%が有機系廃棄物であり、廃棄物処理費は、都市の中央が高額で、外にいくにつれて安くなるように設定している。Dry および Wet の分別が実施されているが、廃棄物収集において、結局混合されて回収されている。13 種類の 297 の収集車があるが、ほとんどの車両が古い。

最終処分場は大きなものが２つあり、４つの小さい処分場がある。一番大きな処理場で、８４７トンの処理を行なっている。YCDC は、ランドフィルガスの回収を行う計画を持っている。２番目の最終処分場は、状況は、上記のものと同じだが、処分場からの滲出液が問題である。小さい処分場に対して、YCDC は、小型の焼却炉の導入を考えている。

リサイクルの状況は、プラスチックバックからのペレットのリサイクルが小さい規模ながら行われている。リサイクルフローの把握が必要。GHG 推計では、22.88kg のメタンが発生し、480 トンが焼却によって排出。トータルで月に 22,342 トンの CO2 が排出

している。廃棄物管理を通じて、LCA の観点から推計すると約 18,000 トンが排出されている。

廃棄物管理計画が非常に重要。埋め立てからのガス回収は重要であるが、タイのケースから考えると埋立地が閉鎖してからの回収のプロジェクトでは、３０％のメタンが既に放出されることになる。迅速な対応が必要。廃棄物の水分は、焼却への影響が大きい。焼却前の事前処理が必要。廃棄物-エネルギーの技術も重要であるが、低炭素化という視点からも適正な廃棄物管理の GHG 削減へ貢献する。

質疑応答：

・（ミャンマー大使館 Eizen Oo 氏）：ミャンマーの状況を理解する上での、環境政策や廃棄物に関連した情報を日本で共有して頂き、感謝。

・（IGES）２回目への連絡会議への参加を依頼。

-ディスカッサント：東京都環境局廃棄物対策部資源循環推進課 中村幸子氏

アジア大都市ネットワ-クを実施している。廃棄物分野で実施。ネットワークというのは交流していくには、実費を自分たちでだしてもらっているため、これまでまだ交流というものがなかった。昨年度 JICA での草の根プロジェクトで、廃棄物管理でのプロジェクト形成へと至った。廃棄物最終処分場の管理への知識の共有や資源循環をどうすすめていくかもポイントとなるため、施策への貢献も行なっていく。

今後の予定は、協力へ向けて契約を結び、技術的な協力を推進していく。ヤンゴン市から職員を招聘し、研修を実施し、意見の交換等も行なっていく予定である。

質疑応答：

環境省廃棄物リサイクル部対策部　大東氏：JFE から静脈産業の海外展開の話があったので、担当者が話をすべき点であるが、紹介。アジア地域を中心に支援している。個々の FS だけを支援しているわけでなく、焼却だけでなく、回収も含めどう協力・貢献できるのかを念頭において取り組んでいる。事務次官が最近では、ALL-JAPAN でいこうとよく話をしている。積極的に情報を交換して、進めていければいいと考えている。

全体議論・情報交換

大阪市： ミャンマー・ヤンゴン市。２４年の２月に関西経済連合会のミッションが最初。大阪知事と一緒にミッションに行った。下水の分野での協力を行ってる。本年度では、クレアとして、モデル事業を採択された。下水道の維持管理、人材育成を行なっており、下水道が先行して実施を行なっている。環境面、水質汚濁の防止、環境管理といった都市施設の町全体からの行政的な支援・施策・提案を考えている。都市全体を管理している大阪市の知見を提供協力していくことを考えている。

アジア経済研究所小島氏：廃棄物焼却の予算に関しては、少し弱いのではないか？インドネシアのケースの紹介があったが、４０００ドル、ミャンマーは１０００ドル。JCM の元で、CO２あたりの買取の価格によって補助も考えられるのではないか？

環境省植松氏：今年から設備に対しての補助を出している。CO2 から１トンあたりいくらといった数字はでていない。インフラの半額は支援できている。石原大臣の話。オペレーションへの補助を出すことも考えている。JICA への共融資。CO2 あたりの補助額といった議論もあるが、ケースによって変わっていく。

IGES 小圷：今のところ価格というのはでていないが、価格というのは出せる。

アジア経済研究所小島氏：１トンあたりのコストが高いと選びづらいということもあるのではないか？

JFE エンジ高橋氏：ごみ焼却。大都市圏では、新しい処分場の用地を探すことが難しいこともある。メーカーとしてもコスト削減といったことも考えている。

PPP で事業を行なっているが、ASEAN では、若干魔法の杖と思われているところもある。事業性が必ずしも高いわけではないことをきちんと伝えていく。その場合は、民間企業が話をしてもなかなか信じてもらえないところもあり、事例の紹介等、自治体からの話をしてもらいたいと思っている。

IGES 小圷：CDM の経験から、ある程度の規模で、売電して実施していく。単に焼却だけでは事業コストをカバーできない。しっかり事業の採算性といったところも重要。ガスの回収量が推計よりも低い場合もあり、事業性としてある程度の規模が必要。データの不足といったことが宮澤からの発表であった。

日本工営庄司氏：ヤンゴン市でのマスタープラン、さらにティラワ経済特区のマスタープランを進めている。ALL JAPAN で進めていると言ったときに、縦割りでの連携がうまくできないなと感じている。希望としては、他省との情報交換を進めて行って欲しいなと感じている。

JICA　杉田氏：報告書が今後でてくるが、ここでも紹介する。７月１５日に都市開発アドバイザーを委嘱する。市長の下に JICA の職員を配置している。意見交換会等実施させていきたい。低炭素都市ということですが、調査がまだまだ配慮が進んでいないが、廃棄物での知見は溜まってきている。ゴミ収集の費用負担や、各世帯数といった数字は収集されている。スマートコミュニティー等今後案件形成をすすめていきたいと考えている。国交省、経済産業省等の協力については、推進していきたい。

JICA 川村氏：気候変動対策室は、プロジェクトにはなっていない。全体的なコーディネーションといったことがメインである。関係機関との情報交換を行なっている。対策室として貢献できることは JCM での基金、ODA を使ったプロジェクトの形成といっ

たことがあるのではないか。またプラットフォームという話もあったが、提供させていただきたい。

IGES 小圷：皆さんからの情報を活用しつつ、共有していきたい。

日本ミャンマー協会　松田氏：去年設立した協会であるが、１００社登録。ティラワの工業団地に関係の深い企業が多い。業界としてティラワにでていく会社が多いということ。環境に負荷をかける企業もある。環境問題がことに関連してくる。連絡会には参加していきたい。日本の企業とミャンマーの企業を結びつけるような会を開催する。ヤンゴン市からは環境に関する企業を連れてきてほしいという要望がある。

大成建設：ミャンマーでは、１９９７年からヤンゴン空港の拡張といったことに関わってきた。第１回の GGEG の会議に参加。ヤンゴンにオフィスを再開した。今後、民間企業の工場を作る際に、建築会社として貢献していきたい。日本のプレゼンスが弱くなってきているように思われる。中国からの投資が増えている中で、どうプレゼンスをあげていくかが課題。オールジャパンという話もあったが、こういったアプローチも重要でないかと考える。ヤンゴンに事務所があるので、情報提供も含め、コンタクトしてもらいたい。

DOWA エコシステムズ山本氏：インドネシアでは、有害廃棄物の処理。タイでは、廃棄物処理として焼却している。JFE の炉である。GGEG に参加しているが、まだまだ環境保護法がしっかり作られていないなか、施策がないと入っていけないような状況。法律の改正といった意味で、情報共有を期待する。

川崎市環境総合研究所荻原氏：地球環境センターが頭になり、JFE エンジニアリング、IGES と一緒にペナンでの事業を実施している。メタンの回収をし、発電を行う。ミャンマーに関しては、空白であるが、水の分野での連携の経験があるが、今後進めて行きたい。

北九州市：スラバヤの事業は、コンポストの事業として開始。現在は廃棄物の処理。上下水の事業を行なっている。現在都市のインフラを構築していこうと進めている。北九州モデルとして、技術を集約して、推進している。ミャンマーには、市内の企業が既に進出している状況。市内にミャンマーのパゴタがあり、民間レベルでの交流がある。今年度は、ヤンゴン市、マンダレー市を対象に市場調査、北九州市の事例等を紹介するようなプロジェクトを実施し、環境先進技術の PR 活動を推進する。

みずほ情報総研　小山田氏：まだアイディアベースであるが、企業にプラットフォームを作るだけでは、だめ。まずは 17 の事業に関わっている事業者や自治体から意見を聞きながら進めて行きたい。

アジア経済研究所　小島氏：ヤンゴン事務所があったり、ミャンマーの専門に研究している人がある。全体の話を聞きながら気になった点として、１７の地域があるとのことだが、各国で制度が異なっているため、地域、自治体の権限や制度を整理してお

くべき。26%の電力ロス。こういった情報も整理する必要がある。バーゼル条約の関連で、環境保全新臨床省と話したが、優先度が高いのは、EIA、環境基準など。これらがまだないので、きちんと設置しないといけない。測定やモニタリングは実施しているか？ときいたが、まだラボがない。環境関係の測定の技術の教育機関がまだない。JICA は、過去計測の協力をインドネシア等でやっているので、ミャンマーでも実施できるのではないか？プラットフォームの話がでたが、もう少しスピード感がないといけないかなと感想をもった。

環境省植松：教育省のラボが使えることを考えている。

IGES 小圷：自治体プラットフォーム、どこの市が何をやっているかを整理していきたい。測定というのはニーズがある。MRV に関連して、廃棄物量の測定や、GHG の削減量の計測といったことも考えられる。

IGES 森：キャパビルでのニーズで優先度が高いのは事実である。そこは別途対応されてくると思う。測定に関しては、PCDD がモバイルラボで、実施している。新しい省庁ができたので、これまで担当していた省庁の機材をどうするかといったことになっていると思われる。また、教育関連であるが、各省庁に関連の教育機関があるような状態。

閉会

IGES 小圷：JCM を意識した場合は、MRV、どの方法論、どうパラメーターを考えていくかといったことが焦点となり、紹介していく。エネルギー分野でも調査を進めていく。GGEG の会合もあるので、二回目は紹介をしていきたい。

IGES 森：各自治体や企業がヤンゴン市で活動している。多くの国からの援助もあることから、情報を整理し、効果的に動くという意味でこういったネットワークは重要である。

JFE エンジ高橋：営業活動をしているので、こういった場で話をできない場合もあるが、個別に相談させていきたいと考えている。マンダレー市の公募に対して、スペイン、韓国、マレーシアが応札すると聞いている

IGES 小圷：スピード感も重要という点は同意。

参加者リスト

第１回ミャンマー低炭素都市連絡会/Member list of the Myanmar Low-carbon City Working Group (2013/07/31)

	組織種類 /Category	組織名/Organization	名前/Name	職名/Position
1	政府機関 Government	環境省 Ministry of the Environment of Japan	植松朋樹 Tomoki UEMATSU	国際協力室 環境専門調査員 International Cooperation Office, International Strategy Division, Global Environment Bureau
2	政府機関 Government	環境省 Ministry of the Environment of Japan	大東　淳 Jun Daito	廃棄物・リサイクル対策部 企画課循環型社会推進室　国際循環政策係 Waste Management and Recycling Department
3	政府機関 Government	環境省 Ministry of the Environment of Japan	市川　琢己 Takumi ICHIKAWA	廃棄物・リサイクル対策部 企画課循環型社会推進室　循環政策係 Waste Management and Recycling Department
4	政府機関 Government	在日ミャンマー大使館　Embassy of Myanmar	エイザン オー Ei Zin Oo	二等書記官 Second Secretary
5	政府機関 Government	国際協力機構 Japan International Cooperation Agency (JICA)	佐原寿一郎 Juichiro SAHARA	地球環境部気候変動対策室　副室長　Deputy Director, Office for Climate Change, Global Environment Department
6	政府機関 Government	国際協力機構 Japan International Cooperation Agency (JICA)	杉田樹彦 Shigehiko SUGITA	経済基盤開発部　平和構築・都市・地域開発第一課　主任調査役 Deputy Director, Peace Building, Urban and Regional Development Division 1, Economic Infrastructure Department
7	政府機関 Government	国際協力機構 Japan International Cooperation Agency (JICA)	川村　美穂子 Mihoko KAWAMURA	地球環境部　気候変動対策室 Climate Change Officer, Office for Climate Change, Global Environment Department
8	自治体 Local Government	東京都 Tokyo Metropolitan Government	中村幸子 Sachiko NAKAMURA	環境局廃棄物対策部資源循環推進課　Bureau of Environment, Waste Management Division, Resource Recycling Promotion Section

9	自治体 Local Government	東京都環境公社 Tokyo Environmental Public Service Corporation	磯辺咲菜 Sakina ISOBE	環境技術部技術課国際協力事業担当 International Cooperation, Engineering Division, Green Engineering Department
10	自治体 Local Government	川崎市環境総合研究所 Kawasaki Environment Research Institute, Environment Bureau, City of Kawasaki	牧葉子 Yoko MAKI	所長/Executive Director 環境局理事/Executive Director of Kawasaki Environment
11	自治体 Local Government	川崎市環境総合研究所 Kawasaki Environment Research Institute, Environment Bureau, City of Kawasaki	荻原朗 Akira OGIHARA	都市環境課 プロジェクト研究担当課長 Manager, Project Research Group, Urban Environment Section
12	自治体 Local Government	川崎市環境総合研究所 Kawasaki Environment Research Institute, Environment Bureau, City of Kawasaki	川原　志郎 Shiro KAWAHARA	都市環境課 プロジェクト研究担当研究員 Researcher, Project Research Group, Urban Environment Section
13	自治体 Local Government	川崎市環境総合研究所 Kawasaki Environment Research Institute, Environment Bureau, City of Kawasaki	渡耒　絢 Aya WATARAI	都市環境課 プロジェクト研究担当研究員 Researcher, Project Research Group, Urban Environment Section
14	自治体 Local Government	大阪市 City of Osaka	佐崎俊治 Toshiharu SAZAKI	環境局環境施策部環境施策課 課長 Manager for Environmental Policy, Environmental Policy Division, Environment Bureau
15	自治体 Local Government	北九州市 City of Kitakyushu	久保聖子 Seiko KUBO	環境局環境国際戦略課 課長 Director, Environment Bureau, International Environmental Strategies Division
16	自治体 Local Government	北九州市 City of Kitakyushu	津田優子 Yuko TSUDA	環境局環境国際戦略課 Environment Bureau, International Environmental Strategies Division
17	民間企業 Private sector	JFE エンジニアリング(株) JFE Engineering Corporation	高橋元 Gen TAKAHASHI	海外本部東南アジア事業部営業統括部営業グループ 部長代理 Manager, Business Development Group, Sales and Marketing Department, Asia Pacific Division, Overseas Business Sector
18	民間企業 Private sector	大成建設(株) Taisei Corporation	田中弘靖 Hiroyasu TANAKA	環境本部環境開発部　室長 Chief Manager, Environmental Development Dept. Environment Division

19	民間企業 Private sector	大成建設(株) Taisei Corporation	大槻学 Manabu OTSUKI	環境本部企画管理部　室長 Chief Manager, Planning & Administration Dept. Environment Division
20	民間企業 Private sector	大成建設(株) Taisei Corporation	種村宜彦 Yoshihiko TANEMURA	国際視点営業部　担当部長 Manager, Marketing & Business Development Dept., International Operations Headquarters
21	民間企業 Private sector	DOWA エコシステム(株)　DOWA ECO-SYSTEM Co., Ltd.	白鳥寿一 Toshikazu SHIRATORI , Dr.	環境ソリューション室　室長 General Manager, Environmental Solution Dept.
22	民間企業 Private sector	DOWA エコシステム(株)　DOWA ECO-SYSTEM Co., Ltd.	山本淳 Jun YAMAMOTO	企画室　海外担当部長 Senior Manager , Strategic Planning Dept.
23	民間企業 Private sector	日本工営(株) Nippon Koei Co., Ltd.	庄司茂幸 Shigeyuki SHOJI	海外事業本部 地域整備部 3R & Waste Management Group, Overseas Consulting Administration
24	民間企業 Private sector	日本工営(株) Nippon Koei Co., Ltd.	石川賢 Masaru ISHIKAWA	海外事業本部 環境技術部 Environmental Science & Engineering Dept., Overseas Consulting Administration
25	民間企業 Private sector	みずほ情報総研(株) Mizuho Information & Research Institute, Inc.	小山田和代 Kazuyo OYAMADA	環境エネルギー第１部地球環境チーム　コンサルタント Consultant, Global Environment and Energy Division 1
26	民間企業 Private sector	みずほ情報総研(株) Mizuho Information & Research Institute, Inc.	佐野翔一 Shoichi SANO	環境エネルギー第１部地球環境チーム　コンサルタント Consultant, Global Environment and Energy Division 1
27	一般社団法人 Incorporated association	日本ミャンマー協会 Japan Myanmar Association	松田康徳 Yasunori MATSUDA	中小企業交流促進担当 Specialist for SME business promotion
28	研究機関 Research Institute	アジア経済研究所 Institute of Developing Economies, Japan External Trade Organization	小島道一 Michikazu KOJIMA	新領域研究センター　環境・資源研究グループグループ長 Director, Environment and Natural Resource Studies Group, Inter-disciplinary Studies Center

29	研究機関 Research Institute	インド資源エネルギー研究所 The Energy and Resources Institute	ラビンデル・マリック Rabinder Malik	日本 TERI コーディネーター Coordinator TERI Japan
30	事務局 Secretariat	地球環境戦略研究機関/IGES	森秀行 Hideyuki MORI	所長 President
31	事務局 Secretariat	地球環境戦略研究機関/IGES	小野川和延 Kazunobu ONOGAWA	シニアフェロー Senior Fellow
32	事務局 Secretariat	地球環境戦略研究機関/IGES	小圷一久 Kazuhisa KOAKUTSU	気候変動とエネルギー領域 エリアリーダー Area Leader, Climate and Energy Area
33	事務局 Secretariat	地球環境戦略研究機関/IGES	碓井健太 Kenta USUI	気候変動とエネルギー領域 研究員 Researcher, Climate and Energy Area
34	事務局 Secretariat	地球環境戦略研究機関/IGES	堀田康彦 Yasuhiko HOTTA	持続可能な消費と生産領域 エリアリーダー Area Leader, Sustainable Consumption and Production Area
35	事務局 Secretariat	地球環境戦略研究機関/IGES	ジャンヤ サンーアルン Janya SANG-ARUN	持続可能な消費と生産領域 研究員 Task Manager, Sustainable Consumption and Production Area
36	事務局 Secretariat	地球環境戦略研究機関/IGES	ニルマラ メニプラ Nirmala MENIKPUR	持続可能な消費と生産領域 研究員 Task Manager, Sustainable Consumption and Production Area
37	事務局 Secretariat	地球環境戦略研究機関/IGES	三戸篤史 Atsushi SANTO	持続可能な消費と生産領域 客員研究員 Visiting Researcher, Sustainable Consumption and Production Area
38	事務局 Secretariat	地球環境戦略研究機関/IGES	宮澤郁穂 Ikuho MIYAZAWA	持続可能な社会のための政策統合領域 研究員 Task Manager, Integrated Policy for Sustainable Societies Area

写真

IGES

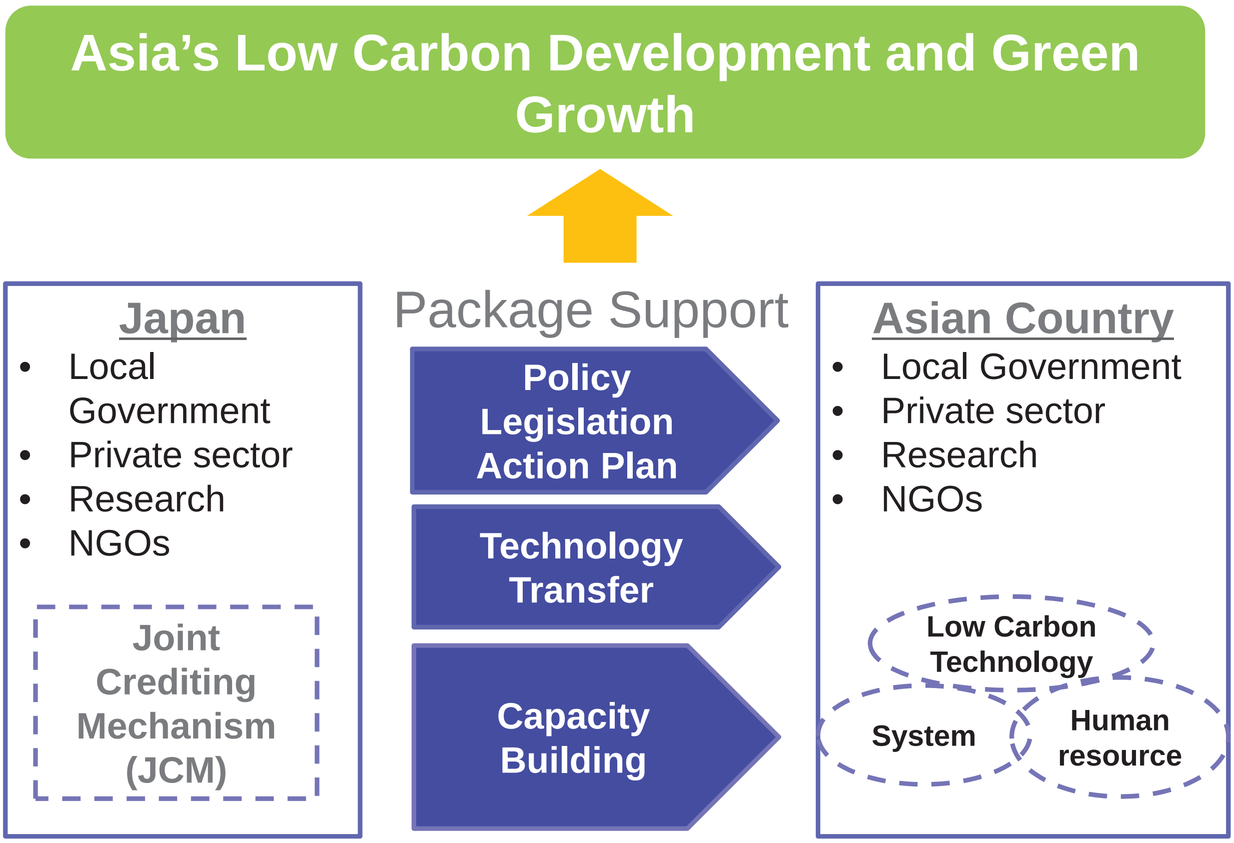
Institute for Global Environmental Strategies

Towards sustainable development - policy oriented, practical and strategic research on global environmental issues

JCM大規模案件形成事業概要と本連絡会の目的について
The overview of Low-carbon Asia Strategy project and the working group on Myanmar

（公財）地球環境戦略研究機関
気候変動とエネルギー領域
エリアリーダー 小圷一久 / 研究員　碓井健太
Kazuhisa KOAKUTSU, Leader, and Kenta Usui, Researcher
Climate and Energy Area
Institute for Global Environmental Strategies (IGES)

Asia Low Carbon Strategy Project



2

Enhancing Policy and Technology Transfer

Low Carbon Policy, Legislation, Action Plan

Japanese City and local government
(i.e. Tokyo, Yokohama, Kawasaki, Osaka, Kita-Kyushu)

Know-how Experience

Asia's city and local government
(Surabaya-Indonesia, Ho Chi Minh-Vietnam, Iskandar-Malaysia)

Low Carbon Technology Transfer & Deployment

Japanese Company and Technology
(Energy efficiency, renewable energy, waste management, water, transport)

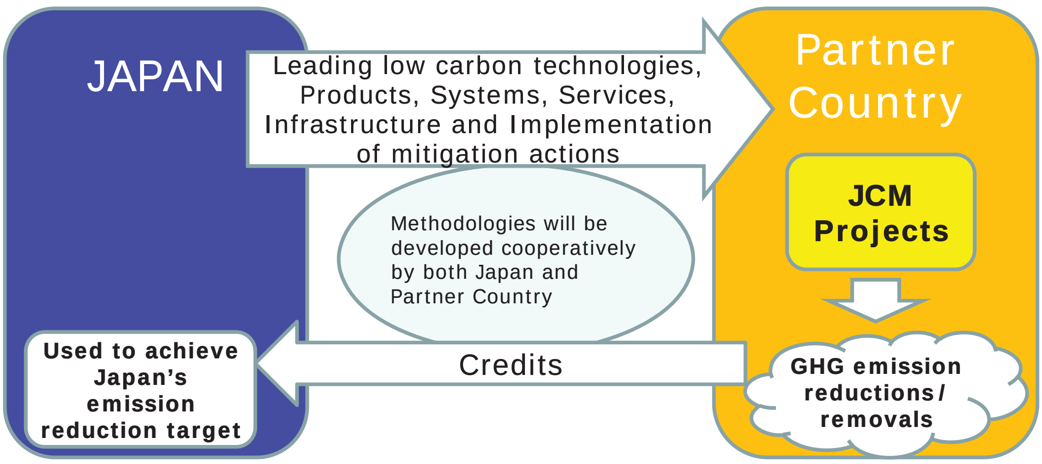
Project development Feasibility Demonstration

Asia's growing private sectors and business

3

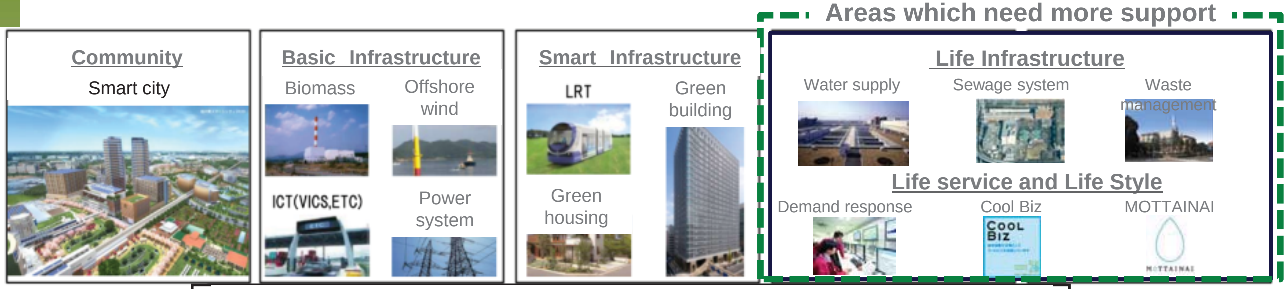
Joint Crediting Mechanism (JCM)

- To facilitate diffusion of leading low carbon technologies, products, systems, services, and infrastructure as well as implementation of mitigation actions, and contributing to sustainable development of developing countries.
- To appropriately evaluate contributions to GHG emission reductions or removals from developed countries in a quantitative manner, through mitigation actions implemented in developing countries and use those emission reductions or removals to achieve emission reduction targets of the developed countries.
- To contribute to the ultimate objective of the UNFCCC by facilitating global actions for emission reductions or removals.



4

低炭素都市づくり
Realizing Environmentally Sustainable Cities by “Leapfrog”



Proposing package of low carbon technology and Know-how possessed by Japan

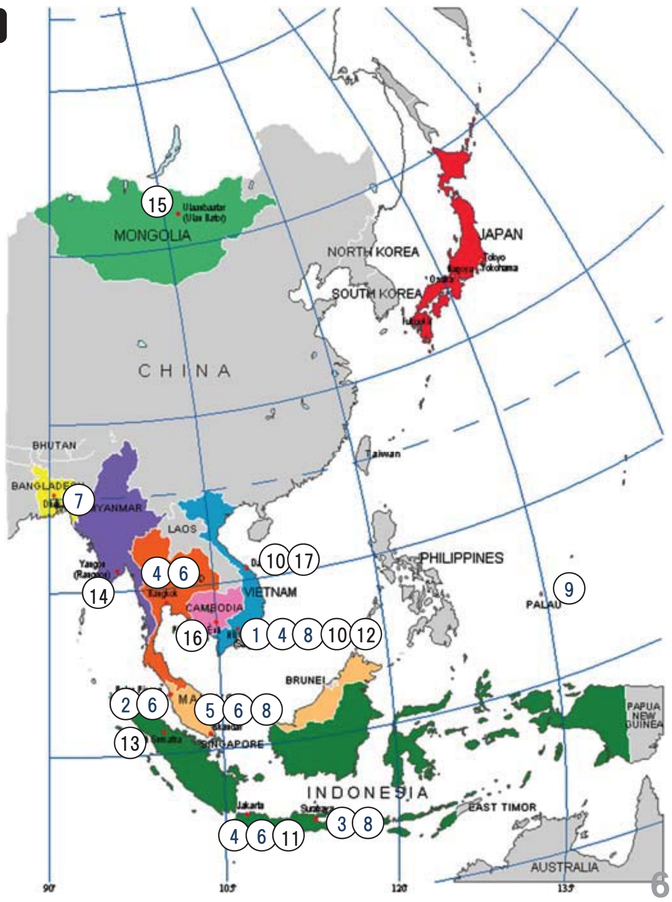
5

(出典: ｱｽﾞﾋﾞﾙ、川崎重工業、清水建設、日建設計、三井不動産、三井ﾎｰﾑ)

17のフィージビリティ・スタディ　ESC Feasibility Study using JCM

採択案件一覧

1. ホーチミン市・大阪市連携による低炭素都市形成支援調査
2. 「Waste to Energy技術」による低炭素都市形成支援事業（ペナン、スプランプライ）
3. スラバヤ市における低炭素都市計画策定のための技術協力
4. ASEAN大都市の交通公害対策ための日本規格のデジタコ普及と地域統一規格化の可能性調査（ジャカルタ、バンコク、ホーチミン）
5. イスカンダル開発地域における温室効果ガス排出削減プロジェクト大規模形成可能性調査（イスカンダール）
6. フロン類の回収・破壊処理の戦略的推進事業（ジャカルタ、バンコク、イスカンダール、ペナン）
7. CO_2フリー・グリーンウォーターの村落地域での供給事業（ダッカ）
8. 低炭素型上水供給システム導入事業検証プロジェクト（スラバヤ、イスカンダール、ホーチミン）
9. 適応と緩和を統合する「島嶼国低炭素化モデル」の検証（パラオ他）
10. 電動バイク普及による低炭素コミュニティ開発事業実現可能性調査（ホーチミン、ダナン）
11. 省エネ推進ファイナンススキーム構築実施可能性調査事業（ジャカルタ）
12. 節水機器・省エネ機器普及による大規模案件形成（ホーチミン）
13. 廃棄物・排水分野におけるリープフロッグ支援事業（北スマトラ）
14. ヤンゴン市における低炭素社会実現支援（ヤンゴン）
15. エネルギー供給側・需要側の効率改善（ウランバートル）
16. 上水道の水対策によるGHG削減効果の定量化・MRV方法論の検討（プノンペン）
17. 本邦廃棄物管理・処理技術の導入及び課題抽出、評価等（ダナン）



6

3つのフラッグシップ都市　Target Cities in 2013

- 12 Cities was selected for pre-feasibility studies.
- スラバヤ（インドネシア）、ホーチミン（ベトナム）、イスカンダル（マレーシア）は3つのフラッグシップ都市。Surabaya, Indonesia, Ho Chi Minh, Viet Nam and Iskandar, Malaysia are 3 flagship cities.
- 姉妹都市を活用。Making use of relationship between Surabaya and Kitakyushu（北九州市）, Ho Chi Minh and Osaka（大阪市）

City	Area of pre-feasibility studies
Surabaya	Energy management; Transport and traffic management, Solid waste management; Water and wastewater management
Ho Chi Minh	Waste-to-energy, Wastewater treatment, Public transportation, Electronic bicycle, Building Energy Management System, ESCO, Energy savings in water supply, Water saving equipment
Iskandar	Implementation of LCSBP（Low-Carbon Society Research Project）by using advanced Japanese technologies (Smart City, ESCO, Energy savings in water supply)

支援ツール（NAMAs/MRV）の開発
Development of Support Tools (NAMAs/MRV)

「アジア NAMA / MRVガイドブック」を作成し、対象国・都市のNAMAs / MRV の開発と実行を促進し、アジアの低炭素発展に貢献

Net Global Reduction for Sustainable Development

- NAMA（Nationally Appropriate Mitigation Actions by Developing Countries：　開発途上国によるその国に適した緩和行動）
- MRV（Measurement, Reporting and Verification：　測定・報告・検証）

3つの支援プラットフォームの形成
Building of 3 Support Platform

アジアでの低炭素都市づくり

大規模案件形成

低炭素技術普及のための環境整備

自治体プラットフォーム
- ・環境先進自治体間の連携・協力を促進
- ・途上国との都市間連携により地元企業の海外進出を支援

企業プラットフォーム
- ・企業の海外展開を支援するワンストップサービス
- ・企業に必要な様々な情報を提供（現地の環境規制、ニーズ、政府機関の支援策一覧）
- ・企業の戦略的提携支援

研究プラットフォーム
- ・研究者と政策決定者の交流・連携を促進
- ・各国・都市における低炭素計画づくりを支援
- ・共同研究の推進

9

Promoting dialogue through Three Platforms

City and Local Government Platform
- Regional and country meeting
- Launch of web site
- Low carbon city policy manual

Research Platform
(LoCAR-Net)
- Networking
- Knowledge-sharing
- Joint Research
- Capacity Building

Private Sector Platform
- Seminar
- Dedicated web site
- Technology match-making
- Investment guide for low carbon project

10

Yangon Project/ヤンゴン事業

- 目的/Objective
  - JCM大規模案件の形成を通した、ヤンゴン市の持続可能な発展への貢献
- 活動/Activities
  - 連絡会：日本の企業・自治体との連携・情報共有
  - 技術調査：現地調査を通した低炭素案件の種の発掘
  - 政策支援・能力構築：ワークショップ開催、GHG排出量試算トレーニング、訪日視察等を通したヤンゴン市の能力向上（H25年度は廃棄物分野中心）

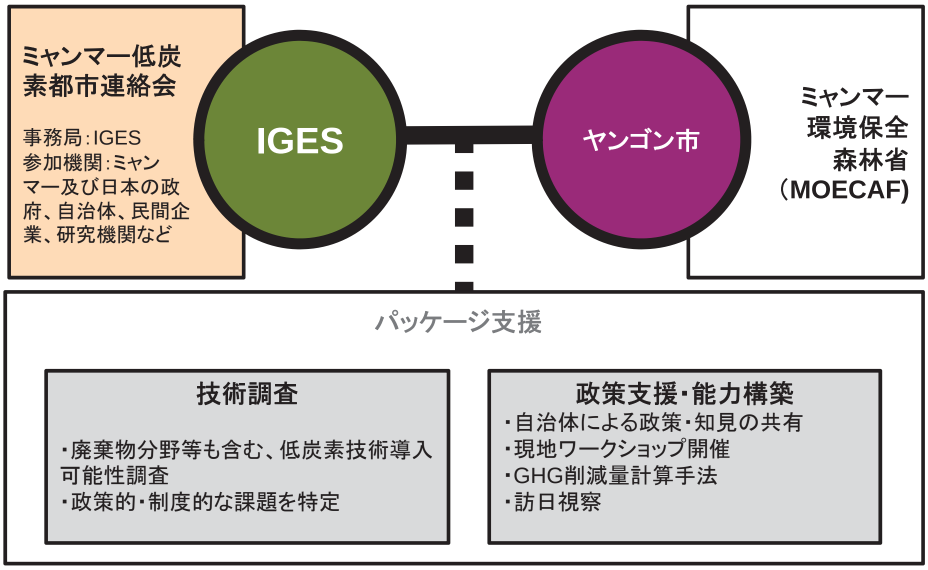
11

Yangon project

- **Objective**
  - Contributing to the sustainable development of Yangon through JCM project formulation
- **Activities**
  - **Working group:** cooperation and knowledge sharing among Japanese national/local governments, private sectors and research institutes
  - **Technology research:** Identifying potential low-carbon projects and technologies
  - **Policy support / capacity building:** Organising workshops, study tour and training on GHG calculation for the staff of City of Yangon

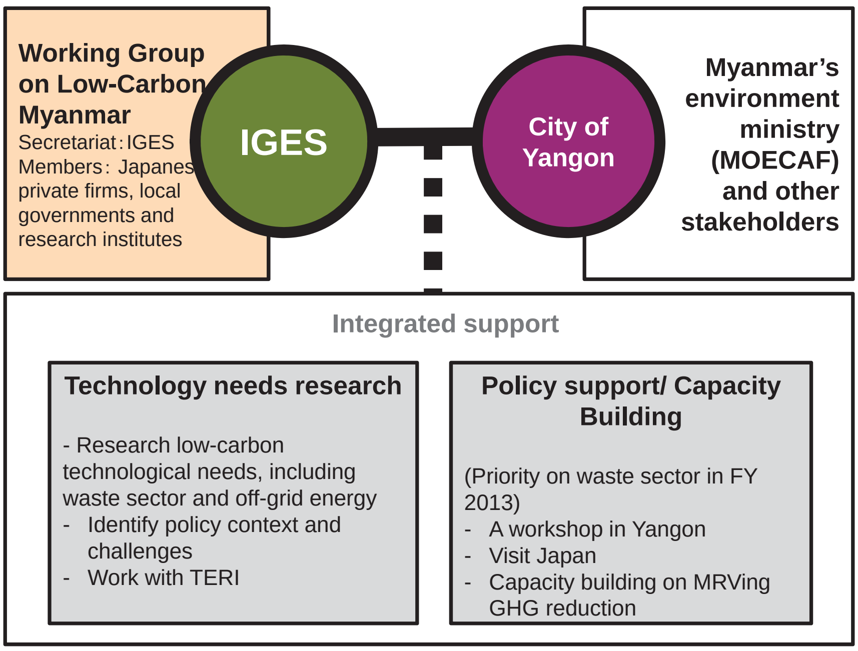
12

事業図/Project illustration



13

Project illustration



14

連絡会開催予定/Planned schedule

July 2013	-	**第一回連絡会開催 / 1st Low-Carbon Myanmar Working Group in Japan**
	-	技術調査開始 /Start technology needs research
August	-	IGESとミャンマー環境保全森林省の覚書締結予定/ MOECAF-IGES MoU to be signed
October	-	**第二回連絡会開催（廃棄物案件のアップデート、エネルギー分野における情報共有等）**
	-	**2nd Low-Carbon Myanmar Working Group in Japan**
November	-	第三回ミャンマーグリーン経済成長フォーラム / 3rd Myanmar Green Economy and Green Growth (GEGG) Forum
December	-	ヤンゴン市にて持続可能な廃棄物管理に関するワークショップ開催/ The City of Yangon-IGES workshop on sustainable waste management
January 2014	-	**第三回連絡会開催 （ヤンゴン市職員発表・本年度活動総括等）/ 3rd Low-Carbon Myanmar Working Group in Japan （ヤンゴン**
	-	ヤンゴン市職員招聘（日程は変更の可能性あり）Invite officials from the city of Yangon to Japan

15

ミャンマーグリーン経済成長フォーラム 11月20～22日

16

ご静聴ありがとうございました。

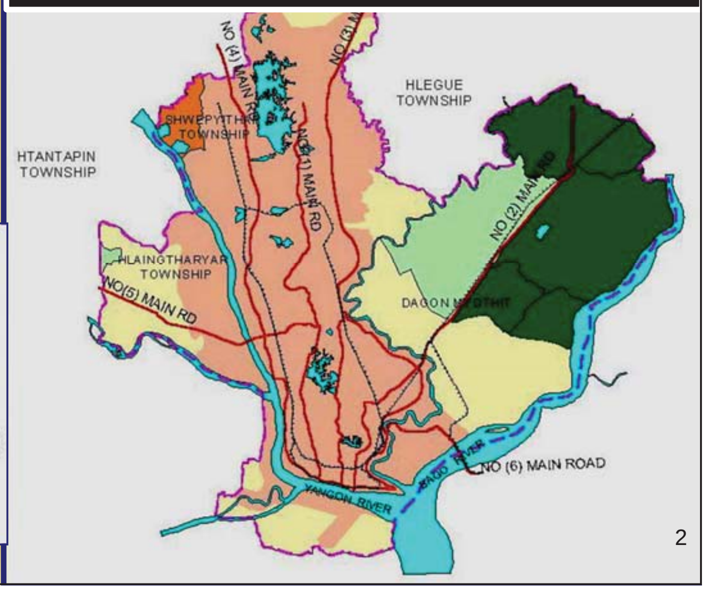
Present Situation of Solid Waste Management in Yangon City

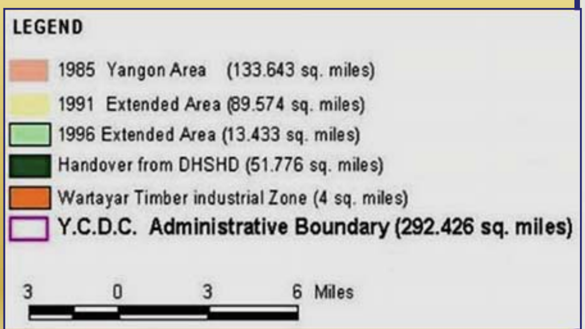
Nirmala Menikpura, PhD
Sustainable Consumption and Production (SCP) Group
Institute for Global Environmental Strategies (IGES)

General background of Yangon City

- Yangon is the former capital of Myanmar and remains as the most important centre of commerce, politics and culture.
- Total area of Yangon city is 759 km^2 and the population is 4.72 million (as of December 2012)
- There are 33 townships in Yangon region and divided into four districts – North, South, East and West

Administrative boundary of Yangon City Development Committee





Source :YCDC

2

Waste management in Yangon City

Pollution Control and Cleansing Department (PCCD) is responsible for waste management in Yangon city

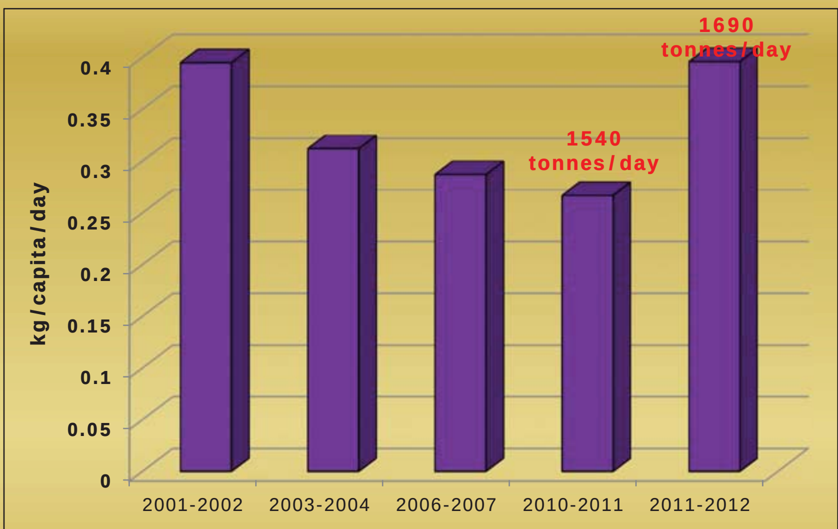
Responsibilities of PCCD in Waste management

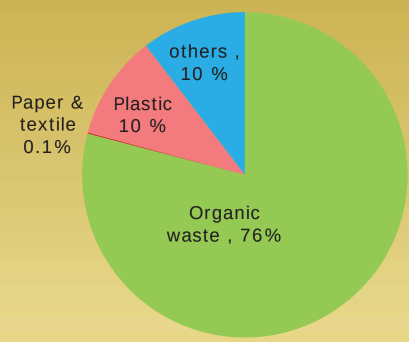
Daily Management
- -Waste Collection
- -Waste Transportation
- -Disposal at the final disposal sites

Pollution Control (progressing)
- -Final disposal sites management
- -Recycling
- -Green composting
- -Awareness raising

3

Waste generation and composition in Yangon

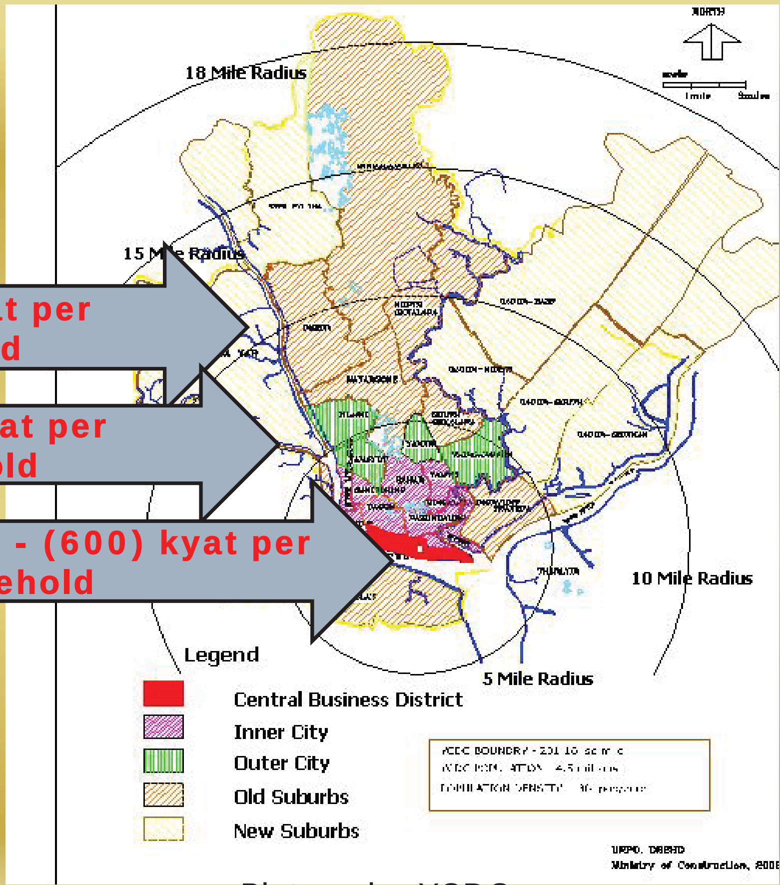




- ❑ Total waste generation - 1,690 toness/day
- ❑ Total waste collection - 1,550 tonnes/day
- ❑ The remaining 140 tonnes share the recycling and illegal dumping
- ❑ More than 75% of waste is organic

4

Monthly fee for waste collection service



Old suburbs-300 kyat per month / household

Sub-Urban - 450 kyat per month / household

Central Business District - (600) kyat per month / household

Charges from commercial centers, hotels etc. are based on sizes, kind of facilities, waste types and others

Picture by YCDC

Waste collection methods in Yangon

1. Bell Ringing System

By carts

By Trucks

2. Collection at a street Dumps Yard

3. Kerb side collection

Pictures by YCDC

6

Waste separation at Yangon

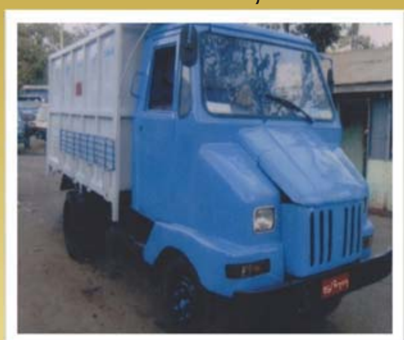
- Waste is mainly separated into two parts: Wet and Dry
- However, all the separated waste is loaded to the same vehicle for transportation

Pictures by YCDC

7

Waste collection vehicles

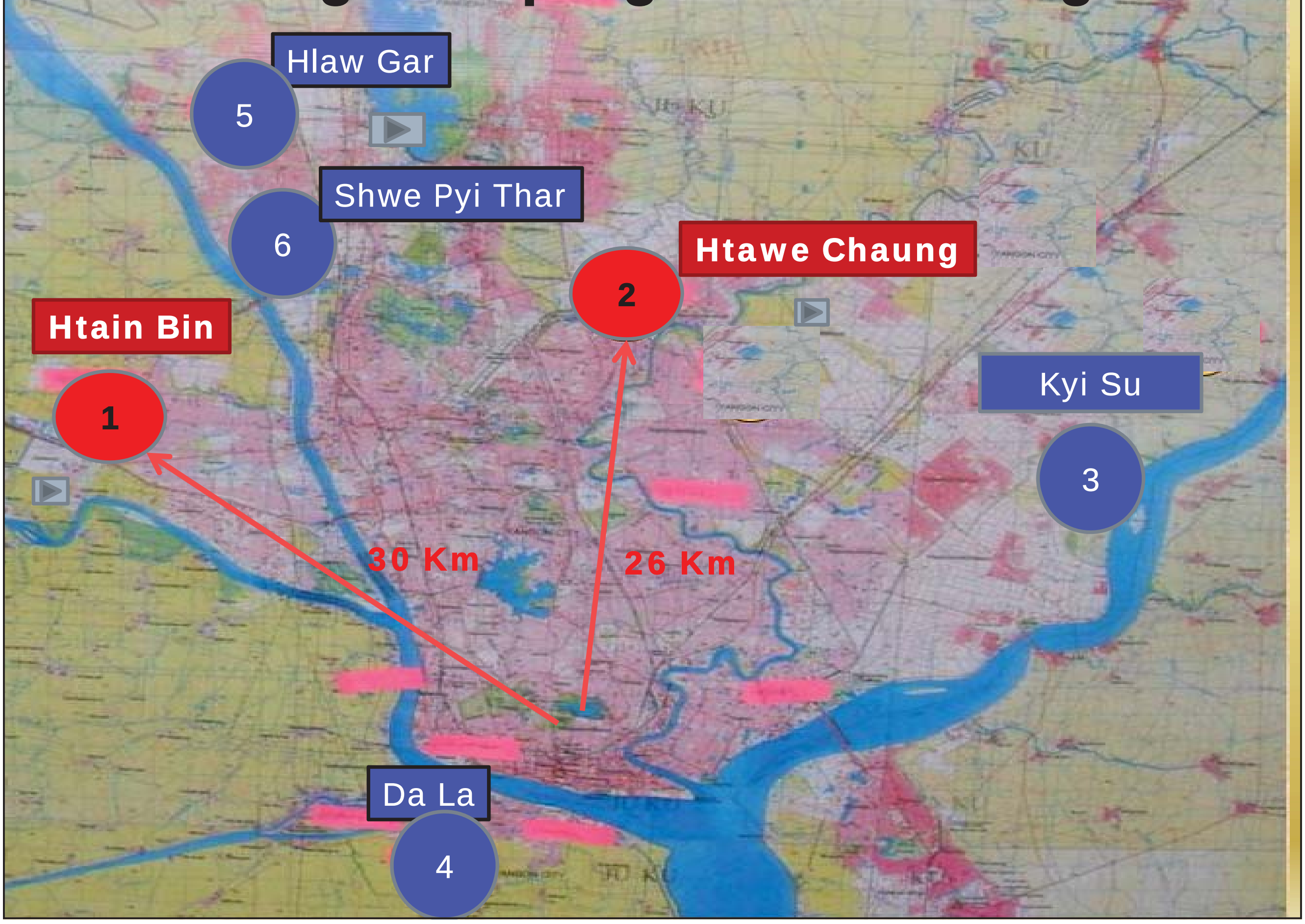
- There are 13 kinds of trucks are used for waste transportation
- No. of trucks available 297 and capacity of trucks varies 2-8 tonnes/trip
- Many trucks are too old and often, vehicle breakdown do happen.



Pictures by YCDC

8

Existing dumping sites in Yangon

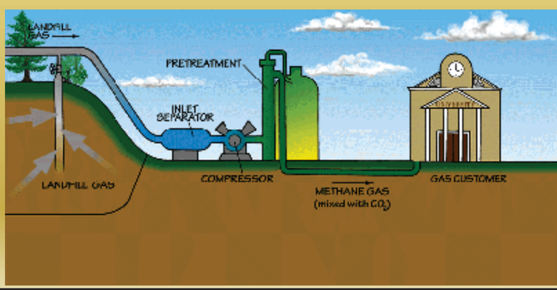


Present situation of open dumpsite at HtainBin

- This is the biggest open dumpsite in YCDC
- 847 tonnes of incoming waste is disposed per day

Future

PCDC is planning to implement a landfill gas-to-energy recovery plant to replace this open dumpsite



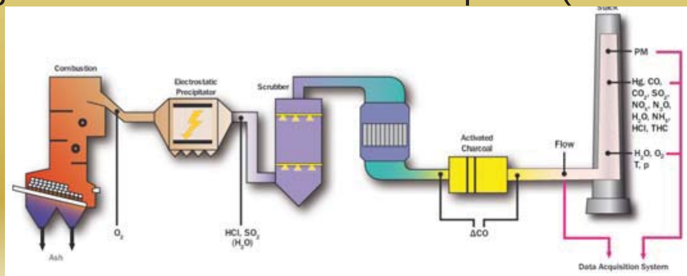
10

Present situation of open dumpsite at Htwei Chaung

- This is the second biggest open dumpsite
- 612 tonnes of incoming waste is disposed per day

Future

YCDC is considering installation of incineration plant (with electricity recovery)



11

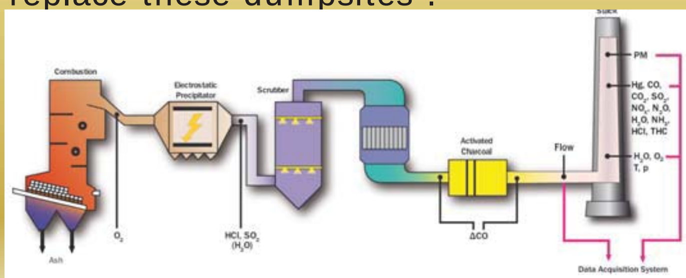
Present situation of small open dumpsites

Dumpsite at Shwe Pyi Thar
Disposal capacity – 50 tonnes/day

Dumpsite at Hlaw Ger
Disposal capacity 25 tonnes/day

Future

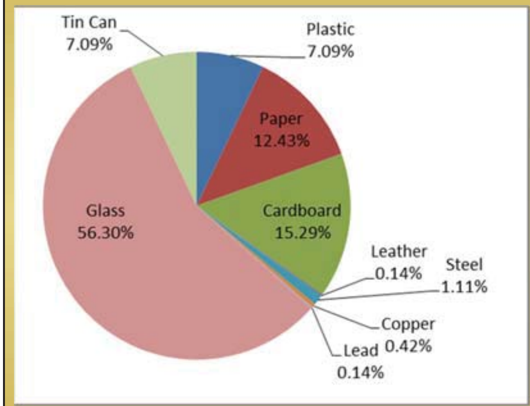
YCDC is considering installation of small incineration (without electricity production) plants to replace these dumpsites .



12

Situation of waste recycling in Yangon

- YCDC has estimated that 86 tonnes/day generated waste is recycling
- Valuable recyclables are stored at household level and sell to the nearby junkshops
- YCDC is also running a small-scale plastic recycling plant and green and blue plastics bag is produced using the waste plastic.



Composition of recyclables in Yangon

Plastic recycling activities at YCDC

13

Estimation of Greenhouse Gas (GHG) emissions from current waste management in Yangon

IGES GHG calculation tool was used to estimate the climate impacts from current waste management in Yangon

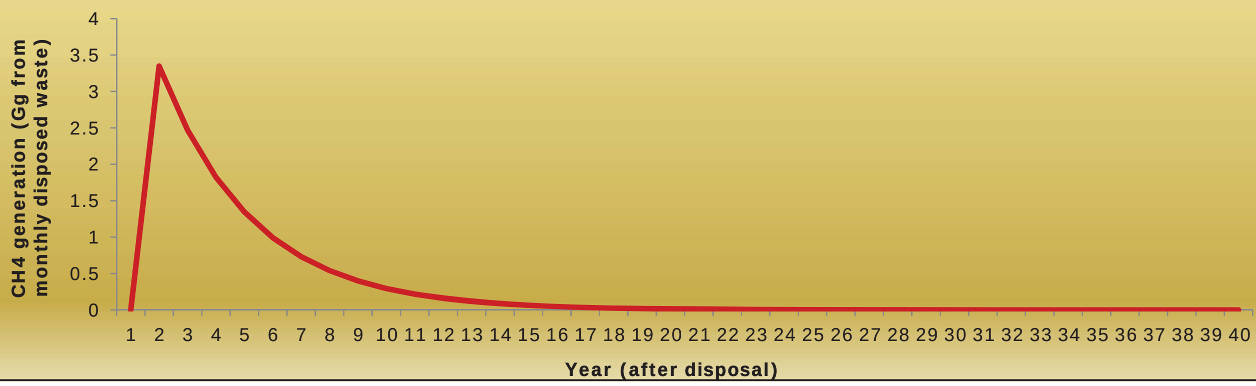
GHG emissions from Waste Transportation

YCDC uses 128,704 L diesel and 900 L of gasoline for waste transportation

GHG emissions from transportation	7.51	kg of CO2-eq/tonne of waste
Monthly GHG emission from transportation	**349**	tonnes of CO2-eq/month

GHG emissions from open dumping

Emission of CH_4 from open dumping	22.88	kg of CH_4/tonne
Direct GHG emission from mixed waste open dumping	480.48	kg of CO2-eq/tonne of mix waste
GHG emission from open dumping from monthly disposed waste	**22,342**	Tonnes of CO2-eq/month



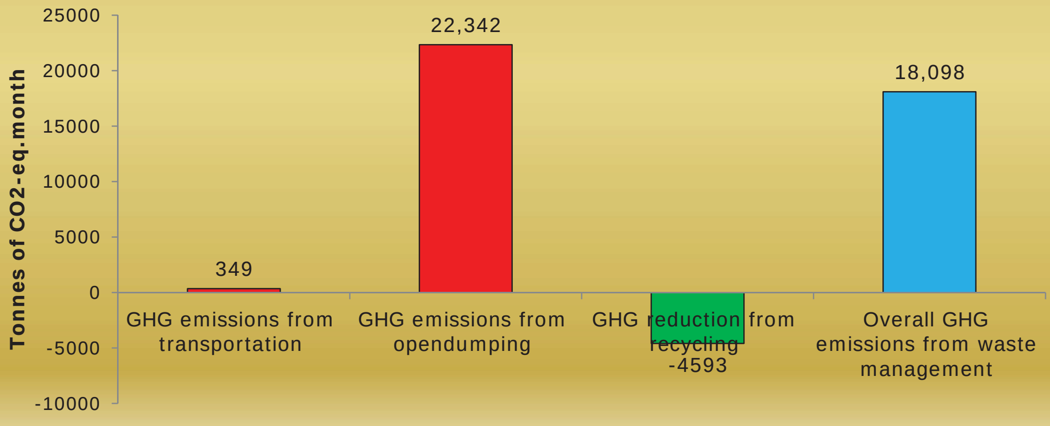
14

Estimation of Greenhouse Gas (GHG) emissions from current waste management in Yangon

GHG emissions from recycling activities in Yangon

Direct GHG emissions from recycling	866.42	kg of CO2-eq/tonne of mixed recyclables
Avoided GHG emissions from recycling via materials recovery	2646.79	kg of CO2-eq/tonne of mixed recyclables
Net GHG emissions from recycling (life cycle perspective)	-1780.37	kg of CO2-eq/tonne of mixed recyclables
Monthly total GHG reduction from recycling	**-4,593**	**Tonnes of CO2-eq/month**

Overall GHG emission from waste management in Yangon



15

YCDC plan for future waste management

Landfill gas-to-energy recovery and incineration would be the two major technologies in the intended waste management system in Yangon

Our suggestions to improve the climate benefits and other co-benefits from waste management

- Careful planning is very important in the designing phase to avoid the failure that may happen after the implementation
- Improving the efficiency of the landfill gas recovery is the key to mitigate GHG. That can be done by starting gas recovery soon while waste tipping continues, and extending the duration of gas recovery project to cover the peak production period of methane
- Composition and the moisture content of the waste can be greatly effected on the efficiency of the incineration plant. Pre-treatment would be necessary to reduce the moisture content waste prior to combustion
- Despite all the waste-to-energy technologies, development of proper recycling scheme in Yangon would contribute for significant GHG reduction and then to attain the target of low carbon city

16

Points to be discussed for further improvements

- How to select a appropriate set of technologies (especially pre-treatments) to match with waste characteristics of Yangon city?
- How to establish a capacity of local governmental officials to plan and operate integrated approach for long term sustainability of waste management?
- How to secure operational costs for upgraded technologies and approaches?
- How to improve the efficiencies of proposed waste-to energy technologies to extract maximum amount of energy from waste?
- How to reduce running costs including fossil fuel input?
- What are the possibilities for applying JCM?
- How to improve recycling activities in Yangon to divert waste flows going into landfill and reduce GHG?

17

THANK YOU VERY MUCH

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18

Institute for Global Environmental Strategies

ミャンマーにおける環境政策の現況について
Current status of environmental policies in Myanmar

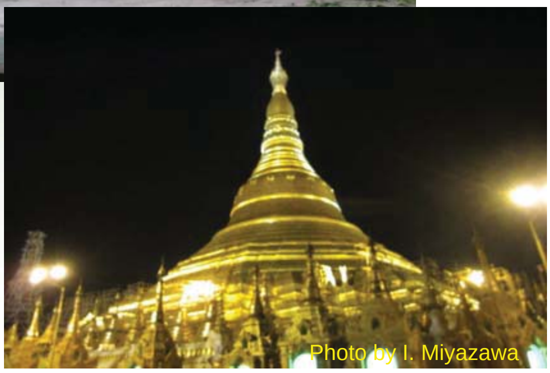


Photo by I. Miyazawa

第1回ミャンマー低炭素都市連絡会
1st Meeting of Low-carbon Myanmar Working Group

14:00 – 17:30, 31 July 2013
Japan Press Center Building

宮澤郁穂/Ikuho Miyazawa
研究員/Researcher
Integrated Policies for Sustainable Societies (IPSS)
Institute for Global Environmental Strategies (IGES)

目次/Outline

- Basic facts about Myanmar
- State of environment
- Environmental law and policies
- Institutions
- Policy options and challenges
- Yangon region/city
- Conclusion

***This presentation is based on the final draft of the Second Environmental Performance Assessment for Myanmar (in press), courtesy of ADB , and the survey conducted during FY2012, commissioned by the Ministry of the Environment, Japan.*

Myanmar's leading newspaper "New Light of Myanmar"


Photo by I. Miyazawa

基礎情報①/ Basic facts

- ASEAN’s second largest land area at approx. 68 sq. km.
- Abundant forests, rivers, wetlands, and coastline.
- More than 300 mammal species, over 1,000 different resident and migrating bird species, 360 reptile species, more than 1,200 butterflies, and more than 7,000 plant species.
- Habitat of elephants, white-handed gibbons, and many other endangered species of wildlife.

Source: UN (2012)

基礎情報②/ Drivers of Environmental Change

- Political opening up and removal of foreign sanctions;
- Massive investment in the infrastructure backlog;
- Decades of limited public expenditure on waste management facilities and environmental monitoring; and
- Influence of external investors looking for relaxed environmental controls.

Foreign investment of permitted enterprises by country of origin (2010-2011)

Country	Investment (USD million)
China	8,269
Hong Kong	5,798
Thailand	2,948
The Republic of Korea	2,675
Singapore	226
Malaysia	77
Japan	7

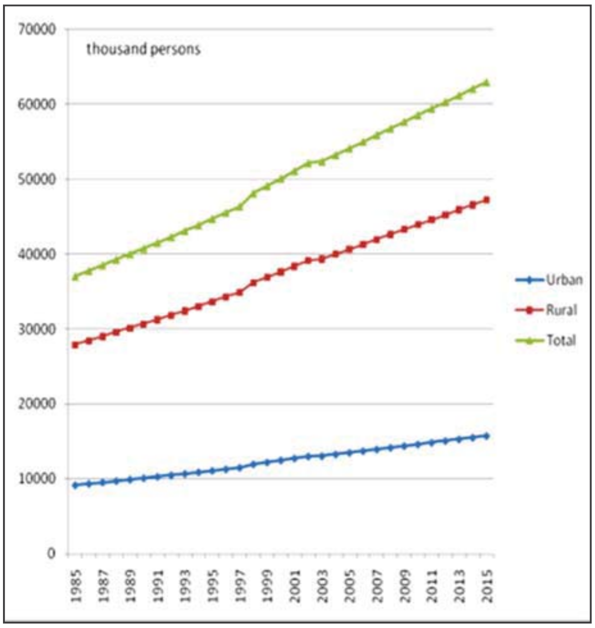
Source: Central Statistical Organization (CSO), Myanmar

Examples include hydropower dams on the Irrawaddy and Salween Rivers, Oil and Gas Pipelines (Shwe and Zawtika), Kyaukphyu Development Zone, Dawei Special Development Zone, Kaladan Multimodal Corridor and roads and rail networks linking to these projects.

基礎情報③/
Drivers of Environmental Change

- Population increase – estimated at >2.0%; 62 million by 2015;
- Deferred consumption and urbanization;
- Massive resource and energy demands of neighbouring countries;
- Global climate change, natural disaster, and ocean acidification.

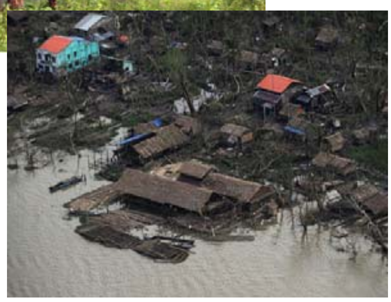
Rural and Urban Population ('000), 1985–2015



Source: CSO, Statistical Yearbooks, 1992–2003.

環境の優先課題
Priority environmental concerns

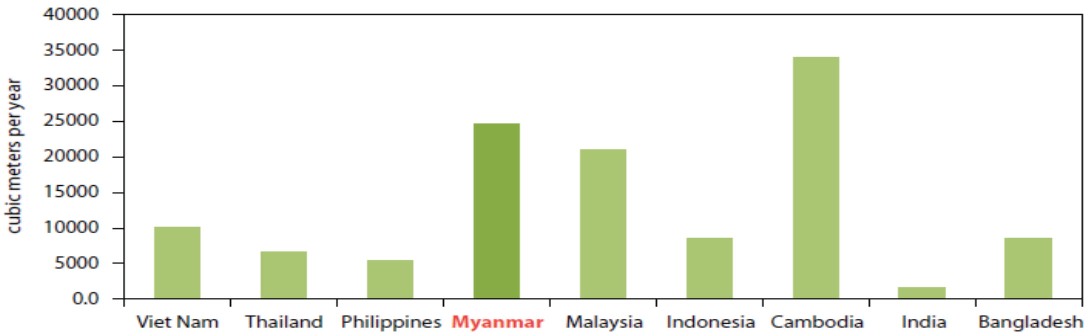
- ✓ Forest degradation;
- ✓ Water resources and water quality;
- ✓ Land degradation;
- ✓ Climate change;
- ✓ Solid waste management;
- ✓ Biodiversity loss; and
- ✓ Impacts of mining on the environment.



環境状況/State of Environment (1)

- Forests accounted for 61% of total land area in 1975, and decreased to 47% in 2010.
- Municipal solid waste in Myanmar consists of organic waste (73%), paper and cardboard (18%), wood (4%), plastic (2%), textile (2%), and other materials (1%);
- Abundant water resources, but limited usage. Hydropower is the most highly developed renewal energy source.

Renewable water resources per inhabitant in neighboring countries (2012)

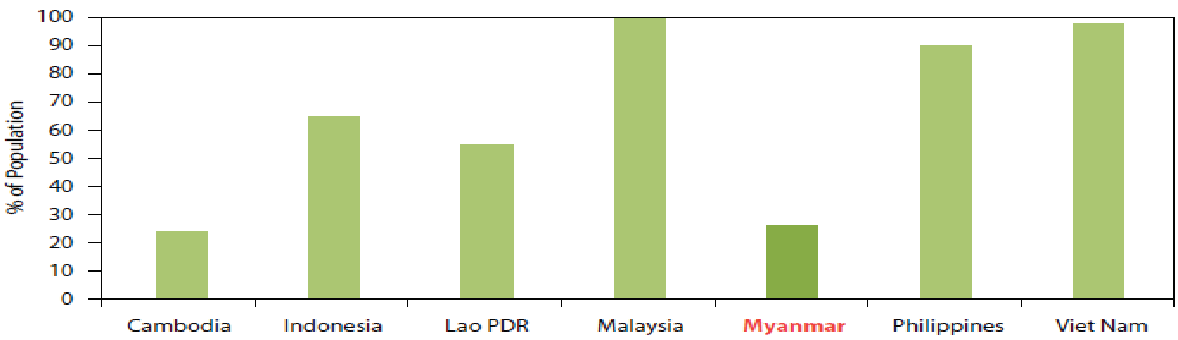


Source: FAO-Aquastat 2012

環境状況/State of Environment (2)

- Limited access to electricity (30% of total population)
- Conventional energy consumption is still low, with nearly two thirds from charcoal, fuel wood and biomass.
- A primary source of air pollution stems from the transport sector, with the number of vehicles on the road doubling since 2004, to close to 2 million.
- Severely affected by extreme weather events.

Access to electricity in neighboring countries (%/population) (2012)



Lao PDR = Lao People's Democratic Republic.
Note: The graph plots 2009 data, except for Myanmar, 2011.
Source: WB-WDI 2012 and data provided by MOEP-1 to the September 2011 ADB mission.

環境関連制度・政策の現状/ Institutional and Policy Responses

Year	Institutions and policies	Responsible institutions
1990	National Commission for Environmental Affairs	
1995	Myanmar Forest Policy	
1995	National Forestry Action Plan	
1997	Myanmar's Agenda 21	
2009	National Sustainable Development Strategy	
2009	Myanmar Action Plan on Disaster Risk Reduction 2009-2015	Ministry of Social Welfare, Relief and Settlement
2008, 2010	Environmental Performance Assessment	MOECAF
March 2012	Environmental Conservation Law (Turing Point!!)	MOECAF
2012	Ministry of Environmental Conservation and Forestry	
draft	•National Adaptation Programme of Action •Initial National Communication to UNFCCC •Environmental Impact Assessment Rules	MOECAF

Environmental Conservation Law (2012)

- Adopted in March 2012. Consists of 14 Chapters and 12 provisions.
- Serves as Myanmar's basic environmental conservation law.

Key Characteristics

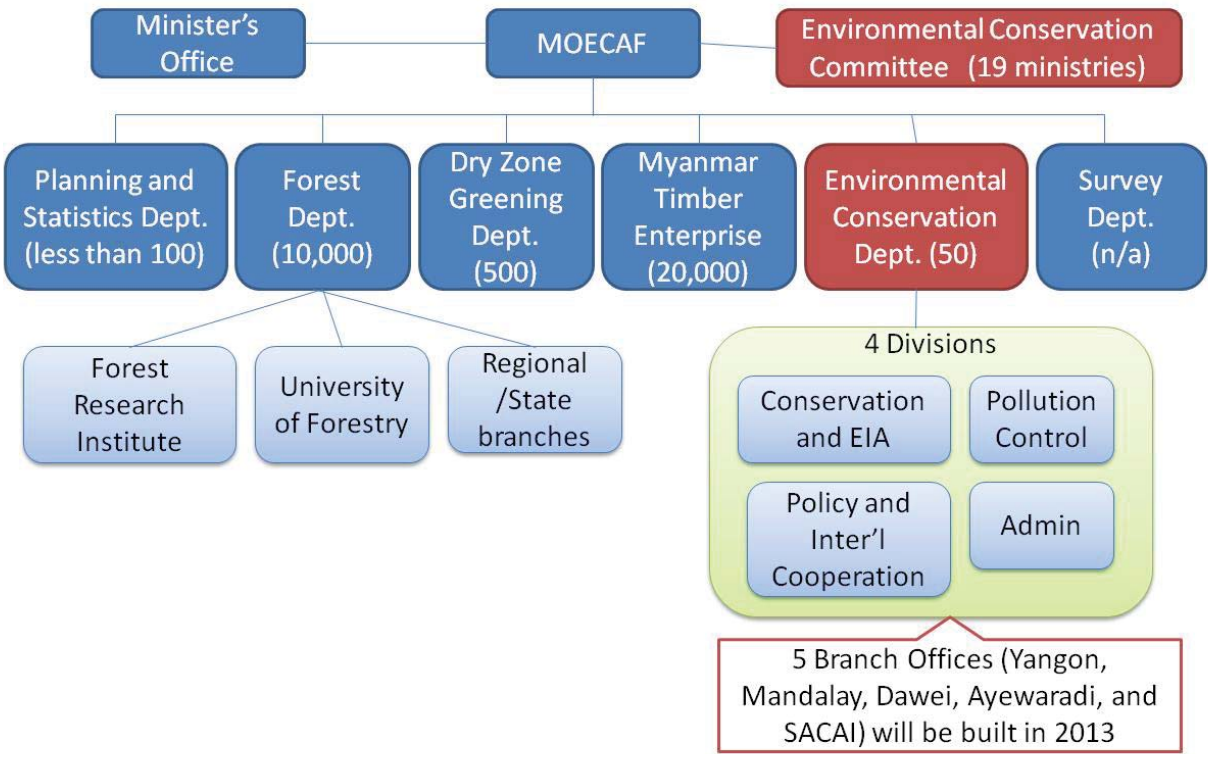
- Establish an **Environmental Management Fund** (incl. *non-compliance fees*) (Chapter IV, Provision 8).
- Lay down duties and powers relating to MOECAF (Chapter IV).
- Establish an **Environmental Conservation Committee (ECC)** (Chapter III).
- If any existing environmental quality standard **is more than the quality standard stipulated by MOECAF, it shall remain in force.** (Chapter V, provision 12).
- The Ministry requires any business or work-sites which may cause impact on the environmental quality to obtain the **prior permission** (Chapter X, Provision 21).
- MOECAF may exempt any Government entity or private business from complying with any provision contain in this Law **for the interests of the Union and its people** (Chapter XIV, Provision 36).

組織図/Organizations

	Ministries		Ministries		Ministries
1	農務省/Ministry of Agriculture & Irrigation)	12	外務省/Ministry of Foreign Affairs	23	鉱山省/Ministry of Mines
2	商務省/Ministry of Commerce	13	**環境森林保全省/Ministry of Environmental Conservation Forestry**	24	計画経済開発省/Ministry of National Planning & Economic Development
3	郵政省/Ministry of Communications, Posts and Telegraphs	14	保健省/Ministry of Health	25	国境省/Ministry of Border Affairs
4	建設省 /Ministry of Construction	15	内務省/Ministry of Home Affairs	26	鉄道省/Ministry of Rail Transport
5	共同事業省/Ministry of Cooperatives	16	観光省/Ministry of Hotels & Tourism	27	宗教省/Ministry of Religious Affairs
6	文化省/Ministry of Culture	17	移民省/Ministry of Immigration & Population	28	科学技術省/Ministry of Science & Technology
7	防衛省/Ministry of Defense	18	産業省/Ministry of Industry	29	社会福祉省/Ministry of Social Welfare, Relief, & Resettlement
8	教育省/Ministry of Education	19	情報省/Ministry of Information	30	スポーツ省/Ministry of Sports
9	電力省/Ministry of Electric Power	20	労働省/Ministry of Labor	31	交通省/Ministry of Transport
10	エネルギー省/Ministry of Energy	21	飼育漁業省/Ministry of Livestock & Fisheries	32	内閣官房/Ministry of President Office
11	財務省/Ministry of Finance & Revenue	22	軍事省/Ministry of Military Affairs	33	法務長官/Attorney General)・会計検査院長官/Auditor General)

環境森林保全省/MOECAF

Organizational Chart of MOECAF



Source: Developed by the author, based on interviews with MOECAF officials

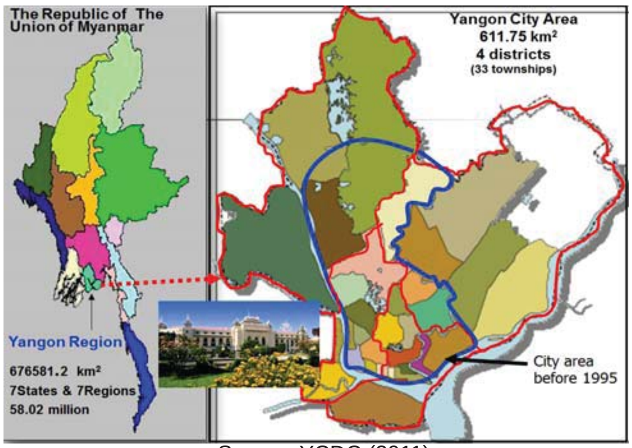
政策課題/Policy Options and challenges

- **Key policy targets (from the latest 2010 EPA reports etc.):**
  - Set aside 30% of total land area under permanent forest estate
  - Increase protected areas to 10% of total land area by 2017
  - Reforest 20,000 ha of degraded land annually
  - Full access to safe drinking water by 2010 (4 million people per year)
  - Save 5% of the total primary energy consumption by 2020 and 8% by 2030, compared to 2005
  - Introduce plastic bag free cities – Yangon & Nay Pyi Taw
  - Surpass MDG targets in implementing national plans
- **Key barriers to ensure environmental sustainability:**
  - Human and social pressures
  - Governance and management issues
  - Significant data gaps

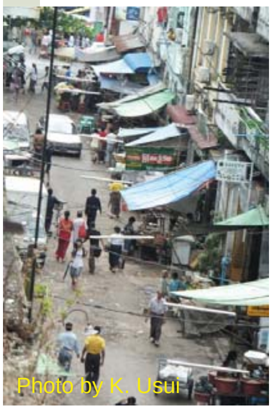
ヤンゴン/Yangon (region/city)

- Population:
  - Region: approx. 7 million
  - City: approx. 6 million
- Labor force: 1,6 million.
- Economic hub of the country
- Around 20 industrial estates.
- Yangon Port, a main river/sea port covering 21 facilities.

Map of Yangon City



Source: YCDC (2011)



- Traffic jams and air pollution is worsening due to rapid rise in the number of passenger vehicles.
- Water supply equipments are very aged.
- Flooding is becoming increasingly serious due to under capacity of drains and blocked rains.
- Kitchen waste (60%) and market waste (15%) are the main waste types generated.

結論/Conclusion

Source: www.livingaloud.com

- Myanmar has significant potential to **leapfrog** ahead of its ASEAN neighbors and to learn from regional and global best practice.
  - **Strengthen institutional capacity for environmental management** of the national and local governments of Myanmar
  - **Put regulatory framework** in place to incentivize environmentally positive activities and **safeguard** against negative environmental and social impacts
  - **Involve civil societies** to reflect diverse local context
- Recent changes and the willingness of the international community to help with improving environmental quality in Myanmar suggest a bright future ahead.
- Japan can play a catalytic role to facilitate south-south environmental cooperation in the Asia-Pacific, in addition to providing latest Japanese technologies and systems.

Thank you very much for your attention!

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URL: http://www.iges.or.jp

3.2 第 2 回　ミャンマー低炭素都市連絡会　12 月 26 日

第２回連絡会は、11 月に開催されたミャンマーグリーン経済成長フォーラム（GEGG）及び 12 月にヤンゴン市開発委員会との共催で実施した廃棄物管理に関するワークショップの成果報告を行った。

主催：公益財団法人　地球環境戦略研究機関（IGES） 日時：12 月 26 日（木）　14:00～17:00 場所：東京都千代田区内幸町 2-2-1　日本プレスセンター4 階会議室

アジェンダ

14:00 - 14:15	**挨拶** -　環境省
14:15 - 14:20	**参加者の紹介**
14:20 - 14:50	**ミャンマーにおける低炭素・気候変動関連政策の最新動向** （気候変動とエネルギー領域　碓井研究員） -　ミャンマー気候変動ハイレベル委員会の設置について -　グリーン経済・グリーン成長（GEGG）にみる低炭素関連政策及びプロジェクトに関する情報 -　日本の自治体や企業のミャンマー進出に向けた方策 -　質疑応答
14:50 - 15:20	**IGES-ヤンゴン市開発委員会共催ワークショップの報告** （IGES　持続可能な消費と生産領域　メニプラ研究員） －　ヤンゴン市における廃棄物政策詳細 －　質疑応答
15 :20 - 15:30	**休憩**
15:30 - 16:00	**二国間クレジット制度（JCM）の最新動向とミャンマーでの案件形成に向けて** （IGES　気候変動とエネルギー領域、小圷主席研究員） －　JCM に関する最新動向 －　ミャンマーにおける案件・形成可能性 -　質疑応答
16:00 -16:30	**全体議論・情報交換**
16:30	**閉会**

議事録

1. 挨拶

IGES 気候変動とエネルギー領域　小圷エリアリーダーが、参加者を歓迎。また、環境省地球環境局国際協力室植松専門調査員より、ミャンマーでの都市まるごと低炭素化とそれに向けた案件形成への期待が述べられた。

2. ミャンマーにおける低炭素・気候変動関連政策の最新動向

IGES 気候変動とエネルギー領域　碓井研究員より表題について発表があった。要旨は以下の通り。

- ミャンマーでの GHG 排出量のデータは 13 年前のものしかなく、現状の把握が困難である。
- ミャンマー政府は 12 月に Myanmar Climate Change Alliance と呼ばれるハイレベル委員会を設置しており、気候変動政策としては大きな進歩である。
- その一方でミャンマー政府は全体的に極めて多忙であり、関係省庁がどの程度気候変動対策を検討するリソースを割けるか不明である。また、本委員会は環境大臣が議長をしていることから、各省庁への影響力が限定的となる可能性もある。
- 気候変動政策はこれから委員会が検討していくところであるが、どちらかというと緩和より適応へのウェイトが置かれる可能性がある。
- クリーン開発メカニズム（CDM）に関しては、2013 年 2 月に初登録案件が誕生しており、他 2 つ（一つは日本工営社が関与）は有効化審査中である。
- 気候変動以外では、環境保全法（2012）に基づき、多くの細則が策定されているところである。
- ミャンマー政府はグリーン経済成長の推進も公言している。11 月の Green Economy Green Growth フォーラムには大統領も参加するなど、影響力を増している。本フォーラムには、IGES を含め日本の公的機関、民間企業も多数参加。
- グリーン経済成長推進の一環として、GEGG Association はミャンマーの各州に Center of Excellence と呼ばれる環境技術のデモサイト作成を進めており、ヤンゴン市のものが最初に完成する予定
- まとめとして、ミャンマーにおいては、環境政策の策定が加速しているものの、国レベル、地方レベル共に、環境を担当する部署のリソースが絶対的に不足。その一方で援助機関、民間企業が詰めかけており、援助合戦の様相を呈している。

質疑応答

- （JFE エンジ）低炭素化に向けて取り組みが加速化されているのは確かであるが、人的な部分は不足している。政府のやる気、意欲はあるが、あまりニーズ等が整理

されていない。この分野については日本からの支援が適切など交通整理をするのが必要なのではないか。私企業がこういったことをすることは難しいので、公的な立場の方々に支援をしてほしい。
- （日本工営）CDM 設計と FS レビューを GEC から支援を受けて 2009 年に実施した。10MW の水力発電を実施しており、ミャンマーの財閥の支援を受けた独立系発電事業者（IPP）がカウンターパート。グリッド排出係数を計算のため情報収集をしているが、データが錯綜もしくは、欠如している。0.27 が暫定的な数字である。2009－2011 までのデータで計算したところ、右肩上がりになっている。最終的には CDM 登録を目指しているが、現段階では双方の勉強の目的で実施している。プロジェクトには MEO が 100%出資している。
- （IGES）グリッド排出係数に関しては IGES も支援したい。

3. IGES-ヤンゴン市開発委員会共催ワークショップの報告

IGES 持続可能な消費と生産領域　ニルマラ・メニプラ研究員による発表がなされた。
要旨は以下の通り。

- 12 月 20 日にヤンゴン開発発展委員会（YCDC）との共催で廃棄物管理に関するワークショップを行った。ヤンゴン市長を始め、環境保全森林省や NGO などからも参加があった。
- ヤンゴンでは廃棄物処分場がほぼ枯渇している状態であり、大きな問題となっている。改善策とて、メタン回収及び発電、廃棄物発電、小規模焼却炉などの導入が計画されている。
- 廃棄物に加えて、ヤンゴン市における大気汚染も大きな問題となりつつある。
- ワークショップの最終セッションの議論において、国際協力、官民連携、ライフサイクル的観点の重要性等が指摘された。
- ワークショップは新聞、テレビ局等メディアも入っており、ミャンマー国営テレビにも放映された。「日本がヤンゴンの廃棄物管理を支援している」という印象を広範囲に作ることができた。

質疑応答

- （環境省）MOECAF に、JICA を通した専門家派遣の要請を行うように提案したが、今のところ要請は来ておらず、話が進んでいない。機会があれば、リマインドして欲しい。
- （JFE エンジ）ワークショップでは、IGES の JCM に関する IGES の発表に加え、民間企業の観点から JCM 資金スキームについて発表させて頂いた。ミャンマー側からは高い関心があり、手応えがあったと考える。
- （IGES）ヤンゴン市の具体的な支援ニーズとして大気汚染対策が挙げられた。大気汚染対策は YCDC では手薄であり、ドイツ GIZ がモニタリング装置を設置しているのみである。また、容器包装リサイクル法への関心も高く、すでに本法律への資料をミャンマー語に訳して職員に配布したと聞いている。
- （大阪市）焼却炉の導入のみが具体的になっているようだが、上流を含めた全体の計画が見えない。そのような計画を支援するのは有用ではないか。
- （JFE エンジ）環境省 FS で政策提言を予定していたが、提言ができる前に入札が

始まってしまったという経緯がある。
- （IGES）ヤンゴン市の最終処分場はすでに満杯に近く、これをどうするかというのが緊急の課題としてある。計画の策定の重要性をヤンゴン市は認識しているが、緊急課題に対処した後に策定する可能性が高い。
- （JFE エンジ）枯渇する処分場への対処が最優先課題となっているのは事実。現状は YCDC の保有する土地にゴミを置いており、溢れかえっている状況。これに YCDC には焦りを感じており、包括的な廃棄物管理計画の策定は後回しになっている。
- （大阪市）政策支援はプラントを稼働させながらでも可能と思うので、是非進めていった方が良いと考える。

4. 二国間クレジット制度（JCM）の最新動向とミャンマーでの案件形成に向けて

IGES 気候変動とエネルギー領域小圷エリアリーダーにより、JCM の最新動向、ミャンマーでの潜在的案件、CDM と JCM 案件の種類の違い、CDM の経験に基づいた技術移転等について発表がなされた。要旨は以下の通り。

- UNFCCC 下において JCM が原則として認められている。ただし詳細は継続して議論中。
- JCM の FS においては、CDM と比較して省エネに関する調査が非常に多い。省エネは日本企業の強みがある分野と考えられる。
- 現在ミャンマーでは環境省、GEC,NEDO 等の資金によって進められている案件が 7 件ほどある。下水処理、ソーラーランタンの普及、バイオマス発電等が有望案件と見ている。
- 来年度は設備補助を始め、JICA や ADB を通した資金スキームも存在し、支援形態が多様化している。
- 技術移転に関する。CDM のレッスン（小圷さん追記）

質疑応答

- （アジア経済研究所）JCM 資金スキームにおける平均的な金額と、GHG 削減量あたりのコストのデータがあると分かりやすいと思う。
- （IGES）JCM は必ずしも削減量を最優先しているわけではないため、削減量あたりのコストを見るとかなり高く傾向にある。ただしそのような削減量あたりの試算は有用と思うので、検討したい。

5. 全体議論・情報交換

・（IGES）大阪市はヤンゴン市と下水処理に関して協力を始めていたと思うが、何か情報があれば共有して欲しい。

・（大阪市）：ヤンゴン市との MoU をまだ結べていないため共有できる情報がまだあまりない。

・（IGES）東京都はヤンゴン市と MoU を結んでいるのか。

・（東京都）：東京都水道局は MoU を結んでいる。廃棄物では Minutes of Meeting を JICA とヤンゴン市、東京都の三者で締結している。

閉会

参加者リスト

	組織種類 /Category	組織名/Organisation	名前/Name	職名/Position
1	政府機関 Government	環境省 Ministry of the Environment of Japan	植松朋樹 Tomoki UEMATSU	環境省国際協力室 環境専門調査員 International Cooperation Office, International Strategy Division, Globl Environment Bureau
2	自治体 Local Government	東京都環境公社 Tokyo Environmental Public Service Corporation	磯辺咲菜 Sakina ISOBE	環境技術部技術課国際協力事業担当 International Cooperation, Engineering Division, Green Engineering Department
3	自治体 Local Government	大阪市 City of Osaka	佐崎俊治 Toshiharu SAZAKI	環境局環境施策部環境施策課 課長 Manager for Environmental Policy, Environmental Policy Division, Environment Bureau
4	自治体 Local Government	北九州市 City of Kitakyushu	津田優子 Yuko TSUDA	環境局環境国際戦略課
5	民間企業 Private sector	JFE エンジニアリング(株) JFE Engineering	高橋元 Gen TAKAHASHI	海外本部東南アジア事業部営業統括部営業グループ 部長代理 Asia Pacific Div. Sales & Marketing Dept,Overseas Business Sector
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14	研究機関 Research Institute	インド資源エネルギー研究所 The Energy and Resources Institute	ラビンデル・マリック Rabinder Malik	日本 TERI コーディネーター Coordinator TERI Japan
15	事務局 Secretariat	地球環境戦略研究機関/IGES	小圷一久 Kazuhisa KOAKUTSU	気候変動とエネルギー領域　エリアリーダー Area Leader, Climate and Energy Area
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18	事務局 Secretariat	地球環境戦略研究機関/IGES	吉田哲郎 Tetsuro YOSHIDA	持続可能な社会のための政策統合領域 研究員 Researcher, Integrated Policy for Sustainable Societies Area

写真

ミャンマーにおける低炭素、気候変動関連政策の最新動向

2013年12月26日

地球環境戦略研究機関
気候変動とエネルギー領域　碓井健太

1

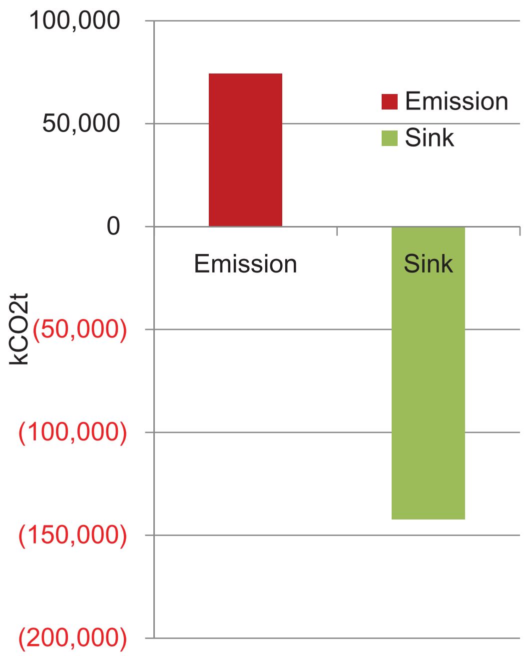
目次

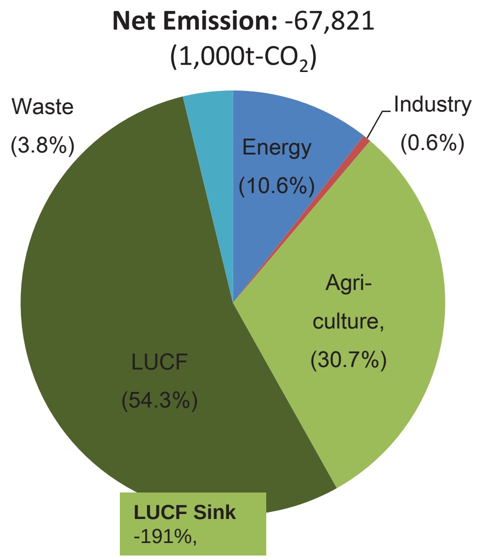
- ミャンマーにおけるGHG排出量
- 政府ハイレベル気候変動委員会
- 気候変動政策
- クリーン開発メカニズム
- グリーン経済

2

ミャンマーにおけるGHG排出量

2000年においてミャンマーのGHG排出量は低く、森林の吸収が大きい。現在も純排出量は負である可能性が高い。





Source: "National GHG Inventory of INC Project, Myanmar." Presentation by Khin Lay Swe (LoCARNet First Annual Meeting, 16 October 2012) データは2000年のもの。

3

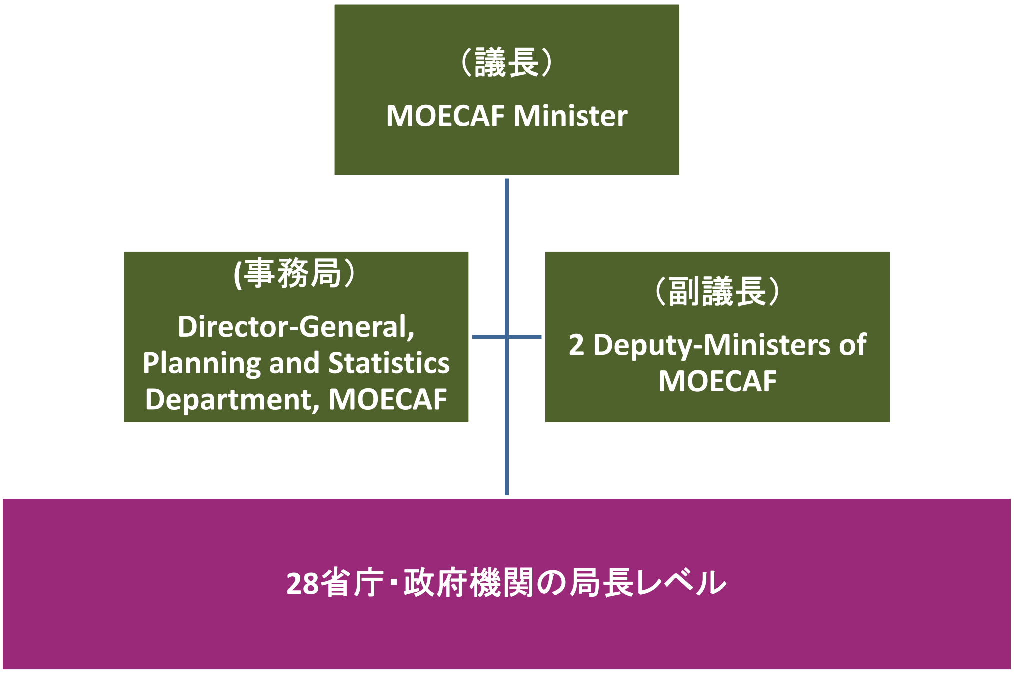
政府ハイレベル気候変動委員会

- Myanmar Climate Change Alliance Committee (MCCA)
  - 2013年12月に始動。
  - 月1回のペースで会合を開催予定
  - 環境保全大臣が議長を務め、関連する28の省庁、政府機関がメンバーとなっている。

出典:ReliefWeb http://reliefweb.int/report/myanmar/government-announces-formation-high-level-committee-climate-change

4

政府ハイレベル気候変動委員会



5

気候変動政策

- 気候変動戦略及び行動計画の策定を、EU、国連人間居住計画（UN-HABITAT)、国連環境計画(UNEP)が支援。
- EUは、Global Climate Change Allianceプログラムの一貫として支援
- 2014年以降、MCCAは普及啓発、キャパビル等も実施予定
- 低炭素成長を目指しつつも、適応へのウェイトが高くなる可能性あり

6

クリーン開発メカニズム

- 本年に初登録案件（水力）
- Carbon Partners Asiatica及び中国Sunshine Kaidi New Energy GroupがMOECAFとMoUを結んでCDM支援を実施。

7

CDM案件

CDM案件名	種類	登録日	年間削減量見込み（t-CO_2/yr）	ホスト国プロジェクト参加者	他プロジェクト参加者	登録済
Dapein(1) Hydropower Project in Union of Myanmar	Hydro power	2013/2/4	709,360	Dapein(1) Hydropower Co., Ltd.	Cleantec Development PCC	Registered
Upper Baluchaung No.2 Hydropower Project in Myanmar	Hydropower	N/A	17,559	NEO Energy Oasis Development Co., Ltd.	Nippon Koei Co., Ltd.	Under Validation
Installation of Energy Efficient Cookstoves in Myanmar (PoA)	Energy Efficiency	N/A	433,720	Core CarbonX Sols Pvt Ltd Myanmar Ceramic Society		Under Validation

8

気候変動以外の動き

- 環境保全法（2012年）に基づき、下記の策定が進行中
  - 環境保護細則（閣議決定済）
  - 環境保護基金（11月時点MOECAF内にて検討中）
  - 環境アセスメント細則（草案完成）
  - 廃棄物国家計画（協議中。UNEP、ノルウェー、KOICAが支援を検討中）
- エネルギー部門戦略（策定中）

9

グリーン経済

- ミャンマーは、「グリーン経済成長」推進を公言している。気候変動政策もその一環。
- Green Economy Green Growth Associationが、環境技術等の普及啓発のため、Center of Excellence をヤンゴンに開設予定。

等を策定中。

10

GEGGフォーラム

- **主催**:グリーン経済成長協会
- **テーマ**:水・エネルギー・食料の連鎖関係
- **ハイレベル参加者**
  - ミャンマー大統領、副大統領、13閣僚、他局長レベル多数
- **支援・協力機関**:
  - ミャンマー国内:6国内企業及び財団
  - 海外政府:ノルウェー、スウェーデン、日本
  - 国際機関:UNDP、UNEP、UNCCD
  - NGO:WWF、スミソニアン学術協会、ストックホルム環境研究所、タイGHG管理機構、横浜国立大学、IGES等

11

GEGGフォーラム

- 日本からの参加者(敬称略)
  - 公的機関:IGES, 北九州市、JICA(タイ駐在専門家)、UNEP国際環境技術センター、横浜国立大学
  - 民間企業:クボタ、JFEエンジニアリング、東レ、パナソニック、日立造船、三菱UFJモルガン・スタンレー証券
- IGESセッション「ミャンマーの持続可能な資源管理のための地域協力」には、ミャンマー、タイ、インドからの専門家、及び日本からJICA、北九州市、JFEエンジニアリングが登壇。

12


MOECAF
ECONOMY
Green
GROWTH
GEGG-Myanmar Association
In Collaboration with
Ministry of Environmental Conservation & Forestry
Third GEGG Forum
THIRD GREEN ECONOMY GREEN GROWTH FORUM
THE NEXUS OF ENERGY - WATER - FOOD
For
Greening and Cooperation
20th November 2013
Sponsored by
Golden


NAYPYITAW

14

15

まとめ

- ミャンマーにおいては、気候変動政策を始め、環境政策の策定が加速している。
- 国レベル、地方レベル共に、環境を担当する部署のリソースが絶対的に不足。その一方で援助機関、民間企業が詰めかけており、援助合戦の様相を呈している。
- 気候変動に関する関心は高いが、依然としてGHG排出量のレベルは低いものと考えられる（ただし交通セクターからの排出増が予想される）。
  – 適応の方によりウェイトを置く可能性が高い。
  – 緩和策は、資金支援と結びつく必要性がある。

16

Overview of IGES-YCDC joint workshop on waste management

Nirmala Menikpura, PhD
Institute for Global Environmental Strategies (IGES)

2nd Meeting of Low-carbon Myanmar Working Group, 26 Dec 2013, Tokyo

IGES
Institute for Global Environmental Strategies

Overview of the International Workshop in Yangon

- International workshop on sustainable waste management in Yangon was held at City Hall, Yangon on 20 December 2013.
- More than 50 people participated in this workshop representing different government organizations, privet sectors, NGOs

IGES
Institute for Global Environmental Strategies

MOECAF

cesvi

JFE

TOKYO METROPOLITAN GOVERNMENT

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz

Part I: Myanmar's Waste Management Policies

Mr. Than Lwin Oo, the Head of Department of YCDC presented the overview of the waste management in Yangon

Then assistant director of MOECAF, Mr. U Hla Maung Thein presented Myanmar's pathway for national waste management policies

Current and Future Waste management in Yangon

Current situation

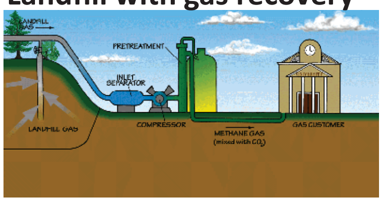
1. Dumpsite at HtainBin

2. Dumpsite at Htwei Chaung

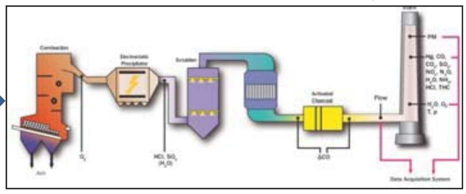
3. Four small dumpsites

Future plan

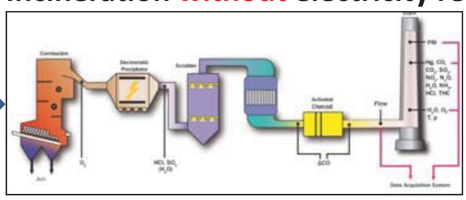
Landfill with gas recovery



Incineration with electricity recovery



Incineration without electricity recovery



Part I: Myanmar's Waste Management Policies

Main issues in Solid waste management in Yangon

- Lack of detailed planning of waste management
- Inefficient waste collection system
- Old equipment for waste collection and transportation
- Improper final disposal
- Unclear enforcement of hazardous/infectious waste management
- Weakness of SWM regulations

Part I: Myanmar's Waste Management Policies

The Policy and Goals for Yangon

- R & D is required on clean air, clean land and clean water
- Need to integrate the action plans for ambient and indoor air quality monitoring and upgrading
- Need to update the legislative system for EIA practice
- Need to enhance the technique on "waste to energy" processes
- Should promote greater awareness of environmental and health risks from poor environmental planning and management
- Should upgrade the city as a green clean and healthy liveable city.

Part I: Myanmar's Waste Management Policies

The way forward in Myanmar (View of MOECAF)

- Formulate national waste management strategic policy framework
- Develop national waste management rules and regulations
- Develop sectorial waste management regulation and guidelines
- Promote green investment in waste sectors
- Formulate environmental quality standards
- Identify priority waste issues and action plan
- Promote appropriate technologies
- Promote people participation through environmental awareness program
- Promote regional level and international level cooperation
- Strengthen institution and capacity building and also coordination n mechanism

Part II : Towards low-carbon waste management: an opportunity of integrated waste management system

Dr. Nirmala Menikpura presented integrated waste management as an approach for GHG mitigations

Mr. Takanobu Iwasaki from Tokyo Metropolitan Government presented the Mechanisms to engage local communities for waste management

Mr. Gen Takahashi from JFE Engineering spoke about the feasibility of incineration technologies

Part III: Understanding the full picture of international cooperation

Mr. Kenta Usui from IGES presented the concept of Japanese Joint Crediting Mechanism

Mr. Takanobu Iwasaki from Tokyo Metropolitan Government spoke about the Yangon -Tokyo Cooperation on Waste Management

Then assistance head of YCDC, presented GIZ’s initiative on waste management in Yangon on behalf GIZ

Part IV: Panel discussion: “the way forward for Myanmar,"

- In this session, a distinguished panel of experts were discussed some key issues related to sustainable waste management in Yangon

-Mr. Takanobu Iwasaki from Tokyo Metropolitan Government
-Mr. Gen Tahakashi from JFE engineering
-Mr. U Hla Maung Thein from MOECAF
-Mr. Gaetano Romano from CESVI
-Mr. Kin win from YCDC

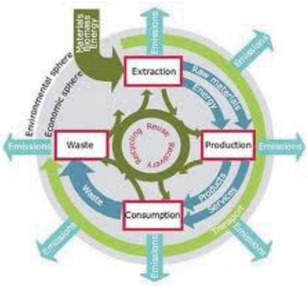
The speakers expressed their opinions and suggestions related to:

- how to promote an efficient waste collection system
- how to make waste management financially sustainable
- how to promote low carbon waste management in Yangon with international cooperation
- how to effectively coordinate increasing international support
- how to engage communities to work on waste management

Part IV: Panel discussion: “the way forward for Myanmar,"

Key messages from the Panel Discussion

- International cooperation is very important
- Private public partnership is essential for sustainable waste management.
- Collaboration at national level and international level is another important issue
- Life cycle management including life cycle cost assessment is lacking, and it should be considered for enhancing sustainable waste management.



Key message to the participants

- It might be very competitive to work with YCDC since many international organizations are already involved with various activities in different sectors
- In order to understand the overall picture of waste management in the near future, it is necessary to engage with all the key stakeholders who will involve in the intended waste management in Yangon

THANK YOU VERY MUCH FOR YOUR ATTENTION

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IGES
Institute for Global Environmental Strategies

二国間クレジット制度（JCM）の最新動向とミャンマーでの案件形成に向けて

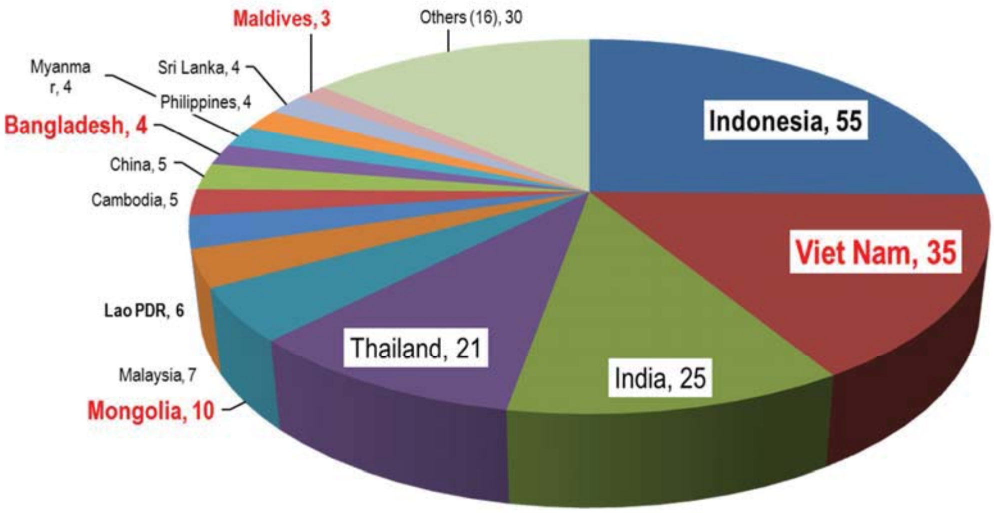
第2回ミャンマー低炭素都市連絡会

IGES 気候変動とエネルギー領域
小圷一久

1

Targeted country of the feasibility studies

Total 248 (2010-2013 Jul.)

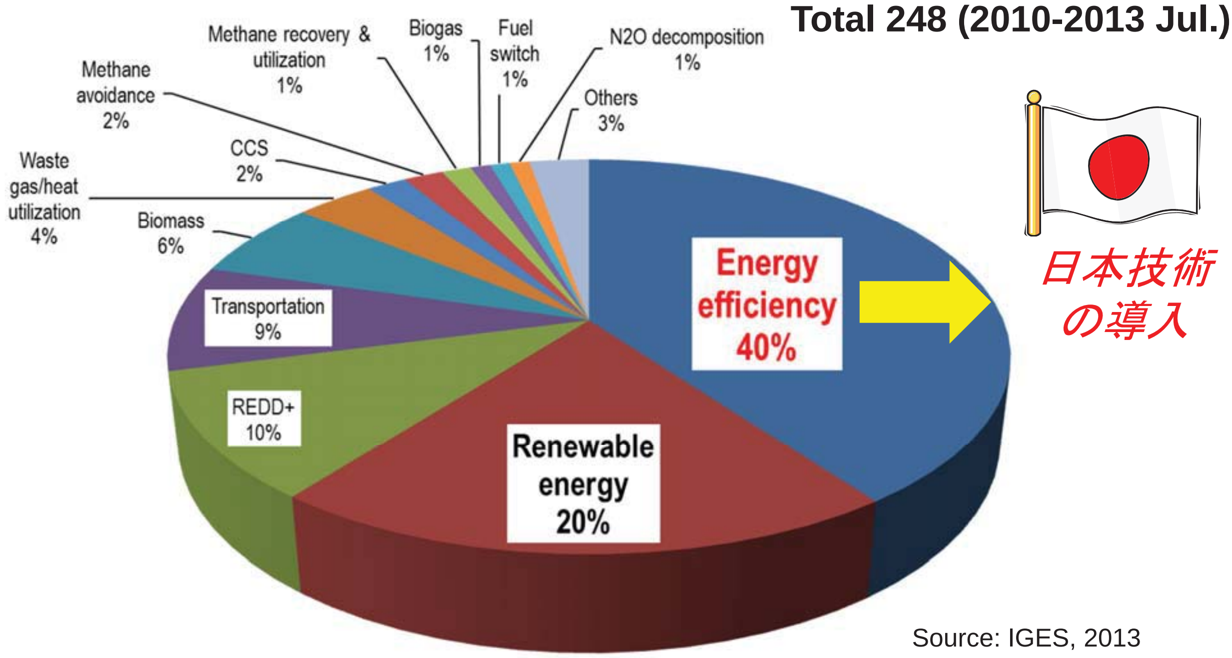


Source: IGES, 2013

2

JCMプロジェクトタイプ

Total 248 (2010-2013 Jul.)



Source: IGES, 2013

Update of the JCM information

3

導入されている事業例

- 再生可能エネルギー：
  - 風力、マイクロ水力、ソーラーランタン、大規模太陽光発電、風力発電、石油プラント省エネ、コンビニ省エネ製品導入
- 省エネルギー：
  - 省エネ送電システム、高性能住宅、ビール工場省エネ、高効率火力発電、石油プラント省エネ、コンビニ省エネ、高効率エアコン普及促進、建物省エネ診断
- 運輸：車両燃費向上（デジタコ）

4

現在ミャンマーで進行中のFS

案件名	実施機関	支援元
小規模流れ込み式水力発電（CDM-FS)	日本工営	GEC
バイナリー地熱発電	日本工営	GEC
太陽光・ディーゼルハイブリッドシステムの導入	みずほ銀行・日立造船	GEC
ミャンマー国ヤンゴン市における循環型社会形成支援及び廃棄物発電事業	JFEエンジニアリング	環境省
無電化地域におけるオフグリッド再エネ電力供給（プレFS)	TERI・IGES	環境省
ミャンマーにおける籾殻ガス化発電の運用性向上研究協力事業	バイオ燃料株式会社	NEDO
ミャンマー国籾殻ガス化発電の現状と無電化村電化の実現可能性に関する情報収集	未定	NEDO

注：これらのFSの全てがJCMを想定して行っているわけではない。

5

その他潜在的JCM案件

- 下水処理
  - ヤンゴン唯一の下水処理場は老朽化。処理施設の更新・メタン回収・発電などの実施可能性
- ソーラーランタン等の普及
  - 無電化地域における導入可能性大
  - IGESがTERIと共同で簡易FSを実施中
  - パナソニックはミャンマー無電化地域向けに、同社製ソーラーランタンを数千台寄贈。
- バイオマス発電
  - 籾殻

6

政府の支援スキーム（経済産業省）

- JCM実証事業（署名国中心）（H25:35億円）
  - 対象：機器設置費、削減量の測定・報告・検証
  - 例：モンゴル省エネ送変電システム
- FS事業（署名国外も可）（H25:3．2億円）
  - 方法論の検討、削減量試算、計画策定
- 人材育成事業（H25:0．8億円）
  - 専門家派遣、研修

7

政府の支援スキーム（環境省）

- JCMプロジェクト設備補助事業（署名国中心）（H25：12億円）
- アジア低炭素社会実現のためのJCM大規模形成支援事業（H25：11億円）
- “一足飛び”型発展の実現に向けた資金支援（基金）：JICA基金（H26：60億円）
- “一足飛び”型発展の実現に向けた資金支援（ADB拠出金）（H26：30億円）

8

他の政府機関による支援

- 日本貿易振興機構（ジェトロ）
  - 環境・エネルギー分野における日本企業の海外進出支援
- （独）日本貿易保険（NEXI）
  - 地球環境保険特約（対象分野事業に係る我が国企業からの関係機器の輸出やプロジェクト参画に際して補償）

他の政府機関による支援

- 地球環境センター（GEC）
  - 設備補助事業、FS
- 海外環境協力センター（OECC）
  - 訪日研修
  - 環境技術ミッション
- 地球環境戦略研究機関（IGES）
  - 案件発掘支援
  - MRV方法論支援
  - 情報普及・啓発

3.3　第 3 回　ミャンマー低炭素都市連絡会　　2 月 25 日

第三回連絡会は、ヤンゴン市の訪日研修と合わせて行ない、ヤンゴン市職員による廃棄物管理の現況に関する発表、及びミャンマーにおけるエネルギー政策に関する情報共有を行った。

日時：2 月 25 日（火）　13:00～15:30 場所：東京都千代田区内幸町 2-2-2 富国生命ビル 1F　パビヨン 言語：原則として日本語（一部英語発表あり）

アジェンダ

司会：地球環境戦略研究機関シニアフェロー　井村秀文

12:00-13:00	昼食（パビヨン）
13:00-13:10	開会挨拶　IGES
13:10:13:20	参加者自己紹介
13:20-14:00	「ヤンゴン市における廃棄物等環境問題と、ヤンゴン市の取り組みについて（仮題）」 ヤンゴン市開発委員会汚染管理清掃局による発表
14:00-14:30	「ミャンマーにおけるエネルギー政策の現状」 IGES 気候変動とエネルギー領域研究員　碓井健太
14:30-15:00	ミャンマーに関する活動の共有
15:00-15:30	全体議論・情報交換
15:30	閉会
16:00-17:30	ヤンゴン市開発委員会汚染管理清掃局職員とのバイ面談

議事録

開会挨拶

地球環境戦略研究機関　井村秀文上級フェローより、挨拶とヤンゴン市職員歓迎の意が述べられた。

参加者自己紹介

ヤンゴン市職員含め、参加者の自己紹介が行われた。

ヤンゴン市における廃棄物管理の現況について

ヤンゴン市開発委員会汚染管理清掃局　Ko Ko Kyaw Zwar 部長による発表。

ヤンゴン市開発委員会汚染管理清掃局の組織図、最終処分場の現況、廃棄物の構成、リサイクルや住民への普及啓発活動などについての発表がなされた。廃棄物収集に関する法規制の必要性、廃棄物収集車の更新の必要性、大規模及び小規模の廃棄物発電の有用性、また、廃棄物輸送に関する中継地点の必要性等が指摘された。

質疑応答：

・Pollution Control（汚染管理）部 と Cleansing（清掃）部の違いは何か。

→汚染管理部 は最終処分場の管理、リサイクル、普及啓発等活動等を行うのに対し、清掃部は日常的な廃棄物の収集業務を行う。

・どの程度の人数が廃棄物収集の任にあたっているか

→自分の部署には 650 人程勤務している。

・（KoKo 氏）家庭用廃棄物に関しては、1350 チャット/3 ヶ月の料金で行っている。料金を上げることには住民が反対している。廃棄物処理費用の三分の一を住人から徴収している形であり、国の予算も一部使っている。

・産業団地等の廃棄物量の表において、工場数の多いところで必ずしも廃棄物回収量が多くないようだが、何故か。

　→廃棄物の収集量は近隣の住民のものも含むため、工場の数だけでなく住民の数が収集量に影響を与える。また、工場の規模も異なる。例えば South　Dagon Industrial Zone には多くの工場があるが、小規模なものが多い。

ミャンマーにおけるエネルギー政策の現況

IGES 気候変動とエネルギー領域　碓井研究員　による発表

ミャンマーにおける包括的なエネルギー政策はまだ議論段階であり Energy Management Committee が現在検討を重ねているところである。ミャンマーにはエネルギー、水力等の資源が豊富にあるが、それらのエネルギーの殆どが中国、タイなどへの輸出に当てられている。都市部での電化率は比較的高いが、地方も含めると電化率は 50%以下であり、カンボジアに次いで低い。データによってはこれより低い値を示すものもある。一時エネルギーの大部分はバイオマスエネルギーで賄われており、次いで水力、天然ガスがある。また、ミャンマー政府内においてはエネルギーに関する業務を行うところが分散している。全体の政策・調整等はエネルギー省で行われるが、省エネは工業省、科学技術省や環境保全森林省が再エネ、地方電化については家畜・水産・地方開発省が担当している。電力省もその中で様々な部署に分かれており、非常に複雑な構造になっている。そのため、政策の一貫性を確保するのが難しい。

（ヤンゴン市　Ko Ko Kyaw Zwar 氏が電力省の組織について補足説明）

質疑応答

・エネルギー源のグラフは、消費ベースか。

→消費ベースだと思うが、確認が必要。エネルギーの輸出が多いため、消費ベースか生産ベースかによって数値が大きく違う可能性がある。

・発電と送電はどの組織が行っているのか。

→発電は主に電力省が行っているが、その下部機関である Myanmar Electric Enterprise 等も関与している可能性。

・ミャンマー政府は、新しく開発されるガス田に関しては極力ミャンマー国内での消費に向けていく方針を決めている。

参加機関による情報共有

・三井住友銀行：ミャンマー大手の銀行であるカンボザ銀行と MoU を締結し、技術支援を行うこととしている。ミャンマーに進出する日本企業の支援等も念頭に置いている。

・大阪市：2013 年後半に排水管理の研修を行うため、ヤンゴン市職員を招聘している。MoU 締結も来年度初旬を目処に調整中。

全体議論

ヤンゴン市と、日本の廃棄物管理の体制について、活発な議論がなされた。主な論点として、下記のようなものがあった。

・東京都は区の単位で廃棄物管理を行っているのに対して、ヤンゴンでは YCDC 自体が行っている。そのため練馬区（明日の研修プログラム）等から YCDC が直接学べるところが多い。

・日本は、民間企業が管理を請け負っていることが多いが、ヤンゴン市では YCDC 自体が行っている。日本の場合、民間企業への支払いは自治体が行っている。

・東京の場合、焼却炉は住宅地のど真ん中にある。衛生的であり、かつ地域のエネルギー供給の一部を担っている。

閉会

閉会後、川崎市とヤンゴン市職員のバイ会談が行われ、川崎市の取り組みの共有がなされた。

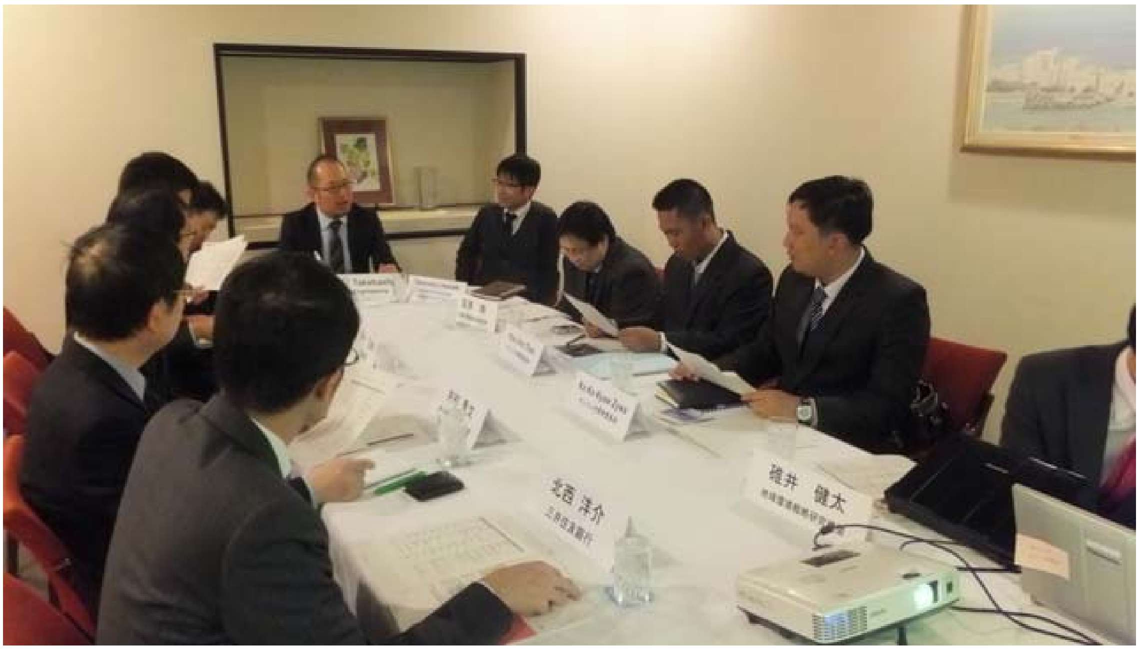
参加者リスト

第 3 回ミャンマー低炭素都市連絡会/Member list of the Myanmar Low-carbon City Working Group
(25th February, 2014)

	組織種類 /Category	組織名/Organisation	名前/Name	職名/Position
1	ヤンゴン市 City of Yangon	ヤンゴン市開発委員会 Yangon City Development Committee	Ko Ko Kyaw Zywa	汚染管理清掃局 部長 Divisional Head of Pollution Control and Cleansing Department
2	ヤンゴン市 City of Yangon	ヤンゴン市開発委員会 Yangon City Development Committee	Khin Ohn Thein	汚染管理清掃局 課長 Sectional Head of Pollution Control and Cleansing Department
3	自治体 Local Government	東京都環境公社 Tokyo Environmental Public Service Corporation	岩崎貴信 Takanobu IWASAKI	環境技術部技術課国際協力事業担当係長 Assistant manager, International Cooperation, Engineering Division, Green Engineering Department

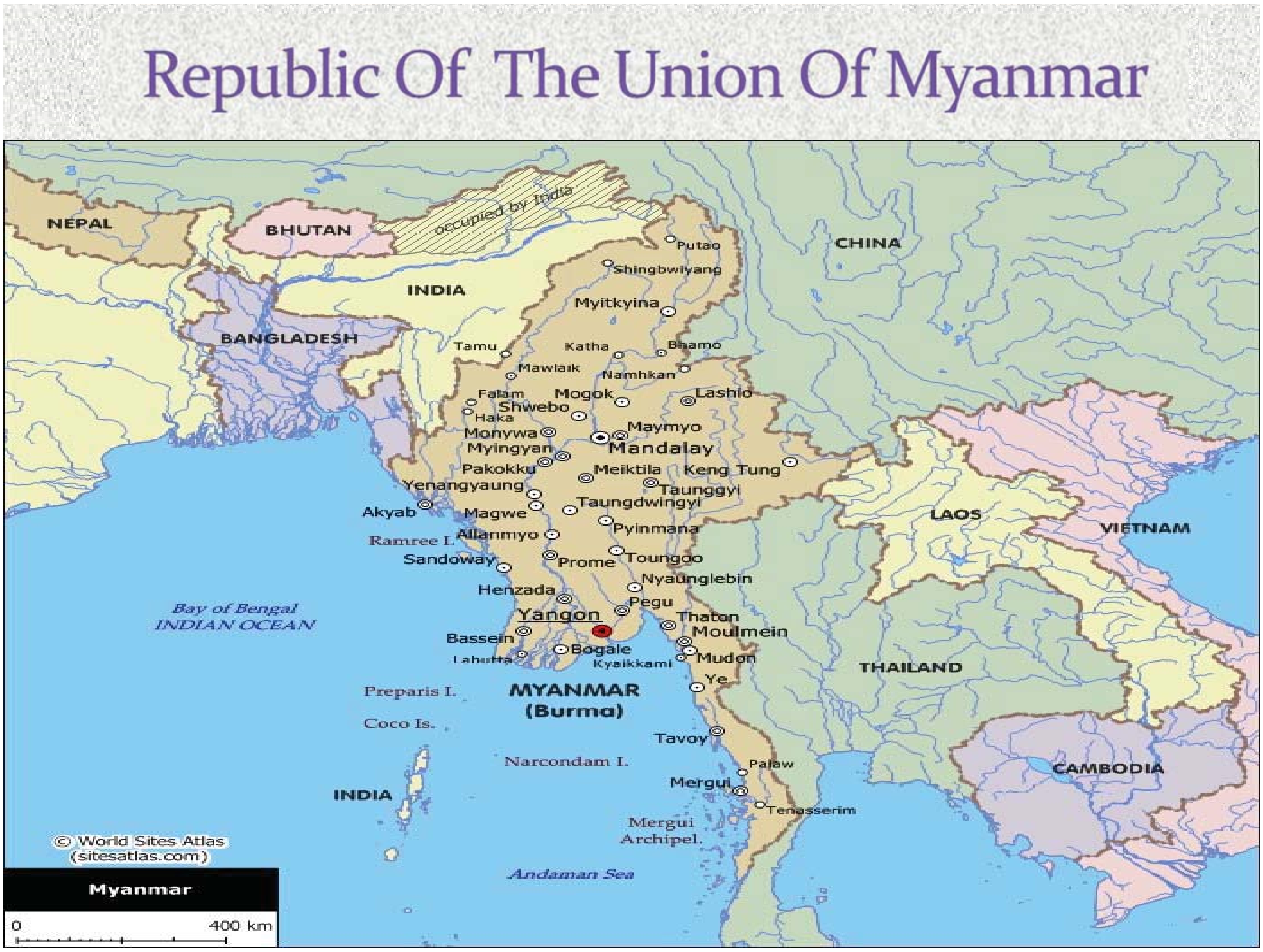
4	自治体 Local Government	川崎市環境総合研究所 Kawasaki Environment Research Institute, Environment Bureau, City of Kawasaki	荻原朗 Akira OGIHARA	都市環境課 プロジェクト研究担当課長 Manager, Project Research Group, Urban Environment Section
5	自治体 Local Government	大阪市 City of Osaka	田畠泰宏 Yasuhiro TABATA	環境局環境施策部環境施策課担当係長 Environmental Policy Division, Environment Bureau
6	民間企業 Private sector	JFE エンジニアリング(株) JFE Engineering	高橋元 Gen TAKAHASHI	海外本部東南アジア事業部営業統括部営業グループ 部長代理/Asia Pacific Div. Sales & Marketing Dept,Overseas Business Sector
7	民間企業 Private sector	大成建設（株） Taisei Corporation	田中弘靖 Hiroyasu TANAKA	環境本部環境開発部　室長 Chief Manager, Environmental Development Dept.Environment Division
8	民間企業 Private sector	日本工営(株) Nippon Koei	庄司茂幸 Shigeyuki SHOJI	海外事業本部 地域整備部
9	民間企業 Private sector	みずほ情報総研(株) Mizuho Information & Research Institute	熊久保和宏 Kazuhiro KUMAKUBO	環境エネルギー第１部地球環境チーム シニアコンサルタント Senior consultant, Groval Environment and Energy Division 1
10	民間企業 Private sector	三井住友銀行 Sumitomo Mitsui Banking Corporation	北西洋介 Yosuke KITANISHI	投資銀行部門 ストラクチャードファイナンス営業部 国内プロジェクトファイナンスグループ Project Finance Group, Structured Finance Dept.
11	事務局 /Secretariat	地球環境戦略研究機関 /IGES	井村秀文 Hidefumi IMURA	シニアフェロー/Senior Fellow
12	事務局 /Secretariat	地球環境戦略研究機関 /IGES	碓井健太 Kenta USUI	気候変動とエネルギー領域 研究員 Researcher, Climate and Energy Area

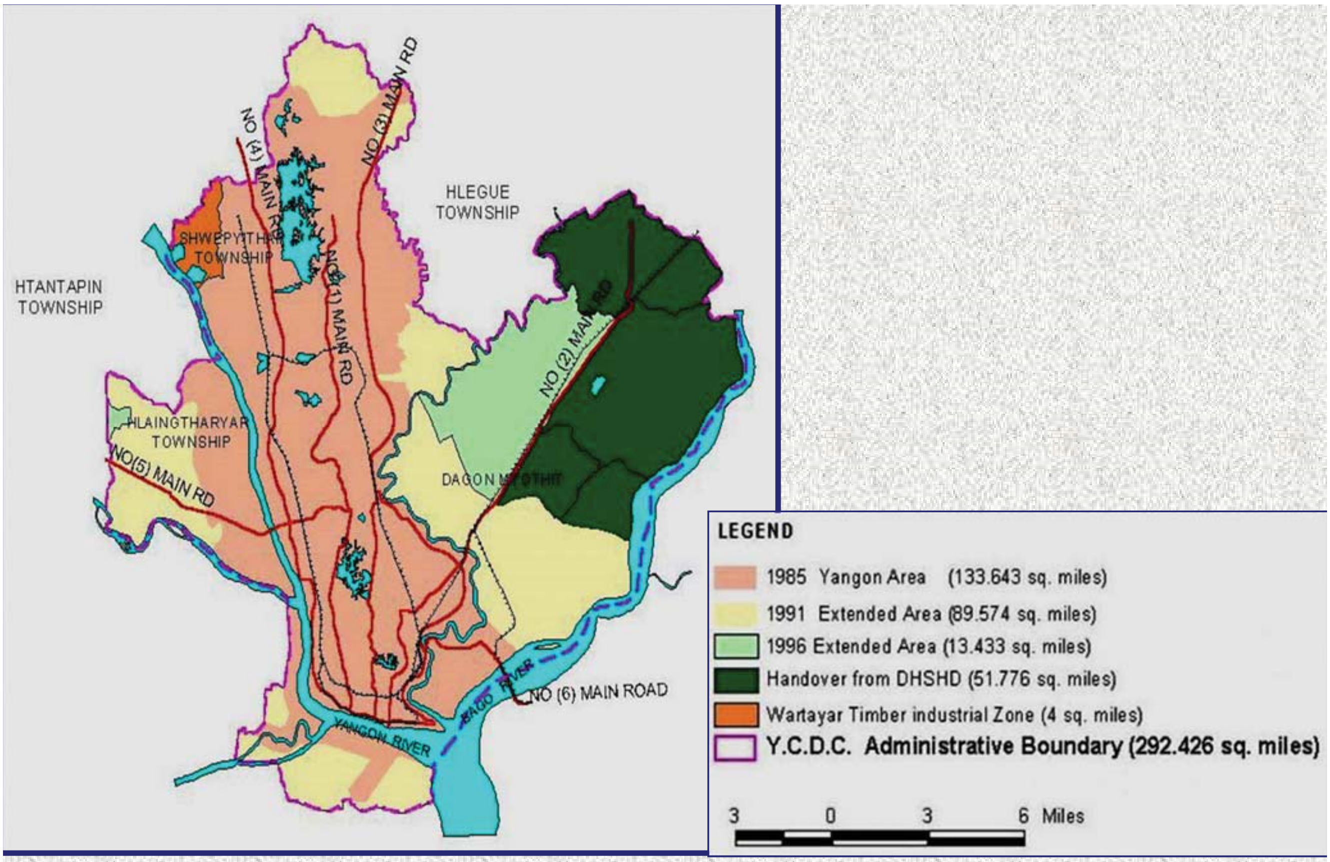
写真




Ko Ko Kyaw Zywa
井村 秀文


Solid Wastes Management
of
Yangon City
YANGON CITY DEVELOPMENT COMMITTEE
Ko Ko Kyaw Zywa
Divisional Head of Department
PCCD, YCDC


Republic Of The Union Of Myanmar
NEPAL
BHUTAN
occupied by India
INDIA
CHINA
BANGLADESH
Putao
Shingbwiyang
Myitkyina
Tamu
Katha
Bhamo
Mawlaik
Namhkan
Falam
Mogok
Lashio
Shwebo
Haka
Monywa
Maymyo
Myingyan
Mandalay
Pakokku
Meiktila
Keng Tung
Yenangyaung
Taunggyi
Akyab
Magwe
Taungdwingyi
LAOS
VIETNAM
Ramree I.
Allanmyo
Pyinmana
Sandoway
Prome
Toungoo
Henzada
Nyaunglebin
Pegu
Bay of Bengal
INDIAN OCEAN
Yangon
Thaton
Bassein
Moulmein
Bogale
Labutta
Kyaikkami
Mudon
THAILAND
Ye
Preparis I.
MYANMAR
(Burma)
Coco Is.
Tavoy
Narcondam I.
Palaw
INDIA
Mergui
CAMBODIA
Tenasserim
Mergui
Archipel.
© World Sites Atlas
(sitesatlas.com)
Andaman Sea
Myanmar
0
400 km



The administrative boundary of YCDC,in 1985 (133.643 Sq-Miles) and now a day (292.426) Square Miles.

Organizational Chart of YCDC

Mayor

↓

Secretary

↓

Joint-Secretary

↓

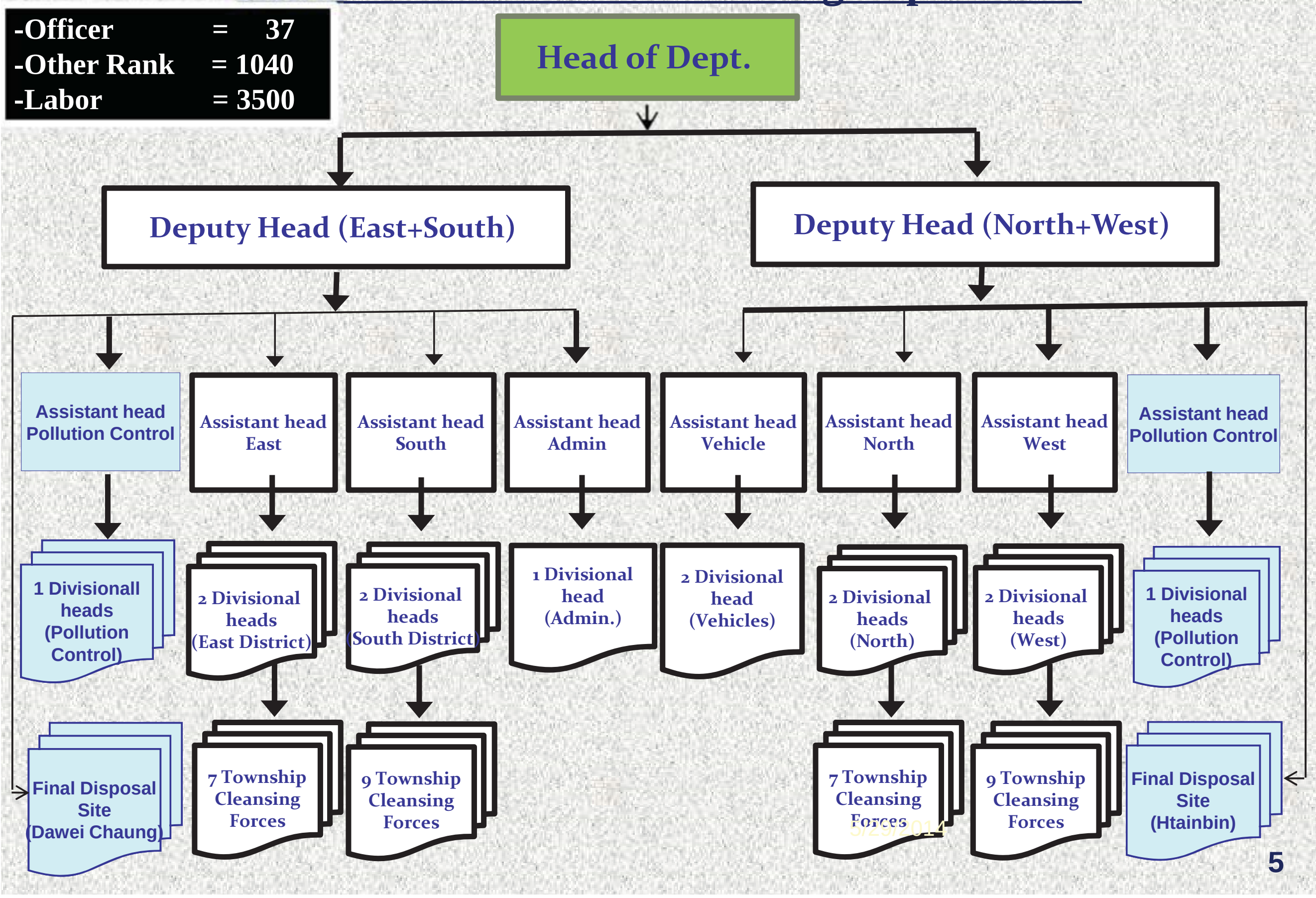
2 persons of Committee Members

↓

20-- Departments

(Including Pollution Control and Cleansing Department)

Organizational Chart of Pollution Control and Cleansing Department



5

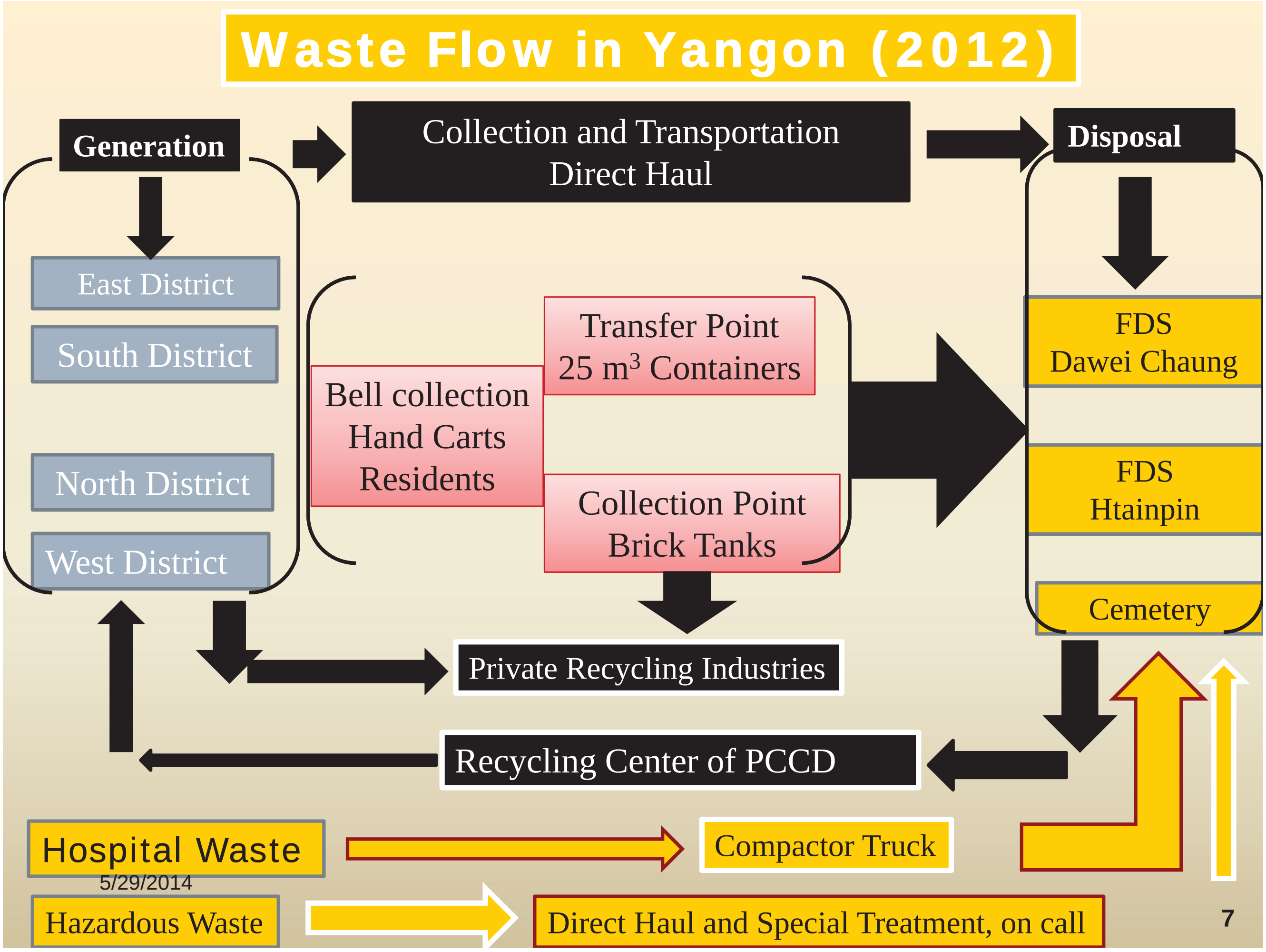
Duties and Function

- Daily Cleansing .
  - Waste Collection (House Holds, Markets, Kerbshops, Commercials, Clinics and others)
  - Waste Transportation.
  - Disposed To Final Disposal Site.

- Pollution Control.
  - Final Disposal Site Management
  - Cemeteries Management
  - Recycling Activities(YCDC and Privates)
  - Green Composting
  - Awareness Program for Local Communities and Schools

5/29/2014

6


Waste Flow in Yangon (2012)
Generation
Collection and Transportation
Direct Haul
Disposal
East District
South District
North District
West District
Transfer Point
25 m3 Containers
Bell collection
Hand Carts
Residents
Collection Point
Brick Tanks
FDS
Dawei Chaung
FDS
Htainpin
Cemetery
Private Recycling Industries
Recycling Center of PCCD
Hospital Waste
Compactor Truck
5/29/2014
Hazardous Waste
Direct Haul and Special Treatment, on call
7


Solid Waste Management
Bell ring collection, Manual Loading, Transport and dispose to FDS.
Temporary Brick Tanks
(617) Nos
8

Solid Waste Management

Dust Bin, transfer to push cart, loading to waste truck, Transport and dispose to FDS.

120 Liter Dust Bins,
On Ground used = 186 - Sets

240 Liter Dust Bins, On Ground used = 2056 -Nos

660 Liter Dust Bins,
On Ground used = 1295 - Nos

Waste collection Vehicle on Road = 294 Nos

There are various types of vehicles, used in transportation of solid waste. Many trucks are too obsolete to use for long term. It should be replaced with new ones.

Activities and facility in Disposal Sites

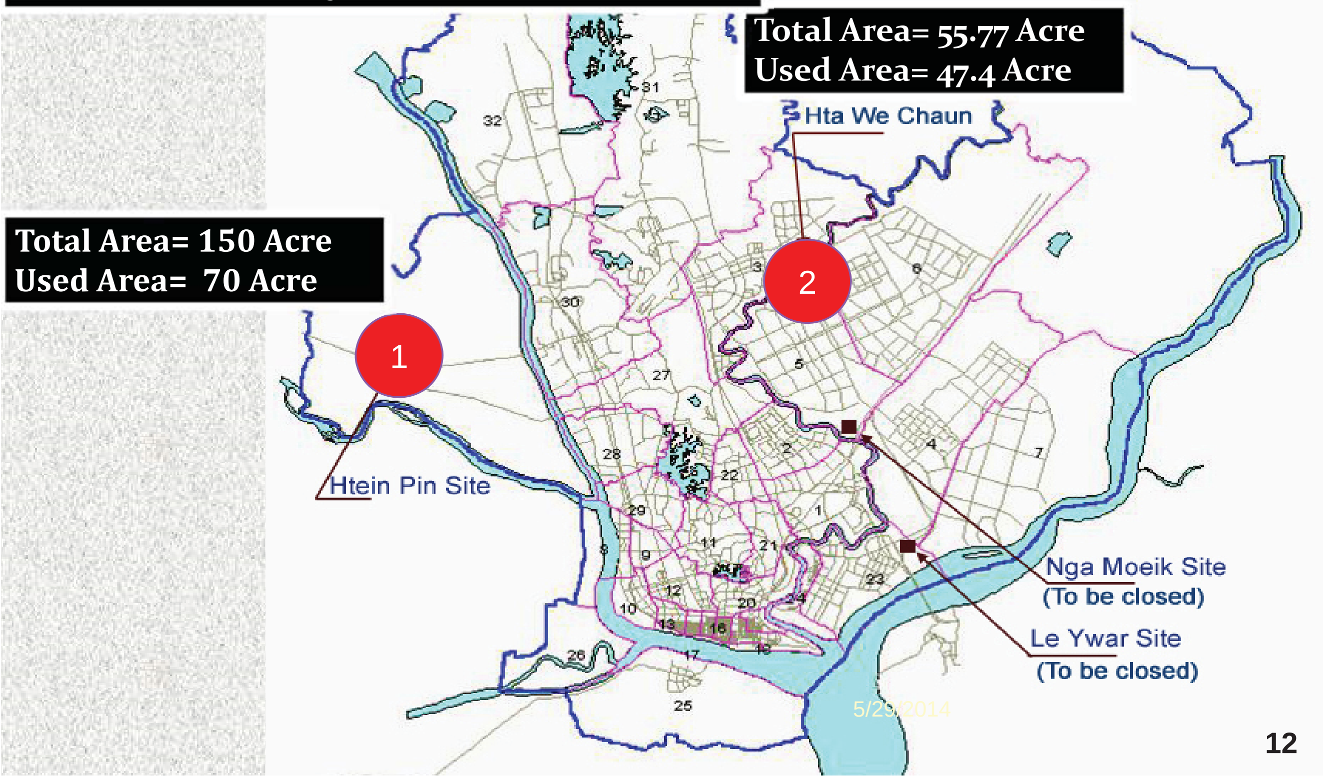
PCCD have two main FDS and each site only one Dozer for dozing all waste.

26-May-14

11

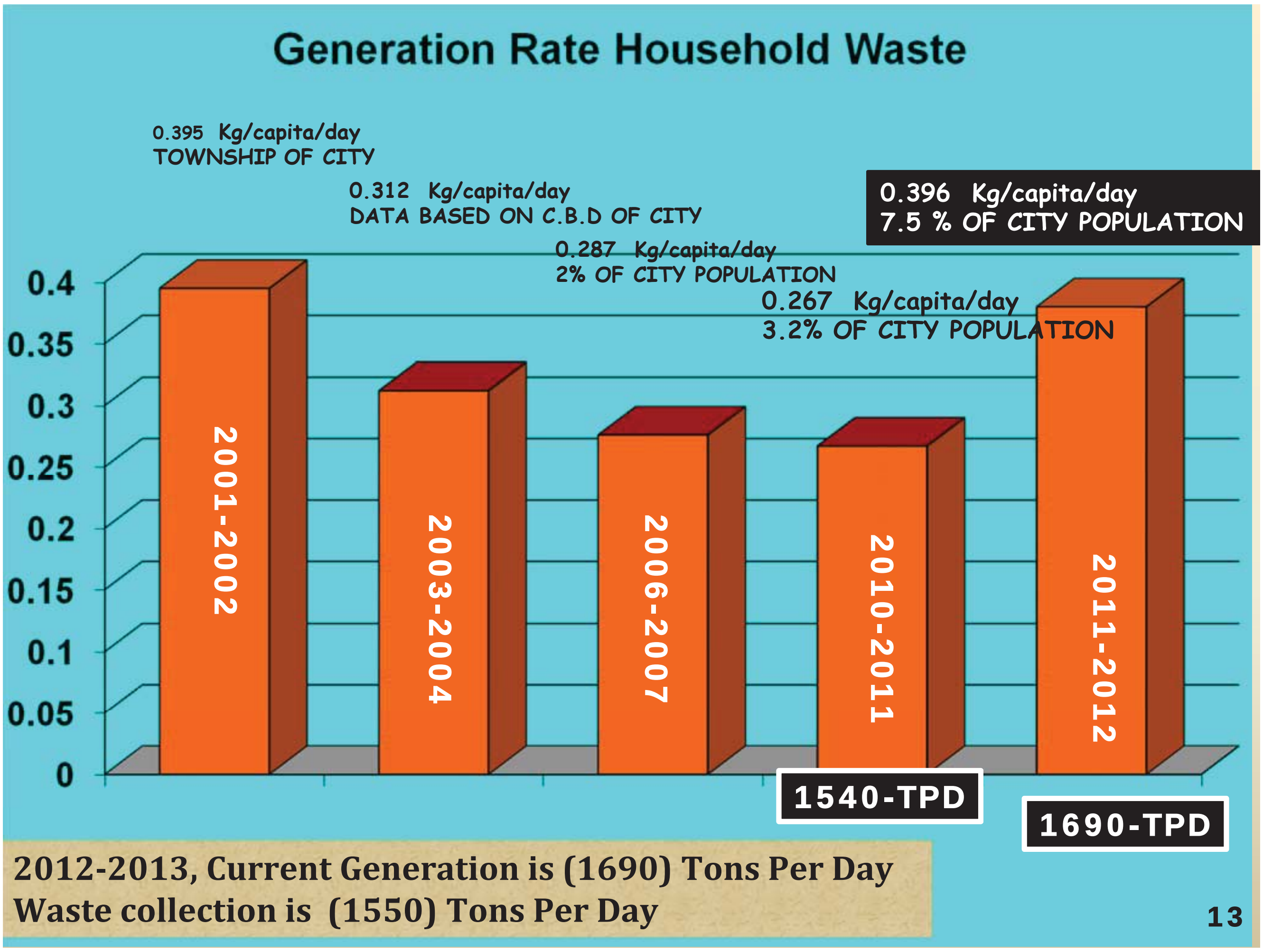
The collected solid wastes were transported and disposed to the two Main FDS. Both of them are 30 km and 26 km away from CBD.

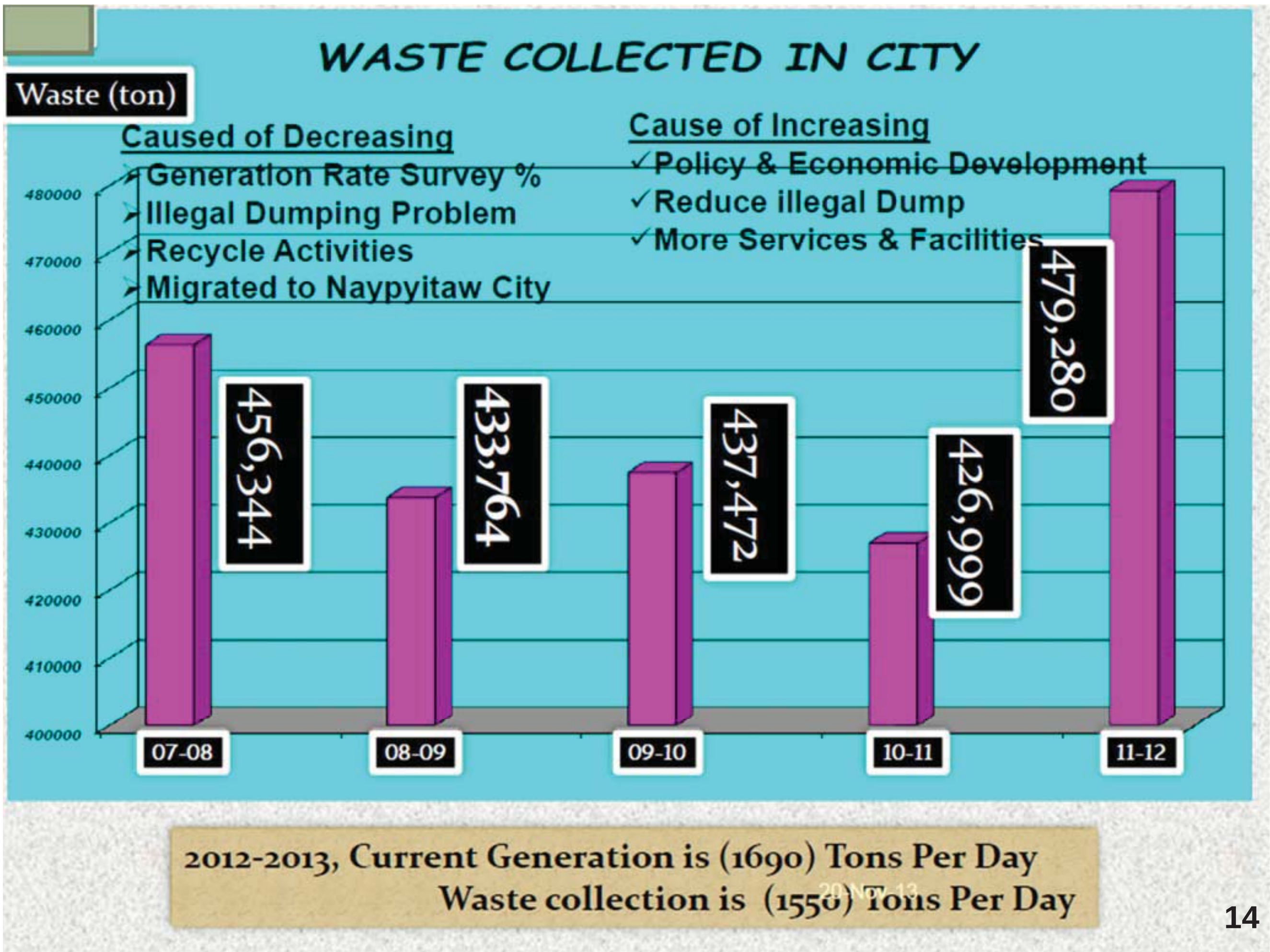
Location Map of Existing Final Disposal Sites



5/29/2014

12


Generation Rate Household Waste
0.395 Kg/capita/day
TOWNSHIP OF CITY
0.312 Kg/capita/day
DATA BASED ON C.B.D OF CITY
0.396 Kg/capita/day
7.5 % OF CITY POPULATION
0.287 Kg/capita/day
2% OF CITY POPULATION
0.267 Kg/capita/day
3.2% OF CITY POPULATION
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2001-2002
2003-2004
2006-2007
2010-2011
2011-2012
1540-TPD
1690-TPD
2012-2013, Current Generation is (1690) Tons Per Day
Waste collection is (1550) Tons Per Day
13

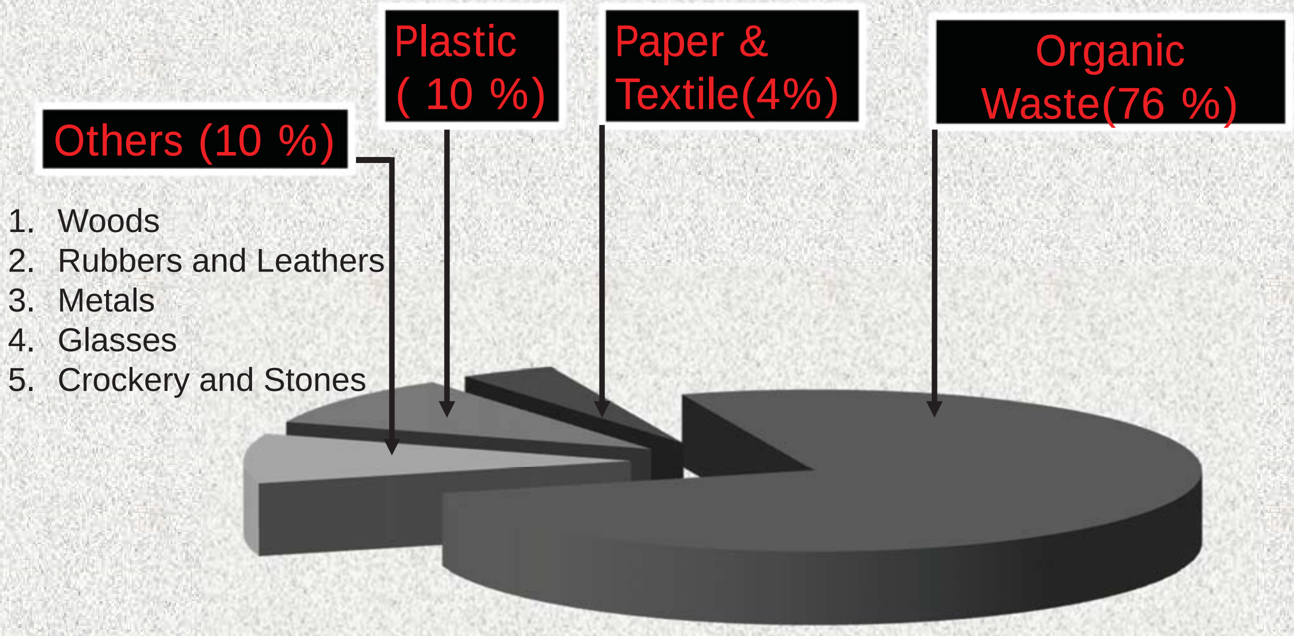

WASTE COLLECTED IN CITY
Waste (ton)
Caused of Decreasing
Generation Rate Survey %
Illegal Dumping Problem
Recycle Activities
Migrated to Naypyitaw City
Cause of Increasing
✓Policy & Economic Development
✓Reduce illegal Dump
✓More Services & Facilities
480000
470000
460000
450000
440000
430000
420000
410000
400000
456,344
433,764
437,472
426,999
479,280
07-08
08-09
09-10
10-11
11-12
2012-2013, Current Generation is (1690) Tons Per Day
Waste collection is (1550) Tons Per Day
14

Existing Used Main (2) Final Disposal Sites & (4) Temporary Small FDS

NO	Location of FDS site	Constructed Year	Planned Capacity	Site (Plant) Area	Dispose Ton Per Day (Current)	Remark
1	HtainBin	2002	-	150- Acre Used- 70 Ac	847	Open Dumping
2	Htwei Chaung	2001	-	55.77 – Acre Used-47.4 Ac	612	Open Dumping
3	Dala	2003	-	1.3- Acre	10	Low Landfill Temporary site
4	Seikkyi Khanaung To	2003	-	0.25 - Acre	5	Low Landfill Temporary site
5	Mingalardon	2003	-	0.91 - Acre	25	Low Landfill Temporary site
6	Shwe Pyi Thar	2005	-	1 - Acre	50	Low Landfill Temporary site

15

Typical Composition



Base on common composition which a few different percentage.
(Depend upon the Wet Season and Dry Season)

16

Hospital Waste Management

Infectious Wastes are dispose to the Incineration Process

Sharp Wastes are dispose to the Deep Well Process

Daily Medical Waste about 1 ton

Industrial Zones In Yangon City

➢Industrial Zones in City	= 24 Number
➢Total Factories	= 3562
➢Garments	= 126
➢Foodstuff	= 334
➢Chemical	= 56
➢Iron and Melting	= 519
➢Cold Storage and Fish Processing	= 45
➢Paper and Cardboard	= 105
➢Distillery	= 9
➢Forest Product	= 148
➢Public Use Goods	= 709
➢Others	= 1511

Daily Waste Generated of Industrial Zones

Sr No	Industrial Zone Location	No. of Zones	No. of Factories	Collected	Remark
1	East Dagon	1	41	3	Food and byproduct of sites
2	North Dagon	1	95	11	"
3	Dagon Seikam	2	94	4	"
4	South Dagon	3	2356	13	"
5	North Okkalapa	2	342	57	"
6	South Okkalapa	1	85	0.4	"
7	Thaketa	1	123	3	"
8	Mingalardon	2	40	6	"
9	Shwe Pyi Thar	4	249	6	"
10	Hly Thar Yar	7	137	6	"
	TOTAL	24	3562	109.4	

On Call System
Waste collected = 109.4 Ton Per Day

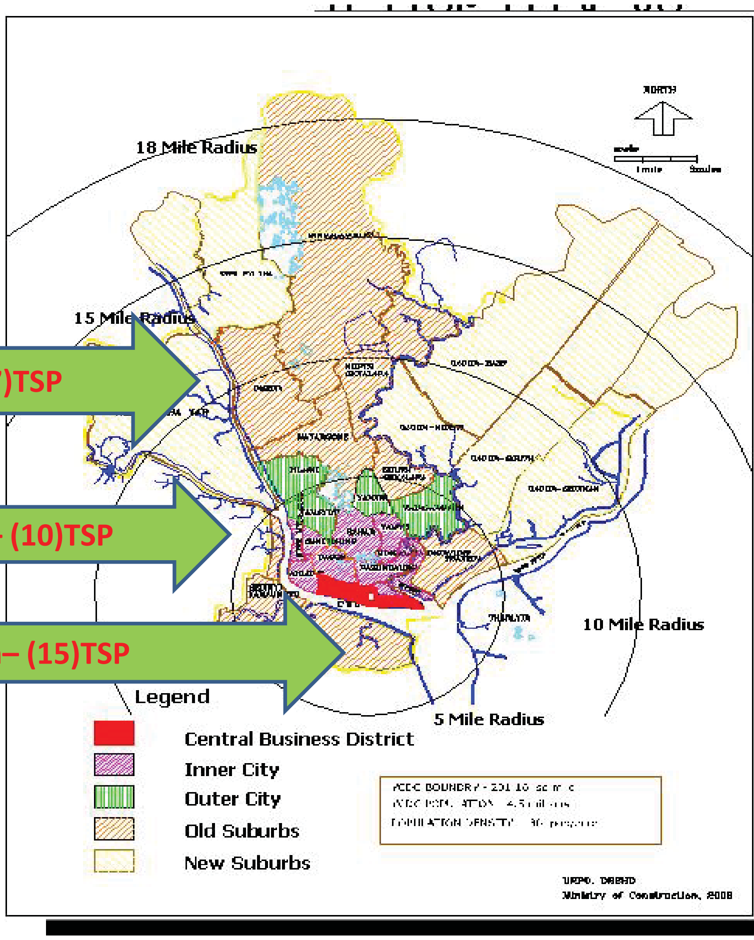
19

Monthly Fee of Household Waste Collection

Satellite (300) kyat per month-(7)TSP

Sub-Urban (450) kyat per month– (10)TSP

CBD- (600) kyat per month– (15)TSP



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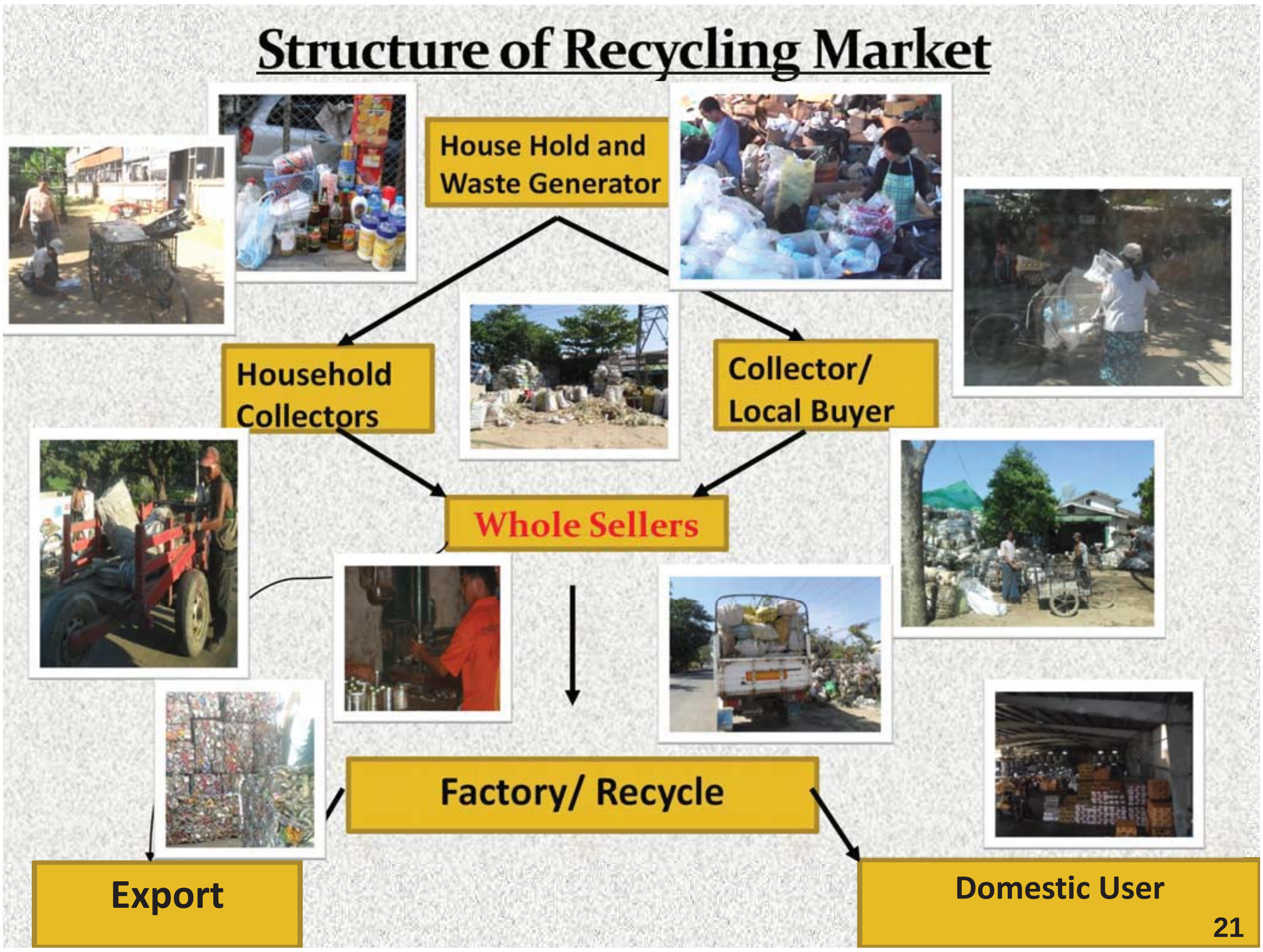
20


Structure of Recycling Market
House Hold and Waste Generator
Household Collectors
Collector/ Local Buyer
Whole Sellers
Factory/ Recycle
Export
Domestic User
21


Manufacturing Process of Recycle Product
Domestic Waste Container
Infectious, Sharp, & Domestic Waste Bags
Plastic Waste
(After Melt)
Infectious Waste Container
Sharp Waste Container
Plastic Bags
WET
DRY
Plastic Resin
Waste Bags Production
22

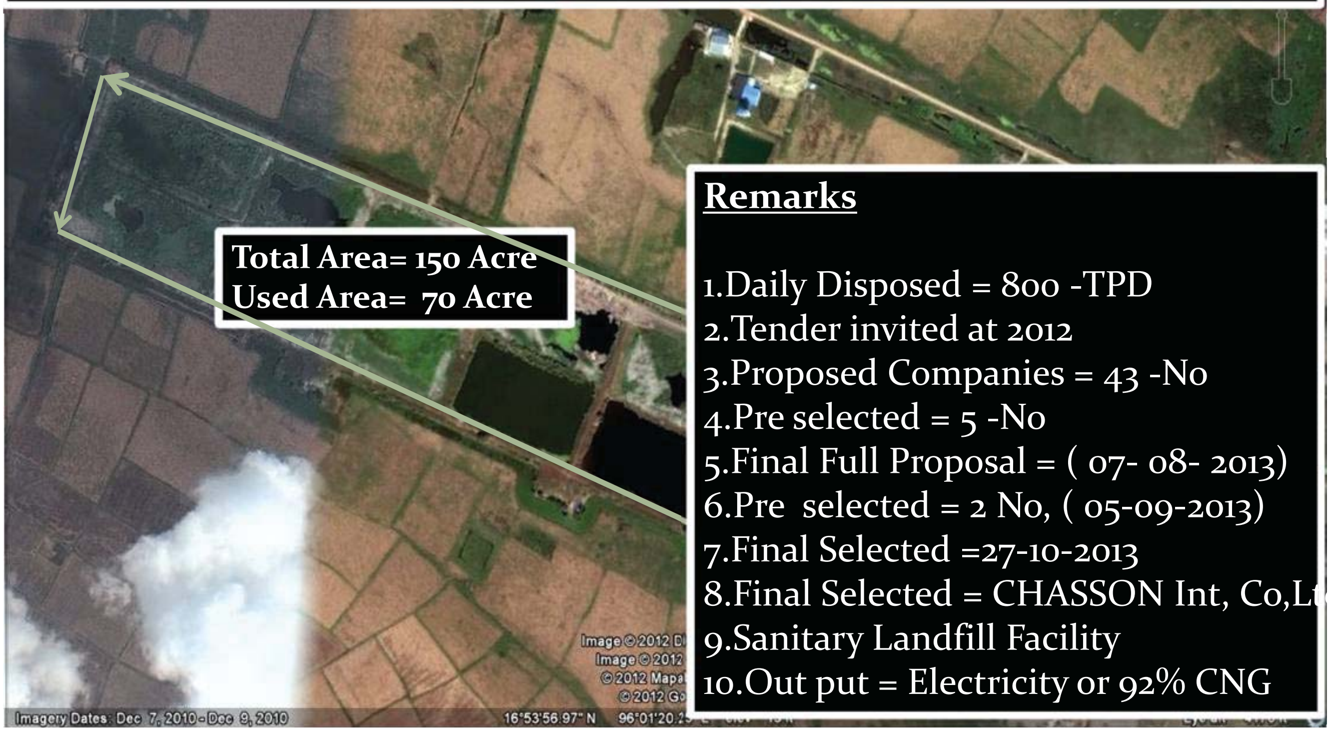
Recycle and Reuse Materials; Direct to Whole Sale Local Buyers ;Data Base on 2012

Particular	Weight (T)	Unit
Plastic	5.1	Ton
Paper	8.94	Ton
Cardboard	11	Ton
Leather	.1	Ton
Iron	0.5	Ton
Metal	0.3	Ton
Copper	0.3	Ton
Lead	0.1	Ton
Glass	40.5	Ton
Tin Can	5.1	Ton

Recycle Waste Generated = 85.84 - TPD

23

Htainbin Final Disposal Site, Tender Invited, Propose Location of (800) TPD Can dispose Domestic Waste of YCDC area, Sanitary Landfill Facilities, Bio-Gas to Electricity or CNG



Remarks

1.Daily Disposed = 800 -TPD
2.Tender invited at 2012
3.Proposed Companies = 43 -No
4.Pre selected = 5 -No
5.Final Full Proposal = (07- 08- 2013)
6.Pre selected = 2 No, (05-09-2013)
7.Final Selected =27-10-2013
8.Final Selected = CHASSON Int, Co,Lt
9.Sanitary Landfill Facility
10.Out put = Electricity or 92% CNG

Htawe Chaung Final Disposal Site Tender Invited, Propose Location of (600) TPD Incineration Plant, WTE

Remarks

1.Daily Disposed = 600 –TPD(domestic)
2.Hazardous waste = 100 - TPD
3.Tender invited at 2012
4.Proposed Companies = 43 -No
5.Pre selected = 6 -No
6.Final Full Proposal = (07- 08- 2013)
7.Pre selected = 2 No, (05-09-2013)
8.Final Selected = 27-10-2013
9.Final Selected = ZEYA & Associate
10.Incineration Plant Facility
11.Out put = Electricity

Key Finding and Main Issues in Solid Waste

1. **Must be need to change the SWM sector including**
   1. **Waste collection**
      1. Need Law, Rules and regulation(Now on going stage)
      2. SWM legislation
   2. **Waste transportation**
      1. Essential need to change the waste trucks, mostly garbage compactor trucks are available
   3. **Final Disposal Site Facilities**
      1. WTE process, on going in two big FDS
      2. Small FDS in (4) townships which also change to Small Scale Incineration Plants. (Base on the no more use existing land area)
   4. **Transfer station facility**
      1. City population growth
      2. Increase waste generated
      3. Land scare
      4. FDS locations are so far from city area

3Rs Activities

Public Awareness program




School Awareness program



Recommendation

- To research and develop on clean air, clean land, clean water.
- To integrate the action plans for ambient and indoor air quality monitoring and upgrading.
- To update the legislative system for EIA practices .
- To enhance the techniques on "Waste To Energy" WTE processes.
- To promote greater awareness of environmental and health risks from poor environmental planning and management.
- To upgrade the city green clean and healthy livable.


Thank You
HOTEL YANGON
Yangon
HOTEL YANGON

Energy policies in Myanmar

25 February 2014

Kenta Usui,
Climate and change Energy area, IGES

1

Outline

1. Current status of energy supply in Myanmar
2. Energy policy and institutional framework of energy policies
3. Potential of off-grid renewable energy

2

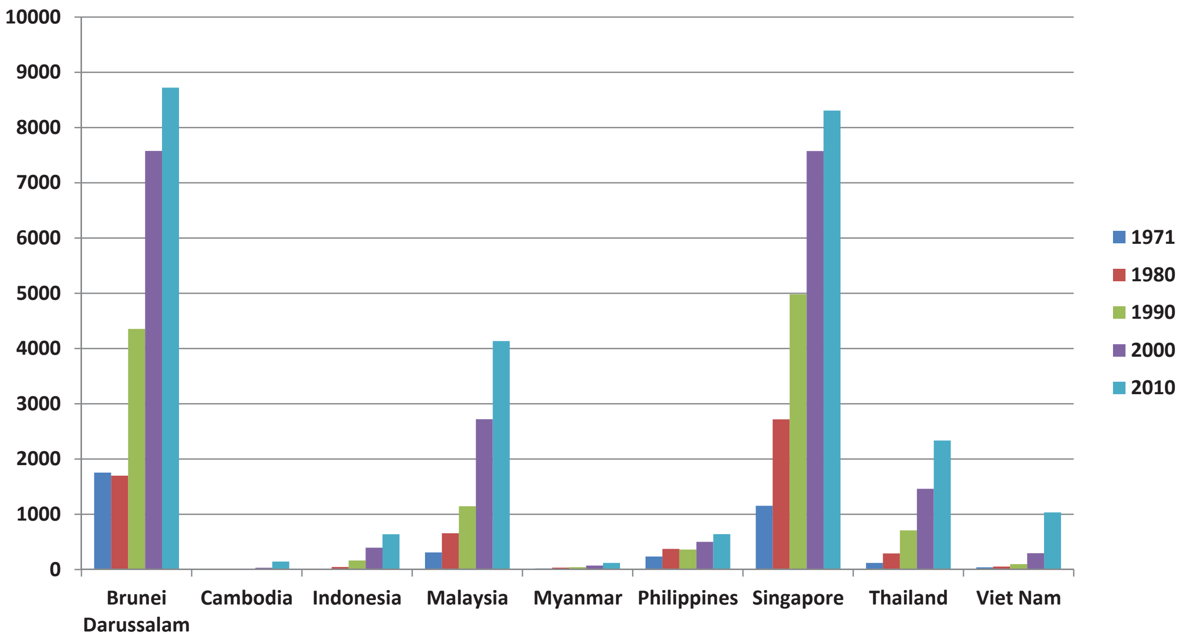
CURRENT STATUS OF ENERGY SUPPLY IN MYANMAR

Electrification rate

Region	Electrification rate (%)	Urban electrification rate (%)
Brunei Darussalam	100	100
Singapore	100	100
Malaysia	99	100
Viet Nam	98	100
Thailand	88	98
Philippines	83	94
Indonesia	73	94
Lao PDR	63	88
Myanmar	49	89
Cambodia	31	91

Source: IEA, 2012

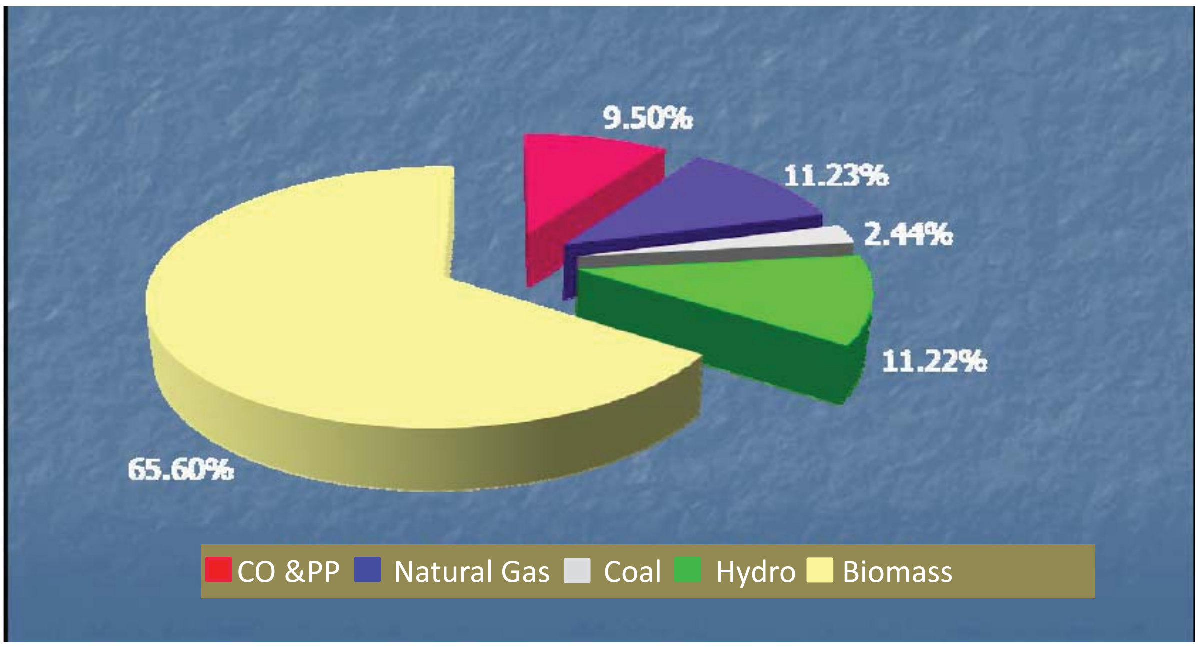
Electric power generation (ASEAN)



Source: World Development Indicators, World Bank (PIDS, 2013).

5

Energy supply



Source: Khaing (2013) Myanmar Engineering Society

6

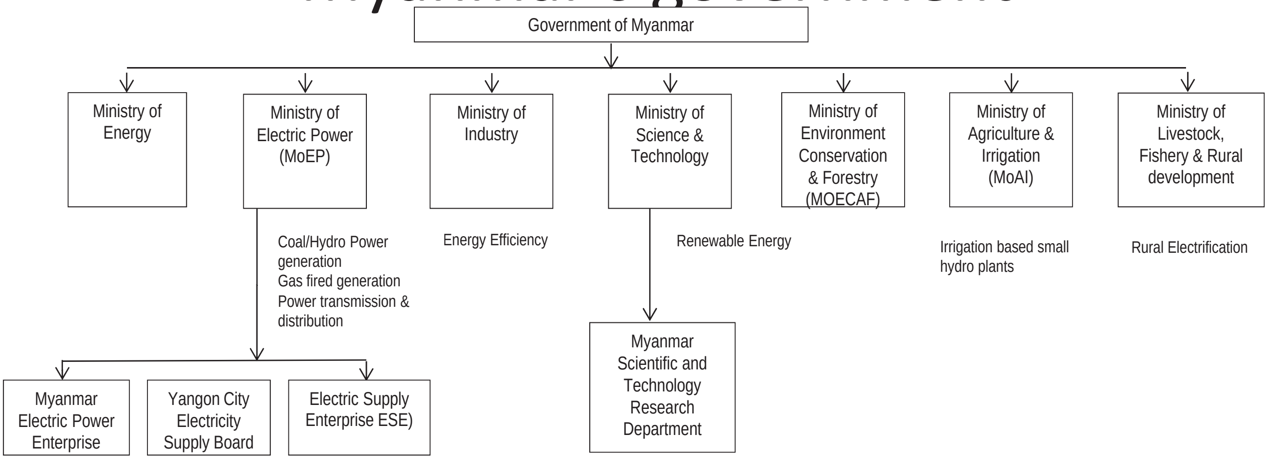
Natural gas reserve

Gas Filed Name	Estimated scale	Annual production	Extraction firm	Notes
Shwe	3.56+ trillion cubic feet	N/A	Daewoo International (60%), Korean Gas Corporation (10%), India's Oil and Natural Gas Corporation (20%), Gas Authority of India (10%)	Export to China starting in 2013
Yadona	5.7 trillion cubic feet	775 million cubic feet per day	Total (31%), Unocal (28%), Thai PTT Exploration and Production Public Company Company (26%), MOGE (15%)	Field life of 30 years. Exported to Thailand. Operated by Total
Yetagun	3.16 trillion cubic feet	424 million cubic feet per day	Petronus (41%) MOGE (21%), Nippon Oil (19%), PTTEP (19%)	Initial involvement by Texaco and Premier Oil.

Source: ADB (2012) Initial Assessment of Myanmar's Energy Sector, Ministry of Energy (2012)

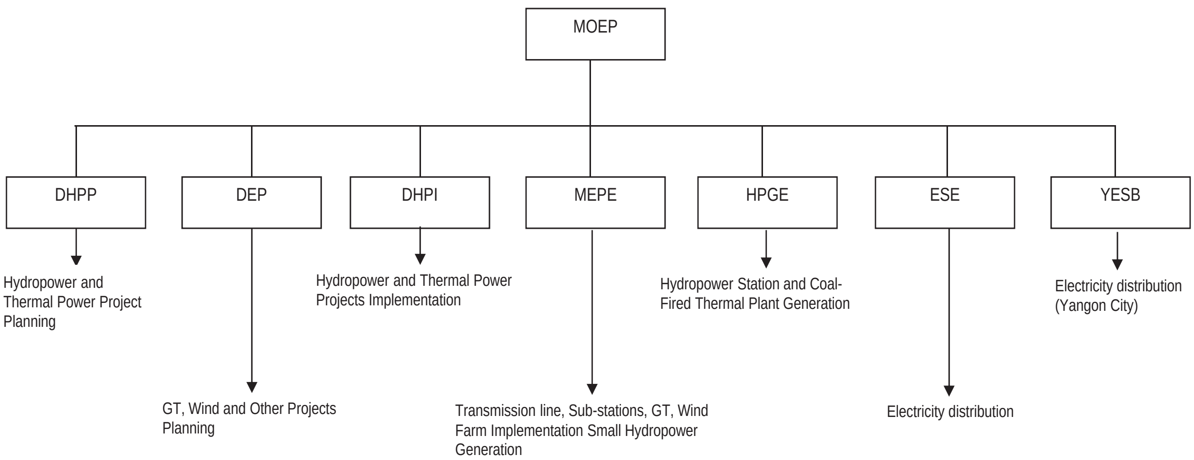
ENERGY-RELATED INSTITUTIONAL FRAMEWORK OF ENERGY POLICIES

Energy-related institutions in Myanmar's government



Energy Development Committee (EDC) & National Energy Management Committee (NEMC), under Government of Myanmar takes care of planning and co-ordination amongst various departments.

Ministry of electric power (MOEP)



DEP = Department of Electric Power, DHPI = Department of Hydropower Implementation, DHPP = Department of Hydropower Planning, ESE = Electricity Supply Enterprise, GT = Gas Turbine, HPGE = Hydropower Generation Enterprise, MEPE = Myanmar Electric Power Enterprise, MOEP = Ministry of Electric Power, YESB = Yangon City Electricity Supply Board.
Source: Ministry of Electric Power.

Conclusion

- Access to energy critical challenge
- Rich in energy resources, notably natural gas and hydropower
- But most of the gas and hydropower electricity is consumed outside Myanmar
- Coal and diesel-fired plants increasing
- Governance or energy sector and electricity is complicated, with fragmented responsibilities.

3.4 連絡会参加機関と連携した、ミャンマーグリーン経済成長フォーラムへの参加

2013 年 11 月 20 日から 22 日にかけて、第三回グリーン経済成長フォーラムが開催された。本会議を日本の優れた技術や制度の認知を高めることができる場として位置づけ、ミャンマー低炭素都市連絡会参加機関と連携し、日本の優れた低炭素技術、国際支援、自治体の取り組み等の紹介を行った。

本フォーラムはテイン・セインミャンマー国大統領から開会の辞があり、他 14 の閣僚が参加した。一日をネピトー、二日をヤンゴンで行い、「水・エネルギー・食料の連鎖関係」を議論したほか、これらの重要な資源を持続可能な形で管理していくため、省庁の違いや特定のセクターに囚われない、統合的な政策の必要性が強調された。

会議二日目に、IGES は「水・エネルギー・食料連鎖の現場：ミャンマーの持続可能な資源管理のための地域協力」というテーマでセッションを開催した。IGES 研究員の他、ミャンマーから三名、タイとインドから三名、日本から三名（北九州市、JFE エンジニアリング（株）、国際協力機構（JICA））の発表者が登壇した。

セッション議論要約

- ミャンマーには、国家レベルでの統合的な政策と、政策調整メカニズムが必要である。 ミャンマーにおける環境問題と地域ごとの多様性を鑑みて、土地利用政策、エネルギー政策、環境に配慮した国家開発計画等、国家レベルでの政策強化の必要性が指摘された。同時に、複数の省庁や当局間での協力、調整を行うメカニズムの必要性についても言及があった。
- 技術的な解決策は重要であるが、導入現場の状況を十分に反映しなければならない。JFE エンジニアリング（株）の廃棄物発電、インド・エネルギー資源研究所（TERI）の太陽光を用いたオフグリッド電力技術等、発表者の多くが技術の秘める可能性について言及した。同時に、無電化地域では携帯電話技術の利用が制限されることなどを例に挙げ、現場に最適な技術を選ぶ必要性も指摘された。
- 気候変動は、ミャンマーに課題と好機の両方をもたらす。 フィリピンにおける巨大台風、5 年前にミャンマーを襲ったサイクロン・ナルギスの事例からも分かるように、ミャンマーにとって気候変動による災害は極めて大きな脅威である。また、水資源が気候変動によって影響を受ける可能性があり、電力供給の多くを水力発電に依存するミャンマーのエネルギー供給に悪影響を与える可能性がある。その一方で、ミャンマーの温室効果ガス排出量は現在マイナスであること、日本の二国間クレジット制度をはじめとした、気候変動対策を支援する資金の規模が増加していることなど、ミャンマーの持続可能な発展にとっての好機も指摘された。
- 地域協力は、ミャンマーのグリーン成長の一助となり得る。 北九州市の都市間協力、インド TERI によるオフグリッド技術協力、タイ温室効果ガス管理機構の能力開発プログラム、日本の低炭素成長パートナーシップなど、様々なアジアにおける

地域協力の可能性について言及があった。また、先進国との協力ではグリーン成長や先進的な技術の導入にかかる追加的なコストの負担が有用である一方、他途上国との南南協力は、農村の電化等途上国ならではの課題に関する協力において重要な役割を果たし得る、との指摘があった。

全体会議及びセッションの様子


ECONOMY
GROWTH
GEGG Forum
(2.2)
Joint Committee to assure flexibility
Project participants
Third Party Entities

Session Agenda

"Positioning Energy- Water- Food Nexus in Practice: Regional Cooperation for Myanmar Resource Sustainability."

Coordinated by IGES, Japan

"Energy-Water-Food" nexus is now at the central pillar to design a country's sustainable development path. Indeed, the demand for all of three resources is increasing globally, and we are already facing the scarcity. Since these resources are interlinked, a policy focusing only in one of them may result in an unexpected problem in another resource. Hence the nexus concept calls for an integrated policy-making, rather than in policies in silos.

In particular, water-energy linkage deserves a special emphasis. Water requires energy for raw water extraction, treatment and supply, and wastewater treatment. On the other hand, energy generation requires water for fuel extraction and processing, cooling and hydropower generation. In the past few years, and the result of the research will be presented in this session.

But more importantly, what does the nexus mean to Myanmar in practice? It is important to go beyond a concept and "move forward and faster" to implementation, as titled in this GEGG conference. It is also important to share lessons in the region, so that Myanmar can build on lessons learnt in the region. Myanmar is in a favourable position to build such cooperative relationship as the ASEAN Chair from 2014. In this context, this session offers two points of discussion.

1. How can we implement the concept of the nexus in practice?
   This point is discussed in Part 1, in which speakers from international institutions, national governments, local governments and private sector offer diverse perspectives. The presentations specifically target themes that water and energy are interlinked; clean energy, hydropower, waste management and smart city.
2. What is the role of regional cooperation to ensure resource security in Myanmar?
   Experts from Thailand, India and Japan will provide their perspective in Part 2. Both Part 1 and 2 will benefit from international perspective, but will be complemented by discussants from Myanmar to ensure the relevance of discussion to Myanmar.

Final Agenda

11:00-11:20	Opening - Opening remarks by Hideyuki Mori, President, IGES - Honourable guest speech by Dr Rajendra K. Pachauri, Chair, The Intergovernmental Panel on Climate Change (IPCC) and Director General, The Energy and Resources Institute (TERI)
11:20-12:00	Introduction: - Towards Myanmar's Green Leapfrog Development: Opportunities and Challenges with focus on Energy and Water sectors: Ikuho Miyazawa, Policy Researcher, Integrated Policies for Sustainable Societies Area, IGES - Resources sustainability in Myanmar: Lessons from integrated assessment of water-energy nexus in neighbouring countries: Dr. Bijon Kumer Mitra, Policy Researcher, Natural Resources and Ecosystem Services Area, IGES Discussion
12:00-13:00	Lunch break
13:00-15:15	Part 1: Practical solutions to address the water-energy nexus: Chair: Hideyuki Mori, President, IGES Presentations: - Opportunities of clean energy solutions in Myanmar and in the region: Dr. U Win Khaing, President, Myanmar Engineering Society - Smart city: Ms. Keiko SASAKI, Director, Kitakyushu Asian Center for Low Carbon Society, Office for International Environmental Strategies, Environment Bureau, City of Kitakyushu - Implication of nexus approach for food security in Myanmar: Dr Ohnmar Khaing, Coordinator, Food Security Working Group (FSWG) - Waste to Energy with elaborate planning: Mr. Kuribayashi Kenji, JFE Engineering Yangon Office Discussion
15:15-15:30	Break
15:30-16:50	Part 2: The role of regional cooperation to ensure resource security in Myanmar Chair: Peter King, Senior Policy Advisor, IGES Bangkok Office Presentation: - Regional cooperation under the framework of Joint Credit Mechanism (JCM) : Policy Researcher, Mr. Kenta Usui, Policy Researcher, Climate and Energy Area, IGES - Capacity building for low-carbon growth in ASEAN: Mr. Satoshi Iemoto/ Dr. Jakkanit Kananurak, Capacity Building and Outreach

	Office Thailand Greenhouse Gas Management Organization(JICA/TGO) - Opportunities of providing off-grid energy solutions in Myanmar and in the region : Mr. Debajit Palit, Associate Director and Fellow, Lighting a Billion Lives Programme, Social Transformation Division, TERI Discussion
16:50	Closing - Hideyuki Mori, President, IGES

Detailed Note:

In the opening remarks, Mr. Hideyuki Mori, the president of IGES, stressed the importance of considering and addressing positive synergies and negative trade-offs between EWF nexus in the context of Myanmar's pathways towards green growth, and mentioned that experiences to be shared from Japan and other countries in the region would be helpful in this sense.

Dr Rajendra K. Pachauri, Chair, The Intergovernmental Panel on Climate Change (IPCC) and Director General, The Energy and Resources Institute (TERI) emphasized the importance of taking into account the culture of the society as Asia has a particular culture, which could be a good driving force of green growth unlike the Western culture of overconsumption. In this sense, local culture could be more reflected in national planning and implementation of green growth. He also stressed the importance of creating skills through proper education at multi-levels (from local to national) for accelerating Myanmar's efforts to achieve green growth.

In introduction, Ms. Ikuho Miyazawa, Policy Researcher at IGES, presented the analysis of the current status of environmental conditions and institutional frameworks based on the IGES Working Paper 2013-4, and recommended 1) to mainstream the idea of green growth in Myanmar's development planning, 2) to strengthen environmental-related bodies such as the high-level coordination body for green growth, and 3) to learn from and working with neighboring countries through south-south cooperation.

Dr. Bijon Kumer Mitra, Policy Researcher at IGES, introduced the lessons from Thailand and India on the water-energy nexus and suggested the following 5 points including; 1) long term energy supply might get negatively affected due to lack of water and energy sector investment can be jeopardized, 2) it is important to consider spatial distribution of water resources for selection of Go and No Go areas in future power plant construction planning, 3) Diversification in energy fuel mix reduce risk of water shortage induced blackout as well as environmental impacts, 4) End-use efficiency improvement has potential to complement significant volume of water for other users, 5) In general, water abundant country like Thailand and Myanmar may not face water shortage for electricity generation. However, climate induced seasonal change of water availability may negatively affect energy supply. The questions are raised regarding difficulties of addressing regional cooperation as it is often driven by the needs of neighboring countries (i.e. energy exportation, water management, and illegal logging etc), as well as the way of non-spatial cooperation.

Co-Chair, U Win Hlaing, DG of MOECAF, concluded that the government of Myanmar is currently in the process of drafting integrated energy policy through a series of dialogue with relevant stakeholders to tackle multiple challenges of access, affordability, and efficient use of energy and water.

Session Part 1 focused on how to implement the concept of the nexus in practice regarding specific issues such as clean energy, waste management, food security, and smart city. Dr. U Win Khaing, President, Myanmar Engineering Society, presented the current status of national policy and institutional reforms in energy sector and opportunities of clean energy solutions in Myanmar and the region, and stressed that there are many potentials in Myanmar to improve access to energy, energy efficiency, and renewable energy including solar and wind power, hydropower, biomass etc, but needs proper policies, institutions, and capacity building.

Ms. Keiko SASAKI, Director, Kitakyushu Asian Center for Low Carbon Society, Office for International Environmental Strategies, Environment Bureau, City of Kitakyushu, introduced the its experiences in overcoming sever environmental pollutions in the 1960s and current activities on smart city, emphasizing the importance of partnership between residents, local government, and private enterprises, as well as a holistic approach to address not only environmental problems but also human development. She particularly stressed it is crucial to conduct a series of dialogues with local residents to ensure their ownership.

Dr Ohnmar Khaing, Coordinator, Food Security Working Group (FSWG) presented the implication of nexus approach for food security in Myanmar and the importance of addressing sustainable use of land. She suggested that it is indispensible to pursue a systems-based preventive approach to ensure food security through national coordination mechanism, multi-stakeholder dialogue, strategies to create issue based networks, sustainable use of water and energy, and centralize regional governance.

Mr. Kenji Kuribayashi, JFE Engineering Yangon Office, shared the company's activities on waste to energy through incineration with elaborate planning in other countries in Asia and planed activities in Yangon region, stressing that the power generation will contribute to stabilize power supply in residential area nearby and lower risks of unexpected environmental impacts.

Part 2 discussed the role of regional cooperation to ensure resource security in Myanmar. Mr. Kenta Usui, Policy Researcher, Climate and Energy Area, IGES, presented the current status of Myanmar in terms of its GHG emission and its impact on climate change and its implications for regional cooperation under the framework of Joint Credit Mechanism (JCM). He pointed out that Myanmar's current level of GHG is negative, it does not make sense to reduce current level of GHG emission. Instead, Myanmar can harness increasing flow of climate finance to benefit its own sustainable development.

Mr. Satoshi Iemoto, JICA Expert, and Dr. Jakkanit Kananurak, Director of Capacity Building and Outreach, Thailand Greenhouse Gas Management Organization (TGO) jointly introduced capacity building activities for low-carbon growth in ASEAN through Thailand Greenhouse Gas Management Organization(JICA/TGO) and Climate Change International Training Center (CITC). The three steps of TGO/CITC were introduced; 1) design of the training course, implementation, and share the knowledge with ASEAN countries.

Finally, Debajit Palit, Associate Director and Fellow, Lighting a Billion Lives Programme, Social Transformation Division, TERI, shared the lessons from India on off-grid energy solutions and its implications for Myanmar and in the region. He emphasized that off-grid energy solution is a good practice of benefitting community, but need to carefully consider and design based on difference local contexts.

ECONOMY Green GROWTH

GREEN ECONOMY GREEN GROWTH-MYANMAR(not-for-profit) ASSOCIATION

35B-15, New University Avenue, Bahan Tsp, Yangon, Myanmar.

30 December 2013

FINAL EXECUTIVE SUMMARY

THIRD GREEN ECONOMY GREEN GROWTH, GEGG FORUM
Energy – Water – Food
Nexus
----- For Greening & Cooperation -----
Moving Forward and Faster

NAY PYI TAW (Myanmar International Convention Center) &
YANGON (Diamond Jubilee Hall, Yangon University)
REPUBLIC OF THE UNION OF MYANMAR
20 TO 22 NOVEMBER 2013

Organized By: GEGG Myanmar (Not for Profit) Association.
In Collaboration with The Ministries of: Environmental Conservation & Forestry, Focal Ministry for GEGG Forum; National Planning and Economic Development; Education; Energy; Science and Technology; Culture; and Myanmar Engineering Society; Association of Myanmar Architects; National Economic and Social Advisory Council, NESAC
Supported by: Tun Foundation, Environmental & Economic Research Institute, Yangon Media Group, Max Myanmar Group & Ayeyarwady Foundation, First Myanmar Investment Co. Ltd, Zaykabar Co. Ltd, Myanmar, Government of Norway, Government of Sweden, Government of Japan, United Nations Development Programme
In Partnership with: UNDP Myanmar Country Office and Regional Resource Center, Bangkok, Thailand, UNEP International Environmental Technology Center, Osaka, Japan, UN Convention to Combat Desertification Global Mechanism, Rome, Italy, The Smithsonian Institution, USA, WWF, Stockholm Environment Institute, Stockholm & Bangkok, Institute for Global Environmental Strategies, IGES, Hayama, Japan, The Norwegian Energy Farm, Norway, Thailand Greenhouse Gas Management Organization (Public Organization), TGO, Bangkok, Thailand, Yokohama National University, Yokohama, Japan and UNEP regional Office for Asia Pacific

SUMMARY HIGHLIGHTS & RECOMMENDATIONS

THE FIERCE URGNECY OF HOW& NOW!

Outstanding Support

The Opening Statement was delivered by H.E. U Thein Sein, President of the Republic of the Union of Myanmar, attended by H.E Dr. Sai Muak Kham, Vice President, 13 Union Ministers, 7 Deputy Ministers , 1 Regional minister, 10 Director Generals, 10 Regional Representatives.
Greetings were given by Prof, Dr Emil Salim, Chairman, Council of Advisors to the President, Indonesia and Ms Julie Jacobsen Takahashi, Charges d'Affaires, Royal Norwegian Embassy, Myanmar.
The President, Vice President, and Union Ministers viewed the winning Exhibitions of Affordable Green Myanmar Homes Design, Cartoons and Photographs of Natural Resource and Environment, and stayed back for Coffee and met with speakers and participants.

- 282 diverse participants <u>registered</u> with the Ministry for Environmental Conservation and Forestry for the Nay Pyi Taw Segment on 20 November, held at the Myanmar International Convention Center. The participants included Members of People's Assembly, the Diplomatic Corps; UN and International Organizations; Private Sector, NGOs, Media, Academia.
- The Yangon Segment held at Yangon University's Diamond Jubilee Hall was opened by H.E U Myint Swe, Chief Minister and attended by the Speaker of the Yangon Region Government Parliament and 5 Regional Ministers.
- 363 and 399 equally diverse participants <u>registered</u> on 21 and 22 November respectively.
- Over half of all registered participants were women..
- A large number of participants attended the Nay Pyi Taw and Yangon segment, but did not register. At the Summary/Concluding Session in Yangon on Friday 22 November, a head count indicated 185 participants remained.
- The Third GEGG Forum received outstanding Myanmar private sector support. These included complimentary air transport from Nay Pyi Taw to Yangon, coach transport in Nay Pyi Taw and Yangon, dinners, lunches and coffee/tea breaks, and the use of the Myanmar International Convention Center in Nay Pyi Taw.
- In Yangon, the Ministry of Education and Yangon University made available the University Diamond Jubilee Hall Plenary Room and six break out rooms for the Parallel Sessions.
- A large number of volunteers from MoECaF and from the organizations of GEGG Myanmar Association Board members provided the indispensable logistic support.
- A CD-Rom disc containing all the Third GEGG Forum presentations was provided every participant.

These are also available in the GEGG-Myanmar (Not for Profit) Association website: www.geggmyanmarassociation.com.

The Table below shows the Profile of registered Participants at the Third GEGG Forum

PRESIDENT	1
VICE-PRESIDENT	1
CHIEF MINISTER	1
UNION MINISTERS	13
REGIONAL MINISTERS	5
DEPUTY UNION MINISTERS	7
DIRECTOR-GENERALS	10
Nay Pyi Taw (20 Nov) Registered	282
Yangon (21 Nov) Registered	363 (Women 125)
Yangon (22 Nov) Registered)	399 (Women 150)
Yangon 22 Nov Concluding Session (Head count)	185
MEDIA	21
SPEAKERS National	38 (10 Women)
SPEAKERS International	105 (22 Women)

- A Design Contest for Green Affordable Myanmar Homes, in collaboration with the Association of Myanmar Architects, Myanmar Engineering Society; a Greening Cartoon and a Photography Contests were also organized for the Third GEGG Forum. Sponsors were contributions by GEGG Members and the Tun Foundation. The Winners received their prizes at the Nay Pyi Taw Lunch on 20 November and in Yangon.
- At the Lunch, the establishment of two Centers of Excellence for Green, Sustainable, Resilient, Smart, CoE GSRS, in Yangon and Mandalay Regions was announced. These will be part of a network of CoE GSRS to increase awareness, demonstrate, train and build capacity to accelerate green economy and green growth, that will take into account the prevailing ecological, economic, social, and cultural norms and practices. The Centers will have Consortiums of National and International Partners.
- A shared and common refrain from the Third GEGG Forum is the imperative need for implementation, with focus on HOW.

  One of the Parallel Session summed up the message “The Fierce Urgency of HOW”
- The Third GEGG Forum succeeded in increasing awareness of the importance of the Nexus of Energy-Water-Food, their inextricable linkages, the multi-faceted interventions available to foster greater integration and coherence for increasing greening and sustainability.
- The three High-level Roundtables Dialogue on Policy, Strategy, Cooperation, Financing and Investment that were held at Nay Pyi Taw, provided insights on the critical determinants for greening and growing the economy, providing a pathway for

sustainable development and importantly poverty eradication, as stated in the Opening Statement of the President.

- The Roundtables were chaired by H.E U Win Tun, Union Minister of Environmental Conservation and Forestry; H.E. Dr U Ko Ko Oo, Union Minister of Science and Technology; and Mr. Putu M. Kamayana, Head, ADB Extended Mission in Myanmar.
- The two Plenary Panels, Chaired by H.E Prof. Dr Emil Salim (Indonesia) and Prof Joakim Öjendal (Sweden), and 12 Parallel Sessions in Yangon on the 21 and 22 November focused on how Science, Technology, Management, Governance, Data, Information and Capacity Building
- These Sessions by 105 international speakers (22 Women) and 38 national speakers (10 Women), the discussions and questions and answers, provided in-depth knowledge and experience for a range of Nexus Green and Sustainability applications, with substantive Recommendations, summarized and highlighted below.

Summary Recommendations

(1) A coherent strategic framework, such as a national green development plan or strategy, is needed. A strategic framework would enable concerted and systemic action to be integrated in development policy, planning and implementation across the water-energy-food security nexus.

(2) Capacity building in biodiversity conservation and natural resource management is needed across sectors including government, academia, and civil society. Strategies should include increasing and diversifying training opportunities, expanding academic curriculum, outreach to communities local to protected areas and the general public, engaging private and corporate partners, improving communication across and among sectors, with the goal of institutionalized conservation capacity building within MoECaF and other ministries for sustainable and long-term capacity building.

(3) Biodiversity databases can help decision makers avoid critical tipping points or mitigate disasters.

(4) Increase application of science and technology to improve conservation and management of natural resources, wild life and endangered species. Remote sensing and geospatial tools are some of the technologies.

(5) In considering transformational technologies for built systems, include materials using bio-mimicry and nano-technologies.

(6) Sustainable Land Management, SLM, is critical to make progress towards a green economy. One of the most significant natural capital assets is productive land and fertile soil. It is central to the nexus that links energy, food, water, and environmental health in an interdependent loop. It is a vital resource for the provision of essential ecosystem services such as ensuring food security, regulating hydrological regimes, providing energy as well as conserving biodiversity, cycling soil nutrients, and storing carbon.

(7) Land use policies should balance community forestry opportunities and high-value non-timber forest product areas with other options for land conversion.

(8) Reduce negative impacts of waste on public health, air, water and soil, by setting a roadmap to assist governments and stakeholders to formulate a national waste strategy, as well as an integrated waste management system at the city level. Some of the main components of the national waste strategy involve international cooperation on technology support and capacity building, designing policies and institutional framework such as an action plan to control water quality, and creating opportunities for options to turn waste into a resource.

(9) Protected Areas (PAs) are cornerstones of biodiversity conservation, but in isolation cannot sustain future biodiversity and human communities. The primary sustainability mechanism is a well-designed PA network, integrating management of land and seascape sectors.

(10) Promote and support innovative natural resource use such as participatory forest and mangrove management, indigenous/endemic species restoration, ecological agriculture and non-tillage farming, agroforestry and multi-cropping agriculture, micro-hydro power generation, labelling schemes for ecological agriculture products and bio-filtering for drinking water,

(11) Long term national planning and strategies are needed and must take into account the fact that small stakeholders are very vulnerable to both climate change and reform strategies.

(12) Facilitate the decentralization of ecosystem and natural resource use management to local communities while ensuring macro-level enabling policies and their compliance.

(13) As infrastructure is being built up, there is an imperative need for the public sector to very consciously make the 'right choices' and also ensure that procurement processes are geared towards procuring high quality and high efficiency technologies. This 'role-modeling behavior' will make a huge impact and serve as a catalyst for much broader adoption.

(14) Involve government, industry and local community partners as early as possible in infrastructure projects and provide knowledge & information sharing in multi- directions.

(15) There is an important need for a coordination mechanism between the public, private and local sector.

(16) Need for Demand-side management planning to better manage the timing of consumer energy use, public awareness campaigns, setting energy efficiency standards for buildings and appliances,

(17) Consider an Energy Efficiency Revolving Fund offering credit lines—initially at no interest—to local banks so that they could provide loans for energy efficiency projects,

and other business to address the lack of awareness of the benefits of energy-efficient technologies or the upfront investment challenges for energy efficient projects.

(18) The national Power Development Plan is vital for upgrading the existing grid. It could be strengthened by including a priority action plan on decentralized mini-grids powered by renewable energy.

(19) Prepare a Report on key issues on development of BioEnergy , including establishment of an Energy Farm, and Center of Excellence.

(20) The role of the financial system is central to accompany the green growth, but changes are needed in the sector to make this happen. It is essential to engage more representatives from the financial industry (e.g. accountants, bankers, etc.) in upcoming GEGG Forums.

(21) Myanmar should prepare a comprehensive and holistic capital market development plan to be implemented in stages over a period of time. It should include: an education programme for retail investors; developing domestic institutional investors including; pension programmes, various savings products (e.g. mutual funds), life insurance etc; establishing strong supporting infrastructure including; adopting international standard accounting policies and practices, transparent legal and enforcement frame work etc.

(22) Foster enabling mechanisms to encourage responsible companies that invest in communities and promote sustainable development

(23) Myanmar Chairing ASEAN in 2014 provides an important opportunity to increase intra and inter-regional cooperation in pursuit of green growth.

(24) Increase Nexus thinking and application that involves interaction between resources, sectors, actors and scale, strengthen (i) communications: transparency and openness, fostering trust, (ii) dialogue: ongoing discussions and negotiations between key stakeholders (as long as one talks, anything is possible), and (iii) governance: rule-based legitimate political decisions, carried out from capable and recognizable institutions.

The 47 page Final Report with the Agenda and Abstracts; and the Parallel Sessions Programme with the List of Speakers, their presentation topics and recommendations are available in the GEGG (Not for Profit) Association website: www.geggmyanmarassociation.com.

4. 技術調査

ミャンマーにおける JCM の実施及び日本の低炭素技術の導入を念頭に置いた技術調査を行った。ミャンマーにおいては電化率が 5 割以下と非常に低く、地方電化が極めて重要な課題にあっていることから、本調査は、無電化地域における再生可能エネルギーを用いた電力アクセス供給に対象を絞った。本調査はインドエネルギー資源研究所（TERI）に外注した。TERI はこの分野において Lighting Billion Lives と呼ばれるソーラーランタン等の普及を通じた電力供給改善プログラムを実施しており、本分野において十分な専門性と知見を有すると判断した。

4.1 調査概要

本調査は、主に文献調査と、ミャンマーでの政府関係者、NGO 等への聞き取り調査を主な手法として行った。現地調査は 11 月のグリーン経済成長フォーラム（GEGG）と繋げる形で行われ、2014 年 3 月 4 日にはヤンゴンにて関係者でのワークショップも実施した。

再生可能エネルギーは主に太陽光、風力、バイオマス、小規模水力の 4 つを検討。ミャンマーの各州におけるこれらの資源の利用可能性を検討すると共に、無電化地域における電源導入モデルを検討した。また、政府機関や NGO への聞き取りを通して、関連する政策や関係政府機関の政府の整理も行った。

4.2 調査結果

本調査の最終報告書は参考資料 6 で英文にて記載しているが、この目次の日本語訳を以下に記す。

「クリーンエネルギーを通じたエネルギーアクセスの提供：オフグリッドエネルギー共有の技術的アセスメント」

本調査の主要な結論を抜粋する。

・ミャンマーにおいて電力アクセスの改善は重要課題と認識されているが、関係機関の調整が困難である。エネルギー政策は政府内でも様々な部署に扱われており、地方電化は Ministry of Livestock, Fisheries and Rural Development のマンデートとな

っている。しかし、再生可能エネルギーは科学技術省や環境保全森林省等も取り組んでおり、「再エネのオフグリッド」となった際にどの省の管轄になるのか明確でない。また、州や市、NGO もそれぞれの活動を展開しており、全体像の把握が極めて困難な状況である。
・ミャンマーにおいて再生エネルギーは極めて豊富であり、ほぼ全ての地域において、二種類以上の再エネ（例：バイオマスと風力、など）が利用可能である
・オフグリッドの再エネ導入モデルとしては、「ソーラー家屋」「ソーラーランタン」「充電ステーション」「ミニグリッド」の 4 種が考えられ、導入サイトの情況に合わせてこれらを組み合わせた導入が可能である。各モデルにおいて、どのように民間企業や NGO、コミュニティを活用できるかが変わってくる。

・再エネ関連の機器は輸入に頼っているが、品質が保証されていない。例えば一部のバイオガス化装置は毒性のある残留物を発生されているし、太陽光パネルも劣悪な品質のものが混じっている。日本や韓国のものは比較的高く高品質であるが、中国製のものの品質は疑問符が付く。しかし消費者は安い方を購入する傾向にある。IEC 規格等を利用して、消費者が品質の差別化できるようにするのが望ましい。

・資金調達は大きな課題であり、金融機関がこのようなプロジェクト投資するならば JICA や ADB や等を通した安価な資金を調達する必要がある。また、このような案件を審査できるよう、金融機関自体への能力構築も必要である。JCM のような制度がミャンマーにおいて動き出せば、高品質のオフグリッド電源導入の費用が下がることにつながり、技術の広範囲な展開に有用である。

・日本の技術や JCM を用いたオフグリッド電源を導入する場合、再エネ資源を踏まえると、下記の州が考えらえる。

S. No.	State/Division	Status of Electrification	Wind resource (m/s)	Solar resource (MJ/m²/day)	Biomass resource	Technology option
1	Tanintharyi	Poorly electrified	7-8 (Good/Average)	15-16 (Average)	Evergreen/ Deciduous forest	Solar-wind hybrid Mini-grids
2	Sagaing	Poorly electrified	3-4 (Poor)	15-17 (Average/Good)	Evergreen/ Deciduous forest/rice husk	Biomass based Mini-grids
3	Rakhine	Poorly electrified	7-8 (Good/Average)	15-16 (Average)	Evergreen/ Deciduous forest/rice husk	Solar-wind hybrid Mini-grids

4.3 現地コンサルテーションワークショップ

アジェンダ：

Stakeholder Consultation Workshop on Off-grid Electricity Access in Myanmar

March 04, 2014,
Myanmar Engineering Society Building, Hlaing Universities Campus,
Yangon, Myanmar.

This half-day workshop is being organized as part of the ongoing research study on off-grid delivery options titled "Delivering energy access through clean energy in Myanmar - A technical assessment for off-grid energy supply". The project is executed by TERI, New Delhi with support from Institute for Global Environmental Strategies (IGES), Japan. Myanmar Engineering Society (MES). The objectives of the study are to:

- Undertake a technical feasibility assessment for identifying alternative technical and delivery model, especially through solar and biomass energy, for enhancing rural electricity access in Myanmar;
- Provide a road map and recommend ways and means for disseminating renewable energy based distributed generation systems and suggest delivery model(s) and implementation arrangements, taking experiences from India and South Asia.

The aim of this workshop is to present the findings from the research study to key stakeholders in the rural electricity sector in Myanmar and to brainstorm for developing the off-grid electricity sector road map for the country.

Program Schedule

09.00 - 09.30:　Registration (with tea/coffee)

10.00 - 10.10:　Welcome Remarks - Mr U Win Khaing, President, Myanmar Engineering Society

10.10 - 10.30:　Presentation on Joint Crediting Mechanism and Objectives of the study: Mr Kenta Usui, Policy Researcher, Institute for Global Environmental Strategies (IGES), Japan

10.30 - 11.00: Presentation on the off-grid study and its findings by Mr Ankit Narula, Research Associate, TERI, New Delhi

11.00 - 12.30:　Moderated Discussion

Chair: Dr Win Khaing Moe, Director General, Myanmar Scientific and Technological Research Department, Ministry of Science & technology, Union Govt. of Myanmar

Co-Chair: Mr U Thoung Win, Vice President Myanmar Engineering Society

12.30 - 13.30:　*Lunch and Wrap up*

議事メモ

日時	3月4日　9:30～12:30	場所	ミャンマー技術協会
参加者	以下を含む、合計20名程度 ミャンマー技術協会　U Win Khiang 会長, TERI Ankit Narula, IGES　碓井		
内容	ミャンマーでのオフグリッド電力供給に関するワークショップ（IGES、TERI、ミャンマー技術協会共催）	作成者	IGES　碓井

ミャンマー技術協会 Win Khiang 挨拶

IGES,TERI 及び再エネ関係者の参加者に感謝。地方電化はミャンマーで重要な領域。2022 までに 75%の電化率達成目標。45000 の村を電化しなければならない。これは政府の目標だが、実際はさらに多くが必要。地方電化は、健康の問題、森林劣化、ジェンダーの課題ともつながる。従って、他の課題とつながっていく必要がある。携帯電話等の通信網の整備とも関連。

Introducing Joint Crediting Mechanism and objectives of the study IGES 碓井発表

JCM の紹介とその資金スキーム、他国での JCM 補助案件、ミャンマーでの潜在的案件の紹介等を行う。

Presentation on the off-grid study and its findings. TERI Ankit Narula による発表

ASEAN 諸国の電化率、ミャンマーの電力価格等の背景の説明。ミャンマーの電化目標を達成するために、1 年に 2300 の村を電化する必要あり。地方電化に関して、省庁間の調整や連携が不足しており、分担が不明快。再エネ資源としては、太陽光、バイオマス、水力、風力等非常に豊富。オフグリッド電化の形として、ソーラーランタン、充電ステーション、ミニグリッド等の形態を提案。エネルギー機器の規格化、資金調達等も重要。

質疑応答

・Khiang:ミャンマーの人々から政府への期待が大きくなっている。電力の供給もその課題も一つで、これの改善は政治的にも非常に重要。政府内での調整がうまくいっていないのは事実。実測値のデータはほとんどない。計測できなければ、存在しないも同然。政策は色々とできつつあるが、人々からすれば政策は重要ではなく、実際に何ができるかというところを気にしている。

・UThan Win：日本の JCM は非常によい機会。ミャンマーで JCM が実施されることを期待。政府は政策を多く議論しているが、実際に実施をどうするか、どうプロジェクトを作っていくかというところをいつも相談されている。MES はこのようなプロジェクトや JCM 制度の実施の力になれる。エネルギー省には、再エネ等に関するデータ整備の必要性を伝えてある。

・オフグリッドは非常に重要。現在の作成中のエネルギー戦略では、再エネ資源の開発や省エネ等が含まれている。実際のところ、政府の支援がなくても、人々は再エネを導入している事例は多くある。国際的な援助もあるが、それぞれ別に動いている。GEGG で共有されたミニグリッドに関するペーパーがあったが、良いペーパーではなか

った。ファイナンスに関してだが、Revolving Fund を国連と現地銀行の資金でやったことがある。JCM でも、ファイナンスを戦略的に検討する必要がある。

・（太陽光の専門家）国際的に、太陽光パネルの価格は大きく下落した。消費者は、店から太陽光パネルやその使い方の情報を得ている。品質や技術情報に関するラベル等はない。JICA の資金で、村に電力を供給したことがある。一般的に、低価格・低品質の製品を使う事が多い。ADB は、400 の村をパイロットとして選定し、再エネでの電源供給を試みている。

どのような資金調達が可能かという課題。ADB は、現地銀行と協力を検討している。ADB は銀行に、グラントや融資を行う。JCM は非常に面白い。案件の一つにディーゼルと太陽光の組み合わせがあったが、これは面白いと思う。何かモデル（デザイン）を作って欲しい。

・（MES）様々な取り組みがあり、それらをつないでいくことが重要。

・（産業省）ここ二・三年、産業省が地方電化を担っていたが、今は Livestock の省へ移っている。今の産業省の機能は、Resource Ministry のようなもの。

・（ヤンゴン技術大学）当大学では、エネルギー関係の修士プログラム等を組んでいる。

・（MES）大学は、高度人材を育成するのに非常に重要。また、将来的にオフグリッドとグリッドが繋がることができるようにする必要もある。法律で、FIT も導入すべき。

・(MES Household Energy Survey 担当者)家庭レベルでの省エネプロジェクトを行っている。電力アクセスがあり、1 日 1 人 2—5 ドルで生活している人々を対象としている。需要と供給を一致される必要がある。

・(Rural Development Department)　コメントなし

プロジェクトサイトについて検討。

・流れ込み式水力は非常に重要。場所については、川の位置等によるので州単位では議論しにくい。バイオマスも必須。

・バイオマスの利用に関する規制などはあるか。

→MOECAF が、森林に関して規制をつくっているが、現在はない。

・タイ政府と、RE の資源審査量の調査を検討している。


IGES
akeholder Consultation Workshop on Off-grid
Electricity Access in Myanmar
Jointly Organized by
The Energy and Resources Institute (TERI),
Institute for Global Environmental Strategies (IGES),
Myanmar Engineering Society (MES).
: Conference Room, MES

（了）

Draft Report

February 2014

Delivering energy access through clean energy in Myanmar - A technical assessment for off-grid energy supply

Prepared by

The Energy and Resources Institute (TERI)

Prepared for

Institute for Global Environmental Strategies (IGES)

The Energy and Resources Institute

...towards global sustainable development

Suggested format for citation

T E R I. 2014

Delivering energy access through clean energy in Myanmar - A technical assessment for off-grid energy supply

New Delhi: The Energy and Resources Institute. 67 pp.

[Project Report No. 2013BL13]

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Table of Contents

List of Tables

List of Figures

Table of Acronyms

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
DEP	Department of Electric Power
EDP	Energy Planning Department
ESE	Electricity Supply Enterprise
GWh	Gigawatt Hour
HDI	Human Development Index
IEA	International Energy Agency
IGES	Institute for Global Environmental Strategies
IPP	Independent Power Producers
kV	Kilovolt
kVA	Kilovolt Ampere
kW	Kilowatt
kWh	Kilowatt Hour
MEPE	Myanmar Electric Power Enterprise
MOAI	Ministry of Agriculture and Irrigation
MOECAF	Ministry of Environment Conservation and Forestry
MOEP	Ministry of Electric Power
MOLFRD	Ministry of Livestock, Fishery and Rural Development
MOI	Ministry of Industry
MOST	Ministry of Science and Technology
MW	Megawatt
NEDO	New Energy and Industrial Technology Development Organization
NEMC	National Energy Management Committee
NGO	Non-Government Organization
PIDS	Philippine Institute for Development Studies
REAM	Renewable Energy Association of Myanmar
TERI	The Energy and Resources Institute
T&D	Transmission and Distribution
UNDP	United Nation Development Program
US	United States
WEF	World Economic Forum
YESB	Yangon City Electricity Supply Board

1. Introduction

With a total area of 676, 578 km², Myanmar is the largest country in Southeast Asia and borders Bangladesh, India, China, Lao PDR and Thailand. The total population of Myanmar is around 61 million, spread across seven divisions and seven states. Administratively, the country consists of 14 states and regions, 67 districts, 330 townships, 64 sub-townships, 377 towns, 2,914 wards, 14,220 village tracts and 68,290 villages. Out of the total population, more than 70% lives in rural areas. The Gross Domestic Product (GDP) of the country stood at around US$ 53 billion, which is estimated to be growing at an annual rate of 5.5% [ADB, 2012a]. Yet the country is a least developed economy in Southeast Asia and poor performer in most indicators of economic and social progress [Turnell, 2011]. In 2010, per capita GDP was about $700, compared to $815 in Cambodia, almost $1000 in Laos, and more than $4900 in Thailand [Sovacool, 2012]. As per 2013 Human Development Index (HDI), the country has one of the lowest human developments with its rank at 149 out of 187 countries [UNDP, 2013a].

Figure 1.1 Map of Myanmar

(Photo source: Wikipedia)

With regard to the electricity access situation, nationally only 49% have access to electricity [IEA, 2012]. The rural electrification scenario is further dismal, with only around 28% of the population having access to electricity. In absolute terms, almost 26 million people were living without electricity in 2010. Further, the electricity consumption per capita in Myanmar is also among the lowest in Asia and had been growing very slowly since the 1980's. It grew from 45 kWh per capita in 1987 to 99 kWh in 2008; however, it is only since 2008 it achieved around 14.7% annual growth rate [ASH, 2012]. Even with this high growth in the last few years, the estimated consumption in Myanmar is only about 121 kWh per capita as compared to consumption of over 684 kWh per capita in India and nearly 680 in Indonesia, as cited by IEA [World Bank, 2013]. While electricity demand is growing fast, the current supply is more than 30 % below demand. Myanmar, thus, needs to address its strategic power and rural electrification sector reform to ensure sustainable access to electricity, which will also be important to attract investment, an essential element for economic growth.

While Myanmar is reportedly focusing on hydro power and gas based power to boost energy supply in the country [ASH, 2012], renewable energy, especially solar, wind and biomass, can play a major role in enhancing electricity access through decentralized options. As an off-grid solution, its significance in creating energy access is vital for Myanmar that faces challenges such as geographical constraints as well as limited financing.

With this background, TERI, with support from IGES, Japan aimed to conduct a technical assessment study, focusing on cleaner and sustainable options for electricity production and distribution in Myanmar to enhance electricity access especially in the rural areas of the country.

Objective of the study

Specifically, the objectives of the study as per the Terms of Reference (ToR) are to:

- Undertake a technical feasibility assessment for identifying alternative technical and delivery model, especially through solar and biomass energy, for enhancing rural electricity access in Myanmar;
- Provide a road map and recommend ways and means for disseminating renewable energy based distributed generation systems and suggest delivery model(s) and implementation arrangements, taking experiences from India and South Asia.

In addition to the above, the study also attempted to explore possible scope of capacity building support and possibility of engaging Japanese private entities using Joint Crediting Mechanism (JCM) promoted by Japanese government.

Tasks/scope of the study

The scope of work included a brief review of the electricity infrastructure, identification and interaction with the major stakeholders playing role in creating enabling environment for the off- grid electricity system. In this technical assessment, the following tasks were carried out;

a. Review of past studies/literature survey. Identification of key players in the rural electrification;

b. Situation analysis of electricity access in Myanmar, including stakeholder discussion;

c. Capacity gap assessment;

d. Data analysis and documentation;

e. Identifying relevant delivery models for enhancing electricity access in Myanmar with the help of successful case studies from neighbouring Asian countries.

Methodology

Keeping in view of the tasks, a well-defined methodology was adopted to achieve the objectives of the project. The methodology is described as follows,

a. A comprehensive literature survey was carried out, while referring research papers and reports published under eminent sources;

b. This was followed by a weeklong mission to Myanmar during 20 -28 November 2013, where a wide range of stakeholders from the field of energy, electricity and rural development departments, academia, research institutions, as well as non-government organization were visited (refer Annexure 1 for the list of stakeholders met). In the same visit the facts highlighted under literature survey were established. In the course of interaction, new facts were discovered, along with latest information was registered and documented.

c. Based on NASA satellite weather database and existing peer reviewed literature solar and wind energy resources assessment was carried out. The biomass energy assessment on the other hand was done using secondary literature such as Global Forest Resource Assessment 2005 of Food and Agricultural Organisation. The data on small hydro power was taken from available literature from relevant Ministries and Departments in Myanmar and previous studies undertaken by Asian Development Bank.

d. The prevalent technology and delivery models from neighbouring countries such as India and Bangladesh were highlighted, as appropriate for Myanmar.

e. Based on above information, a road map was developed for enhancing electrification in Myanmar for off-grid and rural areas.

Report structure

a. The repost is structured systematically providing a clear background on existing contours of electricity system in Myanmar and then moving towards devising strategies for enhancing electrification. The first chapter deals briefly with the background on the energy and electricity access sector in Myanmar. Besides, the scope of work, methodology followed and major tasks in this mission are listed in the chapter;

b. The second chapter describes the existing electricity situation in Myanmar, the policy frameworks, the structure of the power sector and details on off-grid electrification in the country;

c. Chapter 3 provides the details of renewable energy resources, especially solar, biomass and wind, available in the country. Further, the chapter also highlights the applicability of renewable energy technologies in specific geographic locations in the country;

d. Chapter 4 deals with delivery models for enhancing rural access to electricity while taking examples from neighbouring countries of Myanmar.

e. The last chapter, enumerate a road map for developing off-grid infrastructure in rural areas for enhancing reach of electricity in rural areas in the country.

2. Situation analysis

2.1 Energy access in South Asian region

Access to electricity is one of the preconditions for upliftment of people's living standards. It is a critical enabler and economies must secure access to it to underpin social development and for the overall growth. Energy poverty, however, is widespread causing a primary security issue impacting almost 800 million people, particularly women and children, in the developing countries of Asia [Spagnoletti, 2013]. Looking at the ASEAN (Association of South East Asian Countries) region, there exist large gaps in terms of energy use per capita – as shown in Figure 2.1. It is apparent that Myanmar and Cambodia have lowest energy use per capita, whereas Brunei, Singapore and Malaysia has seen consistent growth in their per capita energy consumption.

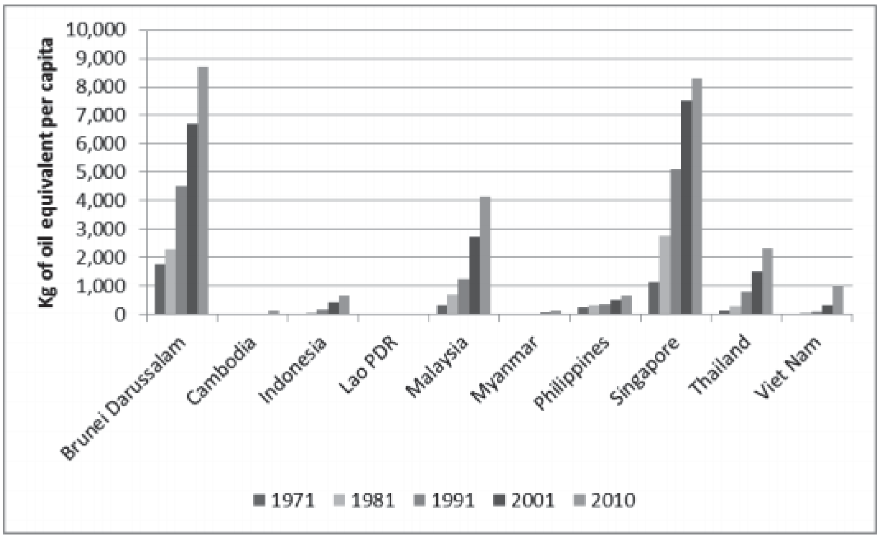


Figure 2.1 Energy use in ASEAN countries

Source: World Development Indicators, World Bank [PIDS, 2013].

For electricity access, Myanmar is standing at the cross roads with approximately 29 million people were living without access to electricity in 2010 [IEA, 2012]. Myanmar has the lowest per capita electricity consumption in ASEAN region, (Table 2.1), mainly due to the low degree of electrification and industrial development in the country [ADB, 2012c].

Table 2.1 Electric power consumption (kWh per capita)

Country	1971	1980	1990	2000	2010
Brunei Darussalam	1754	1699	4355	7577	8723
Cambodia	n.a.	n.a.	n.a.	33	144
Indonesia	14	47	165	395	639
Malaysia	310	657	1146	2720	4136
Myanmar	20	34	43	73	121
Philippines	236	373	361	502	641
Singapore	1155	2718	4983	7575	8307
Thailand	120	291	709	1462	2335
Viet Nam	41	55	98	295	1035

Source: World Development Indicators, World Bank [PIDS, 2013].

As per United Nations, the threshold of 100 kWh per person per year referred as quantum to fulfil basic human need – electricity for lighting, health, education, communication and community services, nine ASEAN members were above the standard in the year 2010 (no data were available for the Lao PDR at the time of this particular study) [PIDS, 2013]. Whereas in the context to modern society's needs – electricity usage of around 2000 kWh per person per year [UN, 2010], only Brunei Darussalam, Malaysia, Singapore and Thailand had electricity consumption per capita above the standard. Thus, to obtain this level, most of the ASEAN members, especially Myanmar, need to increase its electricity production substantially [PIDS, 2013].

Table 2.2 shows electricity access situation in ASEAN region. As per IEA statistics, more than half of the population living in Myanmar resides in dark, partly reflecting the difficulties involved in providing access to modern energy services.

Table 2.2 Electricity access in ASEAN region

Region	Population without electricity (million persons)	Electrification rate (%)	Urban electrification rate (%)	Rural electrification rate (%)
Brunei Darussalam	0.0	100	100	99
Cambodia	10.0	31	91	16
Indonesia	63.0	73	94	56
Laos	2.2	63	88	51
Malaysia	0.2	99	100	98
Myanmar	26.0	49	89	28[1]
Philippines	16.0	83	94	73
Singapore	0.0	100	100	100
Thailand	8.0	88	98	82
Vietnam	2.0	98	100	97

Source: IEA, World Energy Outlook 2012

2.2 Energy and electricity access scenario in Myanmar

In terms of primary energy consumption, Myanmar remains a biomass-centered with a majority of the households (95 %) depending on solid fuels such as wood and rice husks for cooking and heating. Most villagers reportedly spend 233 hours a year (about 20 hours a month) collecting fuel wood that not only contributes to deforestation but also inhibit household productivity. Dependence on solid fuels is largely due to the fact that 70% of the country's population lives in rural areas, far away from the reach of the country's national grid or commercial markets for diesel and kerosene [Sovacool, 2013]. Thus more than two-thirds (70%) of the households also depend on diesel lamps, batteries, or candles for lighting (Figure 2.2 & 2.3) [UNDP, 2013c].

[1] As per government data it is 27% in 2011-12 [MOEP, 2013d]

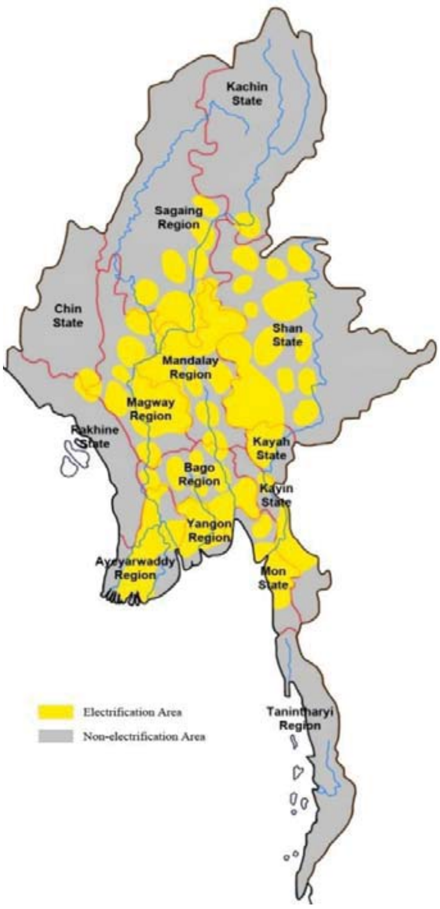


Figure 2.2 Status of electrification in Myanmar (*Source: Palang Thai, 2013)*

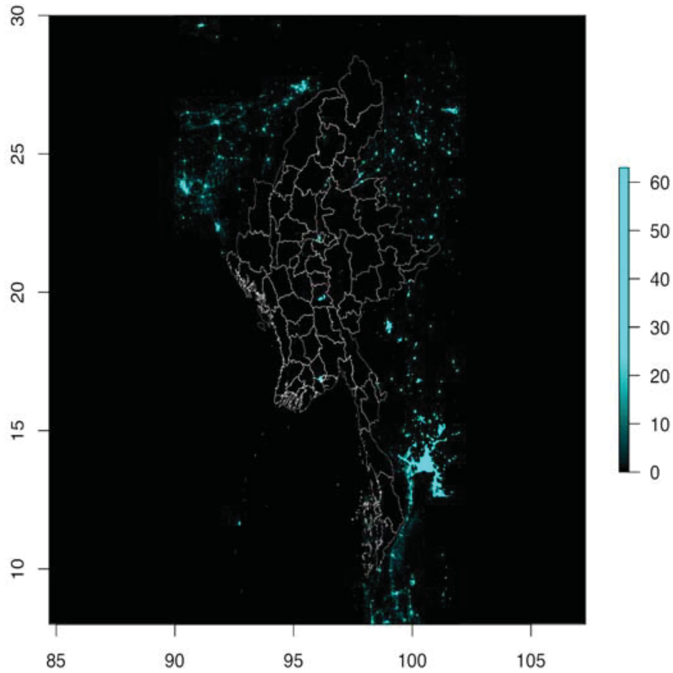


Figure 2.3 Nighttime Lights Imagery of Myanmar

(Source: Image and data processing by NOAA's National Geophysical Data Center. DMSP data collected by US Air Force Weather Agency; Cited in Kumagai S, Keola S and Kudoi T. Review on Myanmar Economy, Bangkok Research Center, http://www.ide.go.jp

Myanmar has abundant energy resources, particularly hydropower. The hydropower potential of the country's rivers, which drain the four main basins of Chindwin Ayeyarwaddy, Thanlwin, and Sittaung, is estimated to be more than 100,000 MW. However, less than 10% of the potential has been harnessed [ADB, 2012c]. In the current electricity mix, major share of generation is of hydro power, contributing around 77% of the total generation of 10835 GWh in the country [MEPE, 2013]. In order to meet the growing electricity demand and to have a better mix of electricity generation, Myanmar is also planning to build coal-fired and gas based thermal power plants [ADB, 2012c].

Further, the peak load demand in Myanmar has escalated from 322 MW in 1990 to 1,533 MW in 2011. At the same time electricity consumption almost doubled between 2001 and 2011 from 3,268 GWh to 6,312 GWh i.e. an increase of around 7% on annual basis during the last 10 years (Figure 2.4). Notwithstanding, the system still suffers from load shedding, corresponding to about 1% in terms of energy, but at times exceeding 250 MW or about 15% of the peak load [ADB, 2012c].

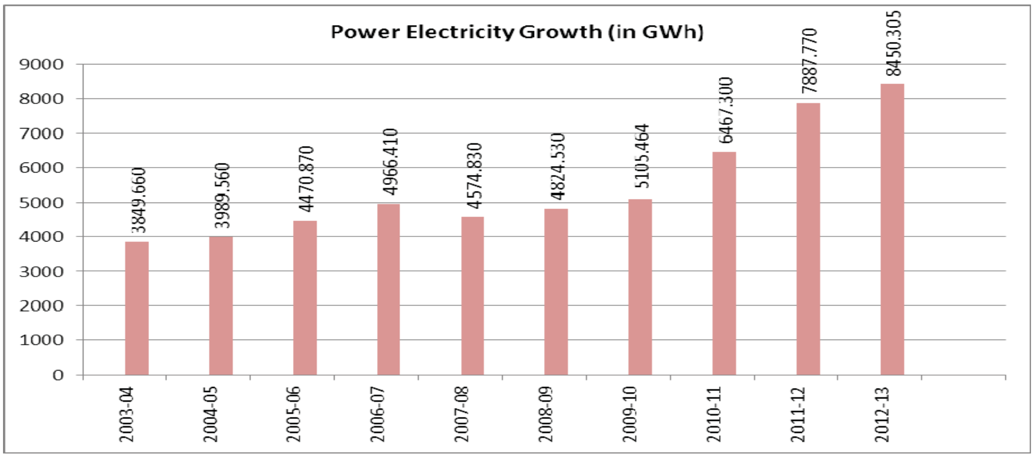


Figure 2.4 Growth in electricity consumption in Myanmar (Source: MOEP, 2013)

The national power grid network covers only 4.5% of the country's 62,218 villages (Figure 2.4), whereas 23% villages are electrified by off-grid means, leaving 73% villages un-electrified [Khaing, 2013]. The areas with lowest electrification ratios are: Yakhine (6%), east of Yangon; Ayeyarwaddy (9%), west of Yangon in the Ayeyarwaddy Delta; and Tanintharyi (9%) in the southeast [ADB, 2012c]. On the other hand, the urban areas of Yangon City has the highest electrification ratio (67%), followed by NayPyi Taw (54%), Kayar (37%), and Mandalay (31%) [ADB, 2013c]. While the average grid access rate was less than 50 villages per year during the 2003 to 2008, it is now being done rapidly (average 800 villages per year) since then. As per verbal consultation with MOLFRD during the TERI Mission, it is reported that 22% of the electrification in the country is through grid electricity, 59% is through diesel based generators in villages, 10% through small-hydro power, 6% is through biomass gasifier and only 3% is through solar power. Table 2.3 and Table 2.4 show the status of rural electrification in the country and Figure 2.5 provides growth of electricity access to villages through national grid.

Table 2.3 Status of rural electrification (as on Dec 2012)

Number of villages	62,218
Electrified villages (grid connected)	2,765
Electrified villages (off-grid)	14,195
Un-electrified villages	45,258
Per capita consumption	131

Source: MOEP, 2013a; MOEP, 2013b, Khaing, 2013b

Table 2.4 Region wise electrification status in Myanmar

State/Region	Total HH	Electrification rate (%)	No of Villages		
			Grid electrification	Off-grid	Un-electrified
Chin State	81055	16	-	326	1026
Mon State	340971	31	254	318	628
Kachin State	217309	26	1	283	2295
Shan State (East)	221825	9			
Shan State (S)	221825	9	374	786	13424
Mandalay Region	1060762	35	738	189	2313

State/Region	Total HH	Electrification rate (%)	No of Villages		
			Grid electrification	Off-grid	Un-electrified
Sagaing Region	862616	22	624	3060	2295
Bago Region	1004863	23	309	2070	2416
Ayarwadi Region	1335968	10	343	2992	8602
Rakhine State	527654	6	-	1033	2827
Taninthayi Region	207153	9	573	1611	2588
Kayar State	47514	41	53	42	416
Kayin State	1315439	23	46	79	1938

Source: MOEP, 2013

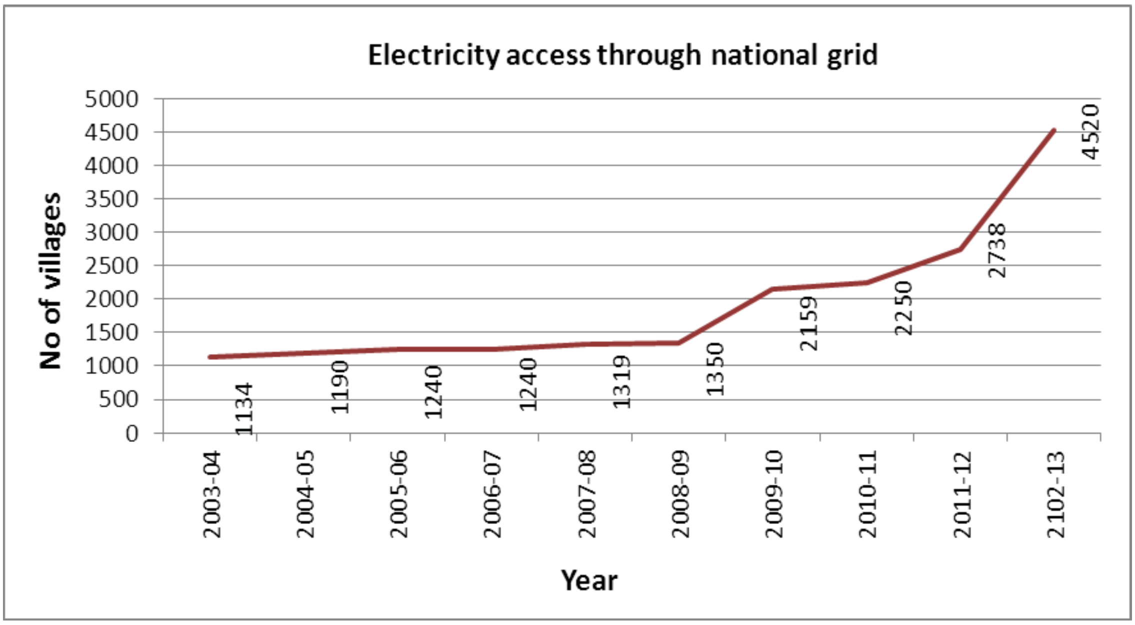


Figure 2.5 Growth of electricity access through national grid (Source: MOEP, 2013)

2.2.1 Myanmar's electricity sector architecture

The four main goals form the basis of Myanmar's energy policy framework: (i) maintaining energy independence; (ii) promoting the wider use of new and renewable sources of energy; (iii) promoting energy efficiency and conservation; and (iv) promoting household use of alternative fuels. Seven ministries in Myanmar are responsible for energy matters, with the Ministry of Energy (MOE) as the focal point for overall energy policy and coordination. The other six ministries are:

(i) Ministry of Electric Power

(ii) Ministry of Livestock, Fishery and Rural Development

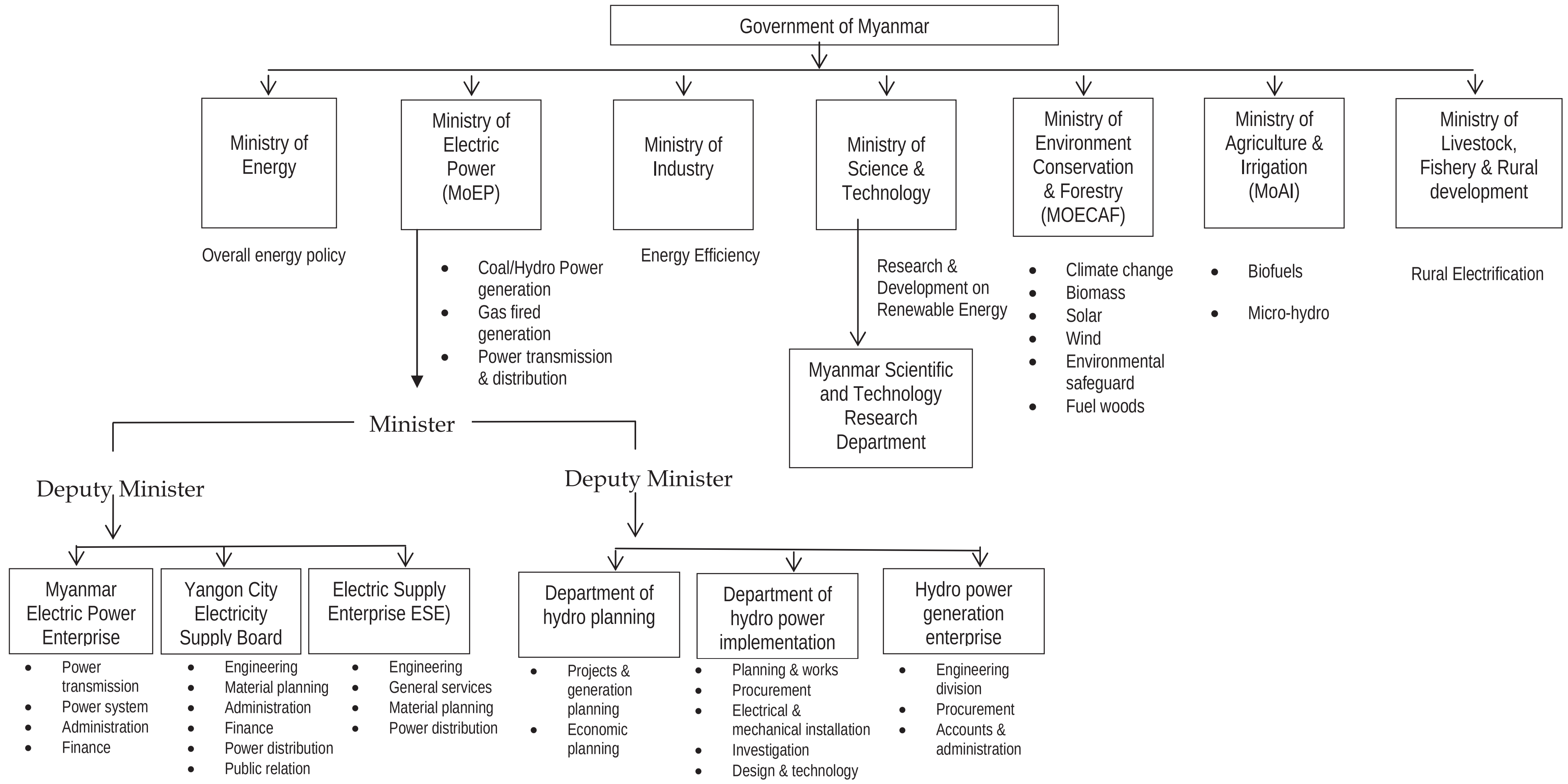
(iii) Ministry of Agriculture and Irrigation

(iv) Ministry of Science and Technology

(v) Ministry of Environmental Conservation and Forestry

(vi) Ministry of Industry (MOI)

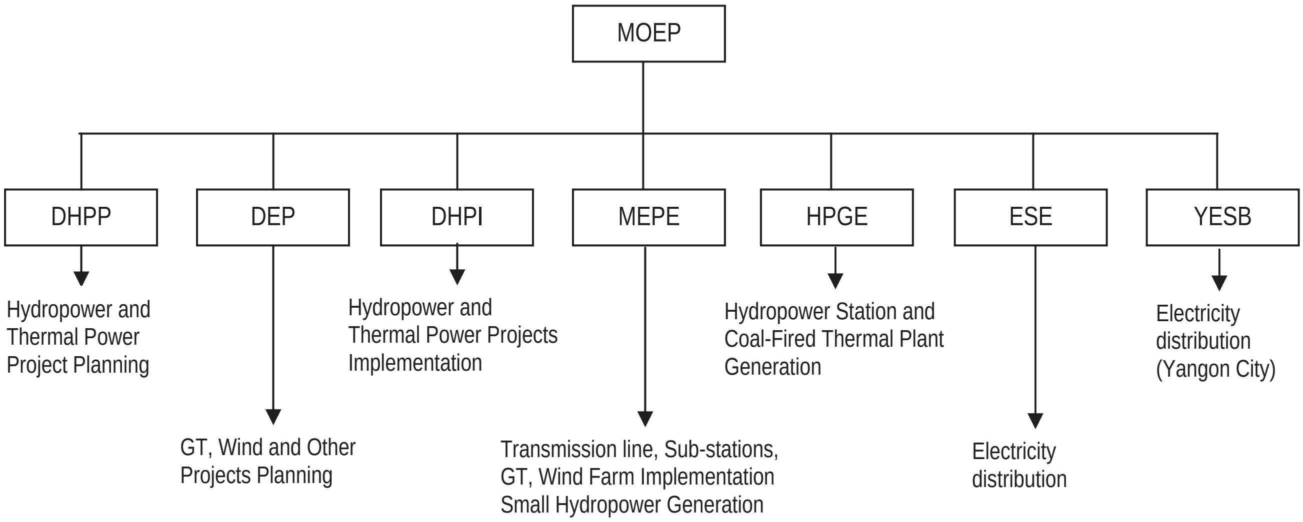
The Ministry of Electric Power (MOEP) is mainly responsible for electric power generation from hydro, coal and diesel along with power generation from gas fired power plants. The extension of transmission and distribution network also comes under the portfolio of MOEP. Figure 2.6 elaborates the government structure, ministries and various departments who are responsible for the energy and electricity related matters.



Energy Development Committee (EDC) & National Energy Management Committee (NEMC), under Government of Myanmar, takes care of planning and co-ordination amongst various Ministries.

Figure 2.6 Government ministries related to electricity in Myanmar

The electric utility sector is divided into the thermal and hydro power and the power distribution sector. Figure 2.7 shows the organization and function of MOEP. Other than MOEP there are number of other Ministries which form stakeholder fulcrum of electricity sector. These are Ministry of Agriculture and Irrigation (MOAI) that takes care of development of biofuels and micro-hydro power; the Ministry of Science and Technology (MOST), which is responsible for research and development in the scientific fields; the Ministry of Environment Conservation and Forestry (MOECAF) that looks after the forests, climate change and environmental standards; Ministry of Industry (MOI), looking after energy efficiency and approves electrical connections for businesses and industries; and Ministry of Livestock, Fishery and Rural Development (MOLFRD) that takes care of off-grid rural electricity access among others.



DEP = Department of Electric Power, DHPI = Department of Hydropower Implementation, DHPP = Department of Hydropower Planning, ESE = Electricity Supply Enterprise, GT = Gas Turbine, HPGE = Hydropower Generation Enterprise, MEPE = Myanmar Electric Power Enterprise, MOEP = Ministry of Electric Power, YESB = Yangon City Electricity Supply Board.
Source: Ministry of Electric Power.

Figure 2.7 Organization and function of MOEP (*Source:* ADB, 2012c)

For a coordinated approach in the energy sector the National Energy Management Committee (NEMC) and the National Energy Development Committee (NEDC) have been constituted in early January 2012 with all the above mentioned Ministries as the members. These Committees are responsible for strengthening the coordination and planning among various departments, ministries and institutions taking care of energy and electricity development in the country.

Role of NEMC

NEMC is a minister-level committee preceded over by the Vice-President No.2 of Myanmar. The NEMC Secretariat is composed of staff seconded from the energy-related ministries. The office functions under the Ministry of Energy. The Cabinet and NEMC represent the primary decision making bodies on energy and environmental affairs, and their responsibility is supplemented with the roles that numerous other ministries play. The NEMC is also responsible for assessing the appropriateness of institutional structure and organizational set up of various energy sector entities, and formulate capacity building program to fulfil the long term needs of the sector. There are 14 members of the committee with the Minister of Energy as the Chair and the Vice president as the Patron.

Constitution of National Energy Management Committee

Patron – Vice President P U Nyan Tun		- 1
Chair – Minister, Ministry of Energy		- 1
Dy. Chair	- Minister, MoEP	- 1
Members	- Union Ministers	- 6
	High Govt. officials	- 1
	Non Govt. officials	- 2
Secretary	- Dy Minister, MoE	- 1
Joint Secretary	– Dy Minister, MoEP	- 1
		Total 14

Role of NEDC

The National Energy Development Committee is to support the activities of NEMC. The committee is composed of various Deputy Ministers, whose responsibility is to implement policies and plans formulated by the ministry and approved by NEMC. Besides, EDC also formulate laws to regulate energy projects and minimize environmental and social impacts, coordinate public-private-partnerships in the energy sector, setting prices for the purchase and sale of energy products etc. In addition to the Energy Management Committee, the Ministry of Energy is the coordinating body for all types of energy in Myanmar, and its Energy Planning Department (EPD) has overall authority for formulating national energy policies [WEF, 2013]. The constitution of the NEDC is as follows:

Constitution of National Energy Development Committee

NEDC – Chair	- Minister, Ministry of Energy	- 1
Members	- Deputy Minister	- 5
	High Govt. officials	- 2
	Non Govt. officials	- 5
	Secretary – Proposed by Chairman	- 1
	Total	**14**

Ministries and government bodies taking care of rural electrification

The portfolio of rural development and related activities, including off-grid electricity access was earlier taken care of by Department of Rural Development (DRD) under the Ministry of Border Affairs. The role has now been recently transferred to the newly formed MOLFRD. MOLFRD ensures the deployment of new technologies, especially renewable energy based for addressing the basic energy requirements of rural households and the agriculture sector. The ministry has established a set of guidelines (having nine point agenda) for enhancing rural electrification in the country. The manner in which MOEERD plans to follow the development of electrification in rural areas is by forming "Rural Electrification Committee" which will be composed of local individuals, and linked to the state and or regional government.

Box1: Rural electrification guidelines of MOLFRD

- These guidelines cover roles and responsibilities of regional and state governments for conduct surveys in rural vicinity and update the relevant departments and ministry so that effective implementation of off-grid electrification can be carried out.
- Invitation of supplementary agencies for participation in off-grid development
- Emphasis on understanding comprehensive design of RE technologies
- Conducting workshops and training for capacity building for distributing knowledge about electricity among communities
- Development of mechanisms related to implementation and monitoring of off-grid electrification;
- Development or devising business plan for commercialization of off-grid electrification technologies etc.

The Ministry of Science and Technology (MOST), which is responsible for research and development, and ensuring the deployment of renewable energy technologies also plays a vital role in off-grid power development. Myanmar Scientific and Technological Research Department (MSTRD), under MOST is the technical arm responsible for implementation activities and projects. Research on micro-hydropower plants, led by the Ministry and MSTRD, includes the design and construction of different types of turbines and synchronous generators for micro-hydropower plants. On the biomass technology front, the development and installation of bio-gas plant for thermal application as well as for electricity generation has been undertaken by the department. . MOST has also undertaking research and development of small-scale gasifier, based on wood-chip and rice husk. These gasifiers are capable of producing 30–50 kW of electricity for villages in rural areas. MOST has initiated research and development on biodiesel, including production in pilot plants using Jatropha Curcas oil. They have installed solar systems to provide electricity to schools and institutes. To help demonstrate the practicality of this initiative, Mandalay Technological University (MTU) has installed 3 kWp photovoltaic (PV) power systems in several MOST technical schools and institutes located in remote areas and without access to the national grid system [ADB, 2012c]. The Ministry and its research department are also working with other technical universities in Myanmar for developing skills of youths on various renewable energy technologies. Apart from this, the department is also involved in establishing standards and norms for renewable energy equipment.

Besides, there are government linked professional institutions such as Myanmar Engineering Society (MES), who are helping promote renewable energy sector in the country and providing necessary technical assistance to other stakeholders for designing and installation of projects. There are also independent NGOs, such as Renewable Energy Association of Myanmar (REAM), who are also working extensively to promote renewable energy activities in the country. Both REAM and MES are actively participating in activities organized by the Government and private bodies for the development of off-grid power in the country and enhancing the use of renewable energy technologies.

2.2.2 Major electricity policies in Myanmar

Myanmar has setup rules and regulation for enhancing electricity infrastructure in the country. Some of these policies are:

a. **Electricity Act, 1948 (amended in 1967)**: This act declares the statutory powers and functions of the state's electricity boards and generating companies with the goal of providing the rational use of the production and supply of electricity.
b. **Myanmar Electricity Law, 1984**: The law requires rational generation, production, transmission, distribution, and usage of electricity.
c. **Private Industrial Enterprise Law, 1990**: The law puts a check in order to avoid environmental pollution in the face of rural development and industrialization, and to promote the use of energy in the most economical manner.
d. **National Sustainable Development Strategies, 2009**: It emphases the promotion of social, economic, and environmental growth and achieve sustainable development.

There are other interventions such as Forest Law, 1992 which besides providing opportunities for the private entrepreneurs to establish plantations and community woodlots on the government land – such that they can used for producing energy and electricity – also safeguard forest (from deforestation), biodiversity and allied constituents. There is also a Conservation of Water Resources and River Law, 2006 which regulates the use of water for economic activities such as power generation etc., besides conserving and protecting Myanmar's water resources, including rivers for sustainable utilization and preventing contamination etc. [UNDP, 2013c].

2.2.3 Grid connected power generation status in Myanmar

The total installed power capacity in the country is about 3,614.9 MW (as of 2013) out of which hydro power contributes to 77% i.e. 2,780 MW and the share of gas and coal is 714.9 MW and 120 MW respectively[1]. The installed and available capacity of generation plant till year 2012 is summarized in Table 2.5.

Table 2.5 Installed and available generation, 2012

Power plant	Installed capacity (MW)	Firm capacity (MW)	Annual production (GWh)
Hydro	2660	1504	7722
Coal-fired	120	27	266
Gas turbine	715	427	2845
Total	3495	1958	10835

Source: [ADB, 2012c], [MEPE, 2013]

The national target is to grow the power generation capacity to 15,000 MW by year 2020-21[UNDP, 2013c] and increase the number of electrified households from 27% in 2011-12 to 45% by 2020-21 and 80% by 2030-31 (Table 2.6) [MOEP. 2013c].

[1] As per MEPE, total installed power capacity in the country is about 3896.05 MW (2013) out of which hydro power contributes to 71% i.e. 2,780 MW and the share of gas and coal is 996.05 MW and 120 MW respectively [MEPE, 2013].

Table 2.6 Long term village electrification plan in Myanmar (Source: MOEP, 2013)

Term	Projected Population (million)	Demand Forecast (MW)	Required Generation (GWh)	Target for Electrified Household (%)
Yr. 2011-12	60.44	1,806	10,444	27%
From Yr. (2012-13) to Yr. (2015-16)	63.14	3,078	17,797	34%
From Yr. (2016-17) to Yr. (2020-21)	66.69	5,686	32,874	45%
From Yr. (2021-22) to Yr. (2025-26)	70.45	10,400	60,132	60%
From Yr. (2026-27) to Yr. (2030-31)	74.42	19,216	111,100	80%

Source: MOEP, 2013

The government also realizes the importance of renewable energy in enhancing energy access. Sources of Renewable energy considered in Myanmar includes: small-hydro[1], solar power, wind energy, biomass power – biomass gasification, biogas & biofuels, geothermal, tidal, and wave [MOEP, 2013a] [MOEP, 2012] [MOE, 2009]. A target of installing 500 MW of renewable energy capacities by 2015 [Khaing, 2012a], and substituting 8% of transport fuel – based on consumption in year 2005 – with Biofuel till 2020, has been launched by government of Myanmar [MOEP, 2012b]. Figure 2.4 and Figure 2.5 shows solar energy and wind power development and the targets set by government of Myanmar.

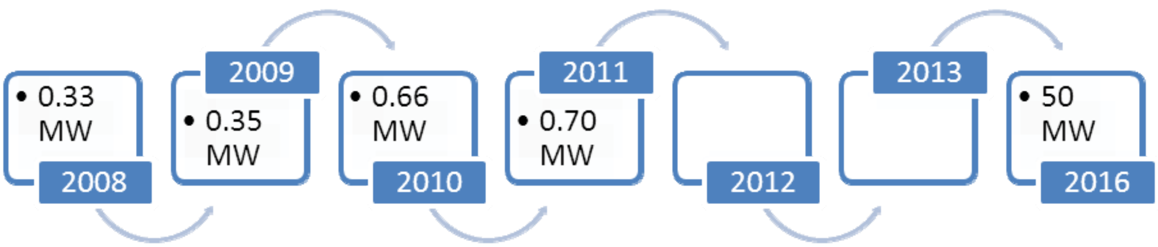


Figure 2.8 Solar energy installed capacity and targets for year 2016

Source: Khaing, 2013b

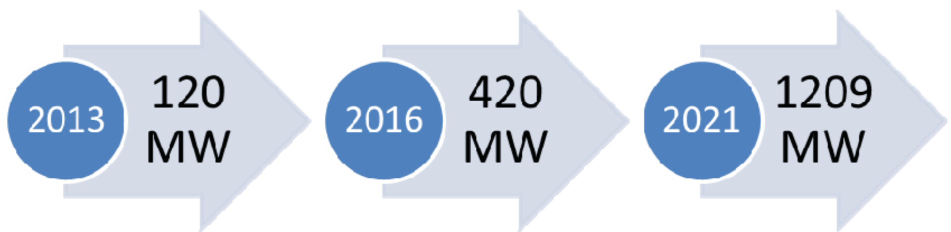


Figure 2.9 Wind energy installed capacity and target install capacity for year 2021

Source: Khaing, 2013b

[1] The classification of small hydro and large hydro as renewable and non-renewable source of energy is not very clear in Myanmar, as it is in many other countries like India which puts hydro power plant as renewable source in case its capacity is less than 25 MW.

By 2012, the maximum power demand in three major districts: Yangon, Mandalay and Nay Pyi Taw were 917 MW[1], 296 MW and 96 MW respectively. The total was 1850 MW in 2012. According to demand forecast the demand shall go up to 2128 MW, 2447 MW and 2814 MW by 2013-14, 2014-15 and 2015-16 respectively[2] [MOEPa, 2013].

During the summer months (December till March), thermal power plants provide 26.5% of the demand compared with 73.5% from hydroelectric which become significantly constrained; whereas during the cooler wet period (June to September), the hydropower contribution increases to 76.9%. In all cases energy from other sources contributes marginally. As apparent, during the wet season the hydropower stations are able to generate at optimum capacity, whereas the grid experience significant load shedding up to 500 MW during dry season because of unavailability of hydro resource. Further, in case no new generation capacity is added, the load shedding may increase up to 800 - 1000 MW by 2014 [WEF, 2013].

The electrification coverage in Myanmar can be accelerated through participation from private sector. However, currently the guidelines and national energy and electricity agenda is not very clear. Besides, laws, regulations and grid-codes that are required to promote and create investor friendly electricity sector are also not laid out clearly. In other words, there is no structured or recognized Independent Power Producers (IPPs) framework in Myanmar [Devex, 2014]. MOEP recognizes that private sector participation is inevitable to meet growing demand and that independent power producers can provide additional generation and overcome the power shortage, even though the generation costs per unit will be higher than existing [ADB, 2012c] [ADB, 2013b].

There are some private sector participation coming in, for example General Electric (GE) from United States , Gunkul and Three Georges Co. are eyeing to install gas based and wind power generation in the country [The Nation, 2014] [Enerdata, 2012]. Gunkul Engineering Public Co of Thailand is to conduct the feasibility on building wind mills at seven places in Mon, Kayin, Tanintharyi region and Shan state to produce 2,930 MW of electricity, while the Three Georges Co of China is also to do so in Chin and Rakhine states, and Ayeyawaddy and Yangon regions to produce 1,102 MW of electricity. Similarly, The Green Earth Power Co Ltd of Thailand is seeking to establish 50 MW of solar power plant in Minbu in Magway Region [Mizzima, 2013b].

Summary

Table 2.5 summarizes the current level of development with respect programs initiated by government, along with targets. With this it is apparent that government realizes the importance of electrification in the country, and that non-conventional means can play a vital role in achieving it.

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[1] As per another source from MOEP maximum demand in Yangon is 791.69 MW [MOEP, 2013c]

[2] As per another source from MOEP the peak demand in 2012 was 1,790 MW and it'll go up to 2,060 MW, 2,370 MW and 2,725 MW by 2013-14, 2014-15 and 2015-16 respectively, as per the demand forecast [MOEP, 2013d]

Table 2.7 Current and targets for various programs and development

Programs/Development	Current					Target				
	2008-09	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2021 - onwards**
Myanmar Electrification rate[1]	13%	13%	26%	26%	26%[2]	26%	DNA	DNA	DNA	DNA
Village Electrification Plan from MOEP[3]	DNA	DNA	DNA	DNA	3,152	3,575	4,116	4,793	DNA	DNA
Solar energy installed capacity and targets[4]	0.33 MW	0.35 MW	0.66 MW	0.70 MW	DNA	DNA	DNA	DNA	50 MW	DNA
Wind energy installed capacity and target[5]	DNA	DNA	DNA	DNA	DNA	120 MW	DNA	DNA	420 MW	1209 MW

DNA: Data Not Available

1 Source: REN21, 2013

2 According to government data it is 27%, whereas IEA quotes it 28%

3 Source: MOEP, 2013a

4 Source: Khaing, 2013

5 Source: Khaing, 2013

Transmission & distribution

The transmission and distribution scenario in the country is poor having one of the highest losses in Southeast Asia (figure 2.6). The network is mainly spread over central region of the country as shown in figure 2.7. The power generated is transmitted to the cities, which mainly cover central region up till Mandalay, covering Nay Pyi Taw, Yangon and adjacent zones, leaving other parts of the country. The main isolated regions include Rakhaing, Kachin, Shan, Mon and Taninthary.

The development and implementation of transmission network is done at 33 kV, 66kV, 132kV and 230 kV. Distribution systems consist of lower voltage levels — 33 kV, 11 kV, 6.6 kV, and 0.4 kV. Two distribution enterprises operate the distribution systems in the country. The Yangon City Electricity Supply Board (YESB) is responsible for the supply of electricity to consumers in Yangon City. The Electricity Supply Enterprise (ESE) covers the rest of the country comprising 13 states and regions.

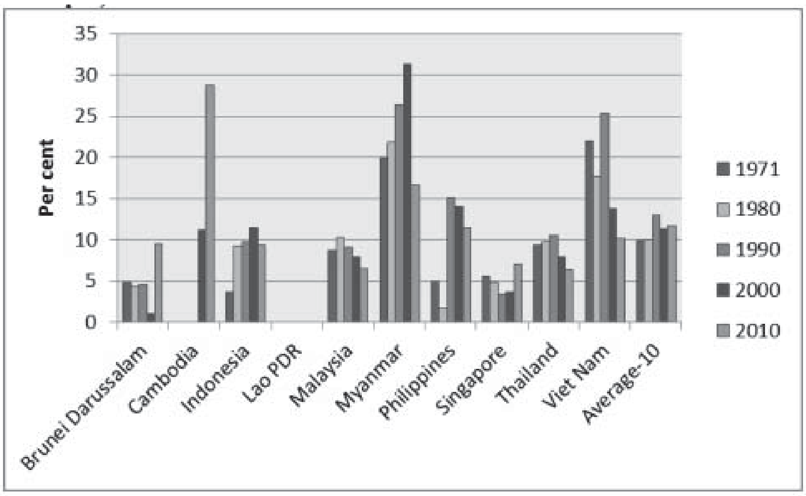


Figure 2.10 Electric power transmission and distribution losses (per cent of output)

Source: World Development Indicators, World Bank (PIDS, 2013)

Electricity tariff

Electricity cost in the country is highly subsidized. There are two categories of electricity tariffs:

1. 35 kyats/kWh for general purpose (households), street lighting, government offices, and low-voltage temporary users; and
2. 75 kyats/kWh for domestic power, small power, bulk (for >30 kW supplied at 33 kV), and high-voltage temporary users [ADB, 2012c].

As per discussions with stakeholders the government acknowledges the low cost of electricity supply and had tried to raise the prices; however the decision had to be rolled back due to agitation and mutiny from civilians. The government is trying again and very soon publish the escalated prices in public.

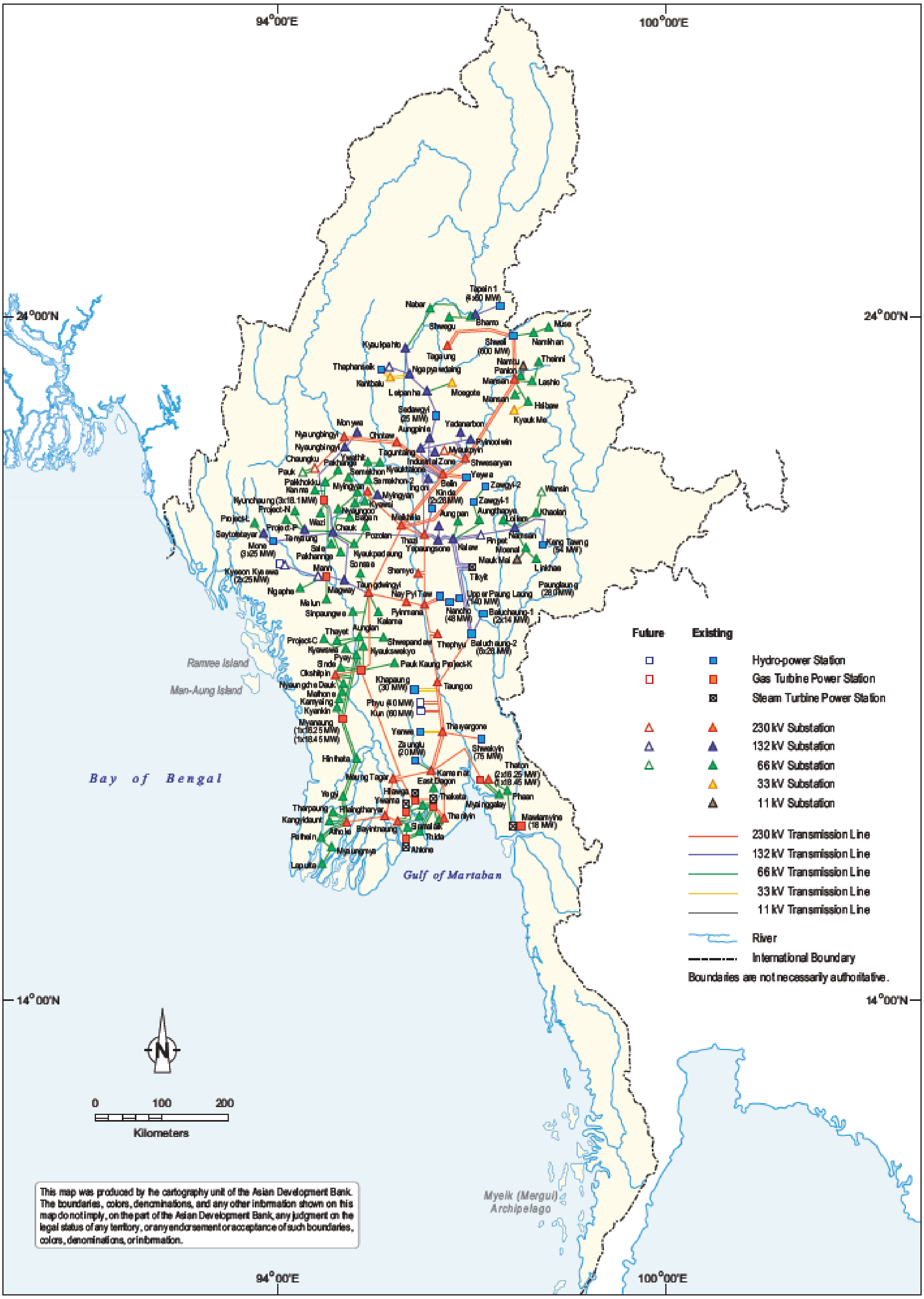


Figure 2.11 Existing transmission network in Myanmar (Source: Ministry of Electric Power (MOEP), September 2011 [ADB, 2012c]).

Major challenges in existing grid connected power system

It is apparent that the electricity system in general is evolving in Myanmar. Besides, there are areas where urgent steps are required in order to have a sound power system. Following points throw light on a few such areas which were pointed out in literature as well during discussions with key stakeholders during the Mission. .

a. At present there is no framework, regulations or guild lines in place for establishing IPPs in the power sector in Myanmar. The obvious advantage of IPPs is the opportunity they offer for private sector players to have a market presence at a lower risk [WEF, 2013].

b. During the dry season, the generation capacity from hydro power drops off due to insufficient water storage in the reservoir.. The consequence to it is the brown outs or load shedding. This is due to skewed electricity generation mix in the country, dominated by hydro power generation.

c. In theory, Myanmar has more than adequate capacity to deal with peak loads. However, inadequate maintenance, lack of investment to upgrade gas and coal power plants, and poor compression in the gas pipelines has made the operation of the gas and coal-fired plants at a significantly lower level than their potential capacity.

d. The national electricity grid reaches only to a small percentage of the population besides suffering from high transmission and distribution (T&D) losses and conductors and transformers are overloaded, resulting in high system losses (27%). This is largely due to poor maintenance of the T&D systems and extensive electricity theft [WEF, 2013].

Off-grid electrification

In light of the above challenges in expanding existing grid system and further challenges of lack of finance, geographically inaccessible villages and limited capability of the government in expanding the electricity infrastructure, off-grid electrification provide a huge potential to provide electricity access to all in Myanmar. As mentioned in the earlier section, more than 29 million people out of 60.6 million still do not have access to electricity in the country and a majority of them are potential off-grid customers. Currently, off-grid electrification in Myanmar is promoted both by the government as well as private sector and individual efforts. The paragraph below elaborates different type of interventions:

Government led off-grid installation

Government of Myanmar realizes the importance of off-grid means for carrying out electrification in the country. As per MOEP, Off-grid electrification that has been carried-out by government in the country is mainly through diesel generators and small/mini hydro power [MOEP, 2013b].

The following are the details of the off-grid electrification projects undertaken by different government agencies in Myanmar:

a. **Small/mini hydro power:** As per government data, 32 small and mini-hydro plants have been installed by Electricity Supply Enterprises (ESE) generally ranging between 1 MW and 10 MW in capacity - all of which have been built by the government outside the grid system supplying electricity to the rural areas. They have a combined capacity of 33,327 kW. In addition to these 32 hydropower stations, another 17 mini hydro facilities with about 5.23 MW of capacity, 29 micro-hydro facilities constituting 378.5 kW of installed capacity and 6 pico-hydro facilities with 35 kW of combined capacity is also functional.

There also exists sites significant micro hydro potential in the country which could be utilized to generate electricity for micro-grids consisting of 50 to 200 homes or in cases of pico-hydro facilities a few interconnected homes. There are also mini hydropower plants installed by irrigation department in the water supply canals/dams, especially in the central and southern region of Myanmar, which reportedly produce around 870 kW of electricity [Khaing, 2013b].

b. **Diesel generation:** A network of 645 diesel generators have been installed by MOEP in various regions, electrifying 312 numbers of villages, cumulatively forming an installed capacity of 77.611 MW [MOEP, 2013b]. These generators are controlled by the regional or state government authorities. Most of these generators are either under/over loaded or runs inefficiently, and many times their operation is constrained due to un-availability of diesel.

c. **Biogas**: Myanmar is an agriculture based economy. People keep animals like cows and other animals especially in the Mandalay, Sagaing, and Magway divisions for milk etc. In order to use the waste generated by these animals and to get biogas which can be utilized, Myanmar government has been running a program since 1980 for using biogas for power generation as well as thermal energy. The total power generating capacity, based on biogas, installed in the country is around 19 MW [UNDP, 2013c]. MOST has set-up 153 bio gas plants for thermal purpose till 2010 in Sagaing, Tanintharyi and Mandalay region in Myanmar. In addition, a total of 867 family size floating type biogas plants, have been constructed in 134 townships in all 14 States and Regions for thermal application [Khaing, 2012].

d. **Solar and wind energy**: As per MOEP & MOLFRD, small scale off-grid units which include 116 kWp of solar energy and 519 kWe of wind energy have been installed till 2009 [MOEP, 2013b]. Some of the pilot projects being implemented by the universities and MSTRD are as follows:

- Solar Photovoltaic Battery Charging Community Enterprise, financed by the Energy Services and Income Generating Opportunities for the Poor (Project "ENSIGN"), in collaboration with Yoma Bank and Energy Planning Department of the Ministry of Energy;
- Demonstrative Research on a Photovoltaic Power Generation System in Myanmar, in cooperation with NEDO of Japan and the Department of Electric Power of MOEP and Solar Power Village Electrification Scheme, with research and development of solar equipment prototypes, supported by the Myanmar Scientific and Technological Research Department and the Department of Physics of the Yangon Technological University;
- MOST has begun providing electricity to schools and institutes by using solar energy. To help demonstrate the practicality of this initiative, Mandalay Technological University (MTU) has installed 3 kW PV power systems in several MOST technical schools and institutes located in remote areas and without access to the national grid system. For each school, there is enough power to supply 10 computers, one overhead projector, IPSTAR internet equipment, and 10 fluorescent lamps.
- There are some small capacity demonstration wind turbines operational in Myanmar, including at the Technological University (Kyaukse), Shwetharlyoug Mountain in Kyaukse Township, the Government Technical High School (Ahmar) in Ayeyarwaddy region, and Dattaw Mountain in Kyaukse Township. In addition,

research and development projects on wind energy are being undertaken at the Yangon University and Department of Electric Power in cooperation with the New Energy and Industrial Technology Development Organization (NEDO) of Japan. Further, NEDO has assisted in installing wind and solar measuring equipment at several sites, to collect data and to conduct feasibility studies for wind-solar power hybrid systems

Private enterprises or individual interventions

There are many plants in rural areas which have been set-up and being operated by private organisations. These plants generate electricity by various technologies such as hydro, solar and biomass gasifier, and supply power to households and businesses in the local area. However, there is limited data available in literature as well as with the government about the number of such plants operating in the country, leaving them majorly un-accounted. All the privately installed plants operate on use-and-pay or on lump-sum payment bases.

Various technologies used by private generators and individuals and their status is described below:

a. **Diesel generators:** The government recognized that a large number of private diesel generators are operational in the country for electrification in villages [MOEP, 2013b]. No record is however, available with the government as of how many are there or what is the total capacity of these private generators. These generators set-up mini-grids and supply electricity to the households, as shared by key stakeholders during discussions with TERI team.

b. **Hydro power:** There are a large number of installations, mainly small, put-up by private enterprises or villagers. These mini-hydro power plants are installed at the drop structure that require a flow rate to operate turbine as small as 0.1~ 0.5 m^3/sec which has enough water head and flowing water rate to generate hydro power. Mostly Propeller type turbine are selected for low head plant i.e. working head is around 1.0 ~ 2.0 m [MOEP, 2013a]. Another approach being used to provide electricity supply is through pico-hydro unit (1-3 kW) based village electricity supply, implemented by wealthy farmers, especially in the southern delta as well as north-eastern hills. These systems supplies electricity to around 10- 15 households for lighting. Those who want to operate TV-sets bring car-batteries to the farmer's house for charging during day-time. These pico-hydro units, ranging from 2 kW to 5 kW, are sold by the Chinese traders in the north and eastern regions bordering China at around $70 to $450.

c. **Solar power**: Solar resource is quite abundant in the country especially in the dry region which occupies the northern part of the Myanmar. Many electrification projects which include solar home systems, battery charging, water pumping, solar systems solution for schools, hospitals, resorts and hotels etc. have been installed in Yangon, Mandalay, Bago, Sagain, Mon, Shan, Ayarwaddy etc. The most common found in the villages is the 50 Wp and 75 Wp solar home systems, available at US$ 300 and US$ 500 respectively. The 75Wp systems combined with a 120 ampere battery can power three 20-watt lights and a television set for about four hours, while a 50 Wp panel with a 70 ampere battery can power three 10-watt lights and a television set for about three hours. There are also some solar mini-grids installed for supplying electricity to houses in villages. Many companies such as Earth Renewables, Sunlabob, Bennu-Solar, Proximity Designs etc. are operating in the country, which supply solar PV systems including solar lanterns and solar home systems. No exact data, however, is available as of how many solar systems or capacity has been installed in the off-grid areas.

d. **Biomass gasifier based power generation:** There are 1,096 numbers of biomass gasifier installed for electricity generation till December 2010, as per statistics from the Ministry of Information, Myanmar [Khaing, 2012a]. These biomass gasifiers use either wood chips or rice husks, and are used for village electrification as well as for industrial purposes. The total biomass based installed capacity is around 19 MW [UNDP, 2013c] [MOEP, 2013b].

Table 2.8 Biomass Gasification based power generation systems (up to Dec 2010)

Sr.No	Region (State & Region)	Number of Plants
1	Kachin State	45
2	Kayah State	1
3	Kayin State	8
4	Chin State	-
5	Rakhine State	17
6	Mon State	35
7	Shan State	62
8	Bago Region	85
9	Sagaing Region	208
10	Tanintharyi Region	9
11	Magway Region	47
12	Mandalay Region	502
13	Yangon Region	3
14	Ayeyawady Region	74
	Total	**1096**

Source: Ministry of Information cited in Khaing, 2012a

Donor funded projects

Other than government and private led installation there are rural electrification projects supported bilaterally or multilaterally by organizations such as ADB, UNDP, UNIDO etc. Many of these projects are based on renewable energy technologies including hydro power, solar PV and biomass gasifier. Particularly solar PV based projects are more in number. Many plants are operated based VECs (Village Electrification Committee[1]) model [MOEP, 2013a]. These projects are only partially recognized or registered by the Myanmar government authorities. For instance, one of the solar PV installer, M/s Earth Renewables, shared that they have undertaken installation of many such projects in Sagaing, Mandalay, Ayarwaddy, Shan & Mon region with funding support from Korea, Japan and other bilateral aid.

[1] A VEC is a community driven model in which rural community plays an important role as a power producer, distributor and supplier of electricity. A VEC, which is made out of beneficiaries, are also responsible for selection of consumers, planning for the distribution networks, tariff setting and revenue collection.

Market and cost of renewable energy interventions in Myanmar

It was gathered during the stakeholder's consultation that market penetration of solar PV, biomass gasifier and hydro power is quite descent in Myanmar. This means that there are good number of suppliers and installers doing business in these technologies. In case of solar PV it was informed that rural communities are well aware about the solar PV technology and there is sufficient influx of rural populations buying such systems for installing in houses or for doing business in the villages. The solar PV panels available in the markets are mostly of Chinese make; however, panels are also imported from Japan and South Korea but the volume of business is comparatively less. It is reported that more than 40 companies in Myanmar are importing solar panels and related products, mostly from China [Vanderschelden, 2013]. Companies of solar PV products doing business in Myanmar include Myanmar Thiha Group of Companies, Earth Renewable Energy Co. Ltd., Smart Group of Companies, Asia Solar Co. Ltd., Nayminn Energy Systems, etc. Various foreign companies doing business in Myanmar includes Ever Exceed Corporation (Singapore), Leonics/Leo Electronics Co. Ltd. (Thailand), Hitachi High-Technologies Corporation (Japan), Kyocera (Japan), Eversolar (Taiwan), Hyundai (Korea) etc. The price of solar PV panels is quite at par with prevalent the international prices in south and south east Asia, which is around 1$/Wp for modules sold by Chinese suppliers and around 2$/Wp for the modules from Japanese and Korean companies. As apparent, Japanese and Korean solar panels come at high cost, but their performance is acceptably better, besides, warranties are also available, as shared during consultations with some of the local companies dealing on solar panels. On the other hand there are concerns about the solar panels imported from China, which experts believe are not reliable and/or sustainable [Evwind, 2013][1].

Tariff of renewable energy projects

The electricity charges paid by consumers in the off-grid areas are highly variable and different for government and private generators. The tariff vary depending on the type of generator i.e. diesel or other means (e.g. solar, mini-hydropower etc.) and ranges between 100 kyats/kWh and 300 kyats/kWh for government generators [ADB, 2012c]. Whereas, the electricity tariff charged by private enterprises not only varies from region to region but also are based on the type of generation technology. For example, the charge of electricity supplied through diesel generator reportedly ranges from 200-300 kyat per kWh or 2000 kyat per point per month in villages. The electricity generated through gasifier is supplied at 200 -700 kyat/kWh or 1000 kyat per month for energizing 20 W light point for 3 hours a day. On the other hand in Rakhine state in the north-western region of the country, a private company supplies electricity in 16 townships (out of 17 townships) at a rate of 500 kyats per kWh, which is almost 14 times the cost in Yangon [Mizzima, 2013].

Challenges in renewable energy based off-grid electrification

It is apparent that there is an urgent need of electrification of off-grid areas in Myanmar and renewable energy stands out as one worthy means to do so. However, there are technical and non-technical challenges for implementation off-grid electrification in the country as described below:

a. **Institutional challenges**: The institutional framework in Myanmar for rural electrification is new and very complicated. Around seven Ministries have a bit of role in off-grid electrification and there is less communication and coordination amongst them.

1

The newly formed rural development ministry – MOLFRD - which has a principal role in rural electrification is currently engaged in building the framework, which it can establish such that electrification task can be taken up by local government machinery. As apparent it is a complex and time taking task which government realizes and doing its effort to sail through. Moreover, the ministry also needs to engage itself in developing proper electrification programs, rules, guidelines, regulations, along with methodologies for monitoring the development which is yet to be formulated. These are very important in order to erect a sound and sustainable system. Overall, it was established that not much emphasis has been given to small scale solar and wind based power generation. Further, it was found that there is absence of flow of information in the system. For instance the government isn't fully aware about installations facilitated or funded by organizations like UNDP, UNIDO etc.

b. **Financial challenge**: There are financial challenges in terms of limited funds available with the government for developing grid infrastructure or invest in physical infrastructure to electrify villages with off-grid technologies like solar, biomass gasifier etc. Limited financial capital available to support for research and development, market-based investment programs etc. Due to subsidized power and petroleum prices, it makes difficult for wind and solar energy alternatives to compete [ADB, 2012c]. The country also have very low power tariff, especially for urban consumers and incurs high transmission and distribution losses. This impact the fiscal health of the utilities and hence, the government in a dual manner. In addition, absence of capital subsidy schemes, interest subsidy/waver schemes etc. which are useful and important for enhancing deployment of Renewable Energy for off-grid electrification, are currently absent.

c. **Technical challenges**: Due to recently opened market and new and rapid development, the government hardly has been able to develop rules and regulations related to technologies. There are less codes and restrictions. The consequence of it was random and unsustainable introduction of technologies and usage. For example in case of biomass gasifier it is only recently the government was able to control and restrict implementation which was hampering environment due to haphazard dumping of the waste water from the gasifiers; which calls for technology upgrade. Similarly, there are hardly any rules for solar PV instruments and machines. Then there is a lack of human resource capacity available for implementation of off-grid measures, especially using renewable energy technologies. Furthermore, there is hardly any onsite measured renewable energy resource data which is very essential and important for renewable energy development.

Inference

The development of electricity infrastructure in Myanmar has been low, with only small percentage of the country connected to grid, mainly central portion covering region/states like Bago, Mandalay, Yangon, Mon, etc. With respect to future plans, MOEP will expand the grid in other areas. Out of 3,614.9 MW of installed capacity, the share of hydro power is maximum (77%), followed by coal and gas based power. In summer season, due less hydro resource and incremental demand, power shortage occurs. In order to avoid that more thermal generation is being planned.

The electrification ratio in the country is lowest in Rakhing. Ayeyarwady, Tanintharyi, Chin, Kayin etc. and highest in Yangon, Mandalay, Naypyidaw (Union Territory), Kayar etc. In off-grid areas the electrification, participated by both government and private, is done through a network of diesel generators and small hydro plants. Renewable energy technologies mainly solar and biomass gasification (rice husk based) are predominantly used in off-grid areas. Many donor funded projects are installed mainly based on solar PV, apart from a few installed by government. The equipment for solar PV, especially panels are mainly imported from China, Japan and Korea. The cost of Chinese panels is quite low and competitive to the international rate; however there are concern about its quality and performance amongst the stakeholder.

The electricity tariff for grid based power is low – 35 kyats/kWh for domestic and 75 kyats/kWh for bulk consumers – and almost constant in all the areas. Whereas, electricity tariff in off-grid areas is between 100 to 300 kyats/kWh for government generators. The tariff for privately generated power distributed amongst rural consumers – either based on renewable or conventional generated power (mainly diesel) – is high and variable ranging between 700-1000 kyats/kWh.

3. Renewable energy resources

This chapter discusses the availability of renewable energy resources in Myanmar. It mainly talks about solar and biomass energy potential in the country and briefly explains small & micro hydro and small wind potential in different parts of country. However, potential assessment of other renewable energy resources such as; geothermal energy, tidal energy, wave energy, large hydro etc. has not been ascertained. as they are beyond the scope of work. Since, historical ground measured weather data for Myanmar is not available, data from secondary sources such as NASA satellite weather database and various research publications from peer reviewed journals have been used for resource assessment in Myanmar.

The NASA weather data for solar and wind energy resource assessment has been generated using the NASA Goddard Earth Observing System - Version 4 (GEOS 4) Multiyear Assimilation Time series Data. The GEOS 4 data set has a spacing of 1.25 degrees of longitude by 1 degree of latitude. Bilinear interpolation is used to produce 1 by 1 degree regions. NASA's global satellite/analysis solar and wind resources data are reliable data sets which can be used for the preliminary feasibility assessment of any project.

3.1 Solar energy

Due to the geographical position of Myanmar between the tropic of cancer and the equator, most of its territories receive abundant and reliable solar radiation all the year round. The annual average daily solar radiation in most of the locations in Myanmar varies between 4.4 – 5.2 kWh/m²/day (Janjai et. al. 2013 and NASA Satellite Weather Data; Table 3.1). Figure 3.1 shows the distribution of solar radiation across Myanmar, according to which 36% of the total area receives annual solar radiation in the range of 5-5.3 kWh/m²/day, whereas, there are only few areas which receives less solar radiation (<4 kWh/m²/day). This indicates that most parts of Myanmar receive relatively high solar radiation [Khaing, 2013b]. The radiation is almost similar to that received during summer months in India and Japan and about 1.7 times higher than Germany, the countries considered aggressive in implementation of solar PV installations in the world.

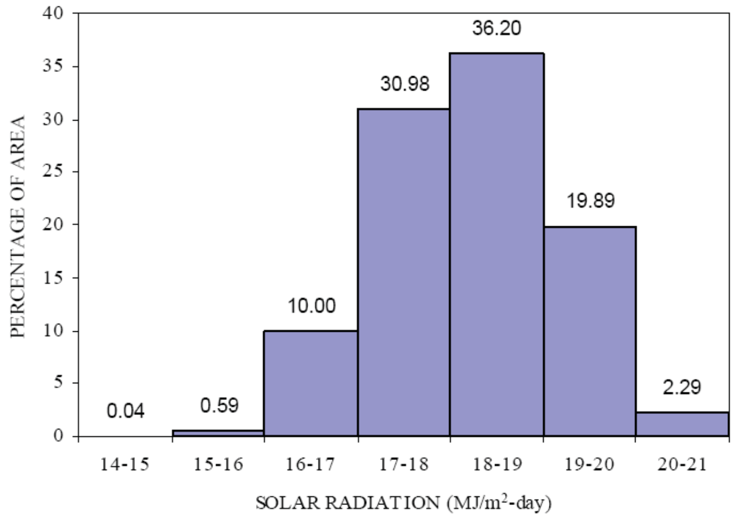


Figure 3.1 Distribution of solar radiation with respect to percentage of the area Myanmar

Source: Khaing, 2013b

Table 3.1 Solar radiation at different locations in Myanmar

Location	Latitude (°N)	Longitude (°E)	Daily solar radiation-horizontal-annual average (kWh/m²/day)
Central region			
Bago	17.3	96.5	4.86
Mandalay	22	96.1	5.12
Meiktila	20.9	95.9	5.18
Maymyo	22	96.5	4.9
Myingyan	21.5	95.4	5.11
Pyinmana	19.7	96.2	5.15
Rangoon	16.8	96.2	4.7
Taunggyi	20.8	97	4.98
Thayetmyo	19.3	95.2	5.14
Toungoo	19	96.4	5.02
Yamethin	20.4	96.1	5.14
Yenangyaung	20.5	94.9	4.84
Northern Myna			
Northern region			
Falam	22.9	93.7	4.81
Katha	24.2	96.4	4.44
Lashio	23	97.7	4.77
Mawlaik	23.6	94.4	4.45
Monywa	22.1	95.1	4.89
Myitkyina	25.4	97.4	4.42
Southern region			
Bogale	16.3	95.4	4.76
Hinthada	17.7	95.5	4.8
Mawlamyine	16.5	97.6	4.67
Mergui	12.5	98.6	5.02
Ye	15.3	97.9	4.82
Eastern region			
Kyaikto	17.3	97	4.81
Western region			
Akyab	20.1	92.9	4.79
Arakan	18.5	94.4	4.91
Keng Tung	21.3	99.6	4.86
Pathein	16.8	94.7	4.96
Pyay	18.8	95.2	4.94

Source: NASA Weather Database

In Myanmar, peak and off-peak solar radiations are observed in the month of April and August. Seasonally, solar insolation intensity slowly decreases from April to August and then again increases. Regionally, central part of Myanmar receives the highest solar radiation. Except some locations at Northern peak of the country, all other locations receive good amount of solar radiation. (Figure 3.2 & 3.3). The potential available solar energy of Myanmar is around 51973.8 Terawatt-hour per year.

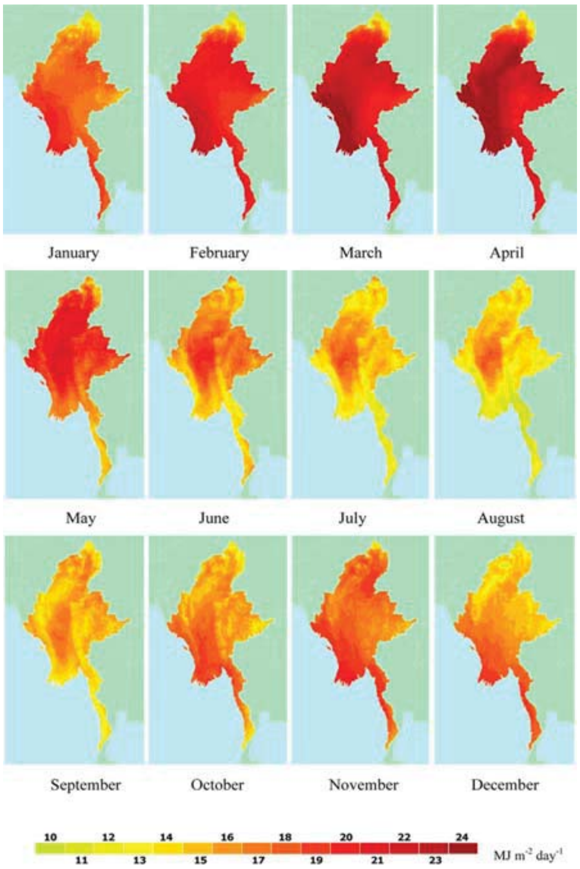


Figure 3.2 Geographical distribution of monthly average global solar irradiation

Source: Janjai et. al. 2013), 1 kWh = 3.6 MJ

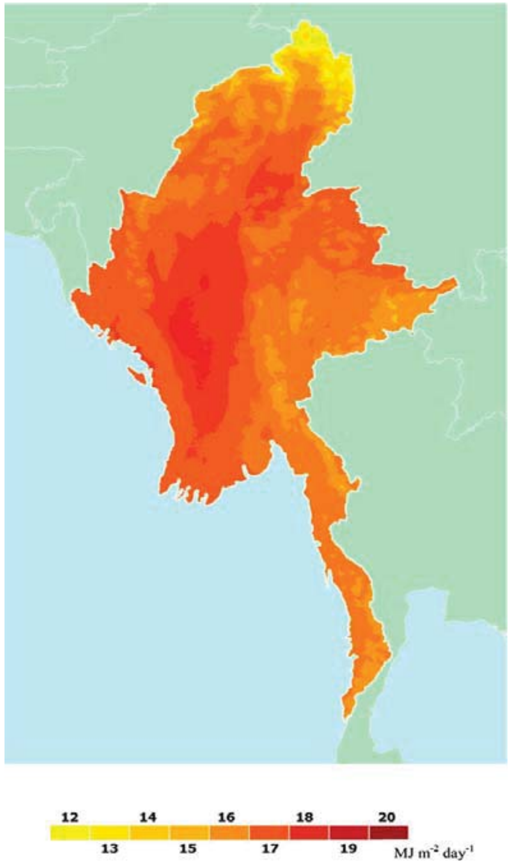


Figure 3.3 Geographical distribution of yearly average global solar irradiation

Source: Janjai et. al. 2013), 1 kWh = 3.6 MJ

- *Most of the territories of Myanmar receive an abundant and reliable solar radiation all the year round.*
- *Potential for 4.4 – 5.2 kWh/m²/day of annual average daily solar radiation in Myanmar.*
- *Immense opportunity for Solar-Biomass-Hydro hybrid projects.*

3.2 Biomass energy

With abundant biodiversity and rice dominating agriculture sector, Myanmar remains biomass rich, with traditional biomass meeting 75% of the country's primary energy supply. This is because more than 70% of Myanmar's population lives in rural areas. Out of the significant primary energy supply, wood alone accounts for more than 90% of the share which is sourced from forests (Figure 3.4).

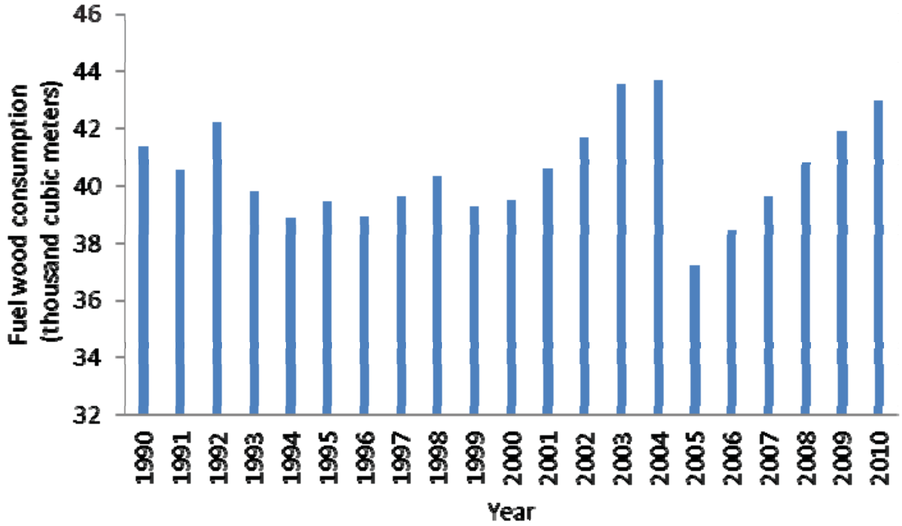


Figure 3.4 Fuel wood consumption data for Myanmar

Source: FAO, 2013

Further, 322,220 km^2 area in the country is covered with forest amounting to almost 49% of the total land area[1]. As per Global Forest Resources Assessment 2005 published by the Food and Agriculture Organization of the United Nations, 100% of forest area is publicly owned and around 77% of the forest can be used for production purposes. The balance is for conservation or reserve forests. The FAO study highlights that the forest and the other wooded land in the country is depleting at the rate of 1.4%. The growing stock is 2,740 million m^3. Of the total growing stock, lops and tops and other wood wastes obtained from the forest and other wooded land can possibly be used for energy generation. Using the Van-Montal's formula (Equation 1), annual forest biomass yield in the country is estimated at around 54.8 million m^3. Assuming 20% of total biomass yield as extractable, and subtracting the amount of fuel wood consumption in the country, it is estimated that there is a potential for about 300 – 400 MW power generation from the woody biomass.

Van-Montal's formula:

$Annual\ Forest\ Biomass\ Yield = (2 * Growing\ Stock)/(Rotation\ Age)$.............Equation 1

The major forest types in Myanmar are mixed deciduous, hill and temperate evergreen and tropical evergreen. Other forest types are dry, deciduous indaing forest and tidal, beach, dune and swamp (Figure 3.5).

[1] Global Forest Resources Assessment 2005 published by Food and Agriculture Organization of the United Nations

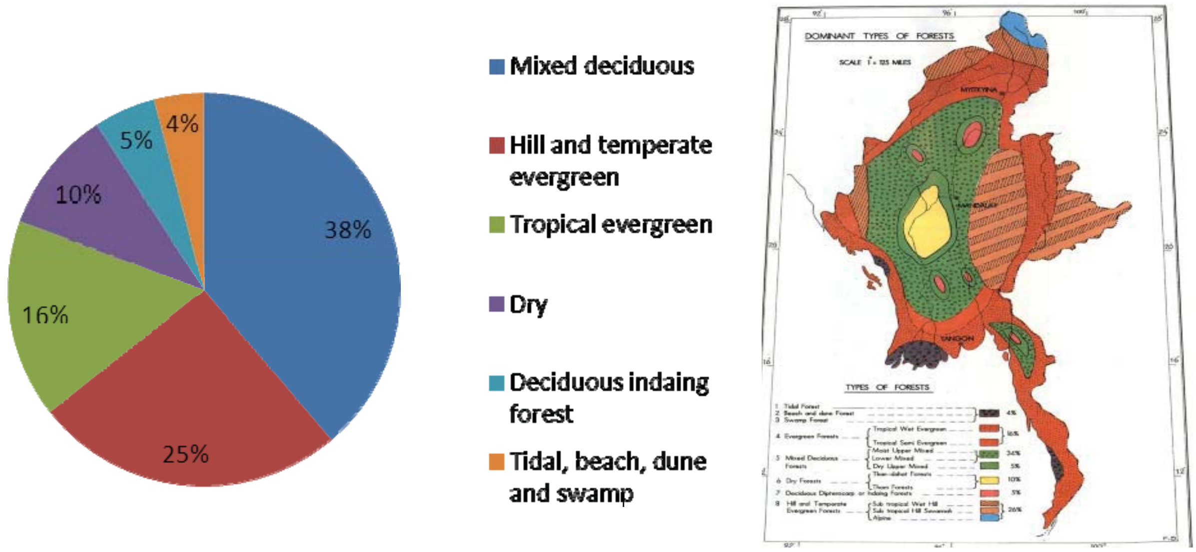


Figure 3.5 Forest types and their percentage shares in Myanmar

Source: Planning and Statistic division, Myanmar

Apart from forest resources, the Myanmar Engineering Society has calculated considerable resource potential for lumber waste, bagasse, molasses, and livestock waste as well, numbers shown in Table 3.2.

Table 3.2 Biomass energy resources in Myanmar

Type	Quantity (million ton/year)
Rice Husk	4.40
Lumber waste	1.50
Bagasse	2.10
Molasses	0.24
Livestock waste	34.4

Source: MES, 2012

Because rice is the major agriculture produce in the country, 21.6 million tons of rice husks from milling each year could potentially generate 4.4 million metric tons of fuel, which can possibly also be used for power generation [MES, 2012]. If 20% of total rice husk is available for power generation, there is a potential for 60 – 70 MWe capacity of power generation.

Using similar assumptions, lumber waste has a potential for 15 – 25 MWe, Bagasse has a potential for 25 – 35 MWe, and Molasses has a potential for 1 – 1.5 MWe power generation capacity in the country. Apart from these biomass resources, there is also huge amount of livestock waste available in the country which can possibly be utilized for power generation using the bio-methanation route. A study by NEDO also estimated that 18.56 million acres of land in the country could generate residues, by-products, or direct feedstock for biomass energy and 103 million heads of livestock could generate animal waste for biogas. This data was estimated by NEDO in 1997 and published in 2005 by Energy Planning Department, Ministry of Energy.

Most of the regions in Myanmar are covered with different kind of forests except some regions in central part of Myanmar (Figure 3.4). Thus, wherever solar or wind resource is there in the country, there is an immense opportunity for either solar/wind - biomass hybrid or solar-wind-biomass hybrid based power projects.

- *Myanmar is rich in biomass due to dominating agriculture sector and forest resources, spread all over the country except few places in central region.*
- *About 1,000 MW of power generation potential from the available biomass resources.*
- *Immense opportunity for solar/wind - biomass hybrid and solar- wind-biomass hybrid power projects.*

3.3 Wind energy

Wind energy is abundantly available in the hilly regions of Chin and Shan States, western part, costal region and some central parts of Myanmar. Wind energy has only been implemented as an experimental phase and this was mainly attributed to field test works by NEDO. Besides, feasibilities studies have also been conducted by two companies and they have found the overall potential in (a) Mon state, Kayin state, Thaninthayi region, Shan state, Kaya state is 2930 MW, and (b) Chin state, Rakhaing state, Ayeyawaddy region and Yangon region is 1102 MW [MOEP, 2012a]. Similarly, as per an independent research, wind energy in selected regions in Myanmar can yield up to 360.1 TWh per year of electricity [Kyaw et. al., 2011].

Yearly average wind velocity in selected cities is given in Table 3.3. For this study, we have taken wind resource data from two sources, NASA and secondary literature (Kyaw et. al., 2011) to validate the variability factor in different data sets. We found that, there is a variation in the wind speed data from one data source to other for few locations. As wind technology in Myanmar is in the experimental phase, Myanmar govt. should take initiatives for installing weather stations to measure wind speed, wind direction and solar radiations (global, direct and diffuse) at different locations in Myanmar. Wind speed data given below can be used for any preliminary techno-economic assessment however, ground measured wind speed data is required for actual estimation of power generation.

Table 3.3 Yearly average wind velocity in selected cities

	Wind speed (m/sec)	
Location	**Kyaw et. al., 2011**	**NASA data (measured at 10m)**
Central region		
Bago	1.1	2.4
Henzada	NA	2.6
Magway	1.5	NA
Mandalay	2.3	2.2
Meiktila	4.8	2.4
Pyinmana	NA	2.5
Rangoon	2.5	2.5
Thayetmyo	NA	2.6
Yenangyaung	NA	2.7
Northern region		

Location	Wind speed (m/sec) Kyaw et. al., 2011	Wind speed (m/sec) NASA data (measured at 10m)
Hakha	4	NA
Homalin	1.6	NA
Lashio	0.3	2.2
Monywa	2.4	2.2
Myitkyina	1.3	NA
Southern region		
Dawei	0.7	NA
Hpa-an	1.9	NA
Mawlamyine	2.3	2.5
Mergui	NA	3.7
Ye	NA	3
Eastern region		
Loikaw	1.7	NA
Western region		
Akyab	NA	4.2
Arakan	NA	3.1
Kyaukpyu	1.9	NA
Pathein	2.2	2.9
Pyay	NA	2.7

The annual average wind speed in most of the locations in Myanmar varies in between 2 – 4.2 m/s at 10 m height as per NASA Satellite Weather Data (Table 3). The Department of Electric Power (DEP) and Ministry of Electric Power in cooperation with NEDO, Japan constructed Meteorological Observation Stations and installed Wind and Solar measuring equipment at some sites.

It can be observed from Table 3.1 and Table 3.3 that there is a potential for solar and wind hybrid power plants in the South-West region of Myanmar. For instance, Akyab, Arakan, Mergui and Ye locations are blessed with both solar and wind resources. There is a potential for small wind turbines in these locations.

- *Wind energy in Myanmar is abundantly available in the hilly regions of Chin and Shan States, western part, costal region and some central parts of the country.*
- *Average wind speed in most of the locations varies in between 2 – 4.2 m/s at 10 m hub height. Literature says there is a potential for 360.1 TWh per year.*
- *Potential for Solar-Small Wind Turbine hybrid power projects in Akyab, Arakan, Mergui and Ye.*

3.4 Small and micro hydro power

Myanmar is topographically endowed with abundant hydropower resources due to numerous river systems that run throughout the country. The World Bank estimates a figure of more than 100,000 MW out of which MEPE has identified 267 sites with a total generating capacity of 39,624 MW. However, existing hydro power stations contribute only 320 MW and hence only 1% of the total capacity has been utilized (Kyaw et. al., 2011).

The small hydro power which is recognised with capacity below 10 MW has a total potential of 196.7 MW. The micro-hydro power alone has a potential of 28.8 MW through 101 numbers of projects explored by the Ministry of Electric Power (2006). Besides this, the potential of large hydro (>10 MW) is 34,568 MW. This immense potential in the country, if harnessed would bring sufficient quantum of electricity at an affordable cost.

Table 3.4 Micro hydro and small hydro potential in Myanmar

State and division	Micro hydro capacity (1 kW to 1 MW)		Small hydro capacity (1 to 10 MW)	
	Number of projects	Projects capacity (MW)	Number of projects	Projects capacity (MW)
Kachin State	17	5.33	14	48.18
Chin state	11	3.48	2	2.8
Shan state	35	10.64	24	63.9
Sagaing state	5	0.806	3	13.3
Mandalay division	3	0.65	2	6.25
Magway division	1	0.1	2	11
Rakhine state	6	1.915	-	-
Kayah state	2	0.158	-	-
Bago division	4	1.89	-	-
Kayin state	3	0.864	1	3
Mon state	5	1.248	-	-
Taninthayidivison	9	1.706	2	19.5
Total	101	28.787	50	167.93

Source: MOEP, 2006

Maximum hydro potential is in the Shan state which is situated at Eastern part of Myanmar. Kachin and Chin states situated at North and West part of the country also have good amount of hydro resources. As mentioned in Table 4, hydro resource is distributed all over the country thus, there is huge potential for hydro and solar or wind or biomass based hybrid power generating systems.

- *Myanmar is topographically endowed with abundant hydropower resources due to numerous river systems that occurred throughout the country.*
- *Potential for 29 MW micro-hydro and 168 MW small-hydro projects.*
- *Huge potential for Hydro-Solar/Wind-Biomass hybrid power projects.*

4. Technology options & delivery models

In this Chapter, some relevant technology and delivery models are presented covering solar, biomass and small wind, which are prevalent in South and South East Asian countries. These models may also be relevant for Myanmar with some customization appropriate to the local conditions in Myanmar.

4.1 Decentralized technology options

A decentralized energy systems is characterized by energy production facilities closer to the site of energy consumption. This means that the electric energy only needs to be transported over short distances. This definition could be used for conventional generating systems as well as for renewable energy systems. In this report, while discussing off-grid power for energy access in Myanmar the focus is around renewable energy technologies. In the subsequent sections various decentralized technology options based on renewable energy are described:

4.1.1 Solar Home System (SHS)

Solar PV technology has been in the forefront for off-grid area electrification in India, Bangladesh, Nepal, Indonesia Sri Lanka etc. The most common solar PV technology used for providing access to clean lighting at the household level is the Solar Home System (SHS). A SHS in particular is flexible, modular, and reliable solar powered system capable of providing improved and clean lighting through the dissemination of highly efficient solar lights apart from the mobile charging facility having recharge facility at home itself.

A typical SHS consists of PV module(s) that charge a battery bank to supply DC electricity to run appliances such as CFL/LED lamps, DC fan, TV, etc. The charge controller which is an integral part of the SHS controls the energy inflow and outflow into and from the battery bank. A typical system size ranges from 10 Wp to 150 Wp based on the utility [Palit, 2013].

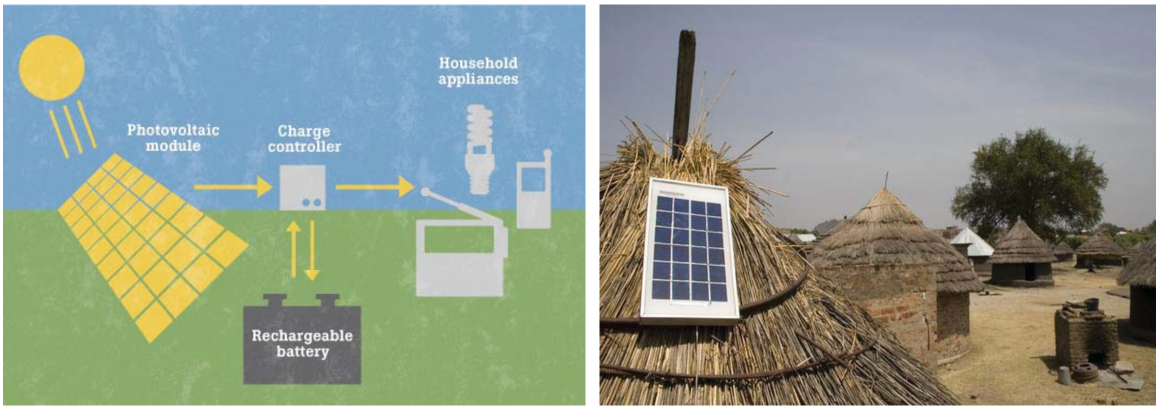


Figure 4.1 Layout of a typical SHS with its application at a village

(Photo source: (a), http://www.ashden.org/ (b) http://www.smartplanet.com/)

Delivery model: Solar home systems are implemented in different countries in South and South East Asia using different type of delivery model depending on local conditions. The two most common models are direct product subsidy based and consumer financing based model. The SHS implemented by the Infrastructure Development Company Limited

(IDCOL)[1] in Bangladesh is one of the most successful examples of consumer financing of decentralised technology. Currently Bangladesh deploys over 70,000 SHS per month, with over 2.6 million SHS already installed in the country, making it one of the most successful off-grid SHS programs, with the highest installation rate in the world. IDCOL implements the SHS program through its 50 partner organizations (POs). The SHS program was developed by IDCOL with the help of the World Bank and GEF to provide electricity to the energy poor. Currently, a number of international financing organisations such as the World Bank, Asian Development Bank, KfW, Islamic Development Bank, etc. finance IDCOL to provide refinancing to its POs. The PO act as the financial intermediaries in the model. They are refinanced by IDCOL through soft loans (6-8% interest with 2 years grace period and 10 years maturity) and grant support (to reduce the SHSs costs) as well as support the institutional development to develop the maintenance service facility in rural areas. In addition, IDCOL is responsible for setting the technical specifications for the solar equipment, developing publicity materials, providing training for PO capacity building and monitoring PO performance. The role of the PO is to select the project areas and potential customers, offer instalments to the customers, install the systems, provide maintenance support, ensure that spare parts are available, consultation with the users before installation, disseminate knowledge for productive use of the system, and to provide training to the users and local technician. The POs provide credit to the customers and the amount is repaid by the customers within a maximum period of 3 years. A customer has to pay 10% - 15% as down payment and the outstanding amount is paid in monthly instalment with 8%-12% service charge, which also covers the maintenance cost of the system. The majority of the POs import SHS components, especially solar panels, from abroad. However, some component manufacturing capacity has also developed in Bangladesh. For example, solar batteries and most charge controllers are being assembled locally in the country, which has also assisted in reducing the price of the systems and also better servicing of the warranty.

SELCO India, a social enterprise operating in India since 1995, has also installed more than 0.1 million SHS mainly in India using the consumer financing model. In addition, rural banks in India have also been financing SHS under the subsidy cum re-finance scheme of MNRE implemented through the National Bank for Agriculture and Rural Development, especially in grid connected areas with poor electricity supply [Palit, 2013]. In addition to the consumer finance model, SHS are also disseminated by government agency with direct product subsidy especially in areas which are not expected to be covered by conventional grid electrification. The direct product subsidy varies between 30 to 90% depending on the locations. Such schemes are prevalent in India and Nepal.

4.1.2 Solar lantern

A solar lantern is a portable lighting device which uses either CFL or LED-based luminaries, housed in an enclosure made of plastic or metal that contains a rechargeable battery (either sealed maintenance free lead acid or NIMH or Li ion) and necessary electronics. The rechargeable battery is charged using a separate PV module by connecting it through an electric plug-and-socket arrangement or sometimes PV module is integrated in the solar lamp itself. The lanterns may have different level of illumination (usually 2 or 3 modes) and can run for 4-20 hours on full charge of the battery and depending on the light output.

[1] IDCOL is a non-bank financial institution (NBFI), established by Government of Bangladesh and licensed by Bangladesh Bank. The role of IDCOL, since its inception, is to bridge the financing gap for developing medium and large-scale infrastructure and renewable energy projects in Bangladesh.

Delivery model: The most common delivery model for dissemination of solar lantern is through retail sales. Being a small product with price ranging between $10 to $50, depending on the product features and illumination, solar lanterns are sold like a household consumer product in most countries. In some cases, micro financing is also arranged by the seller or the buyer avail such financing for local micro financing companies. India, Nepal, Cambodia, Lao PDR are some countries in the region, where solar lanterns are disseminated by private agencies in a large way. In the rural areas of Myanmar also, solar lanterns coming from China are being disseminated by some agencies.

4.2 Centralized technology options

In an off-grid village electrification project when community or collective solutions serve a cluster of households or an entire village and provide electricity generally by generating from a diverse range of small local generators (such as solar PV, micro/mini hydropower, biomass-based technologies and diesel generators), with or without its own storage, and distributing it amongst the consumers, then it is referred as centralized off-grid energy solution. Further, the load can either be connected through a distribution grid commonly called mini-grid and the service provider undertakes the business activities related to generation, distribution and sale (including billing, revenue collection and grievance redressal) of electricity or the products battery can be charged from a central place and delivered to the users. In the subsequent sections various type of centralized off-grid technology options based on solar, wind and biomass gasifier are described.

4.2.1 Solar charging station

The charging station comprises of solar PV modules or hybrid of solar and wind turbine generator in a specific voltage and current configuration to charge: (a) a number of solar lanterns or (b) batteries. The charge controller is designed to ensure that all the lanterns and/or batteries are adequately charged. The charge controller is housed inside a junction box that has sockets to plug-in the leads for individual solar lanterns or batteries. Figure 4.2 shows a layout of a typical battery charging station along with a picture of an application at a village. The charging station is such designed that a lantern or a battery can get fully charged in one full day of sunshine i.e. 5-6 hours. The charged lanterns or batteries can then be taken away for use in individual homes. The key advantage of a charging station is that portable lanterns and batteries can be charged from here and used in individual homes. This model is especially suited for areas where extension of local distribution grid may be difficult because of lower density or forested areas and user want to take advantage of the portability of devices for use in their household. Another advantage is that charging station can be designed modularly and can be scaled up depending on the demand.

Wind turbines which generally have a generation capacity up to 10 kW is usually considered as small wind. They have rotor swept area of less than 200 m^2 and can work in both off-grid and grid-connected applications [CWET, 2010]. The predominant technology used in small wind is horizontal axis upwind turbines with direct driven permanent magnet generators, having cut-in speed at 3 to 4 m/s whereas the generation takes place at wind speeds over this value. Small wind turbines can be run in hybrid mode with solar PV to optimize resource utilization and improve the system reliability. Hybrids have the advantage of supplying energy for longer duration as batteries constantly receive charge both from the wind and from the sun. Further, the combined capacities of the wind generator and solar module are able to generate the required energy at costs lower than that of solar PV alone.

Figure 4.2 A typical solar lantern and battery charging station

(Photo source: (a) TERI, (b) Earth Renewables)

Delivery model of solar charging stations

The charging stations are set-up in villages for charging the solar lantern and or batteries and work on a entrepreneurship driven fee-for-service or renting model. The charging station is usually designed to be operated by local youths or women on commercial principles. The charged solar lanterns or batteries are rented to households and small businesses in the village for a nominal rent (which also includes the charging fee) that is collected by the operator of the charging station. A part of the rental and charging fee is used to meet the operation and maintenance costs of the charging station, while the remainder constitutes the entrepreneurs' monthly income. For households coming with their own lanterns or batteries, the entrepreneur can levy on the charging fee. In case of local demand, the charging stations can also be scaled up by the entrepreneur to solar multi utility centres to provide a variety of value added services such as charging for mobile telephones, battery-operated devices, and Information and Communication Technology (ICT) services and so on. Such types of model have been very successfully run by TERI and OMC Power in India and Sun Labob in Lao PDR among others.

Box 3: Lighting a Billion Lives (LaBL), an initiative by TERI, India

TERI has evolved an innovative renting model for providing access to clean lighting through solar lantern under its Lighting a Billion Lives (LaBL) campaign initiative. The campaign launched in 2008 aims to bring light into the lives of un-electrified and poorly electrified rural people by displacing kerosene and paraffin lanterns with solar lighting devices, thereby facilitating education of children; providing better illumination and kerosene smoke free indoor environment for women to do household chores; and providing opportunities for livelihoods both at the individual and at village level. It has so far covered more than 2500 villages in India and some countries in Africa, thereby impacting more than a million lives of people.

Essentially, LaBL provides a flexible entrepreneurship based energy service model where local entrepreneurs are trained to operate and manage the solar charging station and rent out certified, bright, and quality solar lanterns to the community every evening for a very affordable fee. The rental is typically 5-10 US cents per lantern per night and the operator typically earn approximately US$ 40 – 60 per month by renting out lanterns. A part of the fee/rental is used to meet the operation and maintenance costs of the solar charging stations including replacement of lantern batteries after around 24 months, to ensure its sustainability, while the remainder constitutes the entrepreneurs' monthly income.

The charging stations are operated and managed by local entrepreneurs (Self Help Groups/individual youths) who qualify the selection criteria defined under LaBL. These entrepreneurs are selected and provided handholding support by local implementation partners called LaBL Partner Organization. As part of the capacity building under the program, entrepreneurs are also provided compulsory training (entrepreneurship & technical) apart from other handholding support during the initial few months through the LaBL local Partner Organisation and Project Management Units of TERI in the respective states. Further, all solar charging stations are also linked to the Technology Partners (supplier/ manufacturer/ system integrator) through annual maintenance contracts after the expiry of the warranty period for providing specialized trouble shooting and repair for more advanced technical issues.

The initiative which started in the people's space of PPP now encompasses the strong role of the private sector, the government sector, the communities all working towards common pro-poor agenda. The fee-for-service model of the initiative has ensured that the BoP gets access to clean energy at an affordable price. While the capital cost of setting up

4.2.2 Mini/micro grids

Mini or micro grids are designed to generate electricity centrally and distribute the same for various applications to households and small businesses spread within a particular area. Mini/micro grids can use multiple generation technologies, renewable or non-renewable energy based which can improve reliability of supply. A mini/micro grid can be DC or AC type.

A DC micro grid, powered by solar PV, is designed to generate DC electricity supplying at 24 V DC, and distributed over a short distance from the battery banks to the cluster of households or shops within the village. On the other hand, AC based mini/micro grid, are based on multiple generation technologies, usually supply 220 V, 50 Hz, single or three phase electrical power. These connections can be equipped with energy meters or similar products (such as energy limiter, prepaid meters etc.) to achieve a specific business and operation model. Depending on their capacity, mini-grids can provide electricity for domestic power, small commercial activities and for community requirements such as the supply of drinking water, street lighting, vaccine refrigeration etc. Experience from India shows that mini-grids have been accepted as an alternative to grid-electrification in many remote areas, as users perceive mini-grids very similar to conventional power due to its resemblance to conventional grid system such as overhead low-tension lines, service connections and tariff structures. Technically, mini-grids are preferred over solar home systems, as mini-grids provide electricity services for lighting as well as to run small appliances, whereas solar home systems provide only lighting services [Palit and Sarangi, 2014]. However, SHS deployment negates the need for expensive civil works installation usually required for mini-grids. A brief description of the technologies commonly used for mini/micro grids, are provided below:

Solar AC or hybrid mini-grid

The universal availability of solar energy makes this an attractive resource for a mini-grid which may be in a remote location where there are few or no other options. However, its seasonal and daily variations lead to the need for energy storage, usually batteries. Typically, solar AC mini-grids are designed to generate electricity centrally and distribute the same for various applications to households and small businesses spread within a particular area. They consists of (i) Solar PV array for generating electricity, (ii) a battery bank for storage of electricity, (iii) power conditioning unit consisting of charge controllers, inverters, AC/DC distribution boards and necessary cabling, etc. and (iv) local low-tension power distribution network. An advantage of SMG is that it can be modularly designed and scaled up according to the additional demand in a village or cluster of villages. For example, in India, mini-grids of varying capacities, between 1 kWp and 200 kWp have been implemented, with different implementing agencies adopting different sizing and localized models [Palit, 2013].

Like solar energy, some level of wind energy can be found everywhere and thus can be used to generate electricity. Further, it has the merit of not being limited to daylight hours. However, the highly non-linear relationship between wind speed and the energy that can be collected implies that coastal and hilly locations are the preferred locations. Because wind generation is usually higher in winter or during a monsoon season, it can also partly complement PV generation in a hybrid system so that the battery capacity required for a given level of reliability can be reduced. As mentioned in the previous section, small wind turbines are particularly useful for working in hybrid mode with solar PV in a mini-grid model.

Power from biomass: Biomass Gasification based mini-grid

The term biomass generally refers to renewable organic matter generated by plants through photosynthesis wherein the solar energy combines with carbon dioxide and moisture to form carbohydrates and oxygen. Commercially two technologies are available for power generation from biomass. The more conventional one for power generation from biomass is the combustion route in which the biomass is burnt in boilers to produce high-pressure steam, which drives a turbo-generator for production of electricity. The technology for generation of electricity through direct combustion is similar to the conventional coal-based thermal power generation, and is satisfactory at high unit capacity levels, typically above 5 MWe (though lately, sub MW scale systems have started to be manufactured). The other route is via gasification of biomass, which produces the combustible gas (called producer gas) through a sequence of complex thermo-chemical reactions. Whereas the direct combustion based systems are more suited for grid connected MW scale projects, biomass gasification systems are more suitable for decentralized small and medium capacity biomass-based power generation and so have been discussed in detail here.

A biomass gasifier based power project usually consists of biomass preparation unit, biomass gasifier reactor, gas cooling and cleaning system, internal combustion engine suitable for operation with producer gas as main fuel, electric generator and electricity distribution system. Biomass preparation unit is used to cut the collected biomass to proper size suitable for feeding into the biomass gasifier. In a typical downdraft gasifier the biomass is fed from the top. It passes through the gasifier and undergoes the following sequence of processes - drying, pyrolysis, oxidation and reduction, in a limited supply of air to produce a combustible mixture of carbon monoxide (18% - 22%), hydrogen (15%–20%), and methane (1%–3%); diluents viz. carbon dioxide (9%–12%) and nitrogen (45%–55%); and tar and ash. The gas formed is passed through a cooling and cleaning sub-system that usually consists of a cyclone for particulate removal and a scrubber for cooling and cleaning the gas. Some ash is formed from the oxidation reactions. The ash moves through the reduction zone and gets removed from the ash disposal system (grate and ash collection system). The electricity so generated from the gasifier system is distributed to the consumers through a local mini-grid. Figure 4.4 presents the schematic diagram of biomass gasifier based power generation system

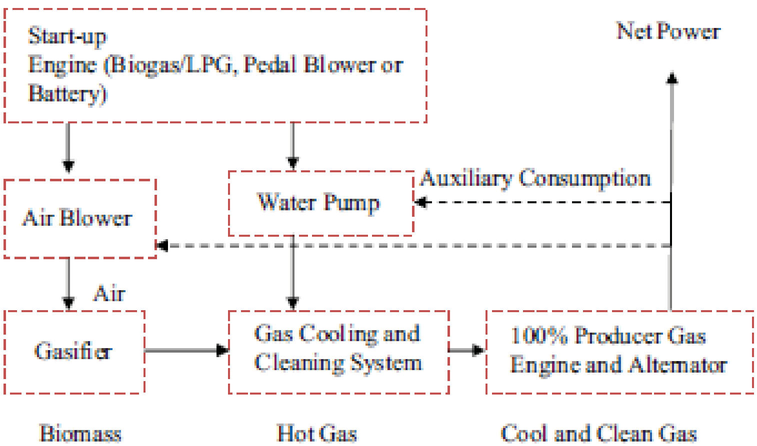


Figure 4.4 Process diagram of biomass gasification based power generation system

The benefit of having gasifier-based based or hybrid mini/micro system is that it can generate electricity as per the end-user requirements and schedules, unlike other in-firm renewable energy technologies such as solar and wind. Moreover, the cost of power generation in such configuration is much more reasonable than other comparable systems such as diesel-based power generation, solar power systems, wind-based power, etc.

Small and micro hydro power

The principle of hydropower generation technology is simple. The energy of flowing water generates electricity when passed through hydraulic turbines. The potential energy of the water is converted to a combination of head pressure and kinetic energy in the penstock and delivered to the turbine and generator. Since water is neither consumed nor polluted in this process, it joins the river course or used downstream for other purposes such as irrigation and water supply. The energy that can be produced then depends on the variation in the available flow rate over the year. Based on installed capacity, classification of small hydropower varies differently in various countries. The classification considered in India is as follows:

- Pico 5 kW & below
- Micro 100 kW & below
- Mini 2000 kW & below
- Small 25000 kW & below

There are several types of schemes to generate electricity as described below (Figure 4.5):

Run of River: A portion of river water is diverted to a channel, pipe line (penstock) to convey the water to hydraulic turbine, which is connected to an electricity generator. Run off river scheme may also have diurnal storage through balancing reservoir.

Reservoir based: A dam is constructed to store the river water during the rainy season and used to generate electricity at the dam toe or further downstream through tunnel or pipelines as per the electricity or downstream water demand for irrigation and drinking water. Such systems are usually large hydropower. However, small hydropower projects can also be built on existing dams/reservoirs, constructed primarily for irrigation and or drinking water purposes.

Canal based: The existing facilities like weirs, barrages, canal falls are utilized for electricity generation.

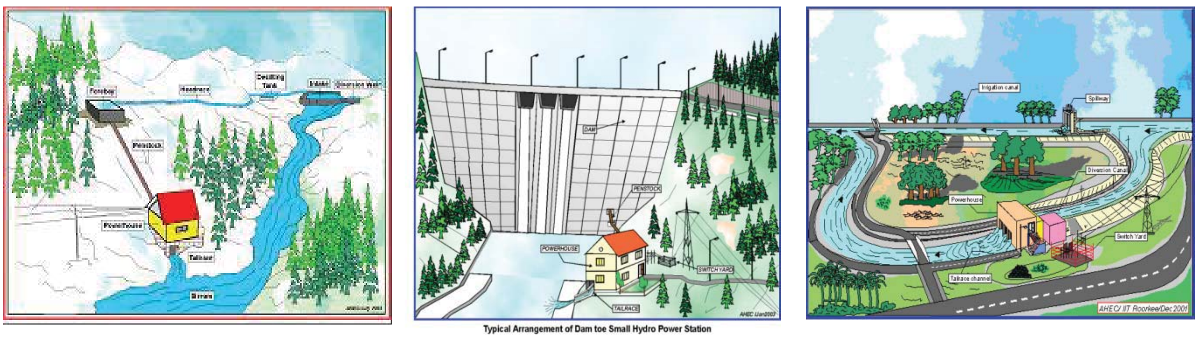


*Figure 4.5 Types of hydropower schemes (Run of River, Reservoir and Canal fall)

Depending on the classification of hydropower, the electricity generated can either be fed to the transmission grid from large hydro power units or distributed in the local area from a mini or micro hydropower unit. As an energy source for a mini-grid, a micro-hydro system on a favourable site has considerable advantages of producing electricity continuously all

*Source:"Review of DGS Technologies, Technical Aspects of Grid Interconnection and Assessment of Renewable Energy Resource Availability & Selection of States - Study on Improved Rural Electricity Services through Renewable Energy based Distributed Generation and Supply", by TERI, Alternate Hydro Energy Centre and IL&FS Energy the year round, though usually with some variations in the output. Thus, they can be run without any or minimal need for backup plant such as storage batteries and diesel generators. However, they do require regular maintenance and supervision, particularly of the screens and trash rack that filter the water entering the system as these can easily become blocked by seasonal debris and require regular manual clearance. Another advantage of micro hydro systems in the low life cycle cost as compared to other renewable energy sources. Thus micro hydro project can encourage development of small & micro enterprises which in turn can improve the load factor of the systems during the day as well as the socio-economics of the communities involved.

Viability of mini-grids

The viability of a grid – AC or DC is based on many factors and there are a variety of options that may reduce the cost of grid or its extension which should be considered beforehand. Thus, in villages where households are not very spread out, solar PV or hybridized version with small wind turbine based mini/micro grids is a preferred configuration. In order to maximize the benefits of the complementary nature of solar and wind resources, and to optimize the cost of systems, hybrid sometimes is a more viable and suitable option.

The options may include usage of higher transmission voltage, use of single-phase distribution, proper sizing and location of transformer, pole design, etc. [SWECO, 2009]

Box 4: Viability of mini-grids

a. *For mini grids with total load ranges > 100 kW*

A rule of thumb which tests the viability of setting-up grid includes a simple empirical formula having two variables: (a) estimated number of potential connections (N) in the community, and (b) average distance of the rural community from the centralized grid (D). To test the viability, calculate the number of connections (N) per distance (D) i.e. (N/D).

- If N/D < 2 connections/km – then grid extension is not likely to be viable
- If N/D > 30 connections/km – then the grid extension is likely to be viable

b. *For mini grids with total load ranging >10kW*

In this rule of thumb, the viability is tested by first calculating the total number of connections (N) within 500 m radius from the rural community centre where the plant is situated.

- If N>100 – the grid could be a viable option. Viability would also depends on load density
- If N<100 – in this case, it'll be challenging to sustain an adequate level of O&M as well as efficient cash management over time.

Source: NORAD, 2009

Delivery models for mini-grids

Two kinds of delivery models are prevalent for delivery of electricity using the mini/micro grid models. They are: (a) community driven model, and (b) privately driven model.

a. *Community drivel models:* Community management of supply systems is a typical service delivery model to serve isolated load centres. In such cases, a village energy committee is created to manage a mini-grid based project or other decentralised energy systems, either in a village or a cluster of villages. Almost all renewable technology such as solar PV, biomass gasifiers' mini hydro systems or hybrid (solar-gasifier, solar-diesel etc.) has attempted to follow this model. Micro hydro based developments in Sri Lanka and Nepal are considered to be successful initiatives, which are run by the local communities using the locally available water resource to meet their energy needs. Solar PV based projects implemented in India following the model have however has been successfu**l.** On the other hand, the model has met with limited success for the biomass gasifier systems implemented under Village Energy Security Programme, in India.

   The model is famous with names such as Village Electrification Committee (VEC), Village Energy Committee (VEC) and Village Development Committee (VDC). As the participation of village community is central to the operation of the system, this kind of model can be implemented where cohesion and sense of involvement is present amongst the members of a community. In this model, the VEC or the VDC plays the pivotal role as a power producer, distributor and supplier of electricity. The service-delivery approach of the model involves formation of a VEC by the Project Implementing Agency (PIA) with representations from villagers and the local governing bodies. The PIA sets up the energy production systems and hands over the facility to the VEC for day-to-day operation and management. A community managed systems in fact are very similar to village co-operatives, The difference lies in the fact that in co-operatives all the consumers/ beneficiaries is the members of the cooperatives with the cooperative established as a legal entity, whereas village energy committee is a loosely formed association of representatives of the local community and may or not be registered under any law.

   In the VEC or the community model, the tariff for electricity is usually set by the PIA in consultation with the VEC. In case the capital cost is almost entirely subsidized, the tariff is set such that the revenue can take care of the fuel and operation and maintenance costs including remuneration of the system operator. Otherwise, capital cost – partially or fully – of the equipment is embedded while calculating the cost of electricity. The VEC is also responsible for arranging the fuel (in case of biomass or bio-fuel projects), either as a contribution from the project beneficiaries on a rotational basis or through purchase from agents such as self-help groups, or through raising energy plantations. User charges are collected by the VEC to meet the operational expenses and they also manage the accounts related to the project [TERI, 2014]. A typical representation of the VEC model is provided in Figure 4.6.

   There are, however, some limitations in the model as observed from many projects implemented in remote locations in India. Sometimes, there is lack of clarity in the roles and responsibilities among the different stakeholders of a project resulting in confusion leading to failure of the project. Further, the model is suitable for those remote areas where the strength of local governance is medium to good, potential for group activity exists and there is social cohesiveness. In the absence of these characteristics in the local community, projects implemented following this model may fail.

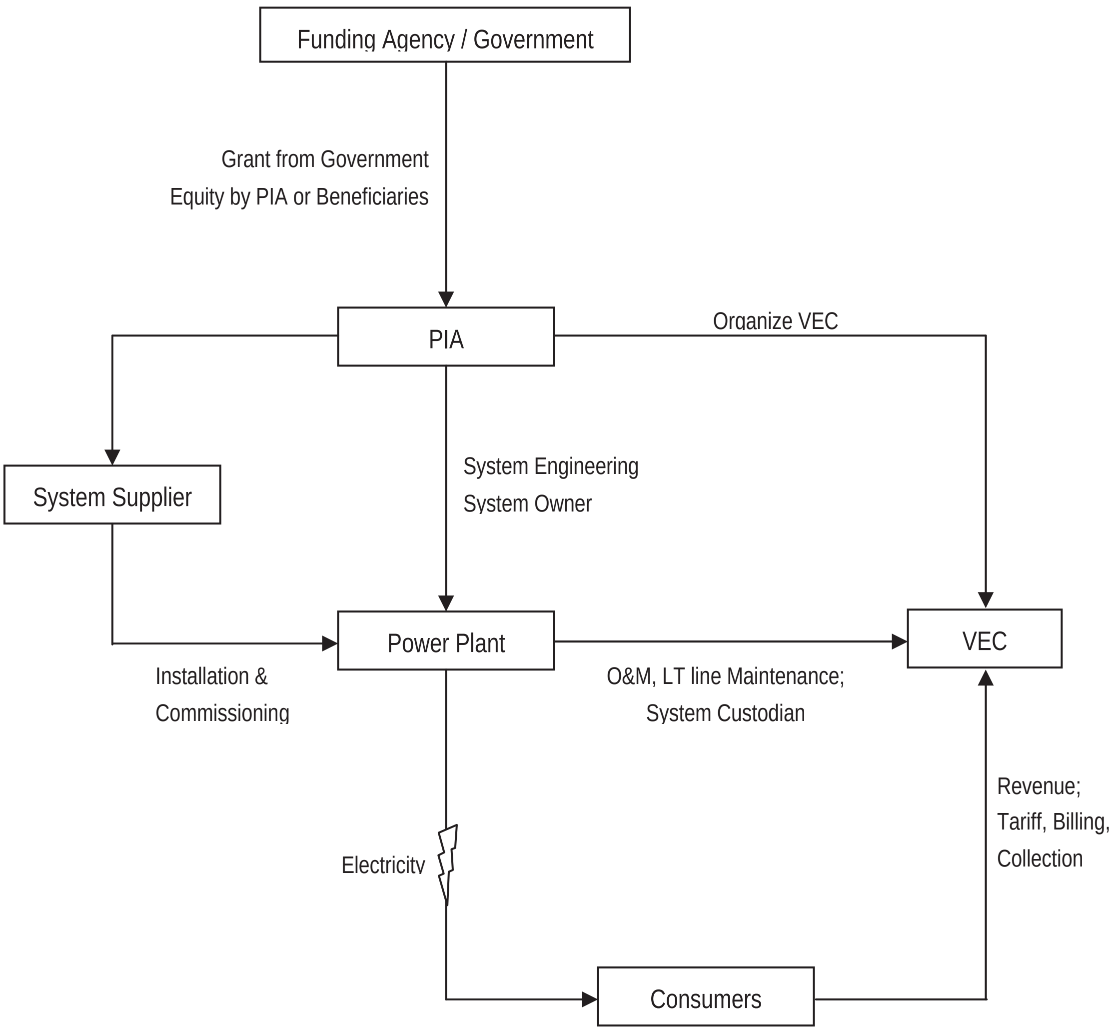


Figure 4.6 VEC model

An example worth mentioning here is the community management approach adopted by Practical Action in micro hydro based mini-grid projects in Sri Lanka [Kritika and Palit, 2013]. Practical Action in the early nineties embarked on an innovative mode to provide electricity to rural households in Sri Lanka through micro hydro based generation. In this model, an Electricity Consumer Societies (ECS), a village organization, were formed for development, functioning and maintenance of village hydro schemes. This was done to instil a sense of ownership among the communities. Further given the geographical location of these micro hydro sites, external agencies were not able to manage on a long term basis. Membership of ECS was essentially from the village.

ECS functioned as an autonomous body, responsible for raising funds, contributing labour, setting tariff structures and managing operation and maintenance. ECS was ably supported by the technical advisory committee of ITSL. A monthly fee of SL Rs. 600/household for a maximum usage of 100 W/household was fixed by the ECS. Further, tariff subsidies or free power were given to poor so that they will not be 'dropped out' in the rural electrification process. The success of model made the Practical Action replicate the same using a commercial approach. While initially the micro hydro model was only for lighting purposes, later on the concept of productive end uses was also introduced. Two main uses were—battery charging and grinding and paddy milling. However, ECSs did not encouraged day time productive end uses, as it consume substantial power, leading to power fluctuations and consequent disputes between high power users and normal users. While these are minor setbacks, the village micro hydro model in Sri Lanka has by and large been successful with increased role of decentralized provincial institutions

b. *Privately driven model*: the projects implemented by private sector follow a commercial approach and are purely demand driven. In these models, a for-profit entity arranges and manages an implementation model (often using one specific technology), identifies suitable villages, builds the electricity supply, and arranges for operations and maintenance, often with the help of local partners. There are different variants of the private sector based models which have been adopted by different entrepreneurs such as: (a) Built, Own, Operate and Maintain (BOOM) - in which a company builds, owns, operates and maintains the mini/micro grid including power generation and distribution systems, with revenues coming from subscriber fees. (b) Built, Own, and Maintain (BOM) – in which a company install the plant and mini/micro grid and provides maintenance for a contract period of few years. The plant is operated by a local entrepreneur who pays maintenance for that specific contact period. Once the contact period is over, the ownership of the plant is transferred to the entrepreneur. (c) Built and Maintain – in which the generators and distribution system is installed by the company which also provides maintenance, whereas the ownership of the plant and its operation remains at the disposal of entrepreneur [UNDP, 2013b].In almost all the cases, the role of government in this case is to safeguard the interest of public and to regulate certain aspects such as environment, disposal, use of raw material, labour laws etc. However, in many cases, the sector has been completely unregulated (except regulations related to electrical safety aspects) as in India. The rationale behind the exemption is the assumption that the local generation and distribution of electricity would be a micro-enterprise with low capital expenditure, short gestation periods and no entry barriers, so competitive market forces would ensure reasonable prices reflecting actual costs.

Another version of the private sector lead model is the public-private partnership model, whereas the private sector pairs up with government resources to support their initiatives. These models develop a business plan that relies on government subsidy or support to make the financial model effective, but is implemented by the private basis. For example, some models have used government funding to support capital cost of a power plant or charging station, but a partial-private model that uses power revenues to pay for operations and maintenance. In spite of projects implemented by private sector in many locations, the private-sector space in most of the countries in the south and South East Asian region is undeveloped, perhaps because of the high risk and relative instability of the market.

A mini-grid model worth highlighting is from Cambodia, where REEs (Rural Electricity Entrepreneurs) operate small diesel generators (or coupled with biomass gasifiers in some cases) and distribute electricity through their own low-voltage distribution lines to local households. Studies report that there are around 600–1,000 rural electricity enterprises supplying electricity services in rural areas and catering to an estimated 60,000 households. The electricity supplied by mini-grid is used to power 2 CFLs and a television set/music system for entertainment. Electricity is supplied for limited hours at tariff ranging from 30 cents/kWh to 90 cents/kWh. However, a limitation of most the REEs are that they use old small generators, with specific fuel consumption. This coupled with losses in low quality distribution systems increases their cost of generation making the systems unviable to operate Thus, few companies are now coupling these diesel generators with biomass gasifier systems to reduce the cost of generation and improve the viability [Kritika and Palit, 2013].

Box 5: Husk Power Systems (HPS), India

HPS is a small start-up company based in Bihar, India and is one of the most widely recognized models of private sector led rural electrification. HPS has reportedly electrified around 300 villages and hamlets since 2007 through the set-up of 80 biomass gasifier plants, thereby impacting nearly 200,000 lives of people,. HPS builds village scale mini-grids using rice husk gasifiers, usually ranging between 30 and 200 kW systems. HPS works only in locations where at least 250 households agree to take connection and it charges a nominal installation charge as well as a regular fee for electricity, sometimes 45 INR per 15 W CFL. It charges a higher rate for commercial use than for residential use. HPS's operation focuses on local community participation and a number of synergies which enable it to profitably sell power to villagers. Revenue from villagers' electricity use pays for the operations of the plant and there is enough profit to pay back the large upfront costs to build the biomass plant. The favourable economics result from a number of specific innovations. For instance, HPS builds rice mill alongside its plant, using surplus power capacity from its power plant to run these mills. It offers free milling to local farmers in exchange for using the rice husks to feed the power plant. As a result it has reduced its fuel costs and simultaneously provided local benefit. HPS has even found out an innovative way to use the charred rice husk and generate additional revenue. The charred husk is used to make incense sticks and this process is usually carried out by rural women, thus providing them with a gainful employment opportunity and in turn additional revenue for HPS through sale of electricity to these employees' household.

Source: Krithika and Palit, 2013

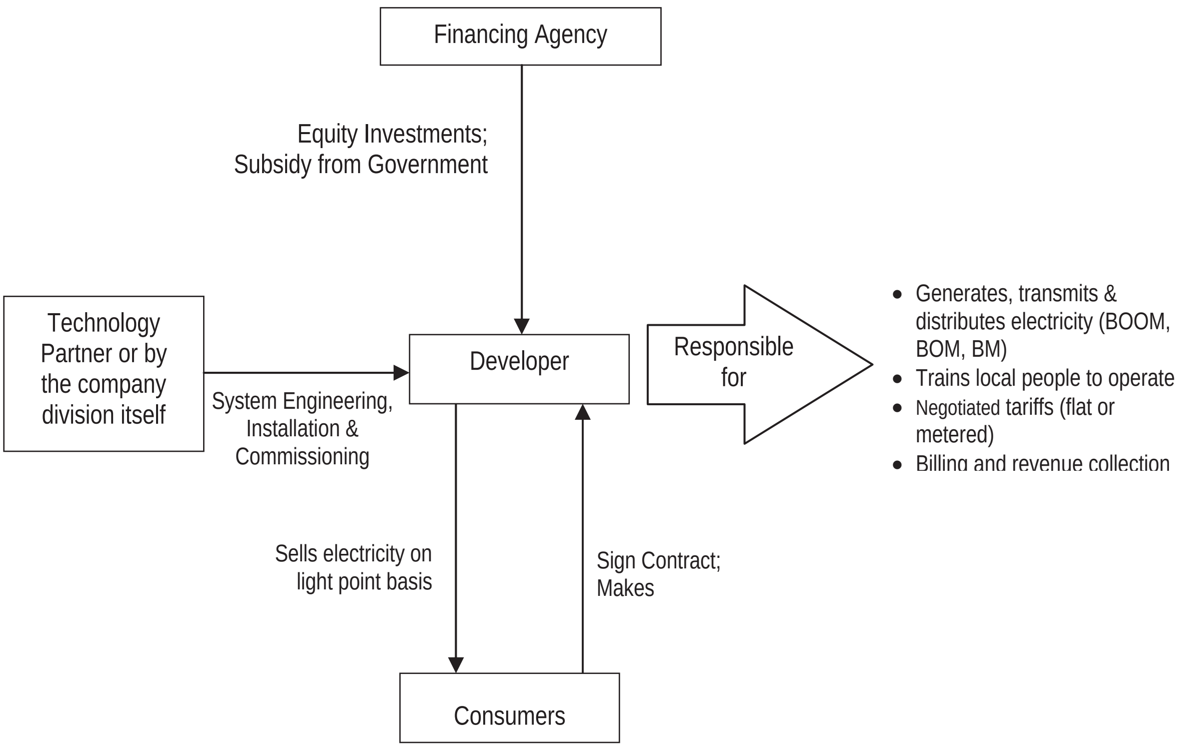


Figure 4.7: Private driven model

5. Road Map for off-grid electrification in Myanmar

Access to affordable and reliable energy services is crucial to reducing poverty and improving health, increasing productivity, enhancing competitiveness and promoting economic growth [IEA 2013]. In case of Myanmar, as discussed in the previous sections, electricity access is far too less as compared to its neighbouring nations. The country, which has 70% of its population living in rural areas, has only 28% of the households having access to electricity. In rural context, only 16% of households have electricity connection and only 4.5% are electrified through national grid and the remaining by off-grid means. Thus, the off-grid options are playing a key role in rural electrification of Myanmar. This chapter, based on the facts and information elaborated in Chapter 2, Chapter 3 and Chapter 4, outlines a probable way forward for enhancing off-grid electrification in rural areas of Myanmar. The chapter also provides policy and capacity building recommendations for enhancing the off-grid electrification efforts in the country. The chapter also proposes a project which can be taken up as a demonstration project in the country with possible funding from IGES/Government of Japan to implement the concept of Joint Crediting Mechanism (JCM) that has been recently launched by the Government of Japan.

As mentioned in the Chapter 2, there are a number of Ministries involved in the electrification process in Myanmar, Two prime ministries are the Ministry of Electric Power (MOEP), who are responsible for extending the grid infrastructure and power generation, and the Ministry of Livestock, Fishery and Rural Development (MOLFRD), that is responsible for promoting off-grid electrification efforts. Other than these two Ministries, the Ministry of Science and Technology, Ministry of Agriculture and Irrigation, Ministry of Environment Conservation and Forestry, Ministry of Industries and Ministry of Energy are also members of the National Energy Management Committee, overseeing the energy sector development in the country. There is also a Village Electrification & Water Supply Committee, headed by the Ministry of Livestock, Fishery & Rural Development

5.1 Target for rural electrification

While currently the electricity grid has been extended to only around 2765 villages (out of the total 62218 inhabited villages) in the country, the Ministry of Electric Power proposes to cover around 4793 villages with electricity grid in the coming three years i.e. by 2016 (Fig 5.1) and cover around 80% of the villages by 2030-31. On the other hand, *the MOLFRD has made provision of electrification of an additional 1300 villages through off-grid technologies by 2015* as part of their mandate as reported during the visit of TERI team. During the meeting of TERI team with MOLFRD officials, they shared that currently they do not have finance to plan beyond 2015.

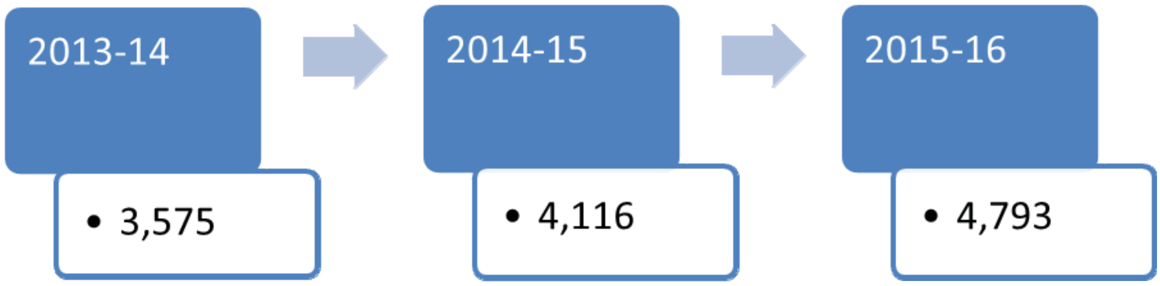


Figure 5.1 Year wise village electrification plan from MOEP.
Source: MOEPa, 2013

However, in the off-grid areas, the electrification is also undertaken by the various organisations, in close cooperation with the district government, with donor funding, Apart from this, off-electrification efforts are also being carried forward by village level committees by raising fund from amongst themselves or by local private developers, who set up biomass gasification or diesel based micro power plants to provide electricity services in a particular territory. It is reported during the TERI mission that various bilateral and multilateral organizations have funded rural electrification activities by setting-up battery charging station, community based solar PV plants etc.; in many cases these plants are not recorded by the government.

5.2 Technical and delivery models for off-grid electrification in Myanmar

The following section, based on the information highlighted in Chapter 4, provides details of some of the probable technical and delivery model that can be taken up for electrification of off-grid locations in Myanmar.

5.2.1 Standalone Charging Station Model

The solar lantern and battery charging stations are relevant and suitable in communities where population is not very dense, people are poor and can't afford to buy an individual equipment and the demand is only for lighting, mobile phone charging and very low consumptive appliances. A standalone solar charging SCS can be supported by the appropriate Ministry or department in Myanmar which can operate through a fee-for-service model. A typical SCS can comprise of facility to recharge and rent around 50-100 lanterns and or batteries, depending on the number of households in the village. Design of a typical SCS is shown below in Figure 5.2. The SCS will charge portable LED lights/lanterns and or small batteries that will be rented by the villagers at a nominal fee. Since battery charging stations are already prevalent in the country, it would be very easy to implement such stations because of existing knowledge about the technology.

The charging station could be provided to a village entrepreneur on down payment and instalment basis (financed by a local bank). The charging station will be handled by the entrepreneur, who also has to be trained to manage the station, operate it and perform basic repairs and maintenance. The entrepreneur can utilize a percentage of the revenue collected from the villagers to repay the loan and the rest will form his income.

Solar technology being modular, the charging station can also be split into modules of 10 lanterns each and each such module can be implemented at separate locations in the villages to serve 10 neighbourhood houses. The entrepreneur can be made responsible to manage the charging stations and also share some revenue with the households, where each of such stations is installed.

5.2.2 Charging station model with DC micro-grids

In addition to a standalone system, there is also possibility for piloting charging stations along with a DC micro-grid system, Experience suggest that some of the users in a village may be reluctant to collect lights/lanterns from the charging station or delivery to each household by the entrepreneur may be a barrier. In such cases, it might be more successful if the central station could be connected directly to each household through a micro-grid charging a nominal fee/month. Such model have been very successfully implemented in India and Bangladesh and have been reasonably successful. A combination of charging station with a DC micro grid also have a good potential to be scaled up to more houses by using larger capacity systems.

In this model, the SCS will provide lamp/lantern recharge to villagers who live away from the micro-grid station and cannot be connected by the DC grid due to high costs of the extension lines. The DC micro-grid, on the other hand will provide access to lighting to households who do not wish to make the efforts of collecting lights/lanterns. The cost structure of the micro-grid will be kept slightly higher in comparison and this customized model will benefit two levels of income within the BOP populations. While the DC micro grid will provide fixed line connection, for LED based lighting, to around 20-30 households/shops within the vicinity of the enterprise, rural community that are slightly away from the micro-grid connection can also avail portable lanterns on rent. The enterprises can have facility to charge mobile phones and also option to sell LED lamps and efficient cookstoves to meet any demand in the villages, thereby acting as rural clean energy hub.

In this model also, the entire facility can be set up by a village entrepreneur, trained by the appropriate agency, on down payment and instalment basis (financed by a local bank). The entrepreneur, will manage the station, operate it and perform basic repairs and maintenance. The entrepreneur can utilize a percentage of the revenue collected from the villagers to repay the loan and the rest will form his income. Here also, the modularity concept can be implemented to implement smaller stations at number of locations in the village, if required. The fee-for-service model for renting of lantern from a SCS or providing only lighting service from a solar DC micro grid may be closer to the need of poor sections of population in the country. Experiences from LaBL program in India also corroborates the fact that without the support of any micro-credit systems and where poor people are expected to pay for the service by their own means, they prefer to pay for the ‘service’, rather than own the solar lighting systems since this exerts less financial pressure on the poor households.

5.2.3 Mini-grids for densely populated areas with potential for productive load

In the areas that are densely populated – such as Mandalay, valley of Ayeyarwady river, Sagaing, Bago etc. – mini-grids based energy supply model are recommended. Given Myanmar’s low electricity consumption, mini-grids can easily cater to such energy needs and can be recognized as fully fledged alternatives to extending the central grid. As discussed in the previous chapter, the architecture of this system is similar to the conventional grid in which consumers are connected to the distribution grid and are billed based on the amount of electricity consumed. Mini-grids can be implemented using solar PV, biomass gasifiers or hybrid systems of solar, biomass, wind and or diesel.

Both community based or private sector led models could be implemented for such mini-grids in the villages, depending on the local requirement and ability to run a particular type of model. In the community based or VEC model, participation of the local and regional/state government become central, in order to have a sustainable system. A proper institutional framework thus have to be established where local representatives of village, local government and people participate in planning, implementation and operation of the system. However, based on experiences from India, it is observed that the beneficiary payment in remote villages is poor and so a project sometimes becomes unsustainable after the initial phase. Keeping this fact in mind, the community model could be modified to develop synergy and also supply electricity to productive enterprises (especially in case of gasifier or small hydro based projects) in the villages in addition to electricity for lighting (Figure 5.2). The tariff charged by the VEC should be such that the commercial users pay a higher tariff to cross subsidize the usually lower payment from the domestic users of electricity.

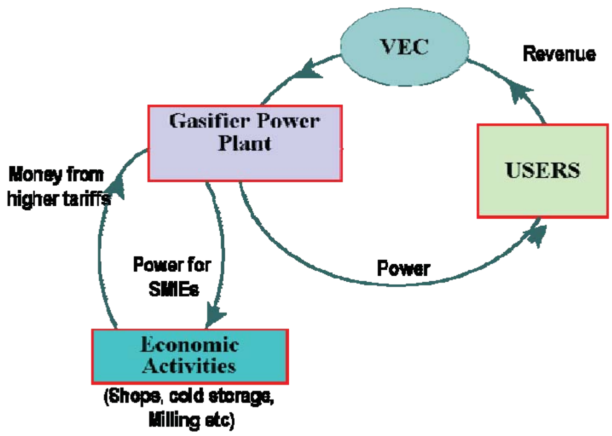


Figure 5.2: Developing synergy with economic activities
(Source: TERI)

Apart from the community based model, the private sector led model also has a huge potential for implementation in the country. The country already has some experience in running biomass gasifiers and diesel generator sets for electricity distribution in rural areas by private youths. Thus, a concerted effort could be made by the district governments, local banks in coordination with the nodal ministry to involve and train local developer as entrepreneurs to set up and manage such mini-grids. While experiences of private sector led model has already been shared in Chapter 4, a variant of the model called the Energy Service Provider Model or BOOM model could probably be tested in Myanmar. This model may be appropriate in 'not so remote' villages with large population or a cluster of remote villages to ensure higher number of consumers comprising of both domestic and commercial consumers.

A district level project developer or rural energy service company could take the lead in clustering the villages and set up individual systems in the villages. The developer will also be responsible for system engineering and facilitating installation of the energy production systems and providing maintenance support services. In addition, a VEC is recommended to be formed by the district government to act as a regulator at the village level and set the electricity tariff, biomass price (in case of biomass projects) and redresses any grievances of the consumers and ensure that the private developer is not exploiting the consumers. An Energy Service Provider, which could be local entrepreneur from the village or nearby village or a SHG will be developed by the project developer and provided the responsibility of plant operation and MBC (metering, billing and collection). In return, the ESP will get a commission to perform the duties subject to achieving the designated plant load factor of the plant and also collection of all payments from consumers. The project developer also enters into a separate AMC (annual maintenance contract) for LT Line and power plant maintenance either with the OEM or any other local agency capable to provide the services. The biomass supply, in case of biomass projects, could be taken care of by local SHGs, developed exclusively for such arrangement, on payment basis. Table 5.1 summarises the possible transactions between key entities identified in the ESP Model.

Table 5.1 Summary of transactions between key entities in the ESP model

S. No.	Entities	Offers	To	Expects in return	Instrument
1	SHGs	Fuel	ESP	Payment for fuel supply (for biomass projects only)	Biomass price set by VEC
2	ESP	Electricity	Consumer	Payment of electricity	Tariff set by project developer in consultation with VEC
3	Consumer	Payment	Developer (through ESP)	Reliable Electricity	Connection Agreement
4	OEM	AMC	Developer	Payment	AMC agreement
5.	ESP	Payment	Developer	Services and training	Lease Agreement

This model is expected to ensure better and reliable supply of electricity to the local area. However, this model will have inherent risks for the private developer and the project viability will critically depend on the collection performance and management efficiency of the developer/ESP. The ESP/developer distributing electricity may not be able to generate adequate revenue in remote areas having chronic problem of poor collection efficiency and existence of consumers paying subsidised tariff. The government may also have to make viability gap funding/revenue subsidy to the private distributor of electricity for sustainability of the model.

5.2.4 Solar Home Systems:

In the sparsely populated areas and high solar radiation, such as the northern districts, solar home systems (SHSs) are suitable for village electrification. The system has the flexibility of designing as per household load (except motor load) demand and can vary from 10 Wp to 200 Wp. These systems can provide power for meeting only lighting load and also meet other load such as DC fan, TV, small appliances etc., which are usually used in rural areas.

A study by the European Union Energy Initiative reports that households in central Myanmar spend around $9.26 per month on candles and torches. Down in the Irrawaddy Delta, the same study reports that mean monthly household spending on candles and large batteries amounts to $12 against mean monthly incomes of US$40-80. At these budgets solar-LED home lighting systems are quite cost competitive, available at US$ 100-300, depending on capacity. For dissemination of such system, the consumer finance model, followed in Bangladesh, could possibly be replicated in the country. If credit were charged at 14-15% per annum, the system cost could be paid off in 3 years, assuming income is not affected by bad harvests or disasters. In such cases, a flexible repayment scheme may also be adopted with higher payment during the after harvesting and lower repayment during the sowing season. To safeguard the loan amount, financing can also be done forming joint liability groups, where liability of one member of the group is borne by collectively by all other members in case of payment default.

5.3 Policy and capacity building recommendations

The rate of success of any electricity access program is directly dependent on the government's commitment to creating an enabling environment on a sustainable manner, which includes having a clear cut policy framework and milestones, systems for defining and enforcing appropriate standards, financial support mechanisms and support for capacity building.

Some of the policy measures which will assist in scaling up the dissemination of renewable energy interventions for enhancing electricity access in off-grid areas are:

5.3.1 Coordinated approach for scaling up off-grid interventions

There are almost a dozen Ministries and government agencies involved in energy and electricity planning, and even greater numbers of actors in the private sector and civil society, which seems to complicate the energy policy landscape. This complex policy environment creates overlapping and at times confusing mandates and poorly coordinated efforts at promoting electricity access. A study by accelerating energy access in Myanmar by UNDP reports that if a micro-hydro plant want to power a village scale mini-grid and also export excess electricity to the national grid, it would require the involvement of the Ministry of Electric Power (responsible for planning permits and maintenance for hydroelectricity, and for transmission and distribution), and the Yangon City Electricity Supply Board/Electricity Supply Enterprise (responsible for electricity sales) and the regional government. Similarly, a hybrid solar-biomass facility would need the involvement of the Ministry of Environmental Conservation and Forestry (responsible for biomass and fuelwood), Ministry of Education (responsible for basic and applied research), the Ministry of Science and Technology (responsible for development of renewable power sources), and, if using direct combustion of biomass, the Ministry of Agriculture & Irrigation. While recently the Government of Myanmar has made the Ministry of Livestock, Fishery and Rural Development as the nodal department for promotion of off-grid interventions and there are also NEMS and NEDC to coordinate various efforts in the energy sector, it is recommended that a Department of Rural Electrification be created in the Ministry of Electric Power for setting up infrastructure both for grid electrification as well as mini-grids projects. This will also ensure that duplication of work (i.e. grid is extended to an area covered with mini-grid/off-grid electrification) is not done and there is certainty for private sector to invest in the off-grid areas as a concessionaire based on set terms and conditions of the government. It is to be noted here that while overall share of power sector is largest at 43% of the total Foreign Direct Investment coming in the country, a major component of this is for large hydropower development [IGES, 2013]. As reported in previous chapters, already entrepreneurial spirit at village level - a major precondition for market based approaches - exists in the country and there are also rural inhabitants who are used to pay for energy services. Thus to attract investment in the electricity access sector, a more coordinated approach is required with a single window service for the private developers desirous of implementing projects in rural areas.

Further, another pertinent issue is related to the risk of obsolescence of the technology that is considered for implementation. This holds paramount importance in the context of grid reaching in the off-grid locations, thereby making the project sunk. This will also need attention through development of appropriate policies, for provision of grid-compatible power conditioning-units in the design of any project and or appropriate grid interconnection standards, so that as and when the conventional grid reaches the site, these mini-grids can simply be connected and kept functional. In addition, smart-grid technology1 has also recently evolved so that existing renewables-based generators in mini-grids may be seamlessly connected to the conventional grid and any number of renewable energy -generators may be connected to the mini-grid to supply electricity to the local area, improving electricity access in the region.

5.3.2 Financing

A key challenge acting as roadblock for up scaling and proliferation of mini-grids and off-grid interventions in many countries is the lack of adequate investment in the sector. Experience for South Asian countries corroborate the fact that most companies active in mini-grid/off-grid distribution are not able to gain sufficient capital to expand or up-scale. Since, these projects operate in rural settings, without any long-term power purchase agreements in majority of cases, with poor consumer load profile; banks are usually reluctant to finance these interventions. Further, high upfront costs have also been acting as a major deterrent. Therefore, debt financing from banks/financing institutions becomes a cumbersome affair for private investors and they are also reluctant to finance these projects without having sufficient collateral and risk guarantees.

Myanmar is not an exception to this important issue. It is recommended that the policy makers may take cognisance of this issue and develop a portfolio or creating a revolving fund for financing of off-grid/mini-grid projects. In this regard, a country level financial institution such as Myanmar National Bank or Myanmar Agricultural Development Bank, can be designated as the nodal financial institution (similar to IDCOL in Bangladesh) for support of range of off-grid systems including individual solar home systems as well as mini-grids based on solar PV, biomass gasification and or mini/micro hydro technology. Such financing mechanism would enable the households and communities and private developers to purchase solar home systems and other stand-alone renewable energy equipment and set up mini-grids through loans and other financing packages.

Five interconnected approaches are recommended here which could address the financing of such systems. First, the financial institutions will have to generate more fund at lower cost of capital, either from the government or international development partners such as Asian Development Bank or Japan International Cooperation Agency etc. Second, the officers of the financial institutions need to be trained beyond giving loans for crops to those involving energy technology, which they have little familiarity with. In addition, a team of 3-4 officials may also be send for exposure visits to Bangladesh or India to learn from real situations Third, the Central Bank of Myanmar, which sets monetary policy, could establish lower interest rates for loans related to energy access, which could be slightly higher than the cost of capital for the designated financial institution. Fourth, the financial institution have to partner with a collection of regional cooperatives, MFIs, and NGOs, to refinance them for energy access for on-lending to consumers willing to procure solar home systems and other stand-alone renewable energy devices. These agencies also have to be supported to create a network of energy enterprises, who could potentially sell and service the systems. Lastly, the government

[1] Smart-grid technology offers ways of integrating off-grid/decentralized energy systems with the centralized gird system in a rational and balanced manner. For instance, off-grid generation system could be controlled dispatched by the central control center and could be tapped during peak hours. Usually the incremental cost for introducing smart systems may range from 10% and above depending on the level of smartness introduced.

could reduce tax on imported parts for solar panels and other renewable energy technologies to encourage use of such systems to enhance rural electrification and promote economic development.

The Joint Crediting Mechanism of Government of Japan can also play a big role in supporting the financing of off-grid interventions in the country. Under JCM, as the Japanese government is supporting technology and finance for the low carbon energy project, mini-grids, community based systems as well as individual off-grid interventions can be financed in Myanmar to take benefit of the carbon credits derived from such projects. Specifically, advanced low carbon and renewable energy technology from Japan could be made available at a significantly lower cost to Myanmar for enhancing their off-grid electrification efforts and also improve the environmental performance and reduce fossil fuel dependency. While such financing can assist in enhancing the electricity access in Myanmar, the benefit to Japan will be two fold – first reduction of green-house gas emission at a significantly lower cost as compared to the cost incurred in reducing GHG emission in Japan and secondly, market opportunities for Japanese renewable energy companies to undertake activities in Myanmar.

5.3.3 Adoption of international standards on technologies

Standards benefit customers and end-users primarily by ensuring quality and safety of products as well as systems or installations. They also benefit enterprises in providing goods and services through sustainable growth deriving from customer satisfaction, resulting in repeat sales and referrals. Another benefit of standards, especially harmonized standards is through the adoption of international standards – is access to quality goods and services. As observed during the TERI mission, various types of solar products are being disseminated in the country for providing lighting and powering low consumptive applications. Though it is user's choice to procure a lighting product, the seemingly endless amount of LED lamps that are available or introduced at different prices seems to be spoiling the market place. The LED products need several of its components such as light and charging source, energy storage and electronics, to be selected and designed appropriately to avoid performance reliability issues. Because the LEDs are supposed to have a very high life, it is essential that all peripheral systems and components are equally having long life for optimum product performance over its lifetime. There is thus an immediate requirement to set and enforce nationally recognized industry standards both for solar PV panels as well as for balance of systems components – such as inverters and charge controllers – for ensuring that different products being disseminated are of standard quality.

Further, as highlighted in the previous chapter, a key issue with gasifier implementation is the release of waste toxic water from the indigenously designed gasifier systems implemented in the country. Thus, standardized performance oriented technical specifications for gasifier systems also need to be developed to ensure quality of the products and their performance.

The IEC Technical Committee has developed international standards for solar PV systems that may be adopted by Myanmar. The IEC standards are used by qualification testing laboratories throughout the world in testing products submitted by manufacturers who wish to enter the PV marketplace. Standard technical specifications are also available with IEC for use in specifying, commissioning and operating PV and hybrid stand-alone systems or micro-grids in developing countries. IEC has also released technical specification for solar-powered LED lighting devices, such as solar lanterns, which can also be adopted by Government of Myanmar.

5.3.4 Establishment of service and training centres

Once technologies start to be diffused and commercialized, policy makers must ensure that proper after-sales service is provided through service and training centres. One of the reasons for the success of the IDCOL program was supporting creation of a network of centres for responsive maintenance and training hundreds of technicians. Bilateral or multilateral support could be tapped by the Government of Myanmar to support the implementing organisations in establishment of service centres. Myanmar has number of Technical Universities and Technical Schools across the country who can be the potential training centres for providing training on repair and maintenance of individual solar products, installation and maintenance of mini-grids, and repair and maintenance of gasifier and mini/micro hydro systems. An example which is worthwhile to highlight here is the Japanese support project to improve maintenance skills for photovoltaic and other renewable power generation systems being implemented in Myanmar.

5.3.5 Multi stakeholder capacity building & collaborative research

Training and capacity building is one of the invaluable instruments for success of any decentralised electricity project. The evidence drawn from the mini-grid and decentralised interventions experience in India reveals that appropriate support systems should be an integration of a strong 'participatory governance system" at the local level and "well-knitted hierarchical system connecting local level management with the top level management regimes". While issues of local in nature could be better addressed through participatory governance systems, the issues related to policy, regulatory and financing can be well managed through a graded system with appropriate intermediary and/or higher-level management regimes. Thus, appropriate capacity building programs need to be developed both for local level stakeholders as well as at the policy, regulatory and financing sector level.

For example, a series of programs, consisting of exposure visits (to South and South East Asian countries with successful off-grid electricity access projects) and training workshops (in-country) for relevant stakeholders from across the value chain of the renewable energy and energy access sector, which includes government authorities, vendors and manufacturers, implementing agencies, research organizations and financing agencies, may be organised over a period of time to scale up the dissemination of off-grid interventions. The training workshops and exposure can also be complimented by creating linkages with manufacturers (e.g. Japanese manufactures as well as from other neighbouring countries such as India, Thailand etc.) and development agencies to develop local renewable energy projects for provisioning of modern energy services. The aim of the training workshop and exposure visit is two-fold. First, it will serve as an arena for the exploration and sharing knowledge on strategies and success factors for implementation and social organization of renewable energy systems both in village scale models and in other off-grid renewable energy based projects. The workshop thus will build on the learning that has been going on through the years of experience with the social and technical aspects of the many off-grid energy projects implemented in India, Bangladesh etc. Secondly, the exposure visit will be an important event in the process of South-South transfer of knowledge on off-grid projects.

Further, knowledge about major characteristic of various rural energy supply options seems limited in the country and data for planning and decision making often either unavailable or inconsistent. The government at national and sub-national levels seems to be in need of specific know-how for rural energy planning. Thus, the government planners and institutions also need to be trained on internationally accepted standards and methodologies for collecting energy data and using that data for planning and strategizing implementation of off-grid electricity access. One high priority item would be conducting a comprehensive assessment of renewable energy resources and needs undertaken with a focus on electricity demand for households, small, medium and micro enterprises, and community and public services. Based on the findings of such a household assessment and an inventory, off-grid energy initiatives could therefore be developed and implemented by the local community-based organizations and or private developers in partnership with technology suppliers. The transfer respective knowledge for the energy access planning will be particularly important to sub-national government and public administration levels as they are geographically closest to future off-grid locations.

In addition, capacity building efforts also need to be focussed on electricity users. Households, village leaders, and even local entrepreneurs are to a large extent unaware about both the technical aspects of renewable energy technologies and associated business opportunities. In this case, it will be more prudent to create a pool of trained persons from the government, financial institutions and civil society sector, who could further create the necessary awareness and training of the end users.

5.3.6 Transfer of technical knowledge and technology

Myanmar does not possess the indigenous technology or intellectual property needed to produce its own renewable energy systems. Patents and intellectual property concerns, however, can prevent developing economies from acquiring these technologies. Thus, it is felt that there is immense requirement for transfer of technical knowhow to assemble solar home systems, solar lanterns, pico-hydro and other small off-grid interventions in Myanmar. Certified and tested solar products with efficient and reliable specifications suited to the bottom of the pyramid populations have to be identified and their reference circuit designs can then be transferred to Myanmarese manufacturers. Once these designs have been received, these local companies can utilize their in-house capacity to shoulder these designs and manufacture the products in the country itself. External support in 'training of trainers' on local assembly of the new products can be provided by technical experts from countries such as Japan, India Thailand etc. Further, individual solar and pico hydro products in completely knocked down conditions can be procured by Myanmarese assemblers from India, Japan or other countries under South-South transfer of technical knowhow and develop these into final products to disseminate through the network of local enterprises.

5.3. 7 Harnessing NGOs' experiences for policy support activities

In Myanmar, NGO's have been playing a very crucial role in rural energy issues vis-à-vis the government. Compared to many other countries in the region, their role has been mainly on service delivery and less on policy advocacy. However, with wide experience, these NGOs are deemed to have a better insights in rural energy issues than some of the governmental organisations, which was also observed during the visit of the TERI team. The familiarity of NGOs with energy and socio-economic issues in remote areas of Myanmar should therefore be valued and harnessed in policy support processes. Further to make the NGOs also learn from the policy development in the sector in other neighbouring countries, exposure visits of select NGOs and civil society organisations such as MES, REAM etc. can be supported. IGES can play a key role in supporting such capacity building and exposure visits specifically related to policy development issues.

5.4 Potential demonstration project ideas with Japanese engagement

The Government of Myanmar has planned to increase the electrification from current level of 28% to around 80% by the 2030-31. This will be achieved with the help of increasing addition of generation capacity from earlier planned 500 MW to 1,000 MW every year. In this regard, both gas based as well as hydro power is being explored to be harnessed for the additional generation to meet the long term demand. However, this will take time and shall be achieved in long term, whereas in order to electrify off-grid areas in short term decentralized technologies can play as vital role. During discussion with different stakeholders in Myanmar, it is reported that the government is planning to electrify at first 100 model villages in different regions and states and 50 villages in self-administrative zones and divisions based on renewable energy. In order to have effective implementation and benefit to the public at-large, it is suggested to that Japanese government support be combined with the planned government schemes. In this regard, IGES can take forward the discussion with the relevant ministries in Myanmar, or specifically with the NEMC/NEDC to select few clusters in different regions and conduct a detailed feasibility study for implementation of off-grid electrification projects with JCM support.

Project Location

Integrating information available from different stakeholder and secondary data, it is suggested that Rakhine, Sagaing and Tanintharyi could possibly be considered and one cluster from each of these regions identified, in consultation with the local government, for preparing the feasibility report. Table 5.2 provides the resource availability and type of technology that can be considered in these regions.

Table 5.2 Brief details of the identified states for consideration of projects with Japanese support

S. No.	State/Division	Status of Electrification	Wind resource (m/s)	Solar resource ($MJ/m^2/day$)	Biomass resource	Technology option
1	Tanintharyi	Poorly electrified	7-8 (Good/Average)	15-16 (Average)	Evergreen/ Deciduous forest	Solar-wind hybrid Mini-grids
2	Sagaing	Poorly electrified	3-4 (Poor)	15-17 (Average/Good)	Evergreen/ Deciduous forest/rice husk	Biomass based Mini-grids
3	Rakhine	Poorly electrified	7-8 (Good/Average)	15-16 (Average)	Evergreen/ Deciduous forest/rice husk	Solar-wind hybrid Mini-grids

Delivery model

One of the delivery models, as mentioned above in section 5.1 could be considered for implementing the project. The detailed delivery model can be finalised based on the feasibility survey and interaction with the local authority in these regions.

Institutional set-up

The detailed institutional set up will be discussed during the proposed stakeholder consultation in Yangon on 4th March and will be suggested during the submission of the Final Report of the Project.

Bibliography

ADB (Asian Development Bank). (2012a): 'Asian Development Bank & Myanmar Fact Sheet'. Weblink: http://www.adb.org/sites/default/files/pub/2013/MYA.pdf (last accessed on 12/02/2014).

ADB (Asian Development Bank). (2012b): 'Electricity Demand and Supply in Myanmar'. Weblink:http://www.ash.harvard.edu/extension/ash/docs/electricitydemand.pdf. (Last accessed on 20/01/2014).

ADB (Asian Development Bank). (2012c): 'Myanmar Energy Sector Initial Assessment'. Weblink: http://www.adb.org/documents/myanmar-energy-sector-initial-assessment. (Last accessed on 20/01/2014).

ADB (Asian Development Bank). (2013): Project Data Sheet. Project: Preparing the Power Transmission and Distribution Improvement Project. Weblink: http://www.adb.org/printpdf/projects/46390-001/main. (Last accessed on 10/04/2013).

ADB (Asian Development Bank). (2013b): Enhancing the Power Sector's Legal and Regulatory Framework. Weblink: **http://www.adb.org/projects/46486-001/details**. (Last accessed on 20/02/2013)

ASH (Ash Centre for Democratic Governance and Innovation). (2012): Electricity in Myanmar: The Missing Prerequisite for Development. Weblink: http://www.ash.harvard.edu/extension/ash/docs/electricity.pdf. (Last accessed on 04/10/2013).

Asia Sentinel. (2013): 'Turning On Myanmar's Lights'. Weblink: **http://www.asiasentinel.com/econ-business/turning-on-myanmars-lights/**. (Last accessed on 20/02/2014).

Corps. (2013): Household energy market assessment: an assessment of household energy use and supply in Mandalay and Chin State, Myanmar. Weblink: http://www.mercycorps.org/sites/default/files/myanmar_household_energy_market_assessment_summary_aug_2012.pdf. (Last accessed on 20/02/2014)

CWET (Centre for Wind Energy Technology). (2010): Wind energy. Weblink: http://www.sari-energy.org/PageFiles/What_We_Do/activities/SAWIE/wiser/cap_dev_program_for_afghan_women_march_22-30_2010/PRESENTATIONS/23032010/ENGLISH/Deepa_Kurup_Wind_energy.pdf. (Llast accessed on 17/07/2013).

Devex. (2014): 'ADB: Solve legal issues before private sector can power Myanmar'. Weblink: https://www.devex.com/en/news/adb-solve-legal-issues-before-private-sector-can/82668. (Last accessed on 20/02/2014)

Enerdata. (2012): '100 MW independent power project in Myanmar will start in 2013'. Weblink: http://www.enerdata.net/enerdatauk/press-and-publication/energy-news-001/100-mw-independent-power-project-myanmar-will-start-2013_15182.html. (Last accessed on 20/02/2014).

Evwind. (2013): Solar energy offer alternative solutions to rural Myanmar. Weblink: http://www.evwind.es/2013/03/18/solar-energy-offer-alternative-solutions-to-rural-myanmar/30873; (last accessed on 17/02/2014)

FAO UN (Food and Agriculture Organization of the United Nation). (2013): Food and Agriculture Organization of the United Nations data. Weblink: www.factfish.com. (Last accessed on 02/01/ 2014.

IEA (International Energy Agency). (2011): World Energy Outlook, 2011

IEA (International Energy Agency). (2012): World Energy Outlook, 2012

IEA (International Energy Agency). (2013): Southeast Asia Energy Outlook, 2013.

IGES (Institute for Global Environmental Strategies). (2013): Enhancing readiness for green growth: A preliminary assessment of Myanmar's policies and institutions. Weblink: *http://pub.iges.or.jp/modules/envirolib/upload/4828/attach/IGES_Working_Paper_2013-04_final.pdf*. (Last accessed on 22/02/2014).

Janjai, S./Masiri, I./Laksanaboonsong, J. (2013): Satellite-derived solar resource maps for Myanmar. Renewable Energy 53 (2013) 132-140.

Khaing, U. W. (2012a): Myanmar's Future Potentials in Low Carbon Energy. Weblink:

http://www.iges.or.jp/en/archive/cdm/pdf/regional/20121113/Discussant_Low%20Carbon%20Energy%20Potentials_U%20Win%20Khaing.pdf. (Last accessed on 15/11/2013)

Khaing, U. W. (2012b): Current Policy and Investment Opportunities in Myanmar. Weblink: http://news.ubmthailand.com/Newsletter/2013/EPA/Files/SessionII/03-Policy%20and%20Potential%20in%20Myanmar2.pdf. (Last accessed on 15/11/2013)

Khaing, U. W. (2013b): Opportunities of clean energy solutions in Myanmar and in the region. Presentation during Green Growth Green Economy (GEGG), 2013.Weblink: http://www.iges.or.jp/files/research/climate-energy/mm/PDF/20131120/3_Khaing.pdf. (Last accessed on 22/02/2014)

Krithika PR, Palit D., 2013. Participatory Business Models for Off-Grid Electrification; In Rural Electrification through Decentralised Off-grid Systems in Developing Countries (ed. S Bhattacharyya), Springer-Verlag London. p. 187-225

Kyaw, W. W./Sukchai, S./Ketjoy, N./Ladpala, S. (2011): Energy utilization and the status of sustainable energy in Union of Myanmar. Energy Procedia 9 (2011) 351 – 358.

MEPE (Myanmar Electric Power Enterprise). (2013): Power System Development Scheme of MEPE. Weblink: http://www.ubifrance.com/medias/press/mepe_9_7_2013_29_31.pdf. (Last accessed on 19/02/2014).

MES (Myanmar Engineering Society). (2012): Myanmar Engineering Society, 2012

Mizzima. (2013a): Thein Sein pledges cheaper electricity for Rakhine State. Weblink: http://www.mizzima.com/mizzima-news/politics/item/10241-thein-sein-pledges-cheaper-electricity-for-rakhine-state. (Last accessed on 22/02/2014)

Mizzima. (2013b): Foreign companies seek power generation in Myanmar through wind power. Weblink: http://www.mizzima.com/business/investment/item/10210-foreign-companies-seek-power-generation-in-myanmar-through-wind-power. (Last accessed on 22/02/2014)

MOE (Myanmar of Energy). (2009): Energy policy (A) – leaders training type.

MOEP (Ministry of Electric Power). (2006): Hydropower Potentials of Myanmar (State and Division Wise).

MOEP (Ministry of Electric Power). (2012): 'Wind Power Resources, Potential and Recent Initiatives in Myanmar'. Weblink: http://www.oilseedcrops.org/wp-content/uploads/2013/06/Ministry-of-Electric-Power-Myanmar-Wind-Power-Resources-Survey-2012-.pdf. (Last accessed on 15/02/2014).

MOEP (Ministry of Electric Power). (2012b): Regional workshop on GMS country Experience in achieving performance target. Weblink: http://www.gms-sef.org/docs/workshops/Regional/REGIONAL_presentations_chiang_mai/S3.4%20MYAMAR.pdf. (Last accessed on 19-02-2014)

MOEP (Ministry of Electric Power). (2013a): Experience with Grid and Off-grid Rural Electrification in Myanmar. Weblink: https://energypedia.info/images/5/54/Zaw_Moe_Win.pdf (Last accessed on 15/11/2013).

MOEP (Ministry of Electric Power). (2013b): Rural Electrification in Myanmar Policies and Recent Initiatives (Grid and Off Grid). Weblink: http://www.gms-sef.org/docs/workshops/National/myanmar%20ppt/day%202/S6.1%20San%20MOEP.pdf
MOEP (Ministry of Electric Power). (2013c): Country presentation of Myanmar: JICA Tokyo international centre "Energy Policy (B) Training Program in Japan". (Last accessed on 29/12/2013)

MOEP (Ministry of Electric Power). (2013d): Present & Future Power Sector Development in Myanmar. Weblink: https://www.uschamber.com/sites/default/files/legacy/international/files/ministry_electric_power_myanmar_2_27_13.ppt. (Last accessed on 19/02/2013)

NEDO. (2012): NEDO's Activities and toward Deployment of Renewable Energy in Myanmar. Weblink: http://www.gms-sef.org/docs/workshops/National/myanmar%20ppt/day%202/S9.4%20Kimura%20NEDO.pdf. (Last accessed on 15-11-2013).

The Nation. (2014): 'Gunkul eyes Thai, Myanmar power sectors'. Weblink: http://www.nationmultimedia.com/business/Gunkul-eyes-Thai-Myanmar-power-sectors-30224068.html. (Last accessed on 20/02/2014)

NORAD (Norwegian Agency for Development Cooperation). (2009): Assessing technology options for rural electrification. Guidelines for project development.

Palang Thai. (2013): Empowering rural electrification in Myanmar – opportunities and policies. Weblink: http://www.palangthai.org/docs/EmpoweringRuralElectrificationGREACEN-NayPyiDawMyanmar9Mar13n.pptx. (Last accessed on 17/02/2014).

Palit, D. (2013): "Solar energy programs for rural electrification: Experiences and lessons from South Asia". Energy for Sustainable Development 17 (2013) 270 –279

Palit, D & Chaurey, A. (2011): "Off-grid rural electrification experiences from South Asia: Status and best practices". Energy for Sustainable Development 15 (2011) 266 –276

PIDS (Philippine Institute for Development Studies). (2013): Energy Market Integration and Energy Poverty in ASEAN. Weblink: http://dirp4.pids.gov.ph/webportal/CDN/PUBLICATIONS/pidsdps1350.pdf . (Last accessed on 29/12/2013).

Ram, S. G. (2012): UNDP programming for rural energy and environmental conservation in Myanmar, 2013–2015: Challenges and opportunities.

REN21 (Renewable Energy policy Network for 21st Century): Renewables Interactive Map Country Profile: Myanmar. Weblink: http://www.map.ren21.net/PDF/ProfilePDF.aspx?idcountry=117. (Last accessed on 20/02/2014).
Sovacool, B. K. (2013): Confronting energy poverty behind the bamboo curtain: A review of challenges and solutions for Myanmar (Burma).

Sovacool BK. Environmental conservation problems and possible solutions in Myanmar. Contemp SE Asia 2012;34(2):217–48.

Spagnoletti, B. / O'Callaghan, T. (2013): Let there be light: A multi-actor approach to alleviating energy poverty in Asia.

TERI (The Energy and Resources Institute). (2014): Renewable energy based rural electrification: the Mini Grid Experience from India.

Turnell. S. (2011): Myanmar's fifty-year authoritarian trap. J Int Aff 2011;65(1):79–92

UN (United Nation). (2010): Energy for a Sustainable Future. http://www.un.org/wcm/webdav/site/climatechange/shared/Documents/AGECC%20summary%20report%5B1%5D.pdf

UNCRD (United Nations Centre for Regional Development), (2013): 'Country Analysis Paper on 3R Practice in Myanmar'. Weblink: http://www.uncrd.or.jp/env/spc/docs/130318Myanmar.pdf. (Last accessed on 20/01/2014).

UNDP. (United Nation Development Program). (2013a): Human Development Report 2013. Weblink: http://hdr.UNDP.org/sites/default/files/reports/14/hdr2013_en_complete.pdf. (Last accessed: 20/01/2014).

UNDP. (United Nation Development Program). (2013b): Sensitization Workshop Manual on Sub Megawatt Scale Biomass Power Generation under the project "Removal of Barriers to Biomass Power Generation in India"

UNDP (United Nation Development Program). (2013c): Accelerating Energy Access for all in Myanmar.

Vanderschelden. D. (2013): Can Solar Energy Provide An Alternative Solution For Burmese Rural Areas?. Weblink: http://broadgateenergy.com/2013/11/28/can-solar-energy-provide-an-alternative-solution-for-burmese-rural-areas/; last accessed on 17/02/2014

WEF (World Economic Forum). (2013): New Energy Architecture: Myanmar

Win, U. T. (2013): RE Mini Grids for Rural Electrification: Project Schemes to Support Mini Grid Electrification, Financing Schemes & Required Technical Support for Project Development at Operational Phase. Weblink:

https://energypedia.info/images/4/49/Col_Thaung_Win.pdf. (Last accessed on 11-15-2013). (Last accessed on 20/02/2014)

Wint Wint Kyaw, Sukruedee Sukchai, Nipon Ketjoy and Sahataya Ladpala. (2011): "Energy utilization and the status of sustainable energy in Union of Myanmar", Energy Procedia 9 (2011) 351 – 358.

World Bank. (2013): Electric power consumption (kWh per capita). Weblink: http://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC. (Last accessed on 19/02/2013).

Annexure 1: List of Stakeholders

Following is the list of stakeholders with whom discussion were held during mission to Myanmar between November 20-27, 2013.

S. No.	Name	Designation	Organization	Meeting Date
1	Mr U Aye Kyaw	Director (Retd.)	Energy Planning Department, Ministry of Energy, Union Govt of Myanmar	20-Nov-13
2	Mr K. K. Hlaing	Chairman	Smart Group of Companies	22-Nov-13
3	Mr Kyaw Min	Director	Earth Renewables Pvt Ltd, Yangon	22-Nov-13
4	Mr Myo Myint	Advisor	Earth Group of Companies	22-Nov-13
5	Mr Aung Kyaw Thu	Engineering Manager (Design)	Earth Group of Companies	22-Nov-13
6	Mr Kyaw Kyaw	Director	Green Planet Association	22-Nov-13
7	Dr Ohnmar Khaing	Coordinator	Food Security Working Group	22-Nov-13
8	Dr Thinn Thinn Latt	Lecturer, Department of International Relations	University of Yangon	22-Nov-13
9	Mr U Aung Myint	General Secretary	Renewable Energy Association Myanmar	23-Nov-13
10	Mr U Hla Myint	Central Executive Committee	Renewable Energy Association Myanmar	23-Nov-13
11	Mr U Than Htay	Central Executive Committee	Renewable Energy Association Myanmar	23-Nov-13
12	Mr Daw Sane Sane	Central Executive Committee	Renewable Energy Association Myanmar	23-Nov-13
13	Mr U Win Khaing	President	Myanmar Engineering Society	23-Nov-13
14	Mr U Myint Soe	Chief Executive Officer	Myanmar Engineering Society	23-Nov-13
15	Mr Khin Maung Win	Joint General Secretary	Myanmar Engineering Society	23-Nov-13
16	Mr Saw Khine Htun	Chief Engineer	Soe Electric & Machinery Co. Ltd	23-Nov-13
18	Mr Phone Wai Myint	International Co-ordination Manager	Soe Electric & Machinery Co. Ltd	23-Nov-13
19	Dr Win Khaing Moe	Director General	Myanmar Scientific and Technological Research Department, Ministry of Sience & technology, Union Govt of Myanmar	23-Nov-13

S. No.	Name	Designation	Organization	Meeting Date
20	Dr Sint Soe	Deputy Director General	Myanmar Scientific and Technological Research Department, Ministry of Sience & technology, Union Govt of Myanmar	23-Nov-13
21	Mr U Hla Thein Aung	Deputy Chief Engineer	Department of Rural Development, Union Govt of Myanmar	25-Nov-13
22	Ms Kyu Kyu Khin	Director	Department of Rural Development, Union Govt of Myanmar	25-Nov-13
23	Mr U Thoung Win	Managing Director	Myanmar International Consultants Limited (MMIC Co., Ltd)	27-Nov-13
		Member	National Energy Development Committee, Union Govt of Myanmar	
24	Mr Win Hlaing	Deputy Director General	Planning and Statistics Department, Ministry of Environmental Conservation and Forestry, Union Govt of Myanmar	21-Nov-13

About TERI

A unique developing country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. TERI has grown to establish a presence not only in different corners and regions of India but is perhaps the only developing country institution to have established a presence in North America and Europe and on the Asian continent in Japan, Malaysia and the Gulf.

TERI possesses rich and varied experience in the electricity/energy sector in India and abroad, and has been providing assistance on a range of activities to public, private and international clients. It offers invaluable expertise in the fields of power, coal and hydrocarbons and has extensive experience on regulatory and tariff issues, policy and institutional issues. TERI has been at the forefront in providing expertise and professional services to national and international clients. TERI has been closely working with utilities, regulatory commissions, government, bilateral and multilateral organizations (The World Bank, ADB, JBIC, DFID, and USAID etc.) in the past. This has been possible since TERI has multidisciplinary expertise comprising of economist, technical, social, environmental, and management.

teri

The Energy and Resources Institute

www. teriin.org

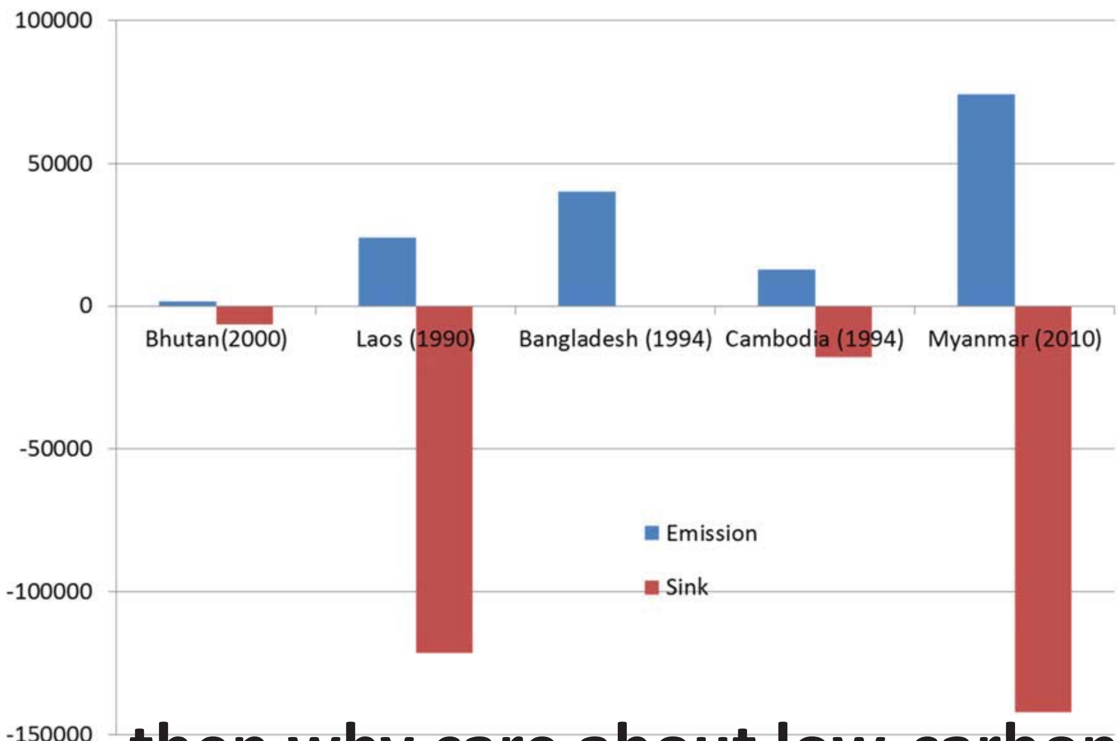
Introducing Joint Crediting Mechanism and objectives of the study

4 March 2014
Kenta Usui
Climate and Energy Area, IGES

IGES

1

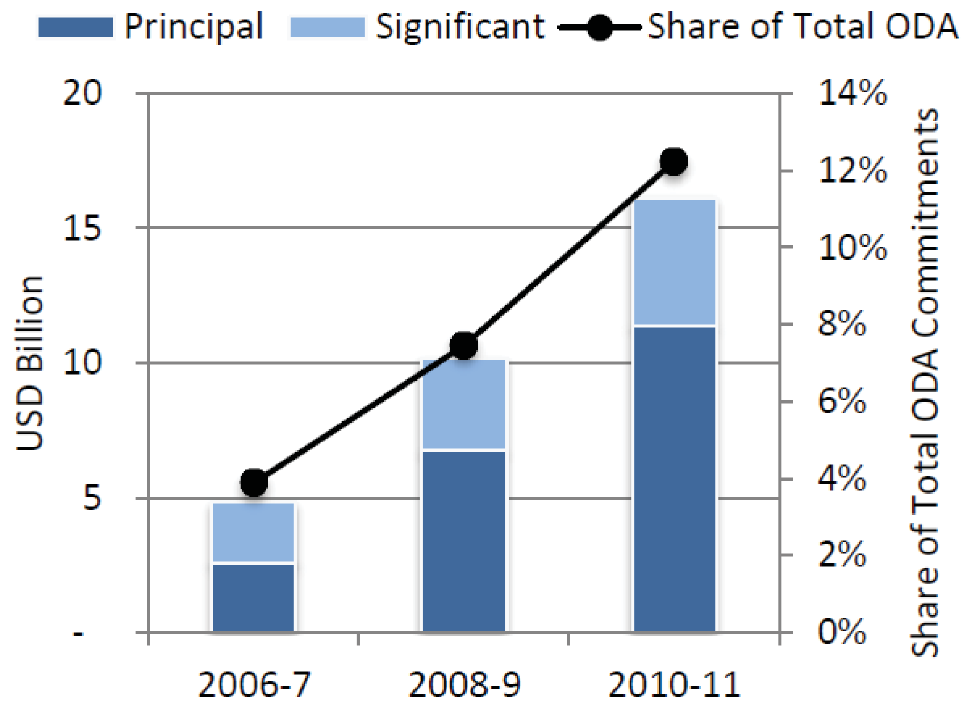
Myanmar’s negative GHG emission



..then why care about low-carbon?

2

Why low-carbon still matters: scale



Bilateral commitments, average over 2 years　Source: OECD

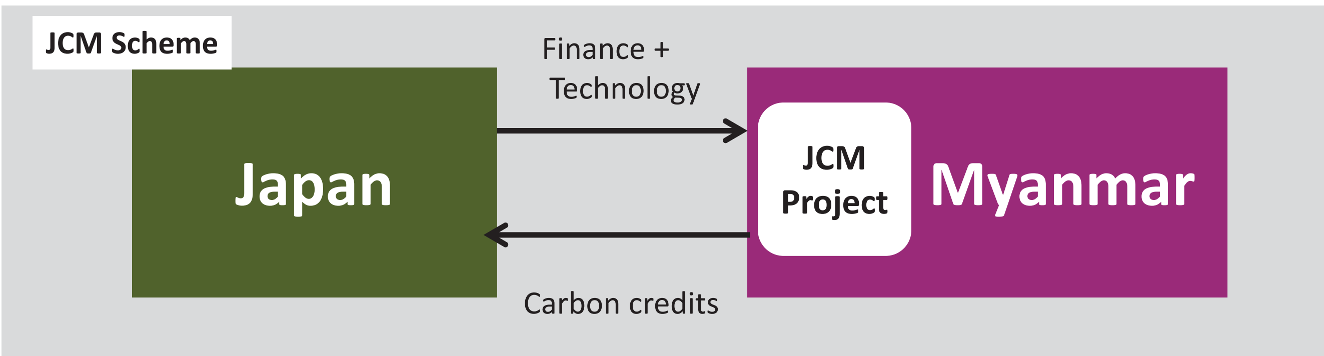
Why low-carbon still matters: co-benefits

Low-carbon measures	Co-benefits
Renewable energy	Off-grid access to electricity, reduced indoor air pollution,
Energy efficiency	Reduced air pollution and energy bills
Integrated waste management	Enhanced recycling, reduced water pollution
Energy-efficient water treatment	Improved water quality
Low-carbon transport	Reduced air pollution and traffic congestion

INTRODUCING JAPANESE JOINT CREDITING MECHANISM

5

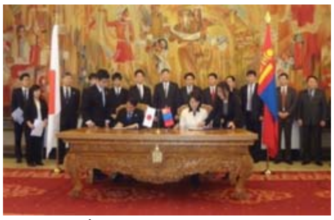
How JCM works



Benefits to Japan
- GHG reduction at lower cost
- Market opportunities for Japanese firms

Benefits to Myanmar
- Advanced Japanese technology made available at significantly lower cost
- Attracts low-carbon investment
- Improved environmental performance
- Reduced fossil fuel dependency

6

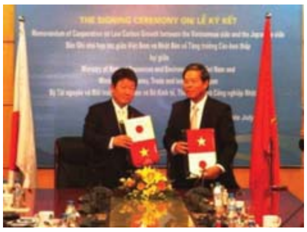

Mongolia: January 2013


Bangladesh: March 2013


Ethiopia May 2013

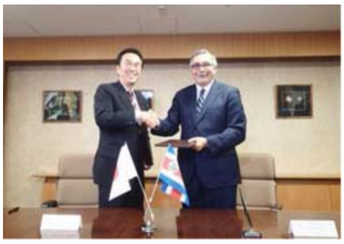

Kenya: 2013 June


Maldives; June 2013


Vietnam: July 2013


Lao PDR, August 2013


Indonesia: August 2013


Costa Rica: December 2013


Palau, January 2014

10 countries signed up to Joint Crediting Mechanism

7

Three key actors in JCM

JC allows projects to focus on Japan's strength and host country's demand

Joint Committee

Decision-making body composed of two governments

PP is composed of Japanese and host country's entities

Project participants

Third Party Entities

Project implementation and monitoring

Validation and verification

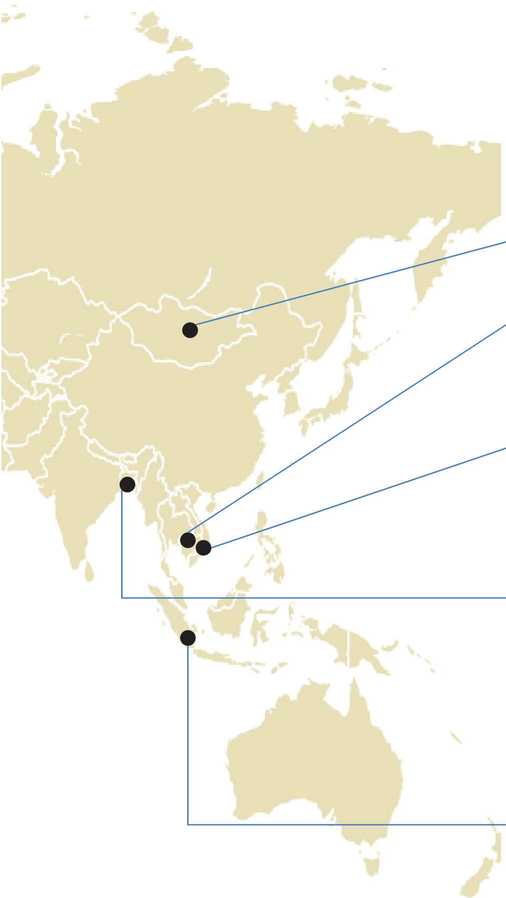
8

Providing incremental cost

- **Japanese government subsidizes low-carbon technologies**
  - Global Environment Centre (GEC) finance up to **50%** of the initial investment cost
  - New Energy Development Organisation (NEDO) provides full initial finance, and installed facilities are purchased by project participants at later stage

9

Ongoing JCM projects



Mongolia
Introduction of energy-efficient heat boilers

Cambodia
Small-scale biomass power generation using sterling engine

Vietnam:
Integrated energy efficiency improvement in beer factories

Bangladesh:
Non-combustive brick making
(does not combust coal)

Indonesia
- Introduction of energy-efficient industrial air conditioner
- Energy improvement in convenience stores (using high-efficiency freezers, air conditioners and LED lightings)
- High-efficiency freezers

With Myanmar…

- Exploring the potential of low-carbon waste management in Yangon
- Exploring the potential of off-grid renewable energy sources (with Indian TERI)

teri

11

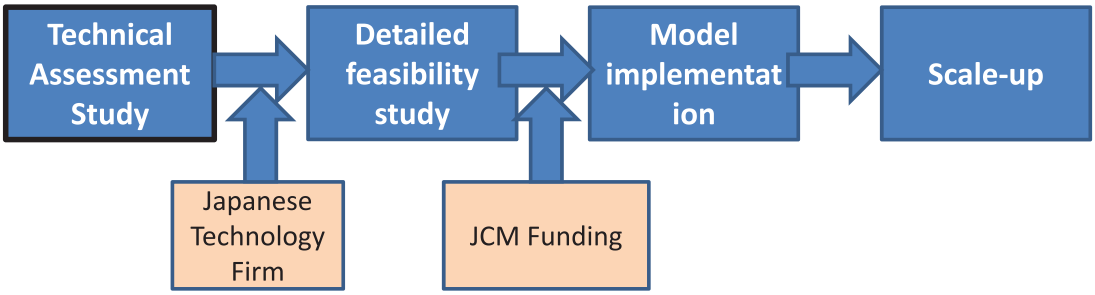
Ongoing feasibility studies in Myanmar

Project	Implemented by	Funder
Run-of-the-river small-scale hydropower（CDM-FS)	Nippon Koei	GEC
Binary geothermal power	Nippon Koei	GEC
Solar/diesel hybrid system	Mizuho Bank / Hitachi Zosen	GEC
Waste-to-Energy incineration plan in Yangon	JFE Engineering	MOEJ
Off-grid energy supply through renewable energies	**TERI･IGES**	**MOEJ**
Risk husk based electricity generation	TBC	NEDO

12

Objective of this study

- Assessment of the overall policy framework of off-grind renewable energy supply and availability of renewable resources
- Basis for potential cooperation/investment by Japanese technology firms (e.g. Panasonic) and implementation



13

Thank you.

14

Delivering energy access through clean energy in Myanmar - A technical assessment for off-grid energy supply

Technical Lead

The Energy and Resources Institute (TERI)

Research Collaboration

Institute for Global Environmental Strategies (IGES)

Ankit Narula
The Energy and Resources Institute (TERI)
ankit.narula@teri.res.in

Structure of Presentation

- About TERI
- Objective of the study
- Situation analysis of rural electricity sector
- Renewable energy resources in Myanmar
- Roadmap for off-grid electrification in Myanmar

What is TERI

- A not-for-profit research & development and policy think tank;
- Established in 1974 in New Delhi;
- More than 1000 professionals, with centers spread across 5 cities in India; Overseas presence in London, Washington DC, Tokyo, Dubai and Addis Ababa

Working Areas

- Energy (inc. RE) & Power
- Regulatory practices
- Habitats and transport
- Environment
- Water and NRM
- Climate policy
- Bio technology
- Social Transformation

Objective of the Study

- Undertake feasibility for identifying alternative technical and delivery models, especially through solar and biomass energy;
- Provide a road map for renewable energy based rural off-grid electrification program for Myanmar;

This workshop aims to present the study findings to key stakeholders of Myanmar and brainstorm for developing the off-grid electricity sector road map

Methodology

- Extensive review of Literature
- Scoping Mission to Myanmar (20-28 Nov, 2013)
- Meeting with key stakeholders (Met 24 experts)
- Data analysis
- Stakeholder workshop (4th March 2014)

- About TERI
- Objective of the study
- **Situation analysis of the rural electricity sector**
- Renewable energy resources in Myanmar
- Roadmap for off-grid electrification in Myanmar

Profile of Myanmar

	Myanmar	Cambodia	Laos	Thailand	Indonesia	India
Total population (million)	61	15	6.5	66.8	246.9	1237
Electrification rate (%)	49	31	63	88	73	75
Total population without electricity (million)	24.7	10	2.2	8	63	293
Rural electrification rate (%)	28	16	51	82	56	67
Per capita electricity consumption (kWh)	121	144	NA	2,335	639	879
GDP per capita ($)	1,126	944	1,369	5,775	3,557	1,516
HDI rank	149	138	138	103	121	136

Source: IEA ,2012; UNDP, 2013; PIDS, 2013; MOSPI, 2013; UNSTATS, 2012

Electricity situation in Myanmar

- More than 70% of rural population depends on diesel lamps, batteries or candle for lighting (typical expense US$ 9-12 per month)
- National power grid covers only 4.5% of the villages; 23% by off-grid means
- Grid covers mostly central part of Myanmar along the highway from Yangon to Mandalay

Number of villages in Myanmar	62,218
Electrified villages (grid connected)	4520
Electrified villages (off-grid)	14,195
Un-electrified villages	43,503

Source: MOEP, 2013;

Region wise electrification

State/Region	Percent Electrified	No of Villages		
		Grid electrification	Off-grid	Un-electrified
Kayar State	41	53	42	416
Mandalay Region	35	738	189	2313
Mon State	31	254	318	628
Kachin State	26	1	283	2295
Bago Region	23	309	2070	2416
Kayin State	23	46	79	1938
Sagaing Region	**22**	624	3060	2295
Chin State	**16**	-	326	1026
Ayarwadi Region	**10**	343	2992	8602
Shan State	**9**	374	786	13424
Tanintharyi Region	**9**	573	1611	2588
Rakhine State	**6**	-	1033	2827

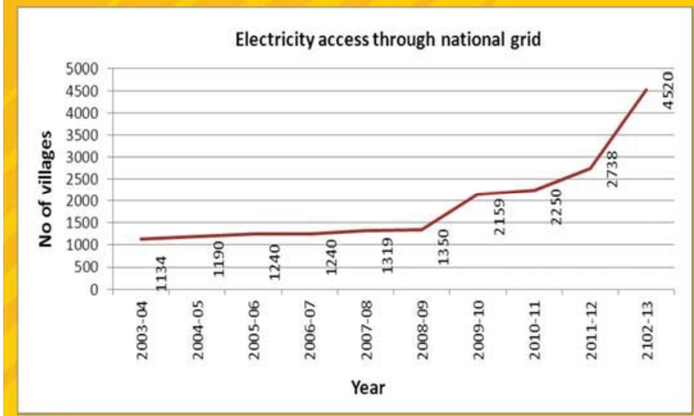
Source: MOEP, 2013;

Source: Palang Thai, 2013

Electricity Tariffs

- Grid connected tariff:
  - 35 kyats (3.6 US Cents/kWh) & per kWh for residential, municipal users and
  - 75 kyats (9 US cents/kWh) for public industry and enterprises.
  - Tariff reportedly to be increased to 50 kyats (5.15 US Cents/kWh) for residential (if consumption exceeds 100 kWh) and 150 kyats (15.4 US Cents/kWh) for public industry and enterprises (if consumption exceeds 5,000 kWh)
- Off-grid:
  - Private Power Providers:
    - Diesel: 200 to 500 kyats/kWh (US$ 24 – 60 cents) or 2,000 kyats/point/month (US$ 2.5).
    - Gasifier: 200 – 700 kyats/kWh (US$ 24 – 85 cents) or 1,000 kyats/point/month (US$ 1.2)

Trend of electrification in Myanmar



Source: MOEP, 2013

- 50 villages per year from 2003-08
- 800 villages per year is being currently electrified (since 2009)
- Considering the current trend, it may take 50 years to electrify all the villages
- Considering the electrification target by 2030, the rate of electrification will have to be increased to 2600 villages per year
- RE based Off-grid options thus have a very big role to play because of:
  - Low gestation period
  - Can use locally available resources, which are in plenty in Myanmar

Experiences of Off-grid Electrification in Myanmar

- Government Supported Projects:
  – Small hydro (1 kW to 10 MW power plants): 32 small and mini hydro plants installed by ESE. Regional govt. – 17 mini/29 micro/6 pico hydro plants. Irrigation dept. installed 870 kW hydor projects.
  – Diesel generators: 645 plant by MOEP (77.6 MW) electrifying 312 villages.
  – Biogas: Power generation from biogas up to 19 MW
  – Solar & wind: 116 kWp & 519 kWe resp. (by 2009)
    - SPV based community battery charging station in collaboration with Yoma bank & Energy Planning Dept.
    - Demo projects with assistance from NEDO, MOEP, MSTRD & Dept. of Physics
    - System installed in schools & institutes with assistance
    - Wind turbines installed at Technological University (Kyaukse), Govt. Technical High School (Ahmar) etc.

Experiences of Off-grid Electrification in Myanmar – Cont'd

- Privately Operated Projects: Diesel, hydro, solar & biomass gasifier
  - 2 to 5 kW hydro systems installed for own use and supply
  - Solar based home systems (SHS), battery charging, water pumping, resorts etc. installed
  - 50 to 75 Wp SHS in villages; comes at US$ 300 to 500
  - Many SPV companies: Earth Renewables, Sunlabob, Bennu-Solar, Proximity Designs etc
  - Around 1,096 biomass gasifier operating (as on 2010) based on wood chips & rice husk for electrification.

Experiences of Off-grid Electrification in Myanmar – Cont'd

- Donor funded projects:
  - Hydro power, solar PV and biomass gasifier
  - SPV based charging stations are installed
  - Many operating on VEC model in Sagaing, Mandalay, Ayarwaddy, Shan & Mon states
  - ADB, UNDP, UNIDO etc. have funded these projects

Targets for electrification

- Grid connected

Term	Projected Population (million)	Required Generation (GWh)	Target for Rural Electrification (%)
2011-12	60.44	10,444	27
2012- 16	63.14	17,797	34
2016-21	66.69	32,874	45
2021-26	70.45	60,132	60
2026 -31	74.42	111,100	80

	2013-14	2014-15	2015-16
Villages	3575	4116	4793

- Off-grid:
  - MOLFRD will electrify 1300 villages by 2014-15

RE Achievement & Target

Wind power targets

2008	2009	2010	2011	2012	2013	2016
0.33 MW	0.35 MW	0.66 MW	0.70 MW			50 MW

Solar power targets

2013	2016	2021
120 MW	420 MW	1209 MW

Source: Khaing, 2013

Issues and Challenges

- Multiple ministries involved in rural electrification – may lead to non clarity in roles , thereby project execution
- While long term target for grid extension and installed capacity exist, Only short term target for off-grid electrification
- Tariff imparity – this may slow the process of off-grid electrification
- Uncertainty in policy framework - private sector may not be willing to invest in off-grid options unless there is clarity on the long term returns from the project

Challenges in RE based off-grid electrification

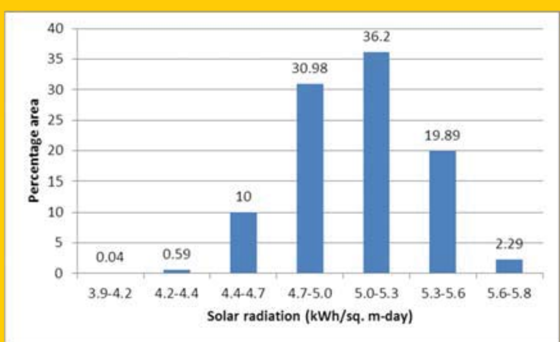
- Technical:
  - Lack of regulations, codes, standards etc.
  - Lack of trained human resources to scale up off-grid
  - Waste disposal from gasifier
  - Limited R&D
- Financial:
  - Limited funds
  - Lack of proper financing mechanisms/rural energy financing market do not exist
- Institutional:
  - Complicated framework
  - Communication & coordination

- About TERI
- Objective of the study
- Situation analysis of electricity sector
- **Renewable energy resources in Myanmar**
- Roadmap for off-grid electrification in Myanmar

Solar Resource

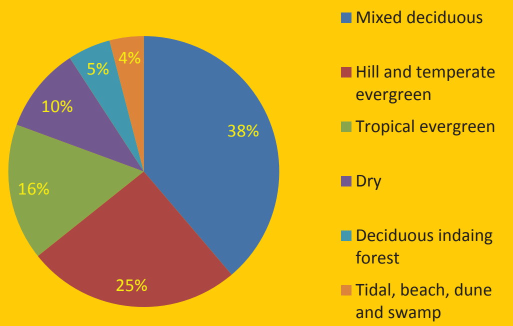
- Annual average daily solar radiation between 4.4 – 5.2 kWh/m^2/day
- Central portion receives highest radiation. Other regions also receive adequate solar radiation
- Total potential: 51973 TWh/yr.

Source: Janjai et. al. 2013



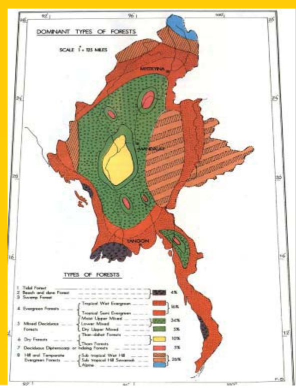
Source: Adapted from Khaing, 2013

Biomass Resource



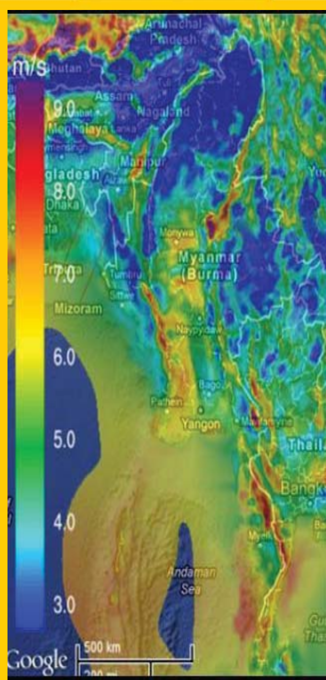
Type	Quantity (million ton/year)	Power generation potential (MWe)
Rice Husk	4.40	60 – 70
Lumber waste	1.50	15 – 25
Bagasse	2.10	25 – 35
Molasses	0.24	1 – 1.5
Livestock waste	34.4	--
Woody Biomass	5,256	300 - 400

MES, 2012; TERI, 2014



Wind Energy Potential

- 2930 MW: Mon state, Kayin state, Thanintharyi region, Shan state, Kaya state
- 1102 MW: Chin state, Rakhaing state, Ayeyawaddy region and Yangon region
- Overall potential of 360.1 TWh



Source: MOEP, 2012

Small/micro hydro Power Potential

teri

- Small/micro hydro potential
- World bank estimates 100,000 MW potential for the country
- ESE installed 33 MW SHP in addition to 6.51 MW installed by other agencies

State and division	Micro hydro capacity (1 kW to 1 MW)			Small hydro capacity (1 to 10 MW)	
	Number of projects	Projects capacity (MW)		Number of projects	Projects capacity (MW)
Kachin State	17	5.33		14	48.18
Chin state	11	3.48		2	2.8
Shan state	35	10.64		24	63.9
Sagaing state	5	0.806		3	13.3
Mandalay division	3	0.65		2	6.25
Magway division	1	0.1		2	11
Rakhine state	6	1.915		-	-
Kayah state	2	0.158		-	-
Bago division	4	1.89		-	-
Kayin state	3	0.864		1	3
Mon state	5	1.248		-	-
Taninthayidiviso n	9	1.706		2	19.5
Total	101	28.787		50	167.93

Source: MOEP, 2006

Challenges – RE resource assessment

teri

- Technical:
  - Inadequate ground measured resource data
  - While many organisation has independently done resource assessment studies, all information have not been compiled and available at a central depositary
  - Validation of satellite based data is required

teri

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Technical and delivery model

teri

- Decentralized/stand-alone interventions
- Centralized mini-grids (solar, gasifier, MHP, hybrid)
- Multiple delivery models, depending on local conditions
  - Village Energy Committee
  - Entrepreneurial approach/Private Sector led
  - Micro financing of stand-alone products

Stand-alone charging station

teri

- Suitable for areas where purchasing power is low (Ref. LaBL, India);
- Demand is only limited to lighting & mobile phone charging;
- Fee for service model (user pay for the service and not buy the product)
- Typically 50-100 lanterns/batteries
- Given to village entrepreneur on down payment and installment (financed by local bank)
- Percentage of revenue to repay loan and rest as income
- It is already prevalent in some areas, hence may be easy to implement
- Local bank financing may be required for infrastructure set up

Charging station with DC micro-grid

teri

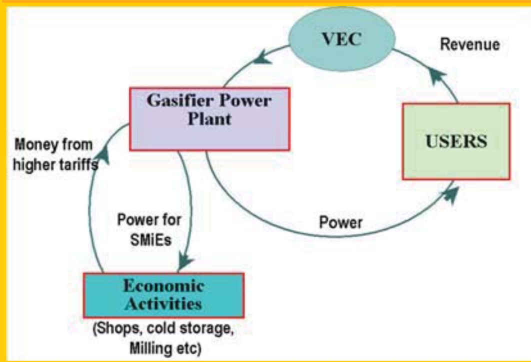
- Combination of SCS and DC micro-grid, Suitable for high density areas -only suitable for lighting load & mobile charging facility
- Micro-grid supplies power from central plant to households using DC distribution line
- For low density areas, line losses will be high, so not suitable
- Fixed connection – LED based light to 20-60 houses
- Fee-for-service: renting lanterns and/or weekly/daily fees for fixed lights –Local enterprise can have option for mobile charging, selling LEDs, and efficient cook stoves, act as energy hub
- Local bank financing may be required for infrastructure set up

Green Mini-grids (AC)

– Suitable for densely populated areas; Mandalay, valley of Ayeyarwady river, Sagaing, Bago etc.
– Can provide both lighting and power productive appliances (full range of rural services)
– Architecture similar to conventional grid
– Can be based on Solar PV, biomass gasifier, hybrid system of solar, biomass, wind and/or diesel

Delivery Model

– Both community based or private sector led implementation based on local conditions
– In VEC model, active participation of local community is central
– However, experience from India shows beneficiary payment is poor in many places because of poor paying capacity
– Integrating livelihood with residential services (Electricity supply for commercial activities)



Mini-grids – Cont'd

– Private model – major role of district government, local bank with nodal ministry to train and select local developer
– Energy Service Provider (ESP) Model or BOOM can be tested in not-so-remote villages, with large population
– District level project developer or rural energy service company taking lead in clustering villages
– Responsible for system the engineering, installation, operating and maintenance
– VEC act as regulator and set tariff, biomass price, redress grievance

Mini-grids – Cont'd

Summary of transactions between key entities in the ESP model

S. No.	Entities	Offers	To	Expects in return	Instrument
1	SHGs	Fuel	ESP	Payment for fuel supply (for biomass projects only)	Biomass price set by VEC
2	ESP	Electricity	Consumer	Payment of electricity	Tariff set by project developer in consultation with VEC
3	Consumer	Payment	Developer (through ESP)	Reliable Electricity	Connection Agreement
4	OEM	AMC	Developer	Payment	AMC agreement
5.	ESP	Payment	Developer	Services and training	Lease Agreement

Viability of mini-grids – Rule of Thumb

For mini grids with total load ranges > 100 kW

(a) Estimated number of potential connections (N) in the community, and
(b) Average distance of the rural community from the centralized grid (D).

If N/D < 2 connections/km – then grid extension is not likely to be viable
If N/D > 30 connections/km – then the grid extension is likely to be viable

For mini grids with total load ranging >10kW

Calculating the total number of connections (N) within 500 m radius from the rural community centre where the plant is situated.

If N>100 – the grid could be a viable option. Viability would also depends on load density
If N<100 – in this case, it'll be challenging to sustain an adequate level of O&M as well as efficient cash management over time.

Solar Home Systems (SHS)

- Suitable for sparsely populated
- Flexible as per individual's demand; can vary from 10 to 200 Wp
- Supply power only for lighting, DC fans, TV etc.
- Price varies between US$ 120 To 160 for 100 Wp systems
- Solar LED home lighting much cheaper: US$ 100-300
- Consumer financing model, similar to IDCOL, Bangladesh, with loan at 12-15% per annum for 2-3 years will help in scale up

Recommendations

- Coordinated approach
  - Have a department under MOEP for rural electrification for grid connected as well as off-grid development may lead to better outcomes
  - Develop Master plan for rural electrification, focusing on both grid and off-grid options
  - Single window service for private developers/ concessionaire approach
  - Aspect of best applied technology. Off-grid plants can be integrated with national grid when grid reaches such areas avoiding technology obsolescence (e.g. China)

Recommendations – Cont'd

- Financing
  - A key challenge in scaling-up and up gradation of projects.
  - Mainly rural areas have high upfront cost
  - Designated Financial Institution who can promote micro financing of SHS, lanterns etc. to consumers and also lend to village entrepreneurs/ private developers at low cost of capital
  - This may be done through:
    - Designated financial institution to generate low cost of capital -assistance from ADB, JICA, World Bank etc.
    - Central bank of Myanmar can have lower interest rate for clean energy project esp., energy access projects
    - The designated institution to partner with regional cooperatives, MFI & NGOs in states/regions for energy access financing
    - Organize training for local financing institutions regarding technology, standards/quality assurance, business model etc.
    - Reduced tax on RE equipment imports & promotion of local manufacturing through technology transfer (e.g. India, Japan, etc.) to keep the product cost low

Recommendations – Cont'd

- Adoption of International Standards
  - Important for both end-consumers and enterprises
  - LED lamps available. Electronics more prone to expiry
  - Performance oriented technical specifications
  - Incorporate environment component in the standards.
  - IEC standards should be adopted

Recommendations – Cont'd

- Establish Service Centers
  - Experience indicate product sale without provision for service may not yield desired results in developing countries
  - Need for after sales service after technology diffusion
  - Training centers for responsive maintenance and training technicians (involve Technical Universities and Tech Schools, spread over entire Myanmar)
  - Bilateral/multilateral support can be tapped in this regards

Recommendations – Cont'd

- Multi-stakeholder capacity building
  - Training workshops (in-country) for stakeholders across value chain of RE and energy access like government authorities, vendors, manufacturers, implementers, research org. & financing agencies.
  - Arena for exploration, sharing knowledge, success stories etc.
  - Exposure visits to successful off-grid electricity access project in South & South-east Asian countries for various stakeholders –
  - Capacity building for researchers on data collection, standards, methodologies etc.

Recommendations – Cont'd

- Transfer of technical knowledge
  - Patents and IPR concerns may hamper in acquiring technologies
  - Transfer of knowledge around technical know-how to assemble SHS, lanterns, pico-hydro systems etc.
  - E.g. Reference circuit designs of technologies to be transferred to manufacturers

Recommendations – Cont'd

- Harness NGO experience for policy advocacy
  - In Myanmar NGOs plays a critical role
  - NGOs mainly restricted to service delivery and less on policy advocacy
  - NGOs have better experience about rural dynamics and energy issues
  - Training/Exposure visits for NGOs along with Government officials for policy learning from other countries (e.g. Indian Solar Mission, Thailand Rural Electrification Program) - Can IGES assist?

Potential demonstration projects

S. No.	State/Division	Status of Electrification	Wind resource (m/s)	Solar resource (MJ/m²/day)	Biomass resource	Technology option
1	Tanintharyi	Poorly electrified	7-8 (Good/Average)	15-16 (Average)	Evergreen/ Deciduous forest	Solar-wind hybrid Mini-grids
2	Sagaing	Poorly electrified	3-4 (Poor)	15-17 (Average/Good)	Evergreen/ Deciduous forest/rice husk	Biomass based Mini-grids
3	Rakhine	Poorly electrified	7-8 (Good/Average)	15-16 (Average)	Evergreen/ Deciduous forest/rice husk	Solar-wind hybrid Mini-grids

Points of discussion

- Feasibility of location & technology
- Delivery models for scale up (Community vs. Private)
- Involvement of local partners (such as MES, others) – what type of involvement

5. 政策支援

ヤンゴン市開発委員会、ミャンマー環境保全森林省（Ministry of Environmental Conservation and Forestry）等の政府関係機関に対して、「持続可能な廃棄物管理に関する国際ワークショップ」の開催を通した政策支援を行った。廃棄物分野における日本企業の技術や日本の都市の経験を共有すると共に、JCM の情報普及を図った。

5.1 ヤンゴン市における持続可能な廃棄物管理に関する国際ワークショップの開催

日時：12 月 20 日　12:00-17:00 場所：ヤンゴン市庁舎 参加者：ヤンゴン市長、YCDC 局長レベル、ヤンゴン管区、環境保全森林省、CESVI、JFE エンジニアリング、東京都等

アジェンダ

International workshop on sustainable waste management in Yangon

12:00 - 17:00, 20 December 2013, Yangon

Venue: Yangon City Hall, Sule Pagoda Road, Kyauktada Township

Language of the workshop: English

Objectives:
- To explore how integrated waste management system can benefit Yangon
- To improve mutual understanding and coordination among international stakeholders

Draft agenda

12:00-12:30	Registration
12:30-13:00	Opening -U Hla Myint, Mayor of Yangon -Kenta Usui, Climate and Energy area, Institute for Global Environmental Strategies Photo session

13:00-13:15	**Tea break**
13:15-14:00 (45mins)	**Part 1: Introduction to Myanmar's waste policies** Chair: YCDC - Yangon's waste management policies, Than Lwin Oo, Head of Department, Pollution Control and Cleansing Department, YCDC - Myanmar's pathway for national waste management policies, MOECAF Q&A
14:00-15:00 (60mins)	**Part 2: Towards low-carbon waste management: an opportunity of integrated waste management system:** Chair: Kenta Usui, IGES - The potential of integrated municipal solid waste management to reduce climate impacts of low-carbon management, Nirmala Menikpura, IGES - Feasibility of incineration technologies, and setting the right tipping fee - Gen Takahashi, JFE Engineering. - Mechanisms to engage local communities for waste management, Takanobu Iwasaki, Tokyo Metropolitan Government Q&A
15:00-16:00 (60 mins)	**Part 3: Understanding the full picture of international cooperation** Chair: Kenta Usui, IGES (5-10 mins each, max 2 slides) - Japanese Joint Crediting Mechanism, Kenta Usui, IGES - Yangon-Tokyo Cooperation on Waste Management, Takanobu Iwasaki, Tokyo Metropolitan Government - GIZ's initiative - CESVI's assistance on Yangon's waste management, Gaetano Romano, CESVI Q&A
16:00-16:45 (45mins)	**Discussion: the way forward for Myanmar** Co-chaired by Nirmala Menikpura, IGES and YCDC <u>Panelists (5 mins each):</u> - Takanobu Iwasaki, Tokyo Metropolitan Government - Gen Takahashi, JFE Engineering - MOECAF - YCDC <u>List of possible questions:</u> - How to promote efficient waste collection - How to make waste management financially sustainable - How to promote low carbon waste management in Yangon with

	international cooperation - How to effectively coordinate increasing international support - How to engage communities to work on waste management
16:45 - 17:00 (15min)	**Closing Remark** Than Lwin Oo, Head of Department, Pollution Control and Cleansing Department, YCDC

議事録

開会挨拶

Hla Mying ヤンゴン市長より、開会の挨拶があった。共催機関である IGES の碓井より、ワークショップの意図を説明、ゴミはゴミではなく、資源であること、ゴミによって収益を得ることも可能であること、国際援助の協調にとって、支援の重複を減らす必要があること、等を説明した。

Part 1: Introduction to Myanmar's waste policies

-Yangon's waste management policies, Than Lwin Oo, Head of Department, Pollution Control and Cleansing Department, YCDC

YCDC Than Lwin Oo 局長より、ヤンゴンの廃棄物管理の現状に関する発表が行われた。住民から廃棄物処理費用を徴収するが、それだけでは不足であり、YCDC の予算を使うことによって実質的に補助金を出しているような形になっている。新しいプラントが 2014 年に稼働予定であり、廃棄物発電も検討している。

-Myanmar's pathway for national waste management policies, MOECAFPart 1: Introduction to Myanmar's waste policies

環境保全森林省環境保全部副局長の Hla Maung Thein 氏による、ミャンマーの環境政策に関する発表が行われた。様々な法律が分断化された存在しており、一貫した法制度ができていないこと、鉱山からの汚染が深刻であることなどの指摘があった。廃棄物管理に関しては、国レベルでの廃棄物管理戦略を策定する動きがある。

質疑応答：
ミャンマーで気候変動委員会が立ち上がったと聞いているが、今はどのような状況か。
→MOECAF の中に気候変動ユニットができている。
国レベルのでの廃棄物管理戦略は、どこかの支援が入っているか。
→ノルウェー、UNEP 等と協議中である。

Part 2: Towards low-carbon waste management: an opportunity of integrated waste management system:
Chair: Kenta Usui, IGES

- The potential of integrated municipal solid waste management to reduce climate impacts of low-carbon management, Nirmala Menikpura, IGES

IGES メニクプラ研究員により、ヤンゴンの廃棄物管理に関する現状分析と提言が行われた。現在の Open dumping である最終処分場から多くのメタンが発生しており、気候変動への影響があると指摘。リサイクル等を通した適切な処理によって、GHG 削減の余地があるとのこと。そのためには特定の技術にのみに頼らず、廃棄物の種類によって資源化、処理の方法を変える統合的な廃棄物管理が必要であると指摘し、タイでの事例を紹介した。廃棄物発電については、廃棄物の中の水分量などによって大きな影響を受けるため、慎重に計画する必要を指摘。

- Feasibility of incineration technologies, and setting the right tipping fee – Gen Takahashi, JFE Engineering.

JFE エンジニアリング高橋氏より、JFE エンジ社の紹介とその焼却技術についての説明の後、JCM の紹介を行った。ミャンマーにおいて焼却炉は初の導入であるため、小さな小型のものから始めて、経験値を積んでいくことが重要であり、低炭素化を目指すことで JCM 等の資金にアクセスできる可能性も指摘。

- Mechanisms to engage local communities for waste management, Takanobu Iwasaki, Tokyo Metropolitan Government

東京都岩崎氏より、東京都の廃棄物管理の事例紹介、容器包装リサイクル法の仕組み等についての発表があった。

質疑応答

・統合的な廃棄物管理（ISWM）に関して、普及啓発をしていくにはどうすれば良いか。
→ISWM には様々な側面がある。低炭素というだけでは住民の理解を得ることは難しい可能性があるため、ISWM による社会面のプラスの影響（衛生状態の改善など）を全面に出していくのが望ましい。また、パンフレット等の出版物も有用。
・（MOECAF）ヤンゴンと東京都、IGES との協力関係を歓迎する。
廃棄物からの GHG 排出量はどのように算定したのか。
→IGES の開発したツールを利用。メタンの削減や、運搬に消費する燃料等も含めて計算している。ツールは IGES の Web サイトから入手可能。
・JCM がミャンマーにおいても存在することを歓迎。
→ミャンマーは JCM にはまだ署名していないが、可能性は十分にある。ミャンマー環境保全森林省と日本政府の間で政府間協議を始める必要がある。

Part 3: Understanding the full picture of international cooperation

- Japanese Joint Crediting Mechanism, Kenta Usui, IGES

IGES 碓井 より、JCM について発表。他国の案件の事例や、ミャンマーで可能性のある案件などを紹介した。

- Yangon-Tokyo Cooperation on Waste Management, Takanobu Iwasaki, Tokyo Metropolitan Government

東京都岩崎氏より、ヤンゴンと東京での双方で行われたワークショップの写真を用いながら、東京都とヤンゴン市が廃棄物分野で協力を継続していきたい旨が伝えられた。

- GIZ's initiative

YCDC Aung Myint Maw 氏より、YCDC と GIZ の協力プロジェクトについて紹介があった。GIZ は大気汚染対策のためヤンゴン市内にモニタリング機器を設置。データをもとに、様々な大気汚染物質が増加していることが示された。

- CESVI's assistance on Yangon's waste management, Gaetano Romano, CESVI

CESVI はイタリア系 NGO であり、EU から資金を得て、イタリアの都市とも連携している。CESVI はヤンゴンの 3 つの地区にて住民への普及啓発活動等を支援している。現在も wet/dry のごみの分別が適切になされておらず、これの改善によりコンポストなどの資源化が推進できるとした。

Discussion: the way forward for Myanmar

主な関係者により、ヤンゴンの持続可能な廃棄物管理に関しての議論がなされた。

東京都：東京都は、ヤンゴン市との協力関係を推進していきたいと考えている。
JFE エンジ：官民の協力が重要である。日本にはそのような協力の事例も多くあるので、参考にしてもらいたい。
MOECAF:包括的な環境戦略ができていないことが大きな課題。廃棄物に関しても適切な管理計画が必要。また、出てきた廃棄物の処理だけでなく、生産段階も含めたライフサイクルでの廃棄物管理が必要である。政府の資金不足が大きな課題であるため、汚染者負担原則を活用できるのではないか。

CSEVI:計測とデータの収集が極めて重要。住民からの課徴金はもっと高くても良いが、住民との対話を行っていく必要がある。廃棄物が全ての人に関係のある問題だという認識が必要。

JFE エンジ：ライフサイクルでの考えは非常に重要であるが、その延長で、ライフコストという考えもある。焼却炉などを導入する際には、初期投資だけでなく、メンテナンス費用、故障のリスク、耐用年数等を含めた長期的なライフコストを考えて決めるのが重要。

閉会：

YCDC と IGES より弊会の挨拶。IGES 碓井は、ヤンゴンの廃棄物や環境の現状はまだまだ情報が不足しており、インターネットでも資料を探せないことが多いとし、YCDC が定期的に関連情報を出版する等することを提案。このような情報、データがあると、国際的な支援を受けやすいことも指摘。

参加者リスト

ヤンゴン市開発委員会（Yangon City Development Committee ）参加者：

1. U Hla Myint、 Mayor 、
2. U Kyaw Soe、 Secretary、
3. U Nyi Nyi、 Joint-Secretary,
4. U Htin Zaw Win, Committee Member (4),
5. U Soe Si, Committee Member (5)
6. U Than Lwin Oo, Head of Department, Pollution Control and Cleansing Department,
7. U Tin Ko Ko, Head of Department, The Administration Department,
8. U Kyaw Than , Head of Department, Budget and Accounts Department,
9. U Aye Kyaw Aung, Head of Department, Work Inspection Department, ,
10. U Aung Sun Win, Head of Department, Co-ordination Department,
11. U Than Htay, Head of Department, Assessors' Department,
12. U Kyaw Min, Head of Department, Revenue Department,
13. U San Shwe Tun, Head of Department, Markets Department,
14. U Than Htike, Head of Department, Veterinary & Slaughter House Department,
15. U Tin Maung Kyi, Head of Department, Engineering Department (Roads & Bridges),
16. U Myint Oo, Head of Department, Engineering Department (Water & Sanitation),
17. U Maung Maung Zaw, Head of Department, Engineering Department (Buildings),
18. U Aung Soe, Head of Department, Motor Transport &Workshop Department ,
19. U Bo Htay, Head of Department, Central Stores Department,
20. U Ko Ko Lin, Head of Department, Playgrounds, Parks & Gardens Department,
21. Dr. Myat Mon Aye, Head of Department, Health Department,
22. Colonel Kyaw Shwe, Head of Department, Security & Disciplinary Department ,
23. U Myat That, Head of Department, City Planning and Land Administration Department ,
24. U Cho Tun Aung, Head of Department, Public Relations and Information Department ,
25. U Aung Soe Than , Head of Department, Production Department ,
26. U Khin Win, Deputy Head of Department, Pollution Control and Cleansing Department,
27. U Hla Win Aung, Deputy Head of Department, Pollution Control and Cleansing Department,
28. U Thar Oo, Assistant Head of Department, Pollution Control and Cleansing Department,
29. U Ye Myint Aung, Assistant Head of Department, Pollution Control and Cleansing Department,
30. Dr. Aung Myint Maw, Assistant Head of Department, Pollution Control and Cleansing Department,
31. U Bgwe Kyone, Sub-District Officer, Pollution Control and Cleansing Department,
32. U Aung Htike, Sectional Head (District Level), Pollution Control and Cleansing Department,
33. U Kyaw Moe Lwin, Sectional Head (District Level), Pollution Control and Cleansing Department,
34. U Tun Tun Thaung, Assistant Engineer, Sectional Head , Pollution Control and Cleansing Department,

他ミャンマー政府機関からの参加者

1. U Hla Maung Thein, Deputy Director - General, Environmental Conservation Department, Ministry of Environmental Conservation and Forestry
2. Mandalay City Development Committee
3. Naypyitaw Development Committee
4. Environmental Conservation Sub-Committee, Yangon Regional Government
5. Environmental Conservation Department, Ministry of Environmental Conservation and Forestry

Yangon Region Government

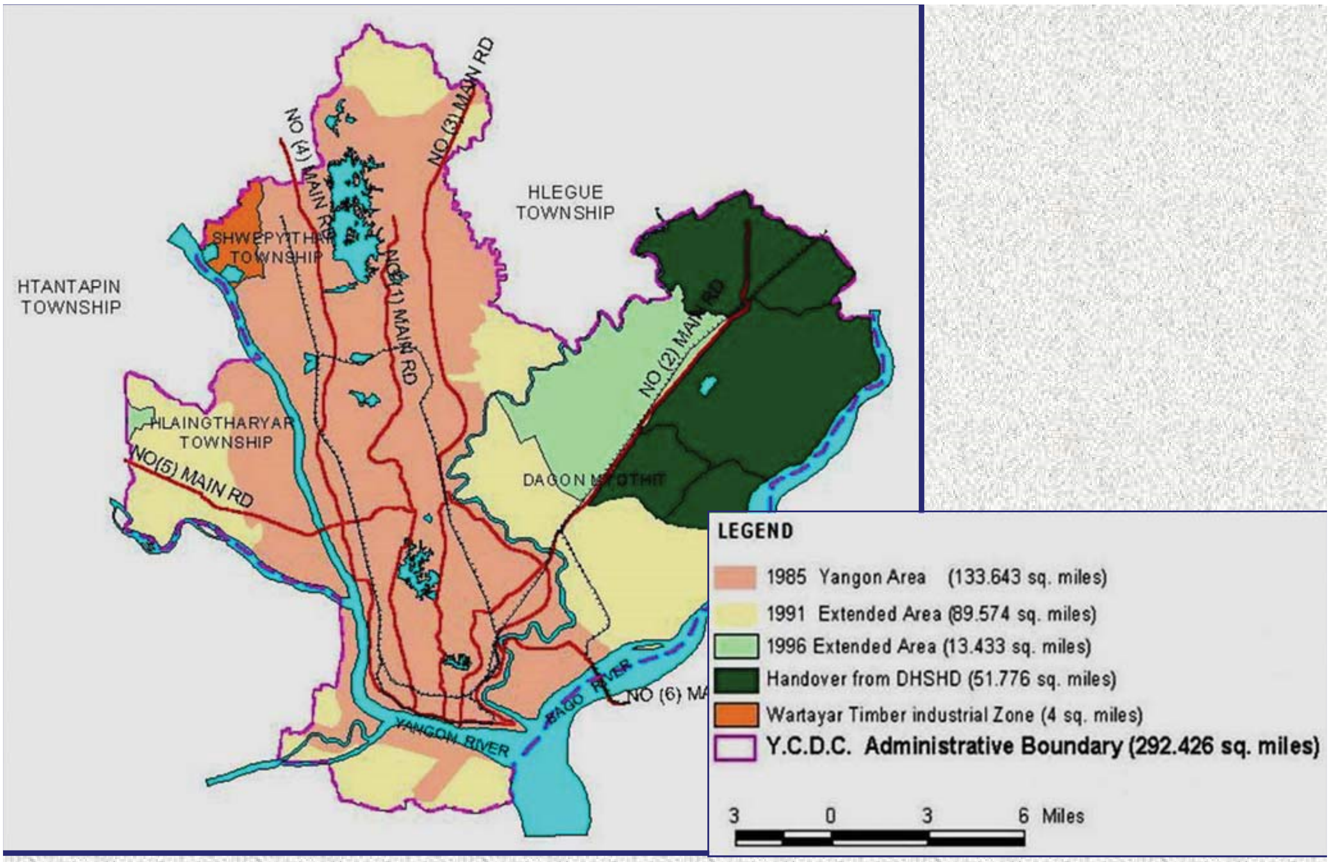
他機関参加者

1. CESVI
2. German International Co-Operation (GIZ) Myanmar

ワークショップの様子


Current Situation
of
Solid Waste Management
in
Yangon City
1


YANGON CITY DEVELOPMENT COMMITTEE
2



The administrative boundary of YCDC,in 1985 (133.643 Sq-Miles) and now a day (292.426) Square Miles.

3

Organizational Chart of YCDC

Mayor

↓

Secretary

↓

Joint-Secretary

↓

2 persons of

Committee Members

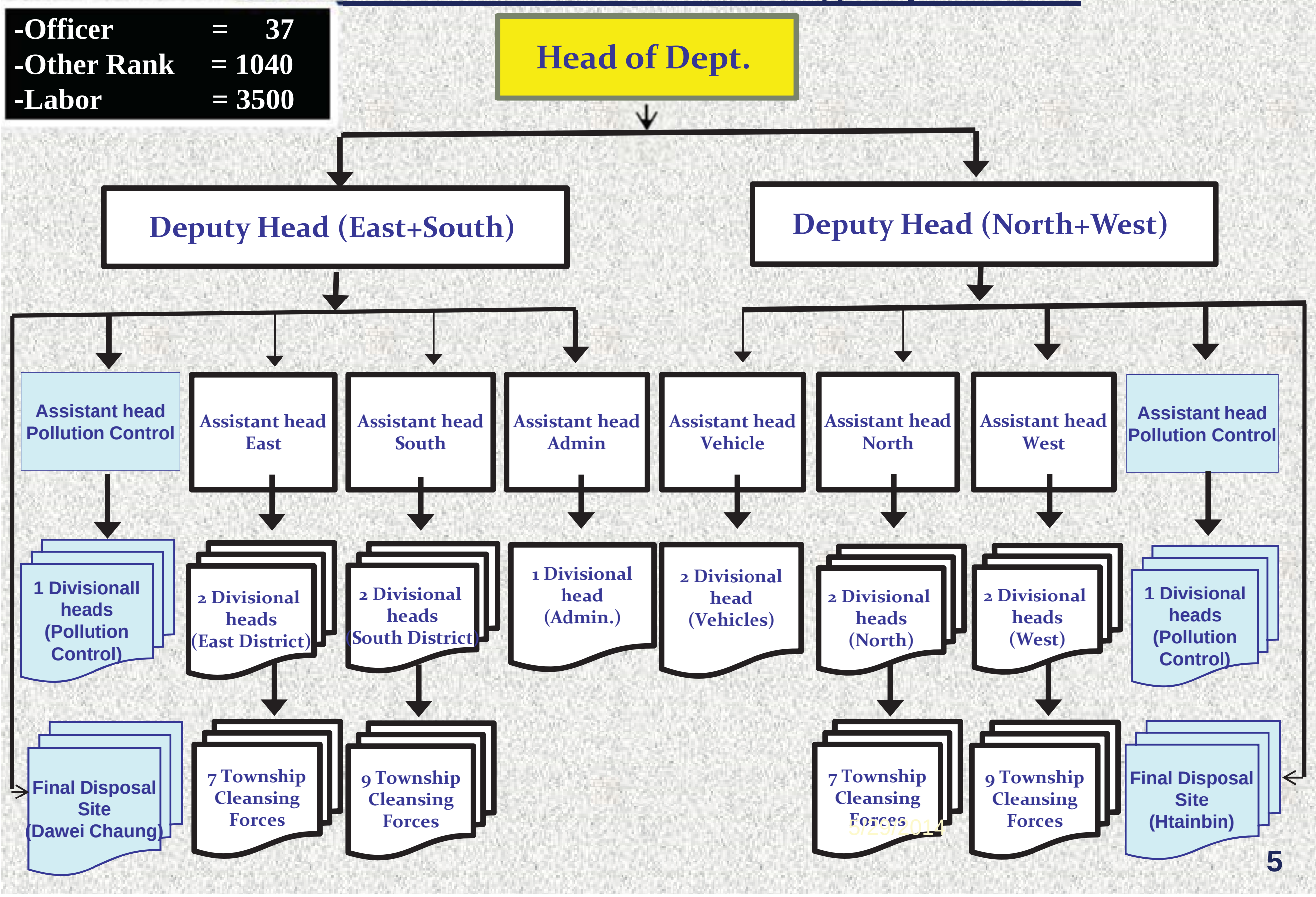
↓

20-- Departments

(Including Pollution Control and Cleansing Department)

4

Organizational Chart of Pollution Control and Cleansing Department

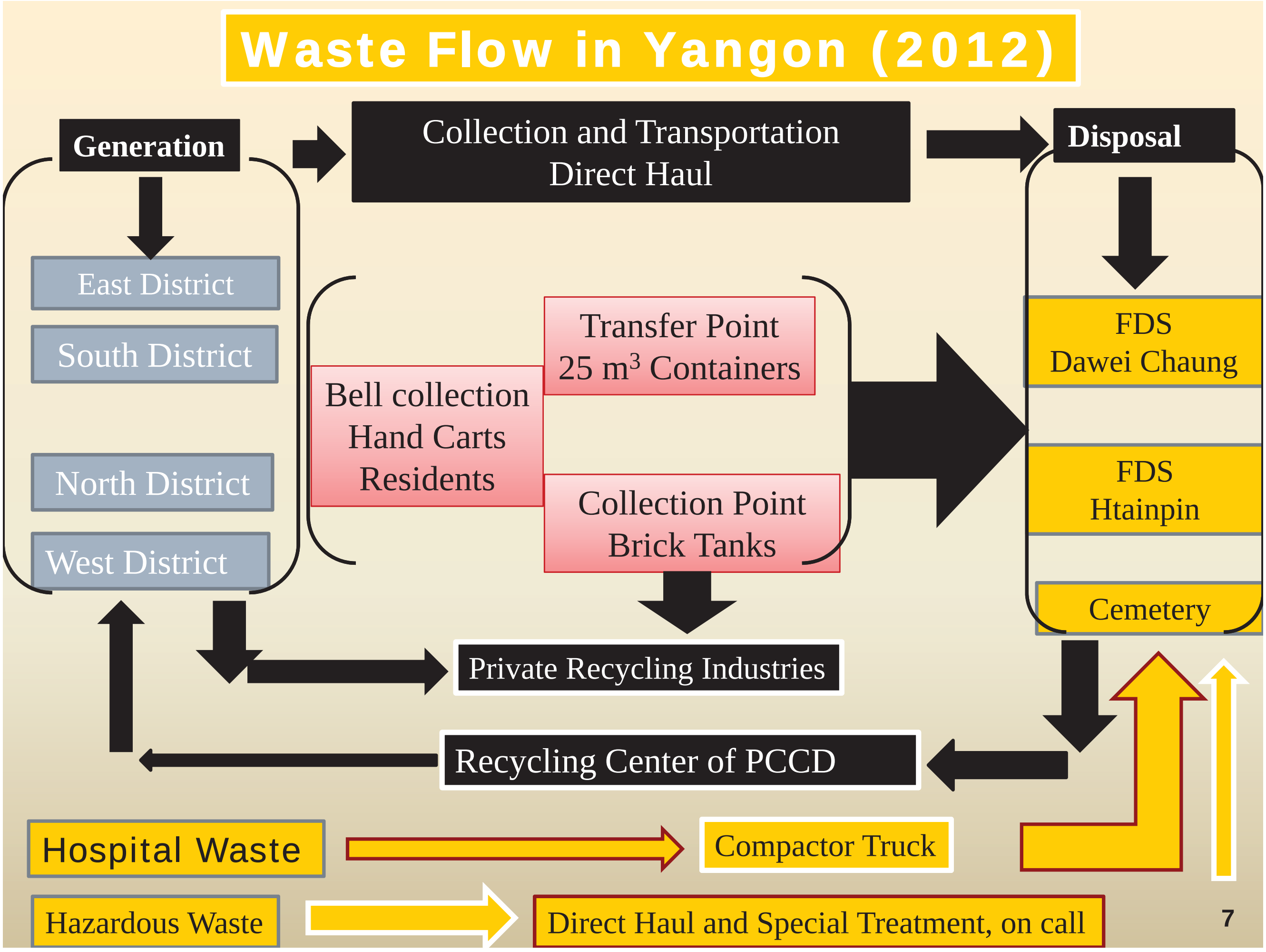


Duties and Function

- Daily Cleansing .
  - Waste Collection (House Holds, Markets, Kerbshops, Commercials, Clinics and others)
  - Waste Transportation.
  - Disposed To Final Disposal Site.

- Pollution Control.
  - Final Disposal Site Management
  - Cemeteries Management
  - Recycling Activities(YCDC and Privates)
  - Green Composting
  - Awareness Program for Local Communities and Schools

6


Waste Flow in Yangon (2012)
Generation
Collection and Transportation
Direct Haul
Disposal
East District
South District
North District
West District
Transfer Point
25 m^3 Containers
Bell collection
Hand Carts
Residents
Collection Point
Brick Tanks
FDS
Dawei Chaung
FDS
Htainpin
Cemetery
Private Recycling Industries
Recycling Center of PCCD
Hospital Waste
Compactor Truck
Hazardous Waste
Direct Haul and Special Treatment, on call
7


Solid Waste Management
Bell ring collection, Manual Loading, Transport and dispose to FDS.
Temporary Brick Tanks
(617) Nos
8

Solid Waste Management

Dust Bin, transfer to push cart, loading to waste truck, Transport and dispose to FDS.

120 Liter Dust Bins,
On Ground used = 186 - Sets

240 Liter Dust Bins, On Ground used = 2056 -Nos

660 Liter Dust Bins,
On Ground used = 1295 - Nos

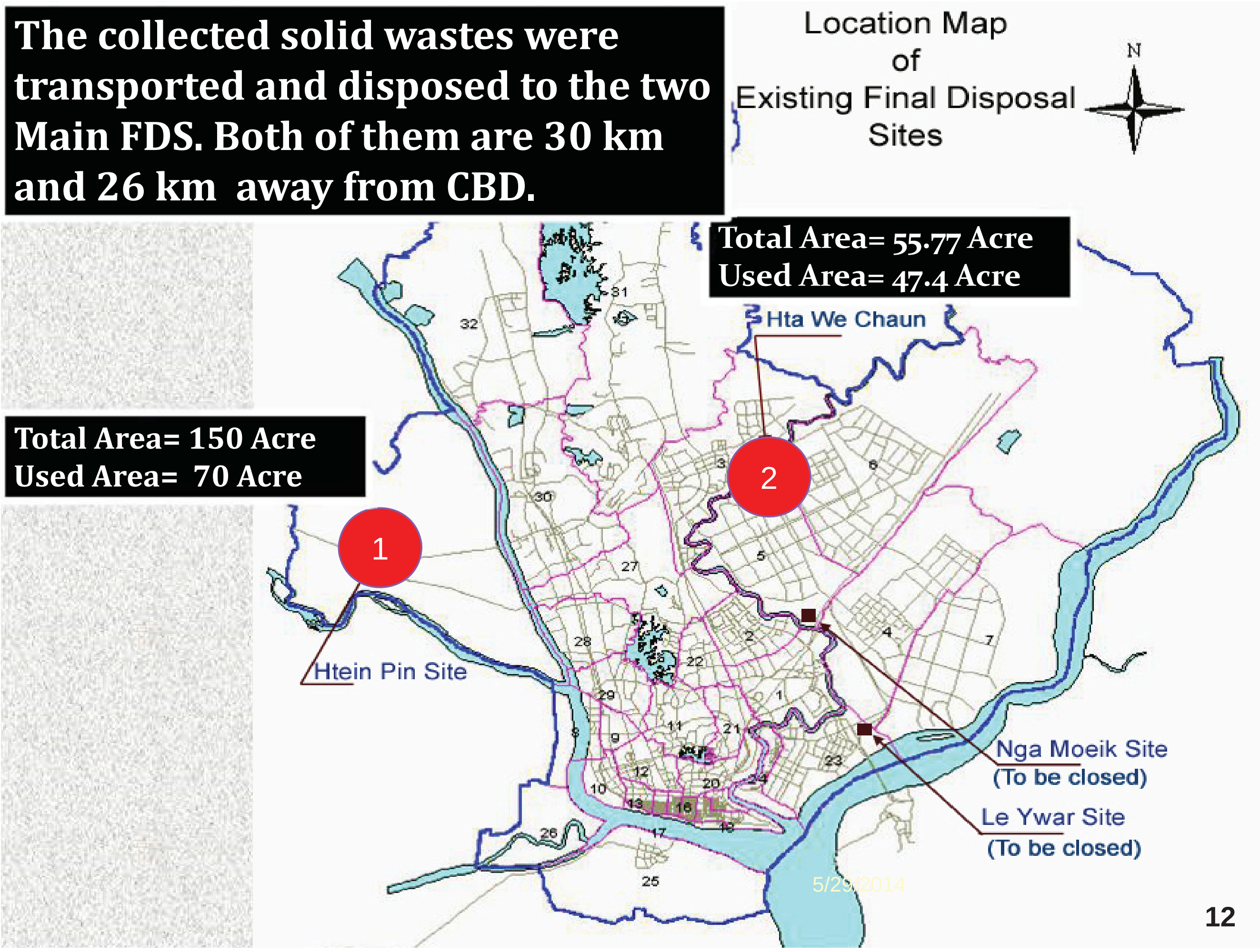
9

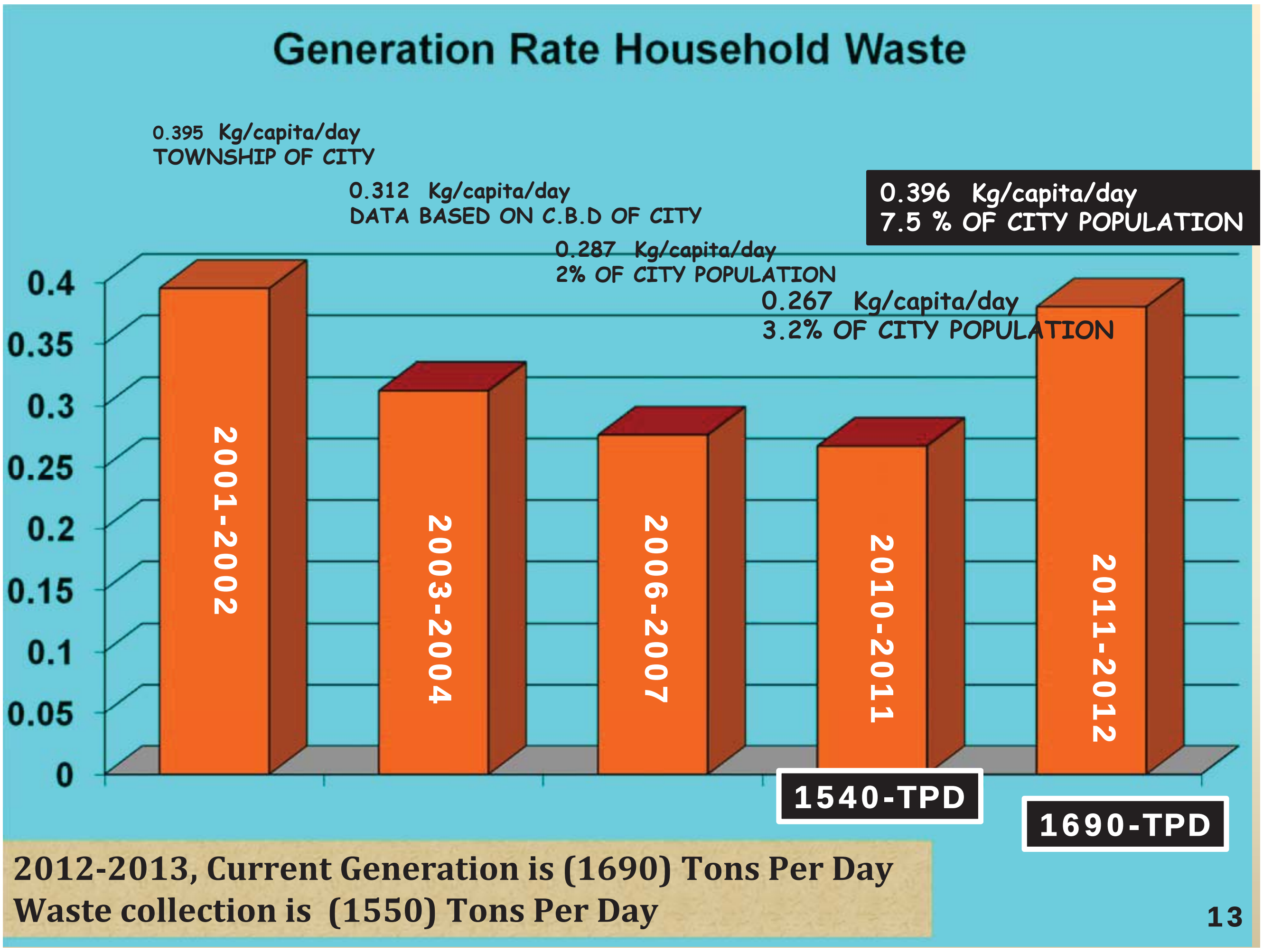
Waste collection Vehicle on Road = 294 Nos

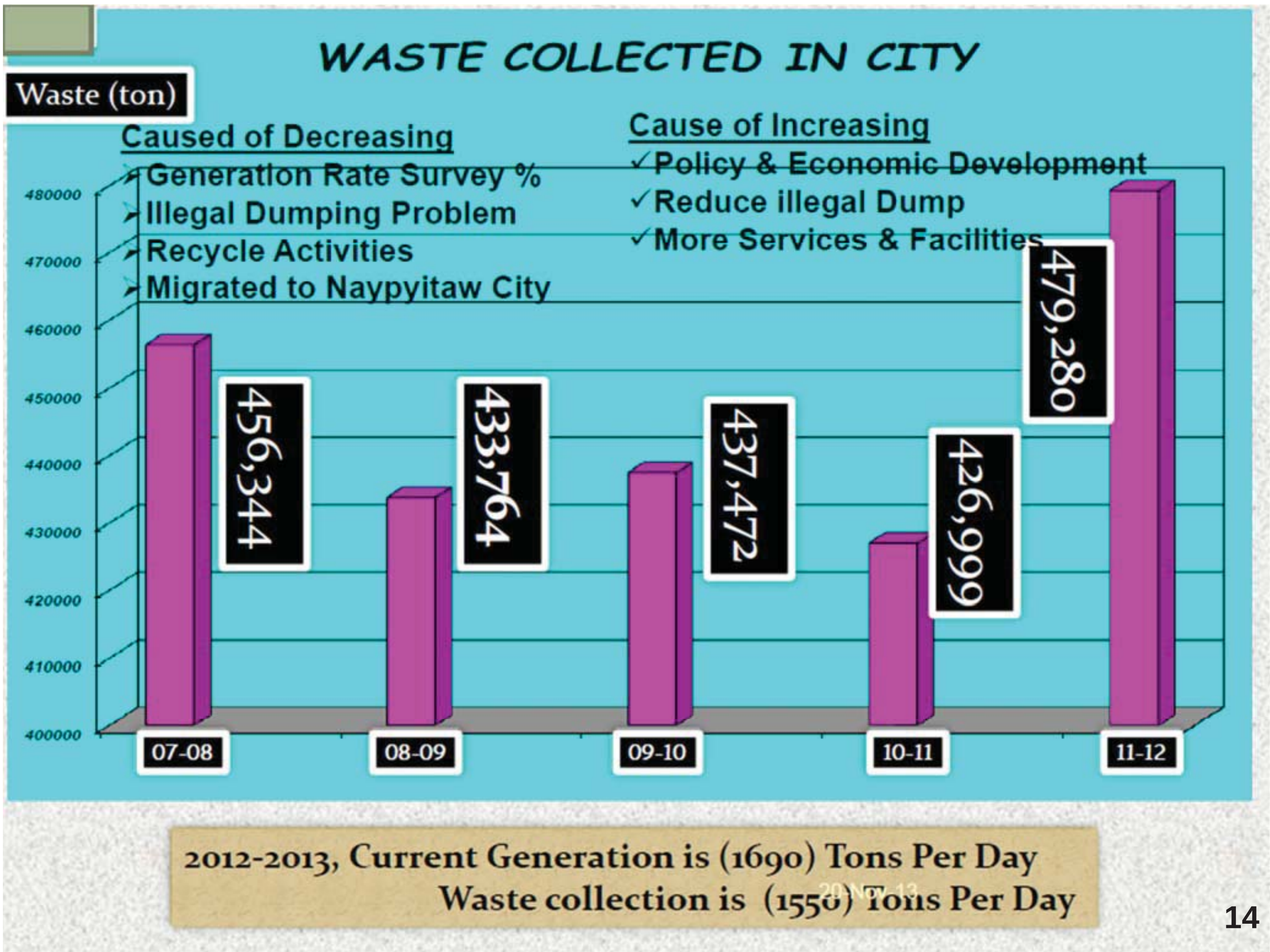
There are various types of vehicles, used in transportation of solid waste. Many trucks are too obsolete to use for long term. It should be replaced with new ones.

10


Activities and facility in Disposal Sites
PCCD have two main FDS and each site only one Dozer for dozing all waste.
11


The collected solid wastes were transported and disposed to the two Main FDS. Both of them are 30 km and 26 km away from CBD.
Location Map of Existing Final Disposal Sites
N
Total Area= 55.77 Acre
Used Area= 47.4 Acre
Hta We Chaun
Total Area= 150 Acre
Used Area= 70 Acre
1
2
Htein Pin Site
Nga Moeik Site
(To be closed)
Le Ywar Site
(To be closed)
12

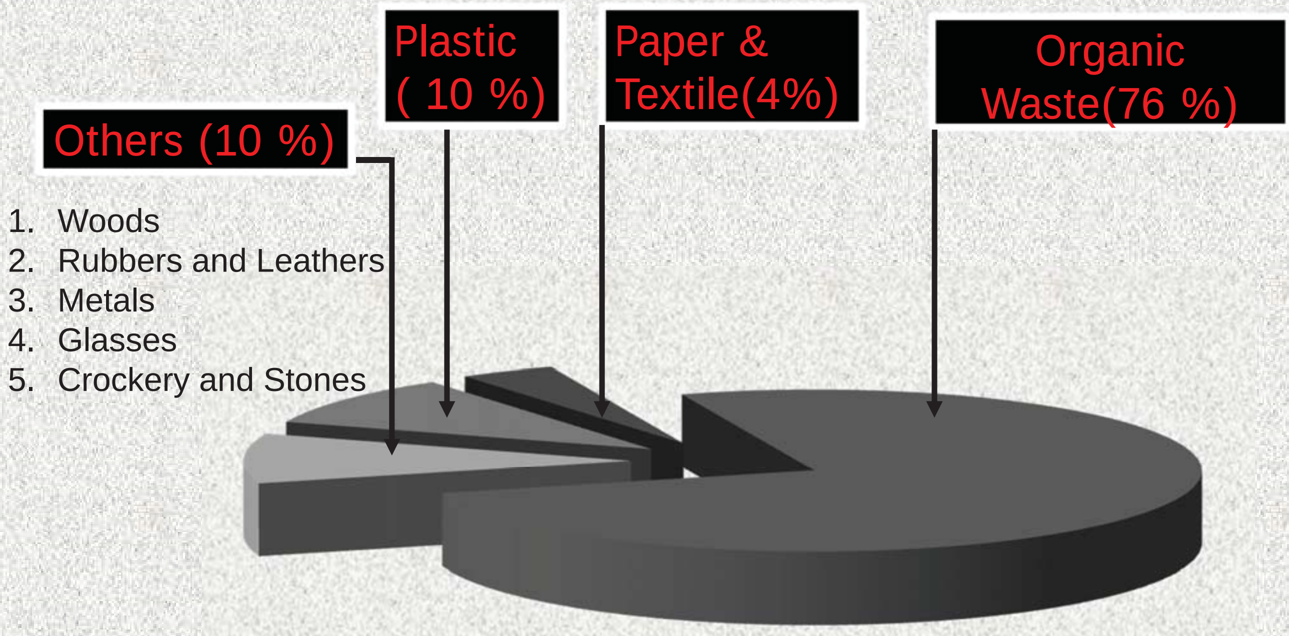

Generation Rate Household Waste
0.395 Kg/capita/day
TOWNSHIP OF CITY
0.312 Kg/capita/day
DATA BASED ON C.B.D OF CITY
0.396 Kg/capita/day
7.5 % OF CITY POPULATION
0.287 Kg/capita/day
2% OF CITY POPULATION
0.267 Kg/capita/day
3.2% OF CITY POPULATION
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2001-2002
2003-2004
2006-2007
2010-2011
2011-2012
1540-TPD
1690-TPD
2012-2013, Current Generation is (1690) Tons Per Day
Waste collection is (1550) Tons Per Day
13


WASTE COLLECTED IN CITY
Waste (ton)
Caused of Decreasing
Generation Rate Survey %
Illegal Dumping Problem
Recycle Activities
Migrated to Naypyitaw City
Cause of Increasing
✓Policy & Economic Development
✓Reduce illegal Dump
✓More Services & Facilities
480000
470000
460000
450000
440000
430000
420000
410000
400000
456,344
433,764
437,472
426,999
479,280
07-08
08-09
09-10
10-11
11-12
2012-2013, Current Generation is (1690) Tons Per Day
Waste collection is (1550) Tons Per Day
14

Existing Used Main (2) Final Disposal Sites & (4) Temporary Small FDS

NO	Location of FDS site	Constructed Year	Planned Capacity	Site (Plant) Area	Dispose Ton Per Day (Current)	Remark
1	HtainBin	2002	-	150- Acre Used- 70 Ac	847	Open Dumping
2	Htwei Chaung	2001	-	55.77 – Acre Used-47.4 Ac	612	Open Dumping
3	Dala	2003	-	1.3- Acre	10	Low Landfill Temporary site
4	Seikkyi Khanaung To	2003	-	0.25 - Acre	5	Low Landfill Temporary site
5	Mingalardon	2003	-	0.91 - Acre	25	Low Landfill Temporary site
6	Shwe Pyi Thar	2005	-	1 - Acre	50	Low Landfill Temporary site

Typical Composition



Base on common composition which a few different percentage. (Depend upon the Wet Season and Dry Season)

16

Hospital Waste Management

Infectious Wastes are dispose to the Incineration Process

Sharp Wastes are dispose to the Deep Well Process

Daily Medical Waste about 1 ton

17

Industrial Zones In Yangon City

- **Industrial Zones in City = 24 Number**
- **Total Factories = 3562**

➢Garments	= 126
➢Foodstuff	= 334
➢Chemical	= 56
➢Iron and Melting	= 519
➢Cold Storage and Fish Processing	= 45
➢Paper and Cardboard	= 105
➢Distillery	= 9
➢Forest Product	= 148
➢Public Use Goods	= 709
➢Others	= 1511

18

Daily Waste Generated of Industrial Zones

Sr No	Industrial Zone Location	No. of Zones	No. of Factories	Collected	Remark
1	East Dagon	1	41	3	Food and byproduct of sites
2	North Dagon	1	95	11	“
3	Dagon Seikam	2	94	4	“
4	South Dagon	3	2356	13	“
5	North Okkalapa	2	342	57	“
6	South Okkalapa	1	85	0.4	“
7	Thaketa	1	123	3	“
8	Mingalardon	2	40	6	“
9	Shwe Pyi Thar	4	249	6	“
10	Hly Thar Yar	7	137	6	“
	TOTAL	24	3562	109.4	

On Call System
Waste collected = 109.4 Ton Per Day

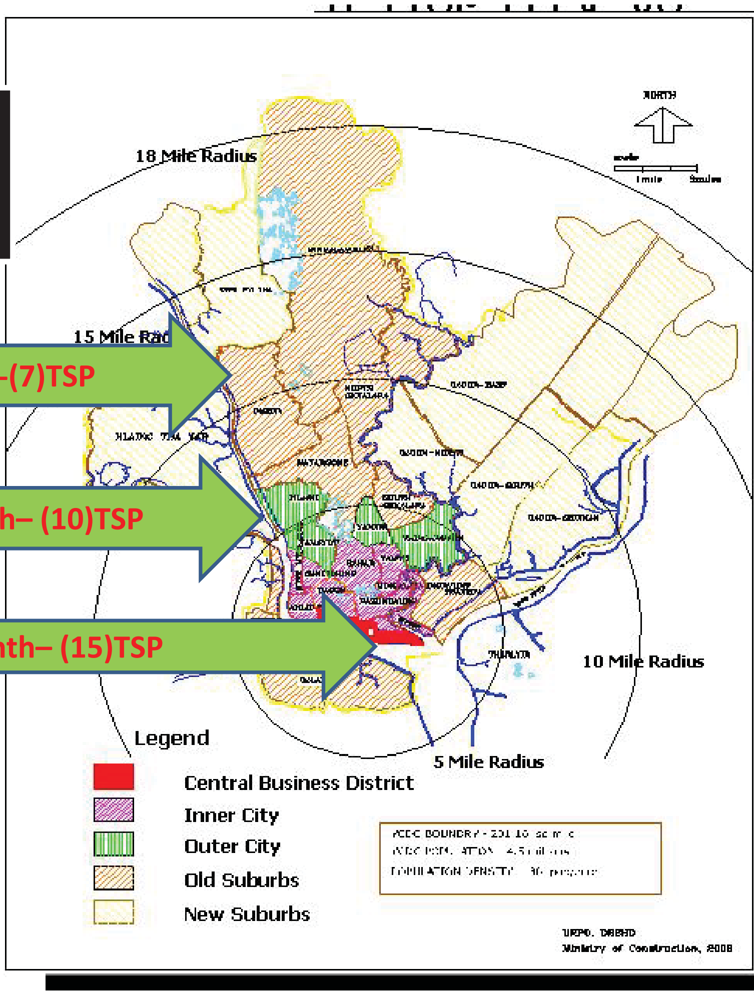
19

Monthly Fee of Household Waste Collection

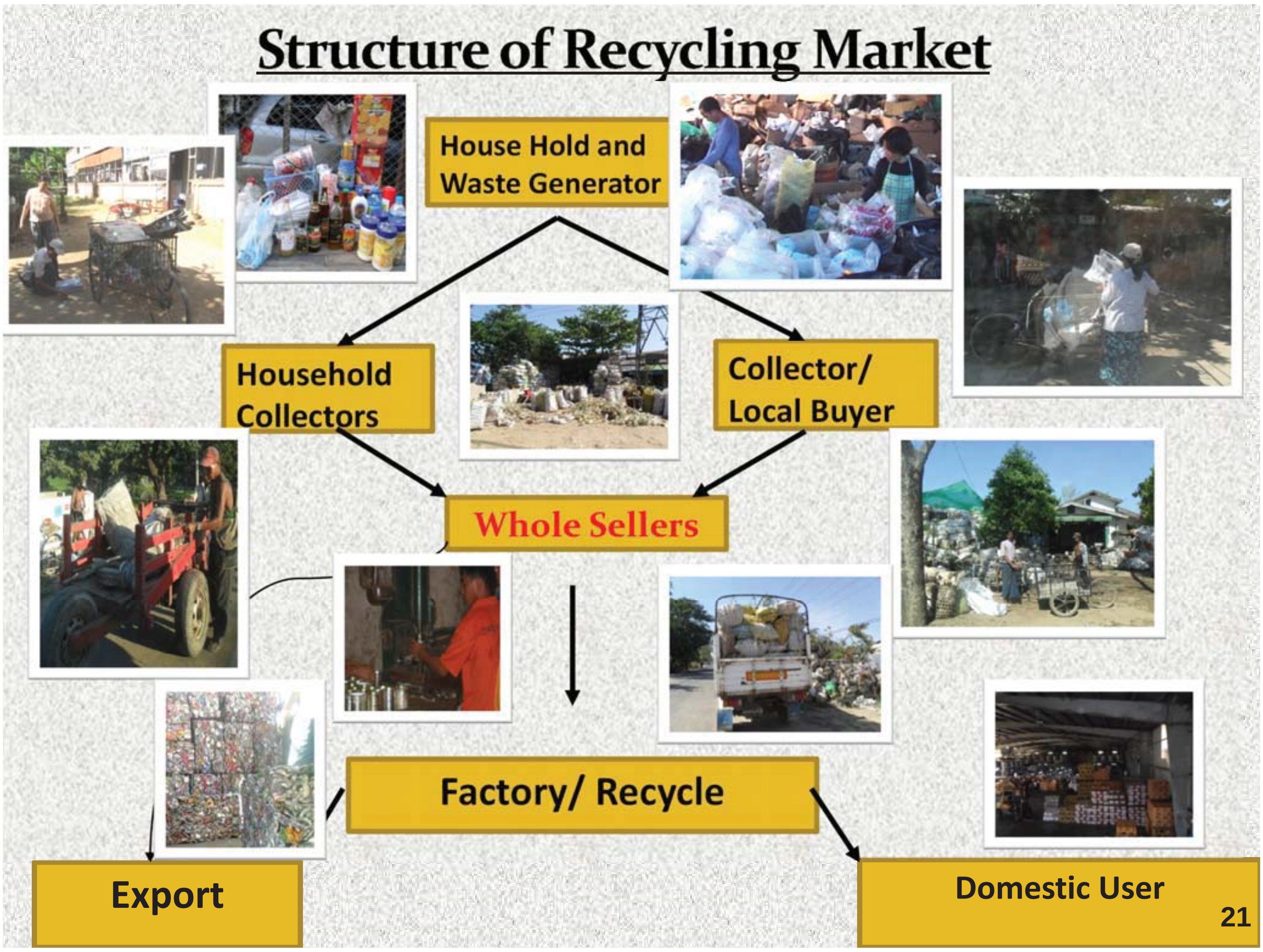
Satellite (300) kyat per month-(7)TSP

Sub-Urban (450) kyat per month– (10)TSP

CBD- (600) kyat per month– (15)TSP



20


Structure of Recycling Market
House Hold and Waste Generator
Household Collectors
Collector/ Local Buyer
Whole Sellers
Factory/ Recycle
Export
Domestic User
21


Manufacturing Process of Recycle Product
Domestic Waste Container
Infectious, Sharp, & Domestic Waste Bags
Plastic Waste
(After Melt)
Infectious Waste Container
Sharp Waste Container
Plastic Bags
WET
DRY
Plastic Resin
Waste Bags Production
22

Recycle and Reuse Materials; Direct to Whole Sale Local Buyers ; Data Base on 2012

Particular	Weight (T)	Unit
Plastic	5.1	Ton
Paper	8.94	Ton
Cardboard	11	Ton
Leather	.1	Ton
Iron	0.5	Ton
Metal	0.3	Ton
Copper	0.3	Ton
Lead	0.1	Ton
Glass	40.5	Ton
Tin Can	5.1	Ton

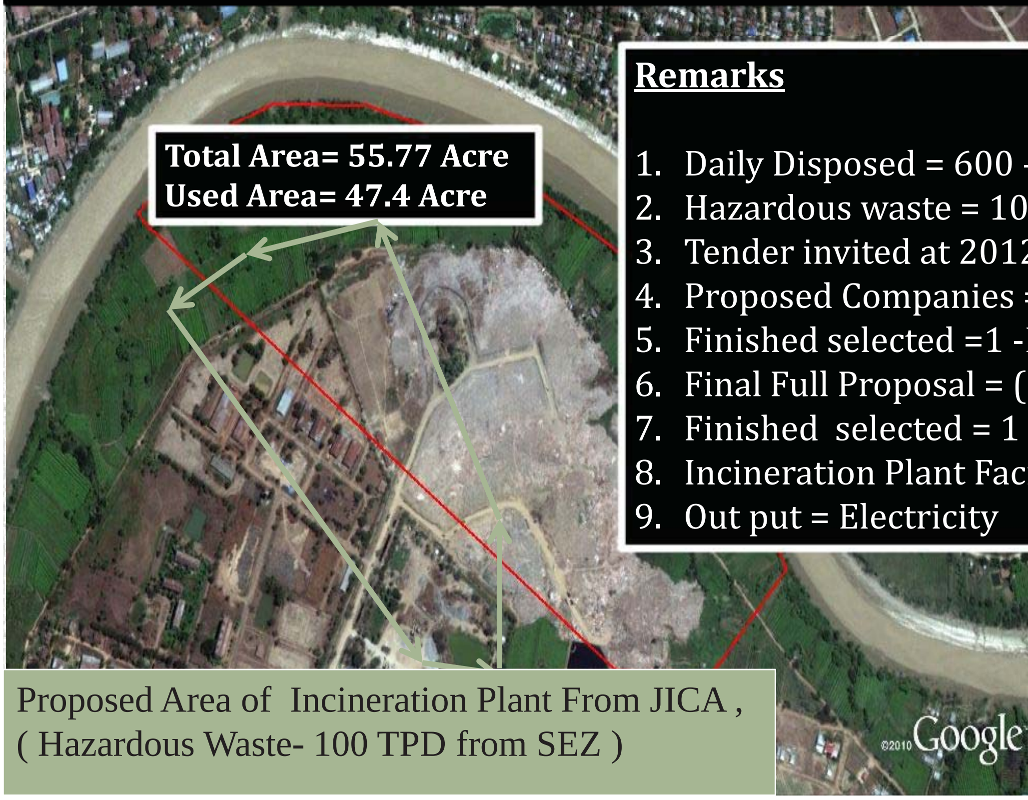
Recycle Waste Generated = 85.84 - TPD

23

Htainbin Final Disposal Site, Tender Invited, Propose Location of (800) TPD Can dispose Domestic Waste of YCDC area, Sanitary Landfill Facilities, Bio-Gas to Electricity or CNG

24

Htawe Chaung Final Disposal Site
Tender Invited, Propose Location of (600) TPD Incineration Plant, WTE



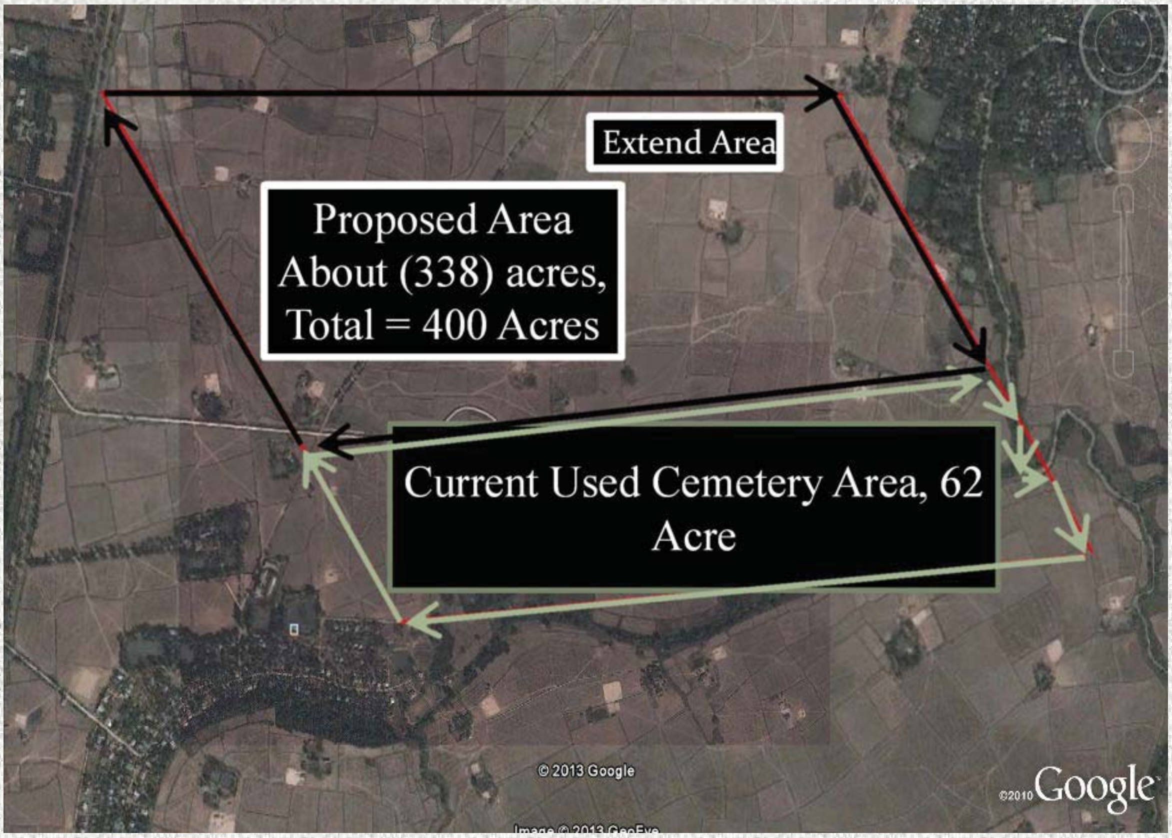
Remarks

1. Daily Disposed = 600 –TPD(domestic)
2. Hazardous waste = 100 - TPD
3. Tender invited at 2012
4. Proposed Companies = 43 -No
5. Finished selected =1 -No
6. Final Full Proposal = (07- 08- 2013)
7. Finished selected = 1 No, (05-10-2013)
8. Incineration Plant Facility
9. Out put = Electricity

Proposed Area of Incineration Plant From JICA ,
(Hazardous Waste- 100 TPD from SEZ)

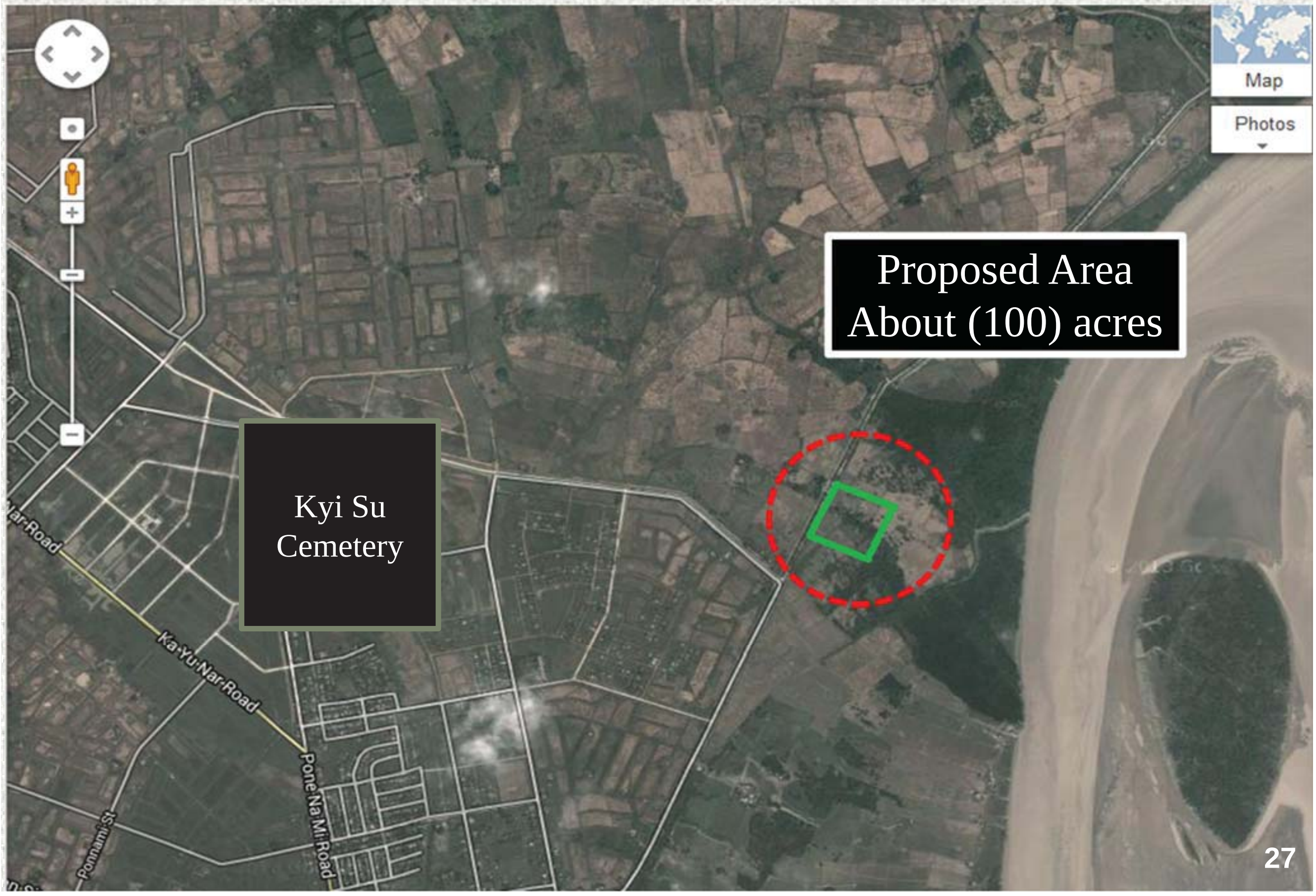
25

Dala Final Disposal Site



26

Kyisu Final Disposal Site



Htainbin Cemetery, Medical Waste Propose Location

Public Awareness program

3Rs Activities

School Awareness program

29

Key Finding and Main Issues in Solid Waste

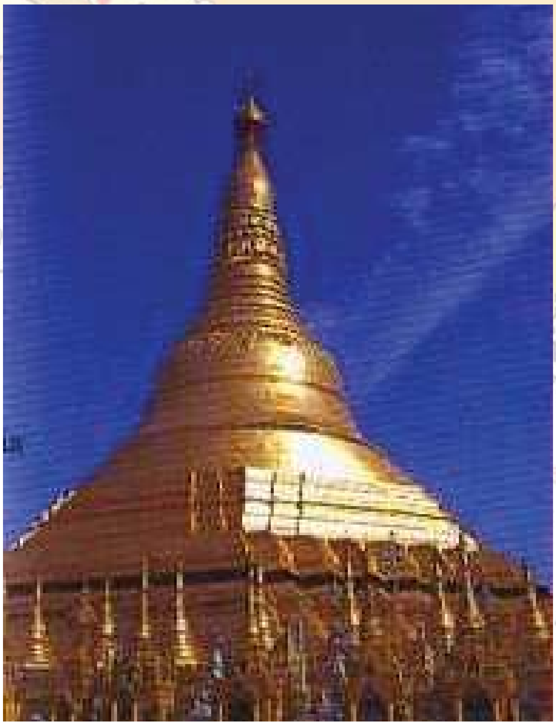
1. Lack of Detailed Planning of SWM
2. Inefficient Waste Collection System
3. Old Equipment for Waste Collection and Transportation.
4. Improper Final Disposal
5. Unclear Enforcement of Hazardous/Infectious Waste Management
6. Weakness of SWM Registration

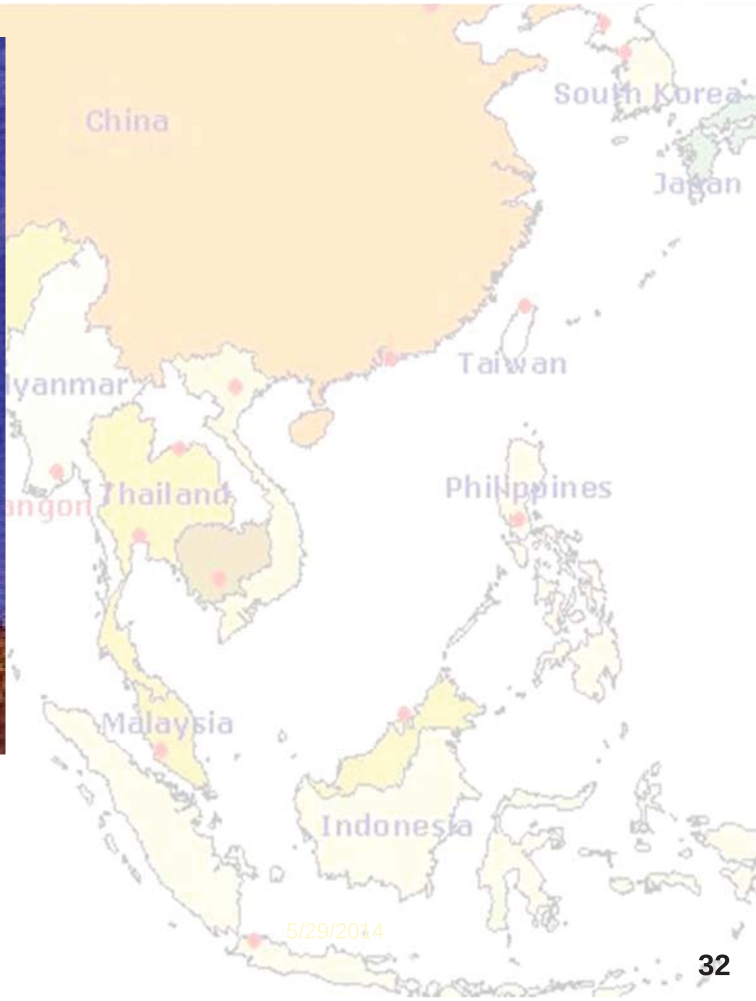
30

Policy and Goal

- To research and develop on clean air, clean land, clean water.
- To integrate the action plans for ambient and indoor air quality monitoring and upgrading.
- To update the legislative system for EIA practices .
- To enhance the techniques on "Waste To Energy" WTE processes.
- To promote greater awareness of environmental and health risks from poor environmental planning and management.
- To upgrade the city green clean and healthy livable.

31





Thank You

32

International Workshop on Sustainable Waste Management in Yangon

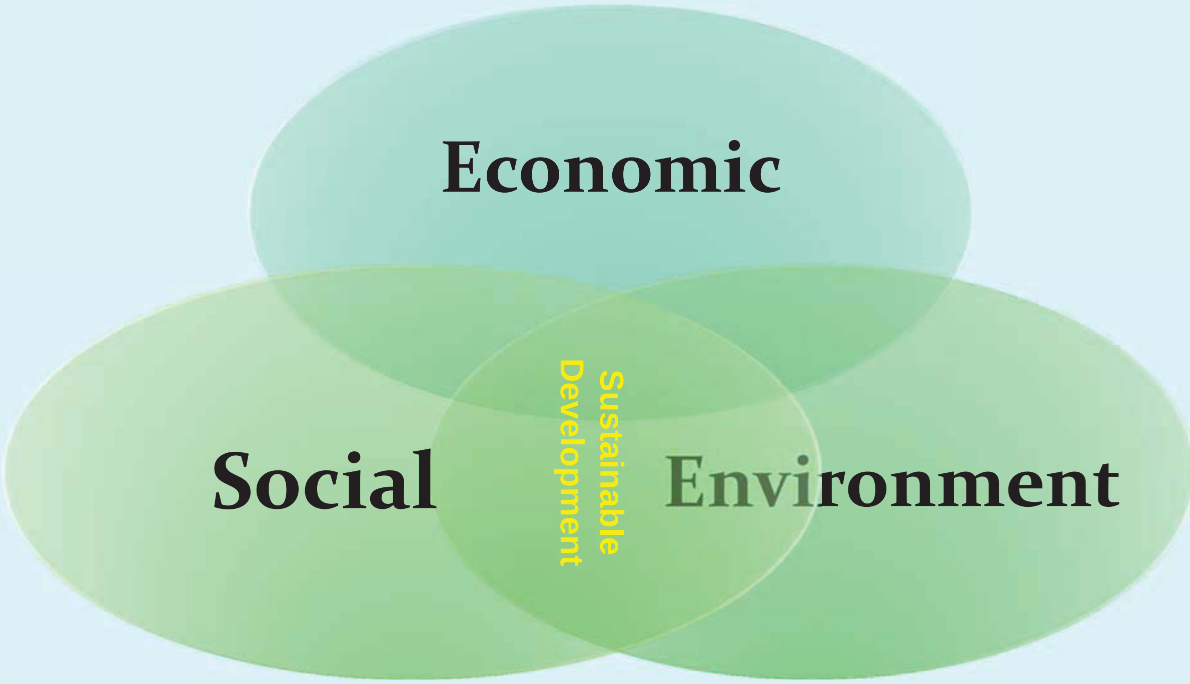
Myanmar`s Pathway for National Waste Management Policy

Environmental Conservation Department
MOECAF
20-12-2013

Outlines

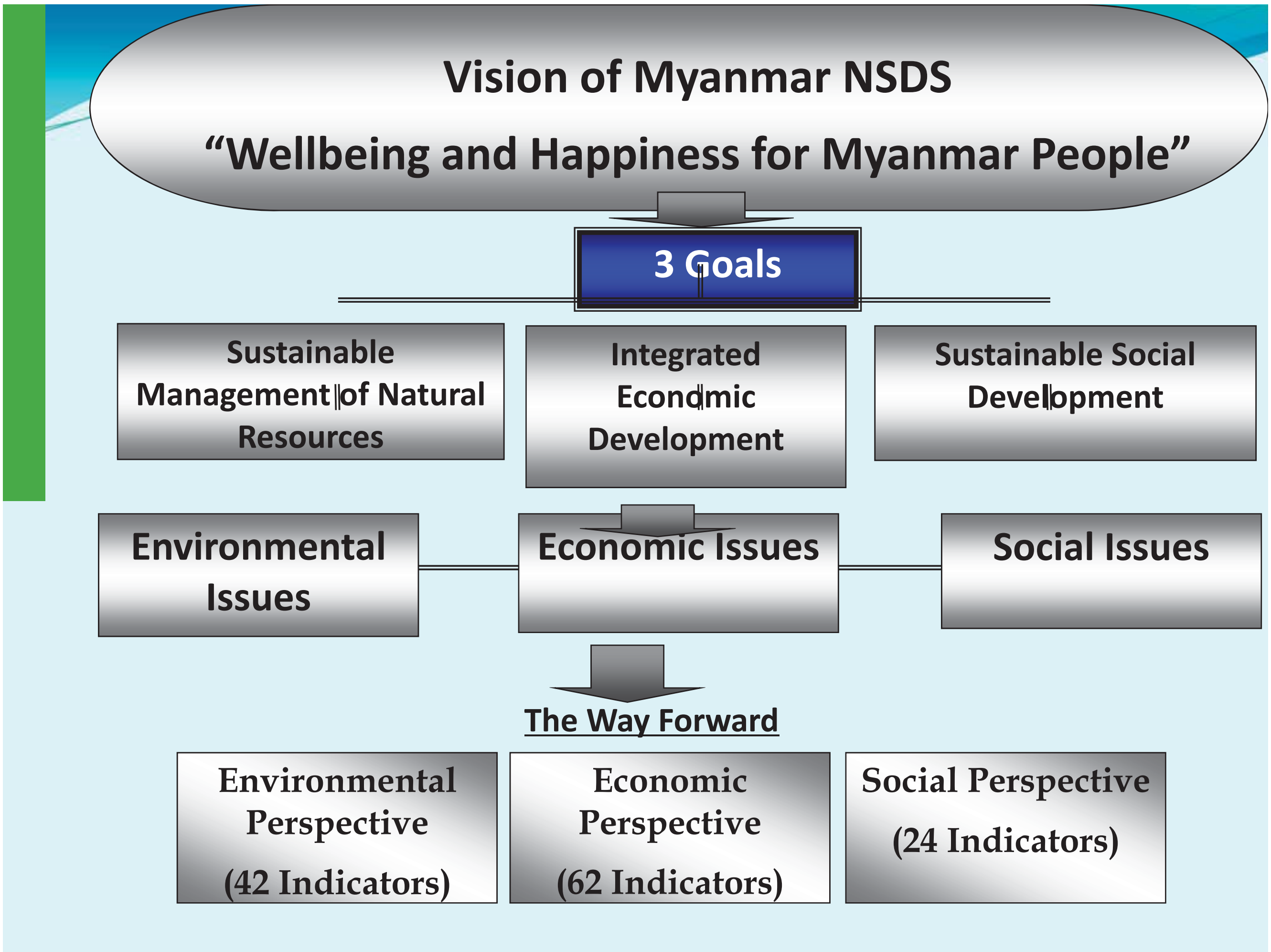
- Policy guidelines
- Opportunities and Challenges
- Waste Management Initiatives
- The way forward

Sustainable Development: Economic and Environment



Environmental Policies and Laws

- Constitution (2008)
- Environmental Policy (1994)
- Myanmar Agenda 21 (1997)
- National Sustainable Development Strategy –NSDS (2009)
- Environmental Conservation Law (2012)
- Environmental Conservation Rules (Approved by Cabinet)
- Procedures for Environmental Impact Assessment (Drafted)
- Sectoral Laws and Policies



Policy guidelines : Environmental conservation

- **To lay down new policy for economic development in parallel with environmental conservation**
- To review and amend laws and enact new **laws on environmental conservation**
- To conserve **Forests and Biodiversity**
- To reduce **Air and Water pollution and** control of **Industrial Waste and** extend **Renewable Energy**
- To mobilize **participation of people and social organizations**

Post Rio+20:The areas to promote Green Economy

- **Energy sector**: Energy efficient and renewable energy
- **Agriculture**: Sustainable Agriculture Production
- **Livestock and Breeding**: Sustainable pet industries
- **Water**: Ecosystem, Quality, Pollution
- **Forest conservation**: Sustainable Forest Management
- **Biodiversity**: Value of Biodiversity
- **Disaster Risk Reduction**: Early Warming system
- **Sustainable Cities**: Green Cities
- **Oceans, Seas and Coastal Areas**
- **Mining**
- **Chemical and Hazard Waste Management**

Policy guidelines : Guidelines of Investment by MIC

Sustainable Development Approach: Opportunity/Challenges?

Opportunity:

Mainstream Environmental conservation into Development Planning to achieve ecologically sustainable development

Challenges:

Increasing Investment through both Industrial-based and Natural-resources based Economic Development

- Development projects in terms of Oil and Gas, Dams and Hydropower, Urbanization and Industrialization
- Leading to cause environmental degradation and pollution.

Enabling conditions: Opportunities

Political Willingness

Policy Guidance by Government is to work for Economic Development in Parallel with Environmental Conservation

National Development Planning

- Environmental conservation in the National Plan
- Requirement of Environmental Clearance (EIA) for approval of the proposed projects in MIC

People awareness

- People are great attention on environmental conservation for their livelihood development and their safety

Challenges & Issues :

Over-use of Natural Resources

- Highly rely on exploitation of Natural resources
- Infrastructure Development: Dam, Highways, Urbanization, land use change ,
- Ecosystem and environmental resources degradation, lost of habitat and biodiversity

  Climate change

Challenges & Issues:

Industrialization

- Increasing Investment from Natural resource based to industrial based economy
- Heavy Industrial development, Special economic zone
- Environmental pollution

Areas of environmental issues

Waste Management Initiatives

- **Myanmar Agenda 21 (1997)** identified four programme areas, waste related areas such as;
  - Improve the solid waste management programme
  - Promote environmentally sound management of toxic chemical and hazardous wastes
- **NSDS:** To promote water quality, air quality, solid waste management and environmentally sound management of toxic chemicals and hazardous wastes.
  - Formulate a solid waste management master plan and guidelines and priority on big cities
  - Enact a hazardous waste law
  - Educate the general public to promote environmentally sound waste management
  - Develop a framework for hazardous waste management
    Encourage private investments in solid waste management services

Waste Management Initiatives

Environmental Conservation Law (2012):

- Prescribing environmental quality standards
- Specifying categories and classes of hazardous wastes
- Treatment of solid wastes, effluents and emissions which contain toxic and hazardous substances
- Maintain a comprehensive monitoring system and implement
- Installing environmental friendly equipment to reduce environmental pollution
- Controlling the wastes in accord with environmentally sound methods

Waste Management Initiatives

National Environment and Health Action Plan:

Priority areas of environmental concern

- Air Quality
- Water supply, Sanitation and Hygiene
- Solid and Hazardous Waste
- Toxic chemical and hazardous substances
- Climate change, Ozone depletion and ecosystem charges
- Contingency planning, preparedness and response in environmental health emergencies

Waste Management Initiatives

Some of Sectoral Waste Related Laws

- The Yangon Water-Work Act (1885)
- The City of Yangon Municipal Act (1922)
- The Water Power Act (1927)
- The Under Water Act (1930)
- The City of Yangon Development Law (1990)
- The Development Law (1993)
- The City of Mandalay Development Law (2002)
- The Nay Pyi Taw Development Law (2009)
- Chemical Safety Law

Environmental Safeguards Initiatives

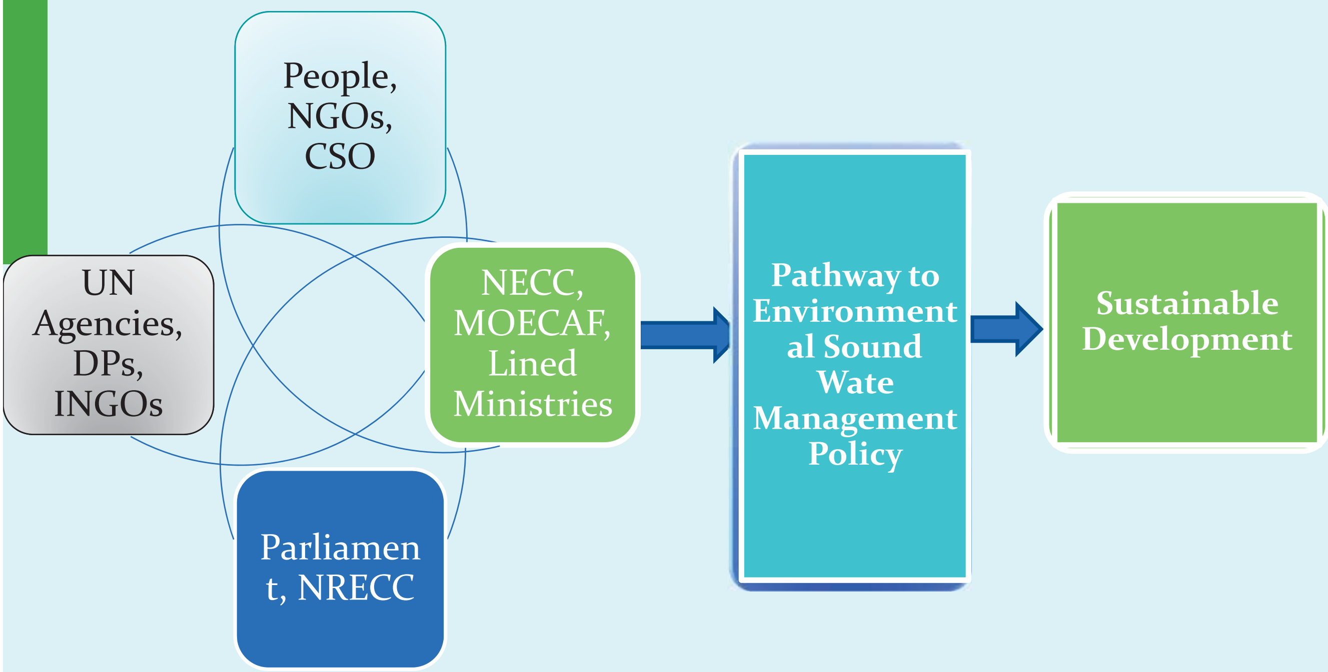
- Environmental Impact Assessment Procedures (Drafted)
- Environmental quality standards (drafting)
- State of Environmental Report (Drafting)
- Capacity Building of Environmental and Social Safeguards Project
- A party to the Stockholm Convention on POPs in July 2004.
- Development of National Implementation Plan (NIP) for POPs
- Environmentally Sound Management on Chemical and Hazardous Wastes (under discussion
- Adviser for Waste Management from KOICA
- Water management and EIA system (in process)
- National Waste Management Strategy (in process)

Gaps

- Specific Rules, Regulation and Guidelines
- Waste Management and National Waste Management Strategies Frameworks Formulation
- Monitoring System
- Technology
- Coordination Mechanism and Institutional Strengthening
- Party of Basel , Rotterdam and Mercury
- Financial Mechanism

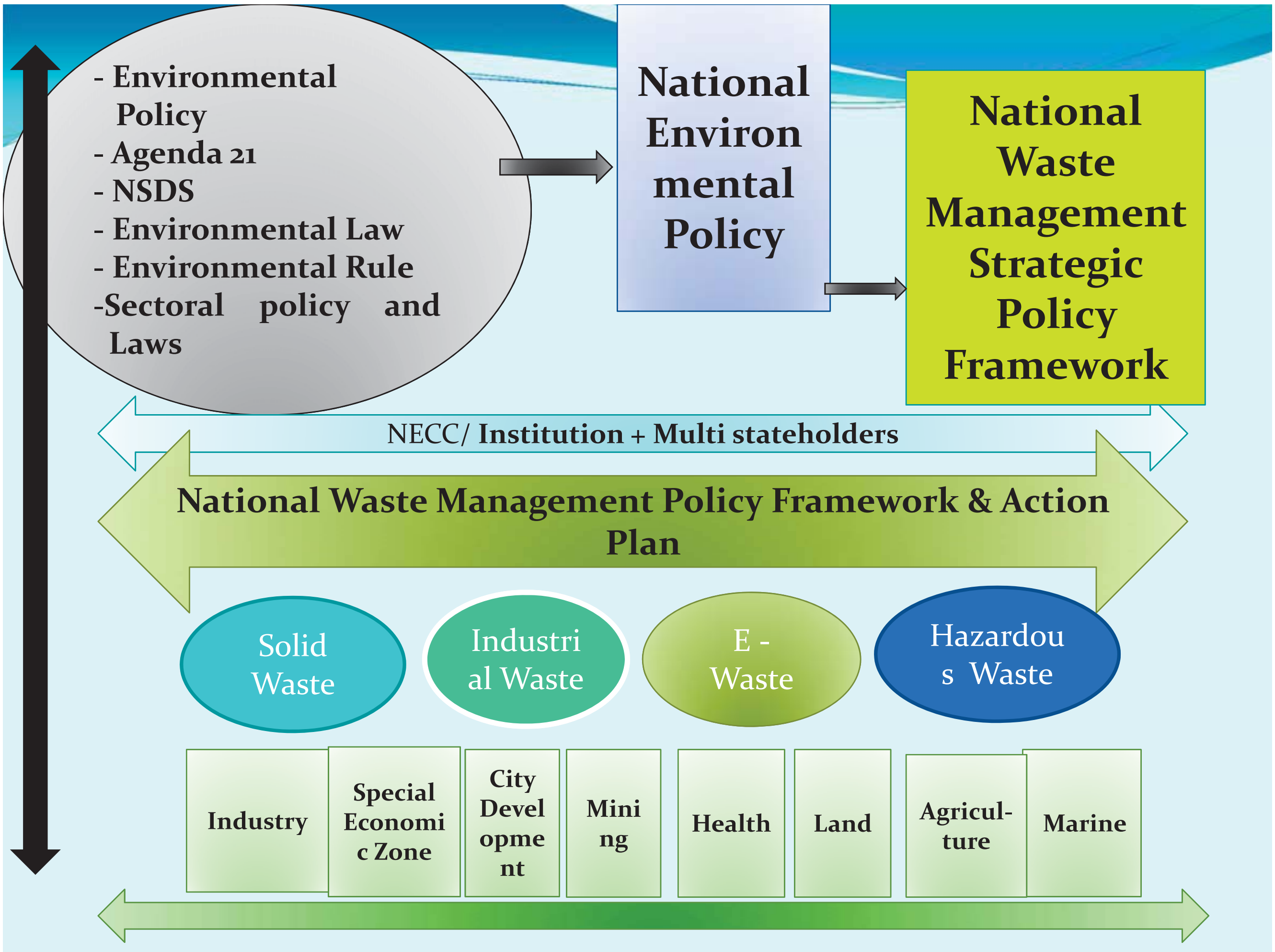
The Way Forward

Collaborative Effort Initiative



The way forward

- Formulate National Waste Management Strategic Policy Framework
- Develop National Waste Management Rules and Regulations
- Develop Sectoral Waste Management Regulation and Guidelines
- Promote Green Investment in Waste Sectors
- Formulate Environmental Quality Standards
- Identify Priority Waste Issues and Action Plan
- Promote Technology
- Promote people particiapation through Environmental Awareness Programme
- Promote regional level and international level cooperation
- Strengthen institution and the capacity building, and also the coordination mechanism



Thank you

Integrated Solid Waste Management: Towards Low-carbon Waste Management in Yangon - Myanmar

Nirmala Menikpura, PhD
Sustainable Consumption and Production (SCP) Group
Institute for Global Environmental Strategies (IGES)

Open Dumping is the Major Disposal Method in Yangon

2

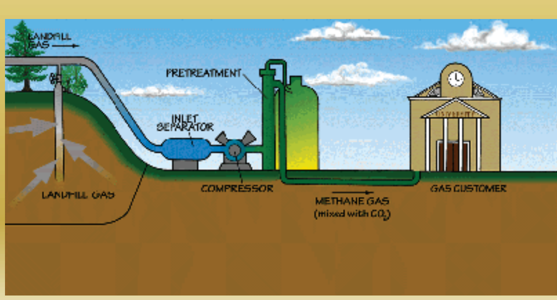
Present Situation of Waste Management in Yangon

- ❑ This is the biggest open dumpsite in YCDC
- ❑ 847 tonnes of incoming waste is disposed per day

Dumpsite at HtainBin

Future

- PCDC is planning to implement a landfill gas-to-energy recovery plant to replace this open dumpsite



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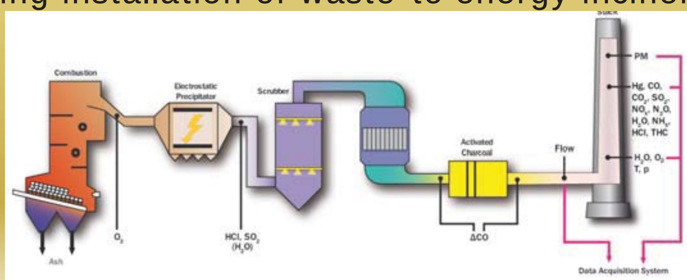
Present Situation of Waste Management in Yangon

- ❑ This is the second biggest open dumpsite
- ❑ 612 tonnes of incoming waste is disposed per day

Dumpsite at Htwei Chaung

Future

- YCDC is considering installation of waste-to energy incineration plant.



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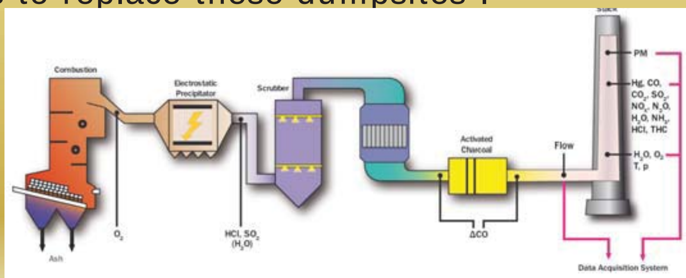
Present Situation of Waste Management in Yangon

Future

- YCDC is considering installation of small incineration (without electricity production) plants to replace these dumpsites .



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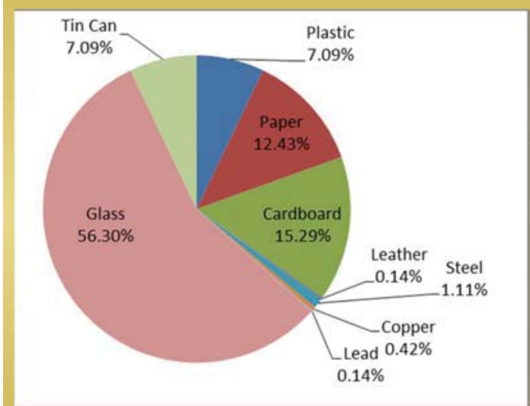
Situation of Waste Recycling in Yangon

- According to Yangon City Development Committee (YCDC) 86 tonnes/day generated waste is recycling
- Valuable recyclables are stored at household level and sell to the nearby junkshops
- YCDC is also running a small-scale plastic recycling plant and green and blue plastics bag is produced using the waste plastic.



Composition of recyclables in Yangon

Plastic recycling activities at YCDC

6

Environmental Damage and Health Issues from Current Waste Management in Yangon

7

Climate Impact from Current Waste Management in Yangon

❑ **IGES GHG calculation tool** was used to estimate the climate impacts from current waste management in Yangon

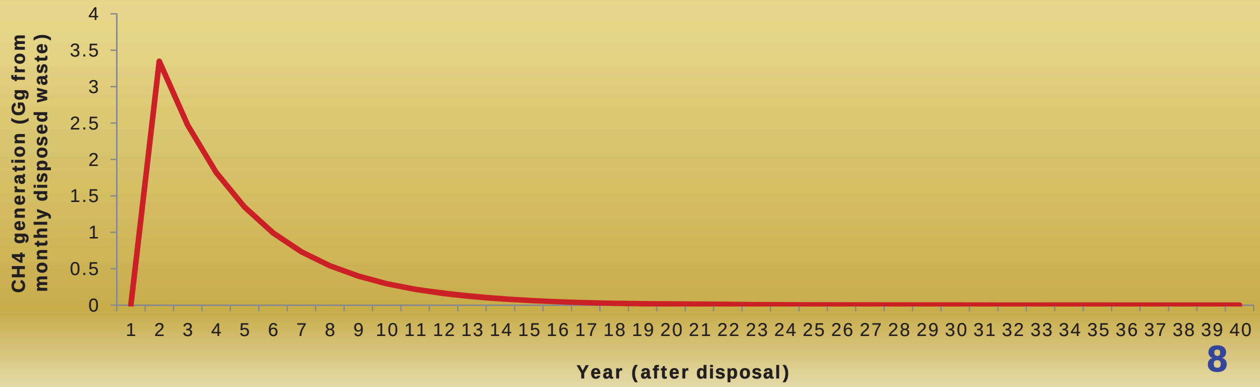
GHG emissions from Waste Transportation

YCDC uses 128,704 L diesel and 900 L of gasoline for waste transportation

GHG emissions from transportation	7.51	kg of CO2-eq/tonne of waste
Monthly GHG emission from transportation	**349**	tonnes of CO2-eq/month

GHG emissions from open dumping

Emission of CH_4 from open dumping	22.88	kg of CH_4/tonne
Direct GHG emission from mixed waste open dumping	480.48	kg of CO2-eq/tonne of mix waste
GHG emission from open dumping from monthly disposed waste	**22,342**	Tonnes of CO2-eq/month



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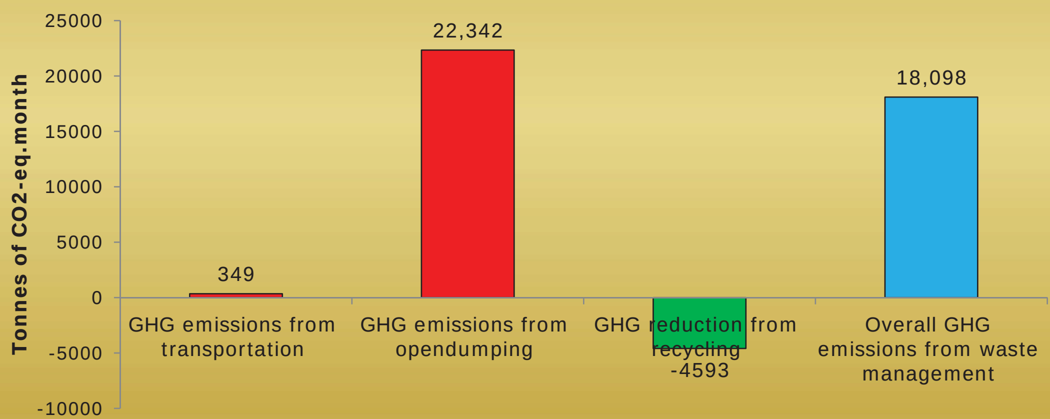
Climate Impact from Current Waste Management in Yangon

GHG emissions from recycling activities in Yangon

Direct GHG emissions from recycling	866.42	kg of CO2-eq/tonne of mixed recyclables
Avoided GHG emissions from recycling via materials recovery	2646.79	kg of CO2-eq/tonne of mixed recyclables
Net GHG emissions from recycling (life cycle perspective)	-1780.37	kg of CO2-eq/tonne of mixed recyclables
Monthly total GHG reduction from recycling	**-4,593**	**Tonnes of CO2-eq/month**

Overall GHG emissions from waste management in Yangon



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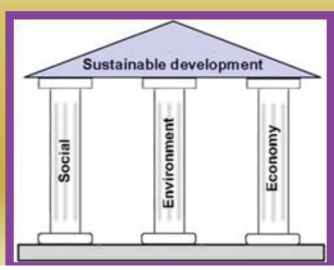
Is the Current Waste Management in Yangon Sustainable?

- The conventional practice of 'collection and disposal' is unsustainable in term of resource inefficiency, environmental impacts and socio-economic impacts

  •Difficulties in finding suitable landfill sites/dumping sites
  •Large costs associated with collection and disposal
  •Recovery of resources (material and energy) is very low and so on

- To overcome these drawbacks **development of sustainable solid waste management methods is crucial**



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Integrated Solid Waste Management: A Practical Solution Towards Sustainable Waste Management

•ISWM would be the most promising approach to solve the waste management problems since it provides multiple benefits from waste

Integrated waste management

Social benefits

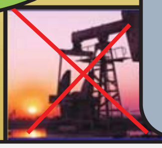
Improve the well-being of the local community
-Creation of jobs
- Improving the indirect income generation ways

Environmental benefits

Improve the efficiency waste management and reduce the emissions to air, water, soil

Economic benefits

Creation of ways of revenue generation to all the stakeholders in waste management process chain



Environmental benefits

Recovery of materials and energy from waste and replace the conventional production processes

•These benefits from ISWM can be achieved by selecting and adapting the best suited technologies to a particular municipality

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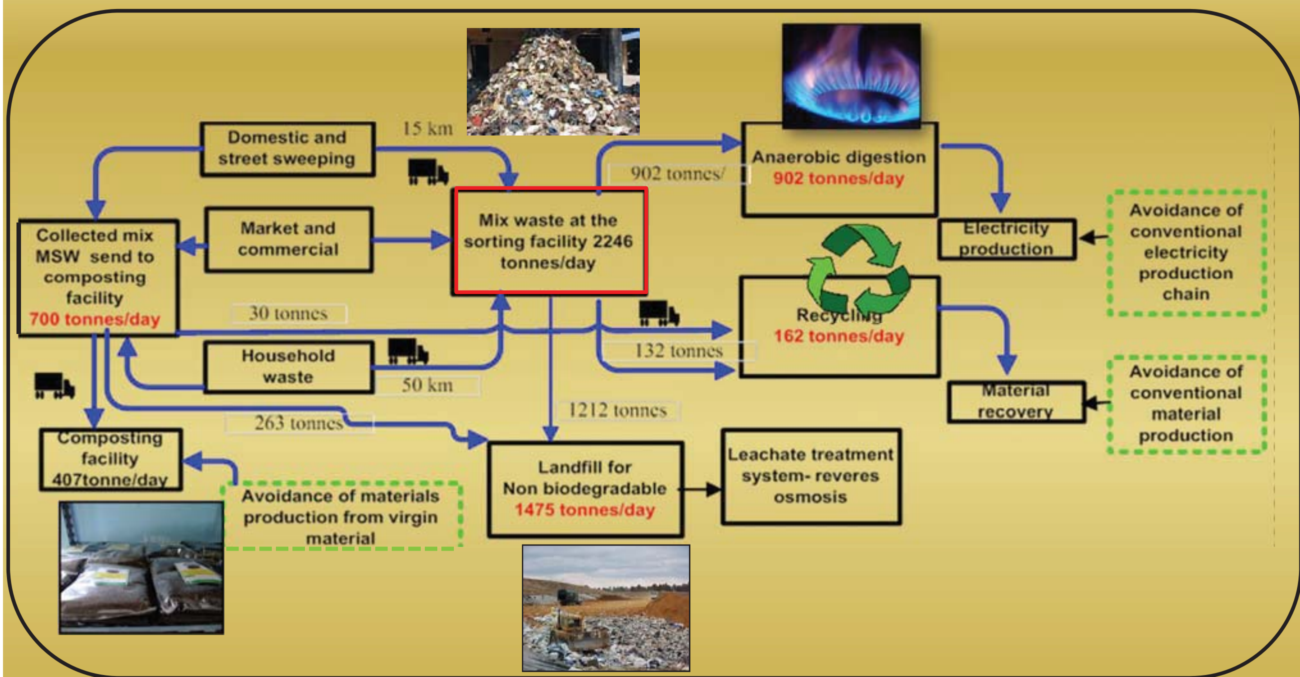
Integrated Solid Waste Management (ISWM): A Practical Solution Towards Sustainable Waste Management



Intended integrated system for Kolkata Metropolitan, India
(Source: Menikpura, PhD thesis, 2011)

12

Integrated Waste Management: Towards Low Carbon Waste Management

A case study Muangklang Municipality, Thailand

- The Muangklang Municipality is located in Rayong Province (190 km from East Bangkok)
- It has a total of 13 communities and covers 14.5 km^2
- The registered population within the Municipality -17,200 (Dec 2010)
- This municipality has initiated an integrated waste management system as a sustainable solution by incorporating effective waste collection and transportation service, waste sorting facility for recovery of recyclables, anaerobic digestion facility, composting facility, raising some farm animals to feed organic waste and so on

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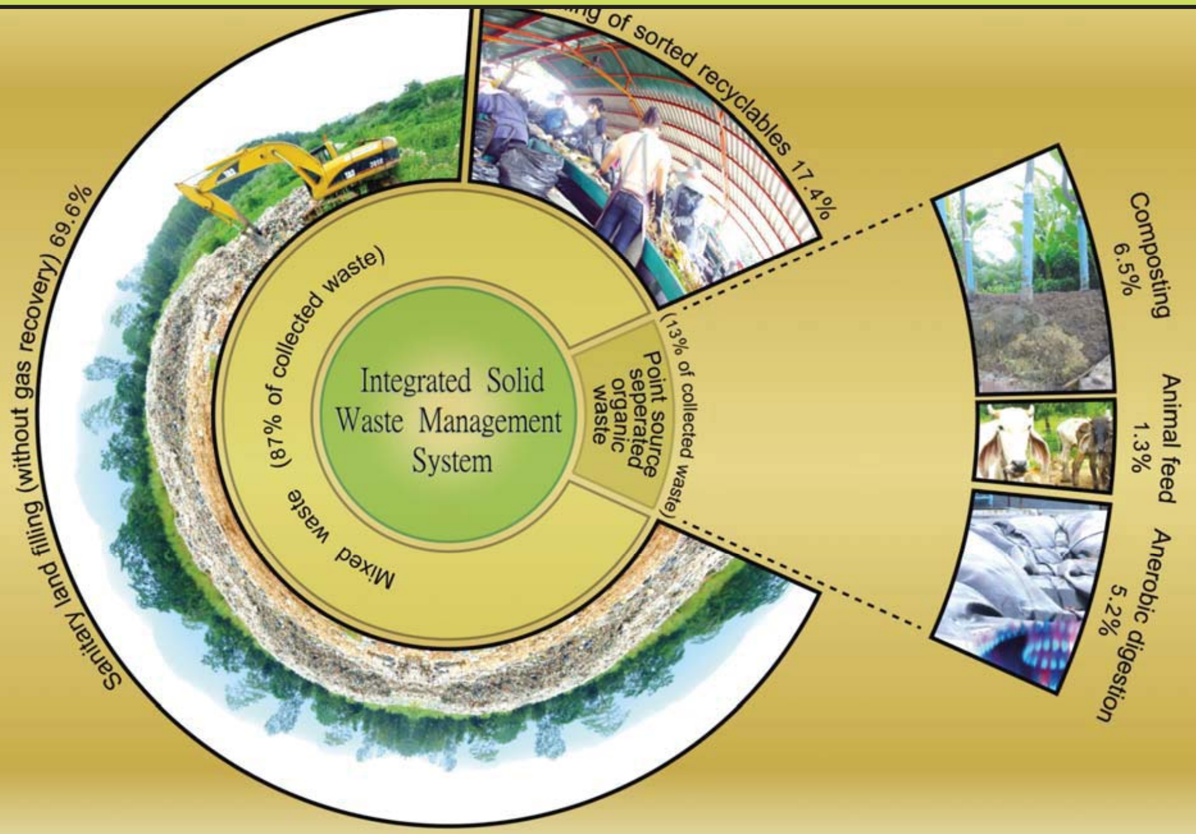
Existing Integrated System in Mungklang Municipality, Thailand



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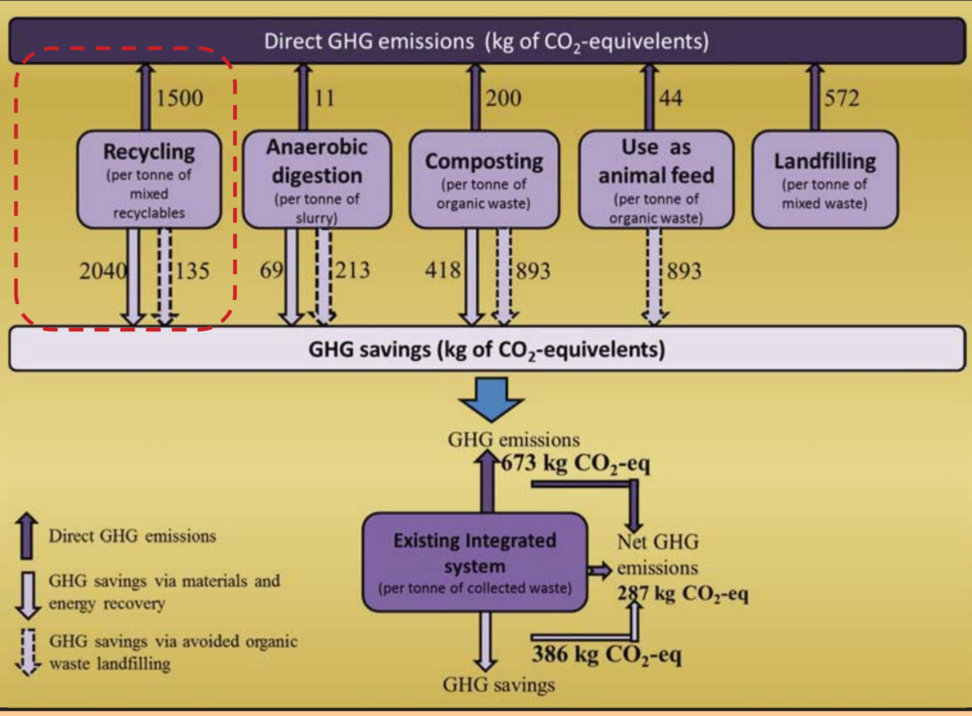
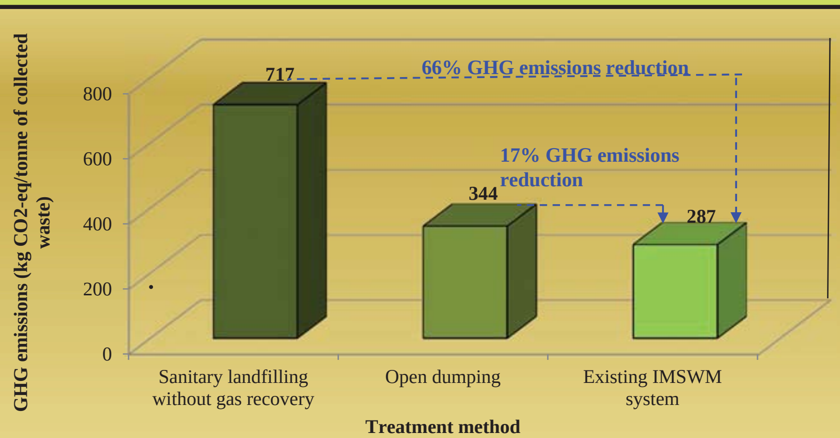
GHG Emissions and Savings Potential from Individual Technologies and Integrated System



•Net GHG emission from the integrated system is still positive due to high fraction of waste landfilling (69.6%)

GHG Emission Reduction from Existing Integrated System as Compared to the BAU Practice



•This integrated system achieved a considerable reduction in GHG emissions by utilising only 30% of collected waste for resource recovery

•Development of integrated systems would be a local initiative that could make meaningful contributions to global climate-change mitigation

•In addition there is a high potential for obtaining socio-economic benefits via integrated waste management

Summary: Towards Sustainable Waste Management in Yangon

- Landfill gas-to-energy recovery and incineration would be the two major technologies in the intended waste management system in Yangon.
- To enhance the efficiencies:

  -Careful planning is very important in the designing phase to avoid the failure that may happen after the implementation

  -Composition and the moisture content of the waste can be greatly effected on the efficiency of the incineration plant. Pre-treatment would be necessary

  -Development of proper recycling scheme in Yangon would contribute for significant GHG reduction and then to attain the target of low carbon city

- For long term sustainability, development of appropriate integrated systems, which designed for maximum resource recovery would be the key driving force towards greenhouse gas mitigation as well as for getting maximum economic and social benefits from waste management in Yangon

17

THANK YOU VERY MUCH FOR YOUR ATTENTION

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IGES
Institute for Global Environmental Strategies

JFE

Feasibility of “Waste to Energy” plant using JCM scheme

December, 2013

JFE Engineering Corporation

WTE

Waste Management

JFE

Waste Management becoming the great concern in the course of economic development

Preferred Solution

Waste To Energy

Support for Materialization

MOEJ being ready to support the developing countries for the “leapfrog” development through various support programs to create the low-carbon society

2

WTE

Smart scenario to appropriate waste management

JFE

1) Standards and regulations
2) Experience and capability
are needed for introducing Large size WTE plant

	FY2012	FY2013	FY2014	FY2015	FY2016
Large Size WTE Plant	MOEJ FS (1st year)	MOEJ FS (2nd year)			LSWP construction
		Small Size WTE Plant	SSWP construction	SSWP operation	

Standards and Regulation

Experience and capability

3

WTE

WTE by PPP scheme

JFE

Important key to realize feasibility of PPP project
1) Reasonable tipping fee and power selling price
2) Garbage volume guarantee by public sector

Project Income

Tipping Fee

Selling power

SPC

Equity | Finance | Grant

Construction

Operation & Maintenance

<Recent case of WTE in Indonesia>

1IDR=0.000083USD

Name of City	JAKARTA	BANDUNG
Project Amount	108 mil USD (1,300bil IDR)	58 mil USD (700bil IDR)
Capacity	1,000t/d	700t/d
Power Generation	17MW	8MW
Tipping Fee	33 USD/t (400,000 IDR/t)	31 USD/t (375,000 IDR/t)
Project Scheme	PPP (25 years)	PPP (20 years)

4

WTE How to introduce WTE

How to allow additional initial cost to introduce low-carbon and cutting-edge WTE technology…

MOEJ's New Support Program Enabling "Leapfrog" Development using JCM scheme

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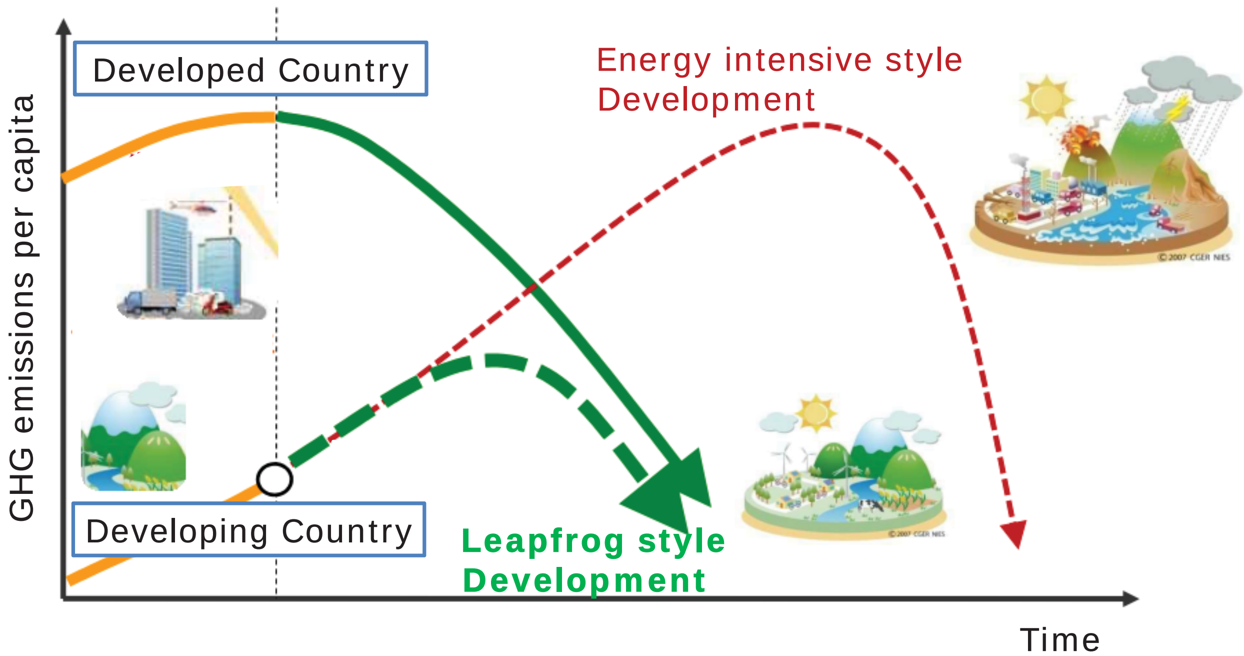
JCM Leapfrog Development



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JCM

Leapfrog Development

JFE

Achieving "Leapfrog" development through creation of low carbon society in Asia-Pacific.

Knowledge, Experience, Technology, Policy

(Participation of various stakeholders)

Capacity Building

(Improvement of environmental low)

Financial Support

(Cooperation with JICA and ADB)

Developing countries

Subject Area ; Environmentally Sustainable Cities

- Energy Saving and Renewable
- Transportation
- **Waste Management**
- Water Treatment

7

JCM

What is JCM?

JFE

JCM = Joint Credit Mechanism

NEW initiative by the Japanese Government to offset its emission reduction targets

A bilateral cooperation scheme addressing climate change through the dissemination of advanced Low-Carbon Technologies and Products to benefit the sustainable development of Developing Countries.

8

JCM

Benefits

JFE

Host Country

- Introduction of advanced Japanese Low-Carbon technology.
- Achievement of sustainable development.
- Acquirement of specialized know-how.

Japan

- Successful offset of own emission reduction targets.
- Dissemination of technology to achieve low-carbon growth all around the world.

Environment

- Reduction in Greenhouse Gas emissions.
- Tackling of climate change issues.

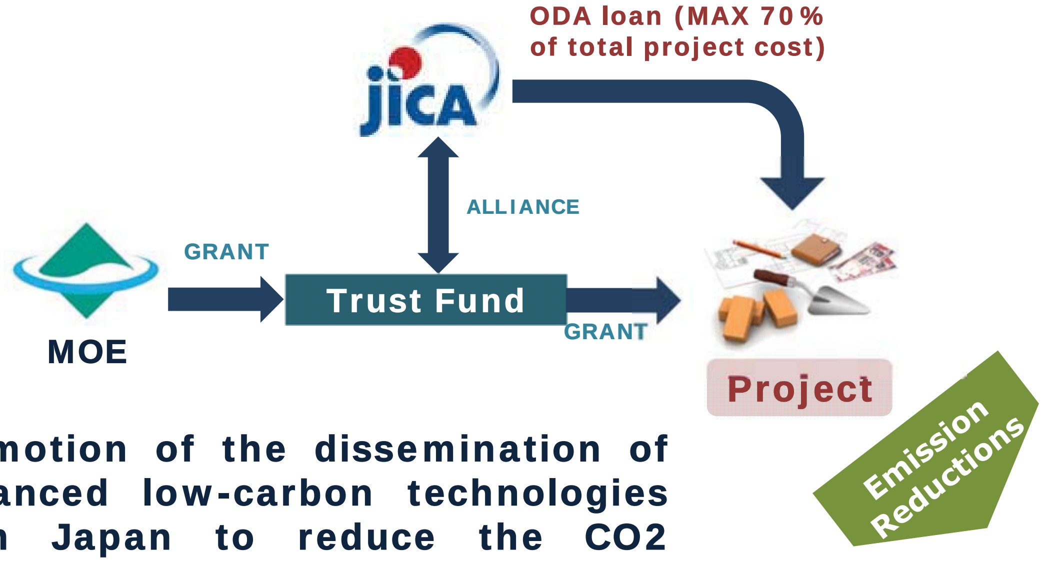
9

JCM

Support Scheme <JICA>

JFE

Fund Supported by the MOE



Promotion of the dissemination of advanced low-carbon technologies from Japan to reduce the CO2 emissions with fair price.

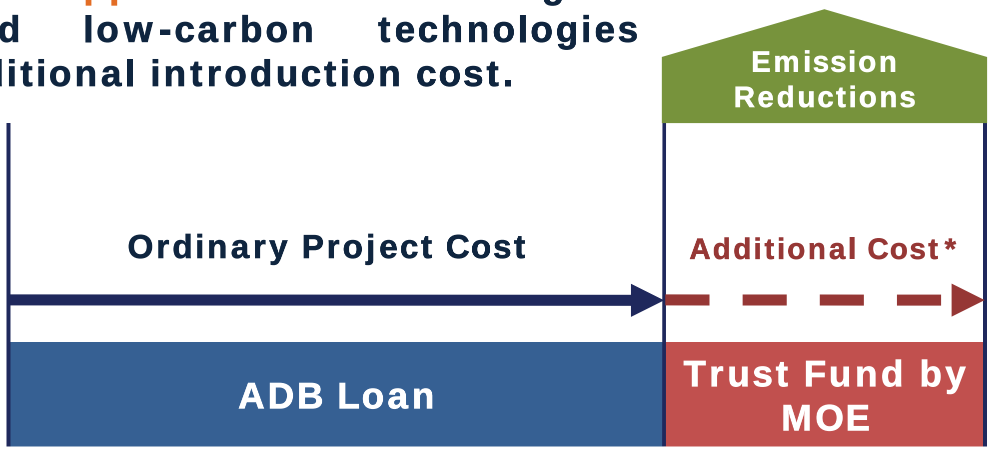
10

JCM

Support Scheme <ADB>

Support through ADB Contribution

Carried out through the funding of Asia Development Bank's trust fund in order to carry out a **coordinated financial support** for the costing of advanced low-carbon technologies with additional introduction cost.



* Caused by the introduction of Advanced Technology from Japan

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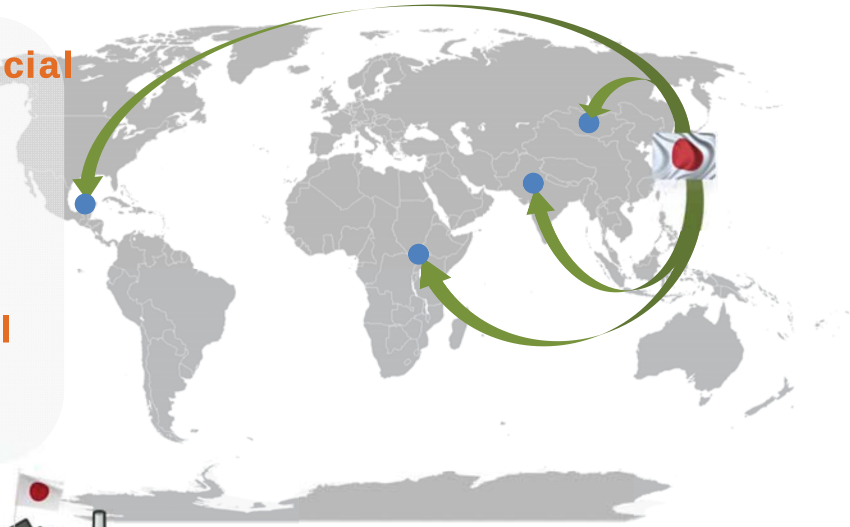
JCM

Support Scheme <Subsidy>

Project Subsidy

Enhancing the **financial viability** of the low-carbon emission projects of Private Sector in countries where Japan has established **bilateral agreements**.



12

Thank you!

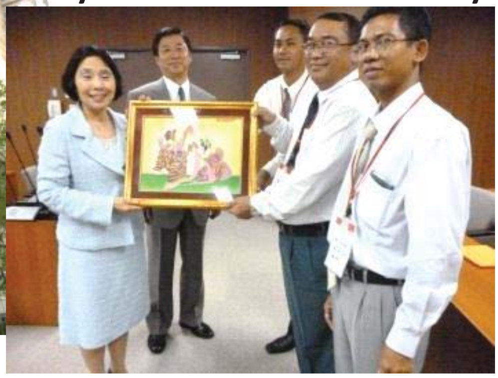
Yangon & Tokyo's Program

Tokyo Workshop / Oct. 2013

Incineration Plant

TMG Building

Waste water Treatment at FDS



Mayors of Mitaka &Chofu City

Yangon & Tokyo's Program

Yangon Workshop / Nov. 2013

Kamayut Township

South District Office

School Program

Htawe Chaung FDS

2

Thank you for inviting!

PCCD Office on Nov.25

3

Cooperation with residents in Tokyo

In the case of container and packaging recycling law in Japan

Taka

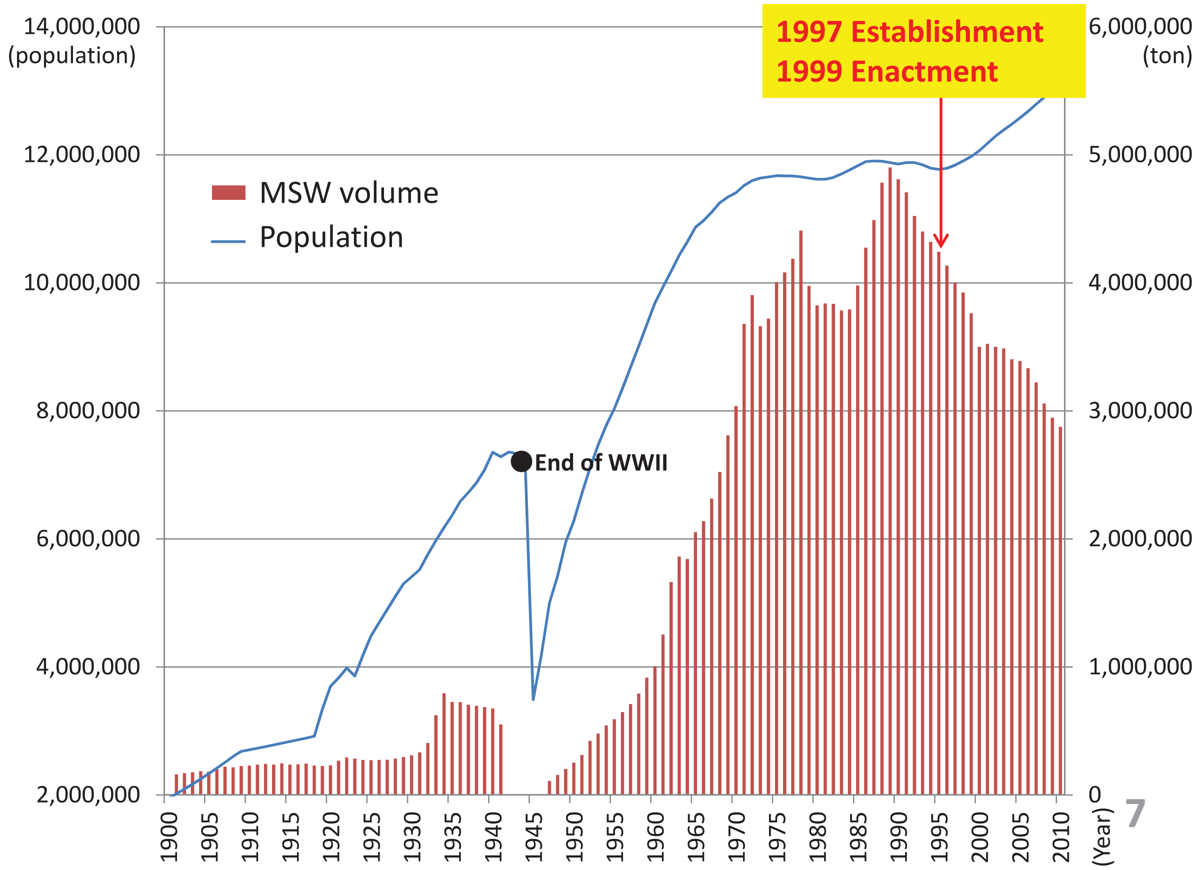
TOKYO Metropolitan Government

A Mechanism for gaining Cooperation from Residents (Case Study)

1. The background of Container and Packaging Recycling Law (CPRL) in Japan
2. Outline of CPRL
3. Consequences after the enactment
4. Amendment in 2006
5. Efforts taken by Tokyo
6. Current status in Tokyo

1. The background of Container and Packaging(C&P) Recycling Law (CPRL) in Japan

1-1. Extreme increase of waste generation



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1-2. Economic condition affects recycling activities taken by local governments

- Even if local governments collect recyclable items (ex. glass bottle) in order to reduce landfill volume, recyclers refused to buy them when the trading prices in the market gets lower.
- Therefore, collection of recyclables ends in vain and local governments have to landfill them.

8

1-3. Necessity of new economical incentive method

Existed national waste and recycling law were not enough to reduce waste generation

Existing Law

Waste Disposal and Public Cleansing Law

Law for the Promotion of Effective Utilization of Resources

"**New Economical Incentive**" was required.

9

1-4. Surrounding pressure

- **CSR** activity taken by private sector
- Similar measures taken by **Germany** and **France**

10

1-5. Consideration of economical incentive methods

- Deposit system
- Charging system and so on…..

↓

Reflecting characteristic of Japan,

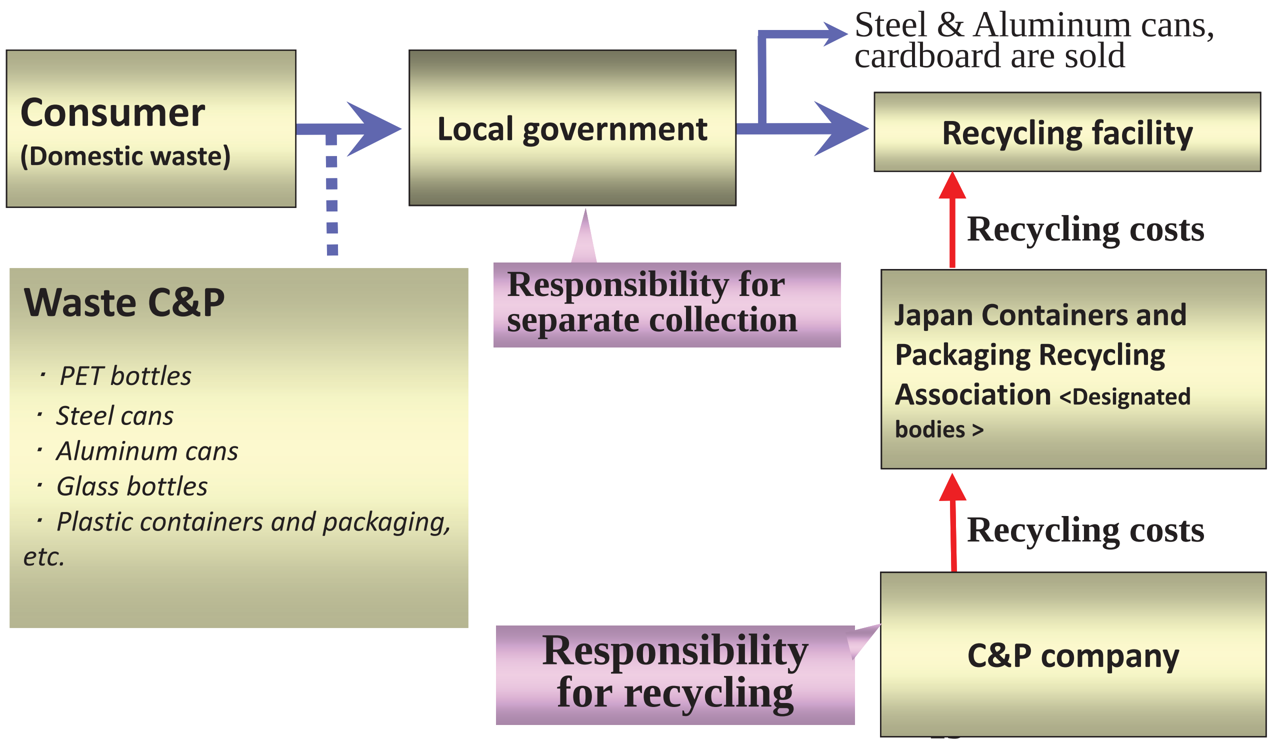
1. **Local governments collect** C&P from household
2. Manufacturer and retailer are responsible for recycling **(EPR)**

2. Outline of CPRL in Japan

i. Role sharing among **resident**, **local government** and **private company**
ii. Subjected item are **all kind** of C&P (metal, aluminum, glass, cardboard, paper, PET, plastic and others)
iii. C&P users and producers are **responsible for recycling**
iv. Local government is encouraged to do **(this is not mandate)**
i. 5-year moratorium on **plastic C&P**
ii. To review 10 years after

Hereinafter, refer a private company who sells their products with C&P, such as Coca Cola, and who produces C&P as “C&P Company”

2. C&P recycling flow



2. Japan Container and Packaging Recycling Association (JCPRA)

- 36 industry groups jointly established
- Activities

i. To conduct recycling for C&P company

ii. To accept recyclables from local government

iii. To make a contract with recycler

Activities of JCPRA

JCPRA

Contract

C&P company

- JCPRA collects recycle fee from C&P company
  (Number of C&P companies:74,371)

Contract

Local Government

JCPRA
- Registers the volume of collected C&P at each LG's stockyard
  (Number of LG: 1,541)
- Supervises proper pick-ups from LG by Recycler
- Collects recycling fee of small sized C&P company from LG
- Survey for quality of recyclables

Contract

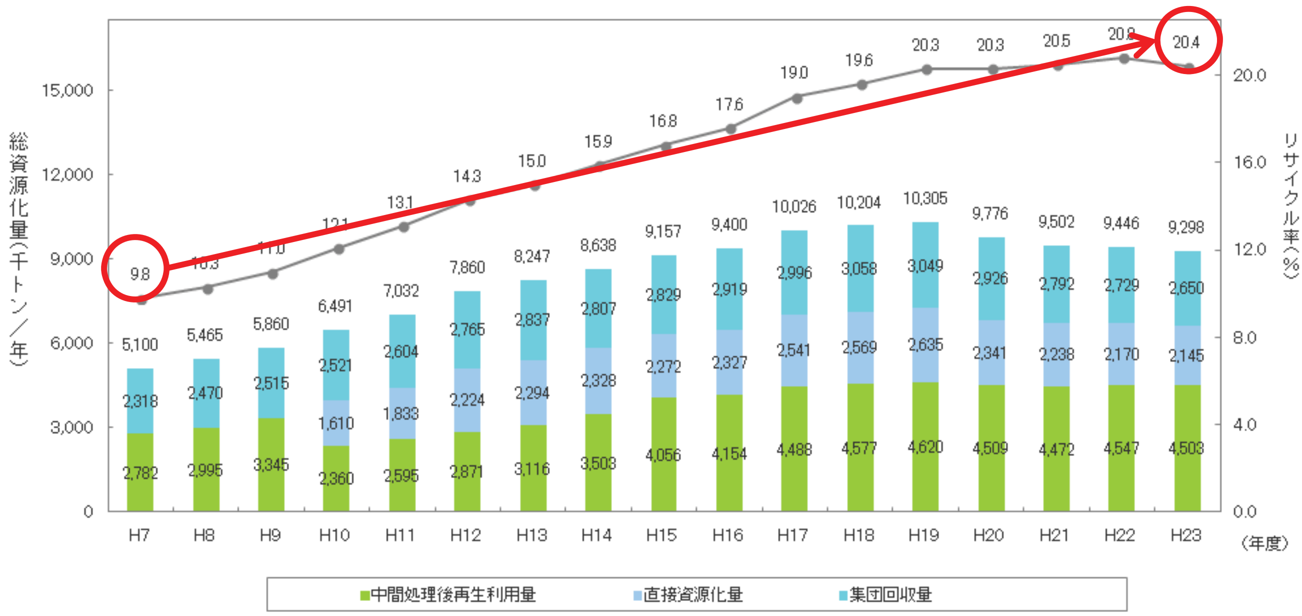
Recycler

JCPRA
- Screens & Registers recyclers (Number of recycler: 227)
- Calls for bids on each item's recycling in each stockyard of LG

15

3. Consequences after the enactment

Recycle rate **9.8%**(1998) ➔ **20.4%**(2011)



16

3. Other disadvantages occurred

i. Cost burden for collection (public side)
ii. Technical difficulty on plastic recycling
iii. Lost of PET bottles

17

4. Amendment in 2006

i. Funding program for local government was added
ii. Heat recovery method for plastic was allowed (only in case of emergency)
iii. Domestic recycling route became principle

18

5. Efforts taken by Tokyo before enactment of CPRL

- Working force on the promotion of C&P recycling was established
- "Tokyo Rule"
  - I. To conduct **once-a-week recyclable collection**
  - II. To require C&P company to take **more roles than law (Collection from resident)**
  - III. In order to **prioritize a PET bottle collection**, TMG collect PET and require C&P company to recycle

19

5. Rule II & III "Setback"

Tokyo tried to impose heavier duty to C&P company.

However, C&P company did not agree.

20

6. Current status in Tokyo

Each local government conducts the recyclables collection within the framework of law

From 2000, responsibility of MSW in the central area of Tokyo, was transferred from Tokyo Metropolitan Government to 23 cities.

Picture : Nerima City

21

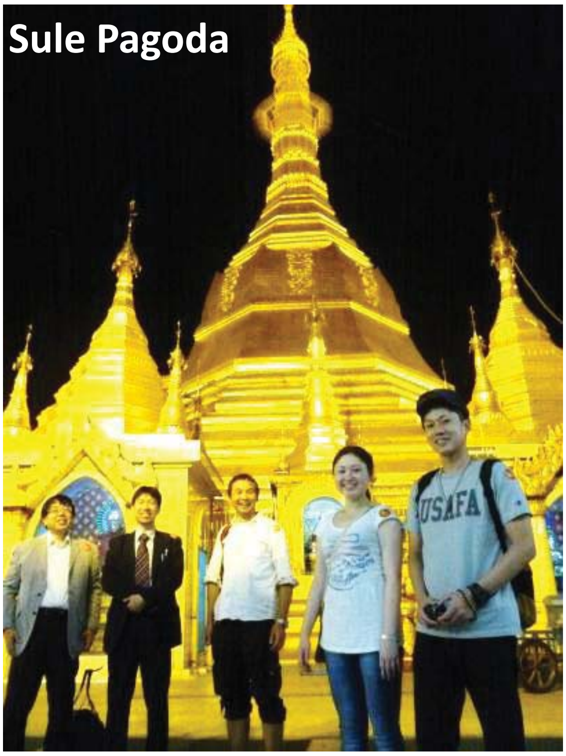
Cooperation with residents for success of the CPRL

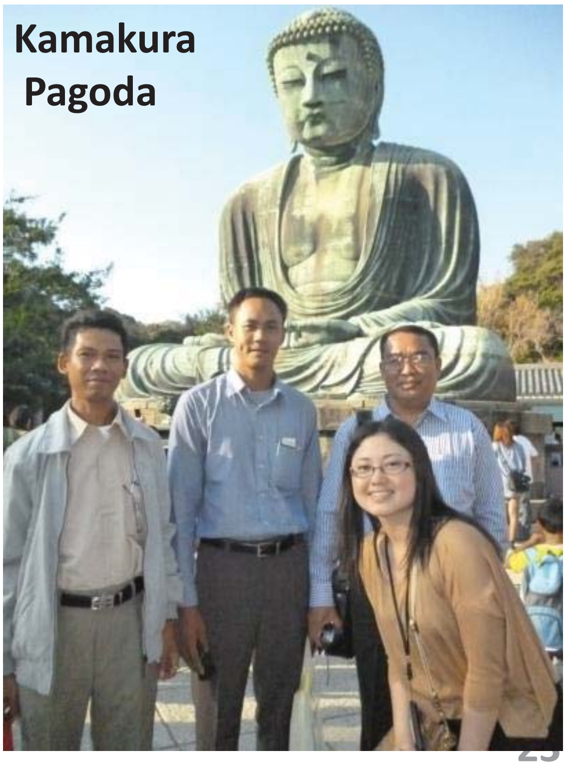
- Source separation
  - To set various category
  - To be practiced perfectly by residents’ cooperation and understanding

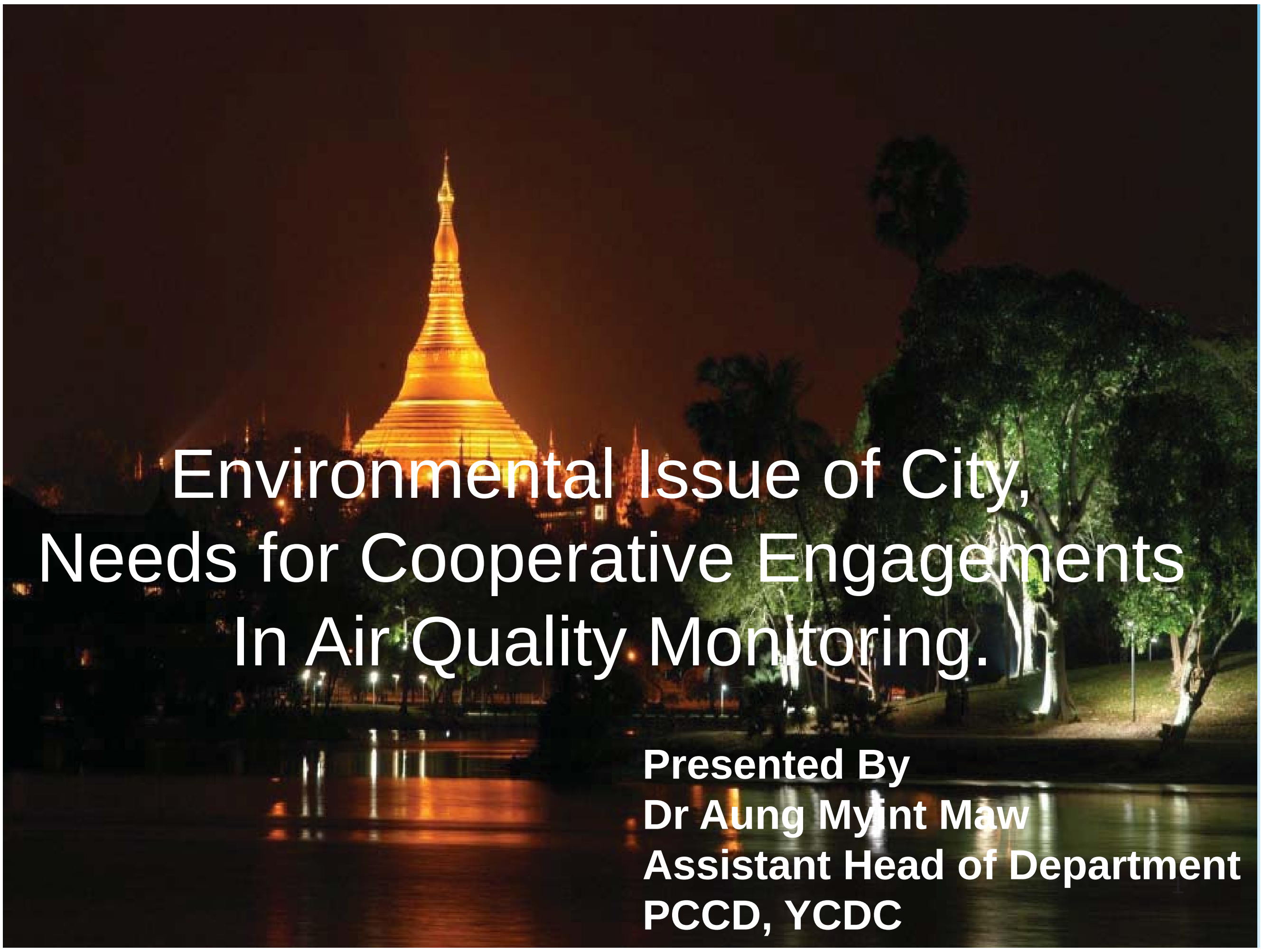
Photo : Toshima City

22

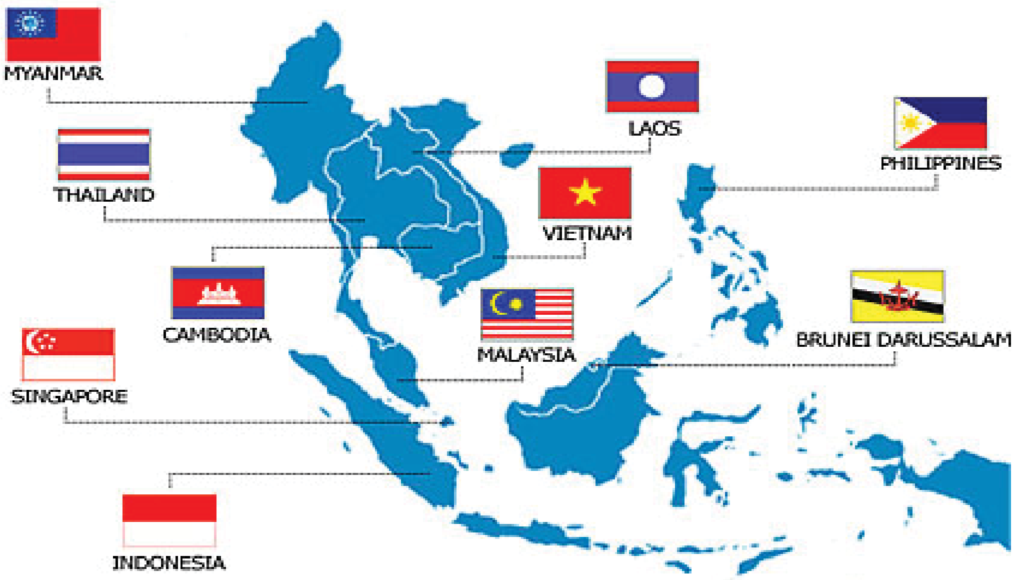
Thank you!







ASEAN – German Technical Cooperation



Participating Countries:
Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand and Vietnam

ASEAN – German Technical Cooperation
"Clean Air for Smaller Cities in the ASEAN Region"

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz

Objective

To equip participants with basic knowledge and information on air quality management and technical knowledge on air quality monitoring

3

ASEAN – German Technical Cooperation

giz

CLEAN AIR FOR SMALLER CITIES IN THE ASEAN REGION

- Local Solutions with Global Impact -

Yangon
Presentation to YCDC

20 February 2013

Roland Haas – GIZ
Principal Advisor/Project Director

ASEAN – German Technical Cooperation

Objective

Small and medium-sized cities are increasingly able to develop and implement measures to improve the air quality.

Indicators

- At least 10 cities (150,000 – 1.5 million inhabitants) have a Clean Air Plan (CAP)
- At least 7 cities are implementing CAPs.

Project Period

January 2009 – December 2015

Clean Air

- Ambient air quality monitoring involves the measurement of various air pollutants present in the air over a stretch of time (hours, days, months or years).

Parking Solution need in Yangon



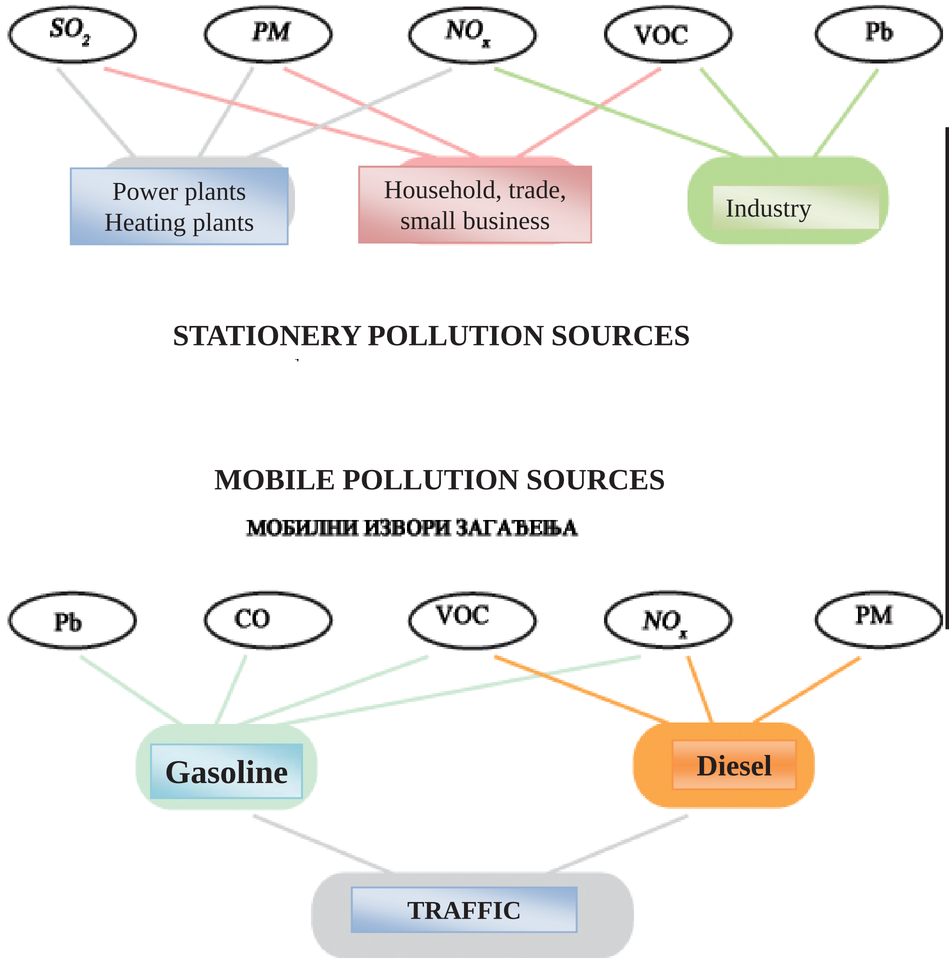

Automobile Growth in Yangon City

Sr	Year	Number of Vehicles(Ygn.)
1	2008	186,931
2	2009	194,087
3	2010	204,763
4	2011	215,893
5	2012(June)	279,096
6	2013 - November	319,211

Automobile import rate is more and more in Myanmar, mostly in Yangon

Main Air Pollutant Emissions From Vehicles

- Diesel Engines
  - Fine Particulate Matter (PM) – nearly all $PM_{2.5}$
  - Oxides of Nitrogen (NOx)
- Four-Stroke Gasoline / LPG / Natural Gas Engines
  - Carbon Monoxide (CO)
  - Oxides of Nitrogen (NOx)
  - Unburned Hydrocarbons (HC)
  - Smoky vehicles emit $PM_{2.5}$
- Two-Stroke Gasoline / LPG / Natural Gas Engines
  - Oil Particulate Matter ($PM_{2.5}$)
  - Unburned Hydrocarbons (HC) – very high!
  - Carbon Monoxide (CO)



Main Air Pollutants and their Emission Sources

(anthropogenic)

Further sources:

- open burning
- sports activities
- …….

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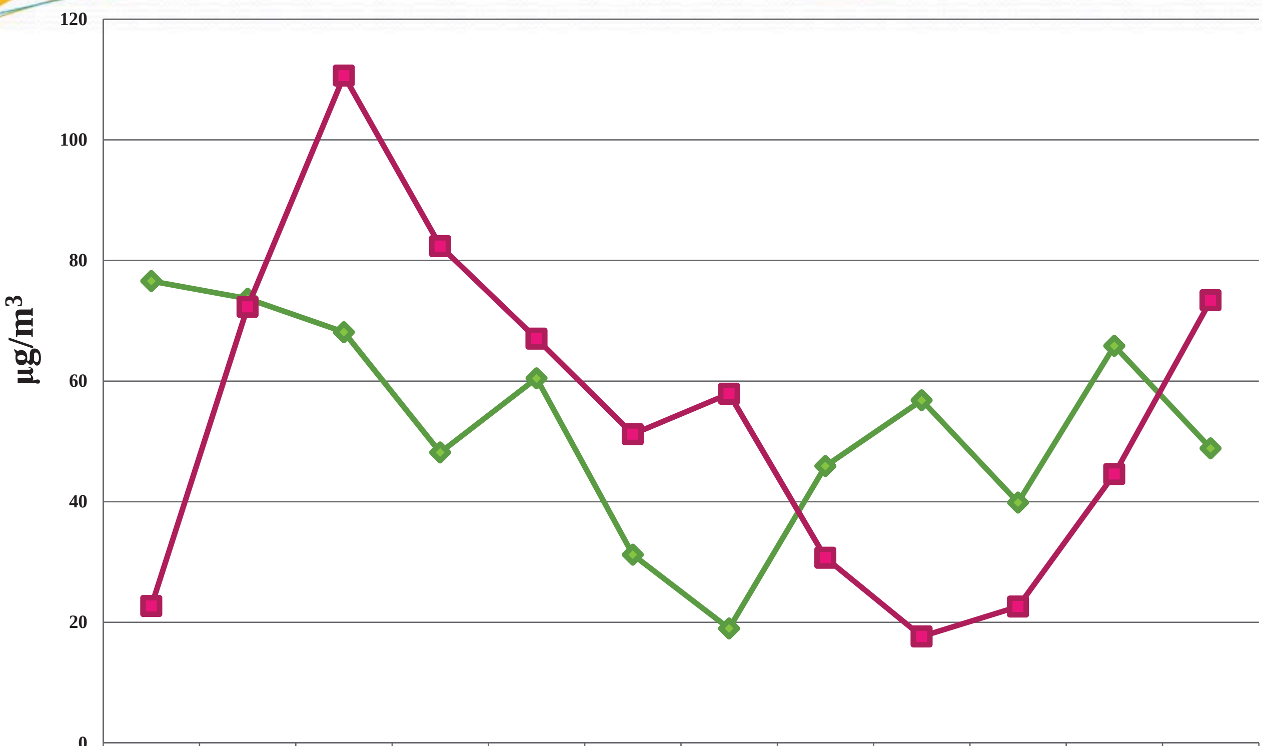
Air Quality Monitoring in 2012

- At 2012, ambient air quality was measured at Nay Pyi Taw and Yangon at our Occupational Health Division from January to December once a week.

12

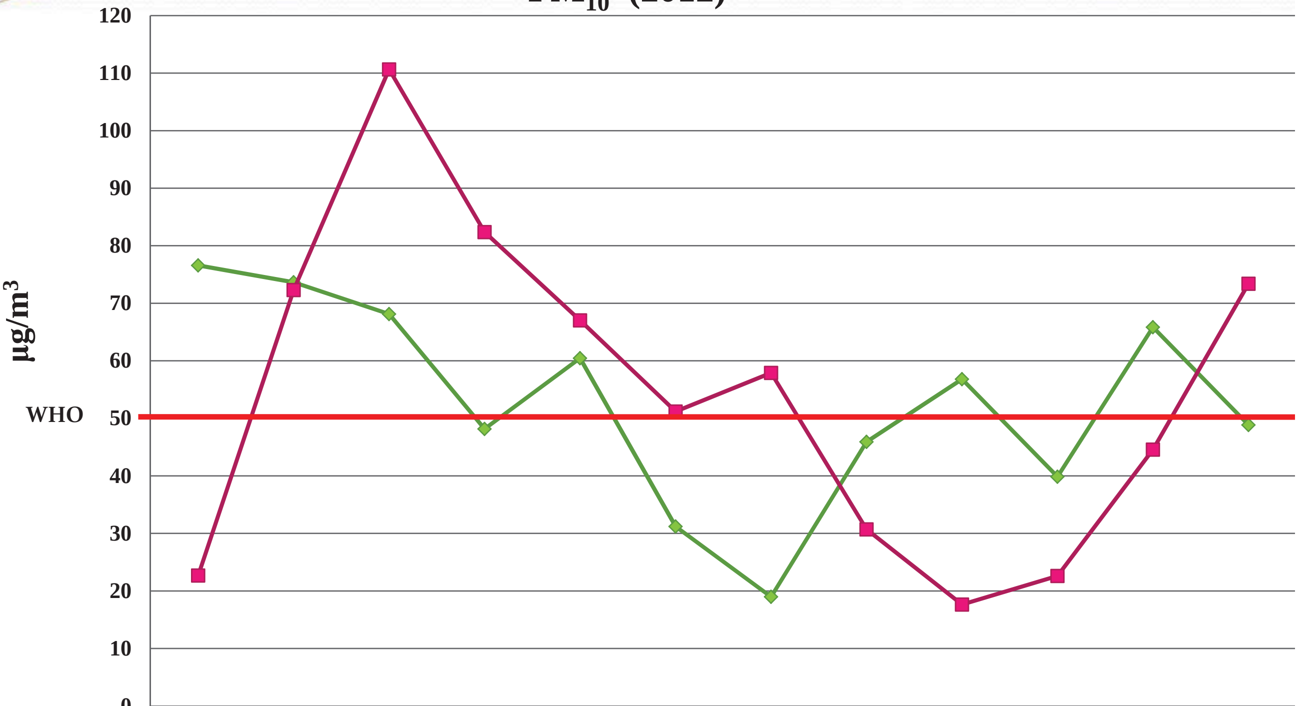
TSPM (2012)



	January	February	March	April	May	June	July	August	September	October	November	December
Yangon	76.58	73.66	68.12	48.17	60.46	31.21	18.98	45.92	56.82	39.86	65.84	48.85
Nay Pyi Taw	22.7	72.31	110.64	82.38	67.03	51.2	57.9	30.7	17.65	22.61	44.58	73.4

13

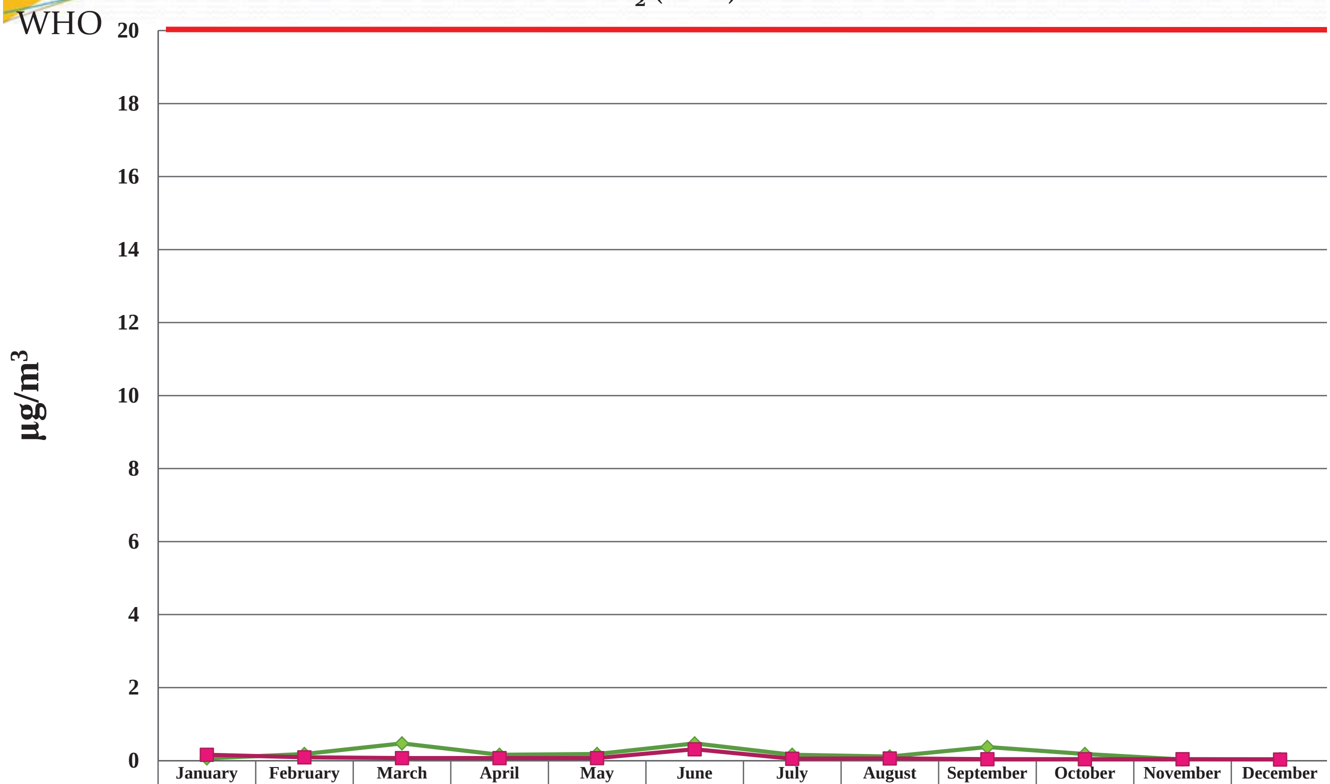
PM_{10} (2012)



	January	February	March	April	May	June	July	August	September	October	November	December
Yangon	76.58	73.66	68.12	48.17	60.46	31.21	18.98	45.92	56.82	39.86	65.84	48.85
Nay Pyi Taw	22.7	72.31	110.64	82.38	67.03	51.2	57.9	30.7	17.65	22.61	44.58	73.4

14

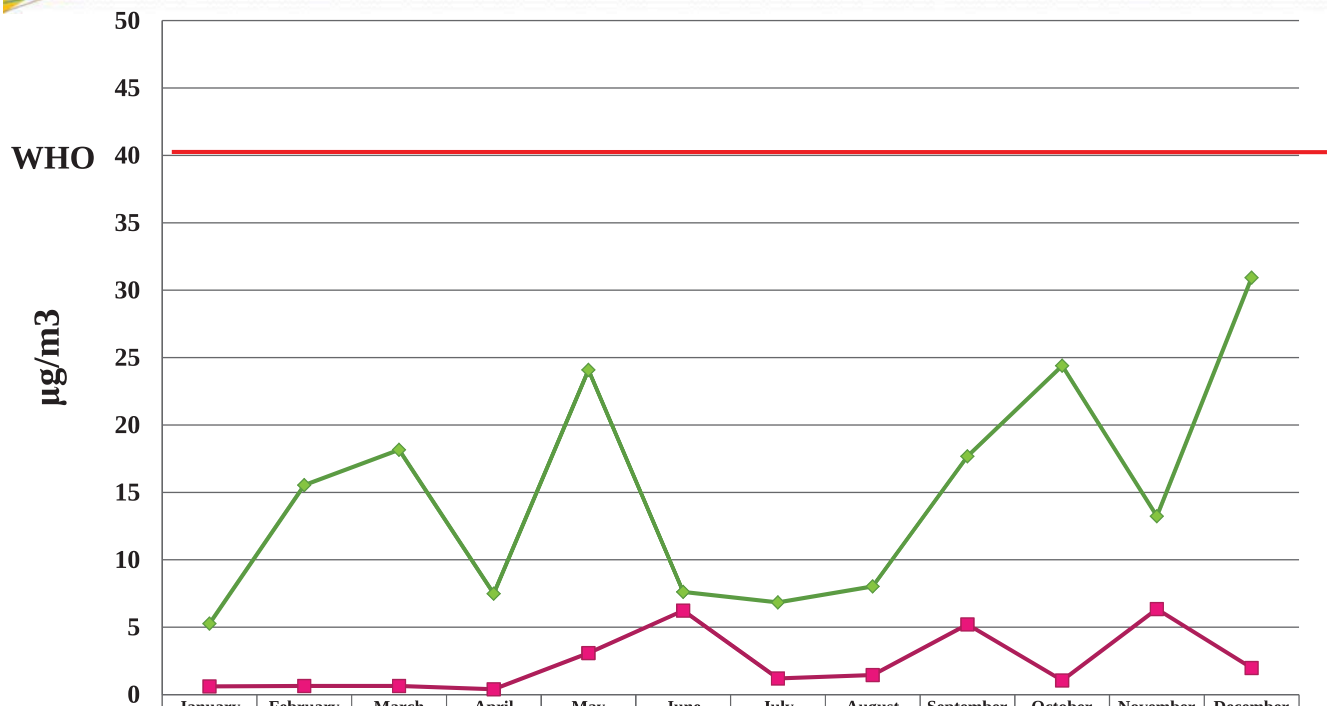
SO_2 (2012)



	January	February	March	April	May	June	July	August	September	October	November	December
Yangon	0.06	0.18	0.47	0.16	0.18	0.47	0.16	0.11	0.37	0.18	0.03	0.04
Nay Pyi Taw	0.16	0.09	0.07	0.07	0.07	0.31	0.05	0.06	0.04	0.04	0.04	0.03

15

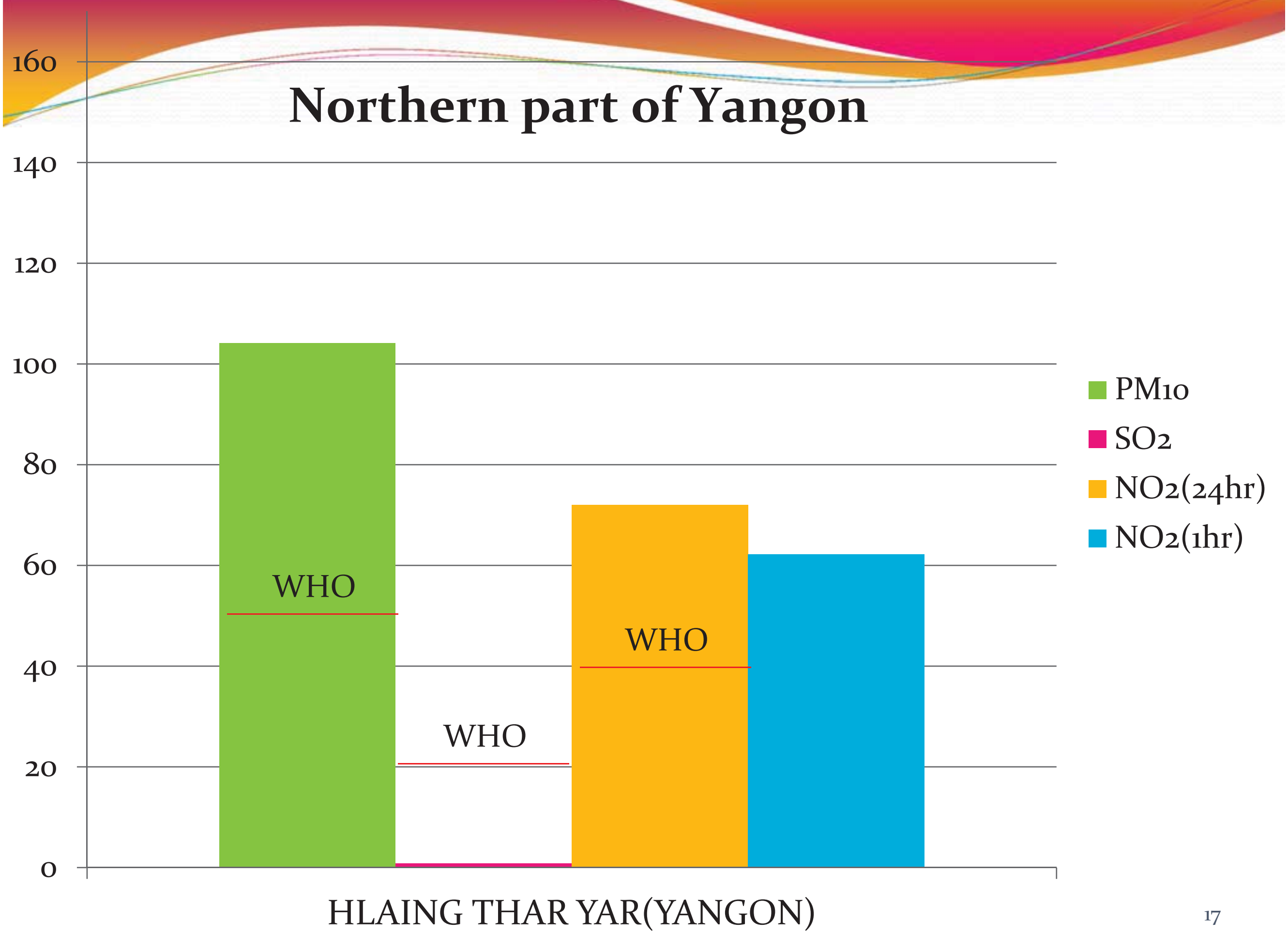
NO2 (24 hr) (2012)



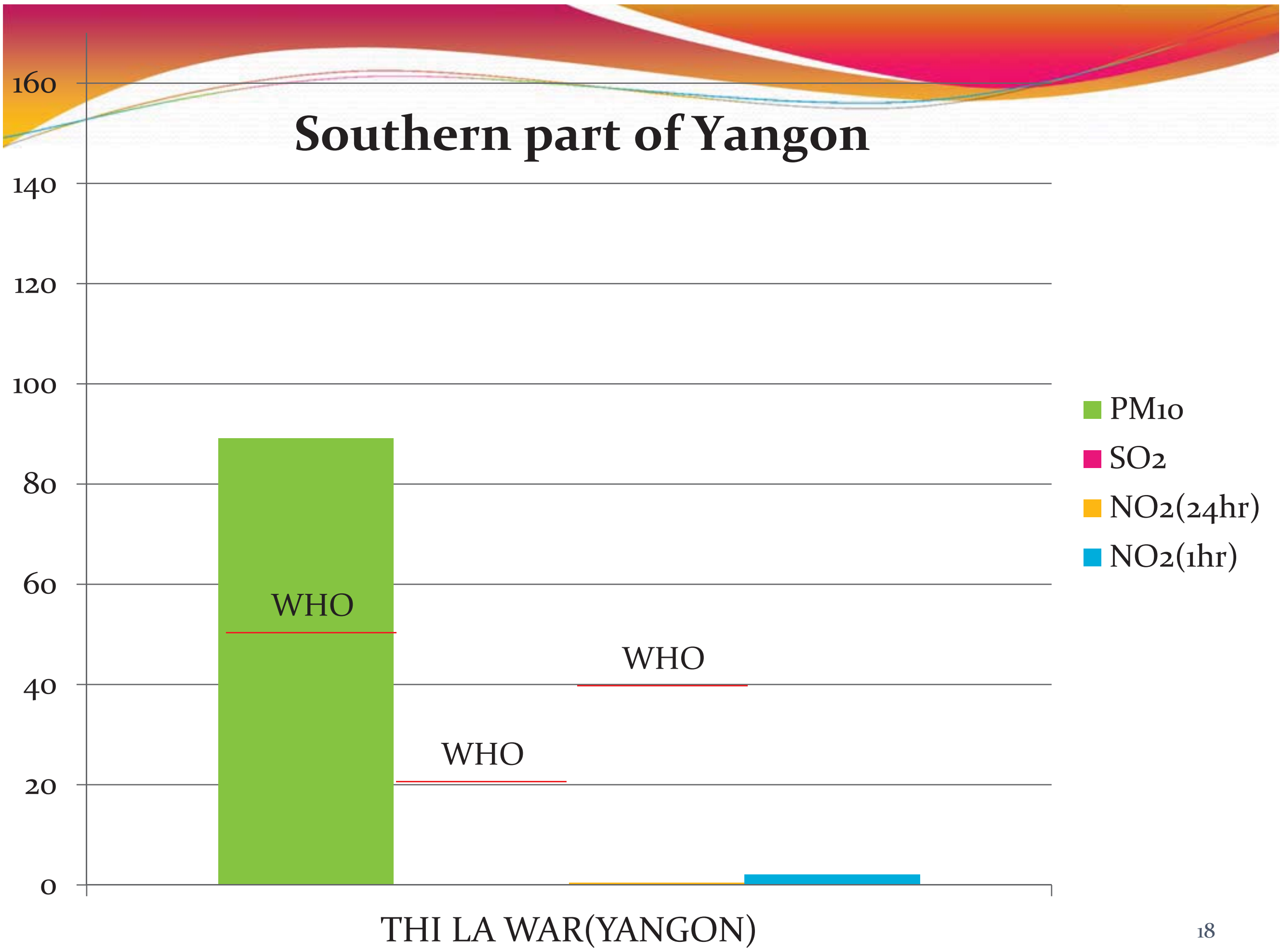
	January	February	March	April	May	June	July	August	September	October	November	December
Yangon	5.27	15.54	18.16	7.49	24.09	7.62	6.84	8.03	17.68	24.4	13.23	30.93
Nay Pyi Taw	0.61	0.64	0.64	0.4	3.08	6.23	1.2	1.45	5.21	1.05	6.35	1.98

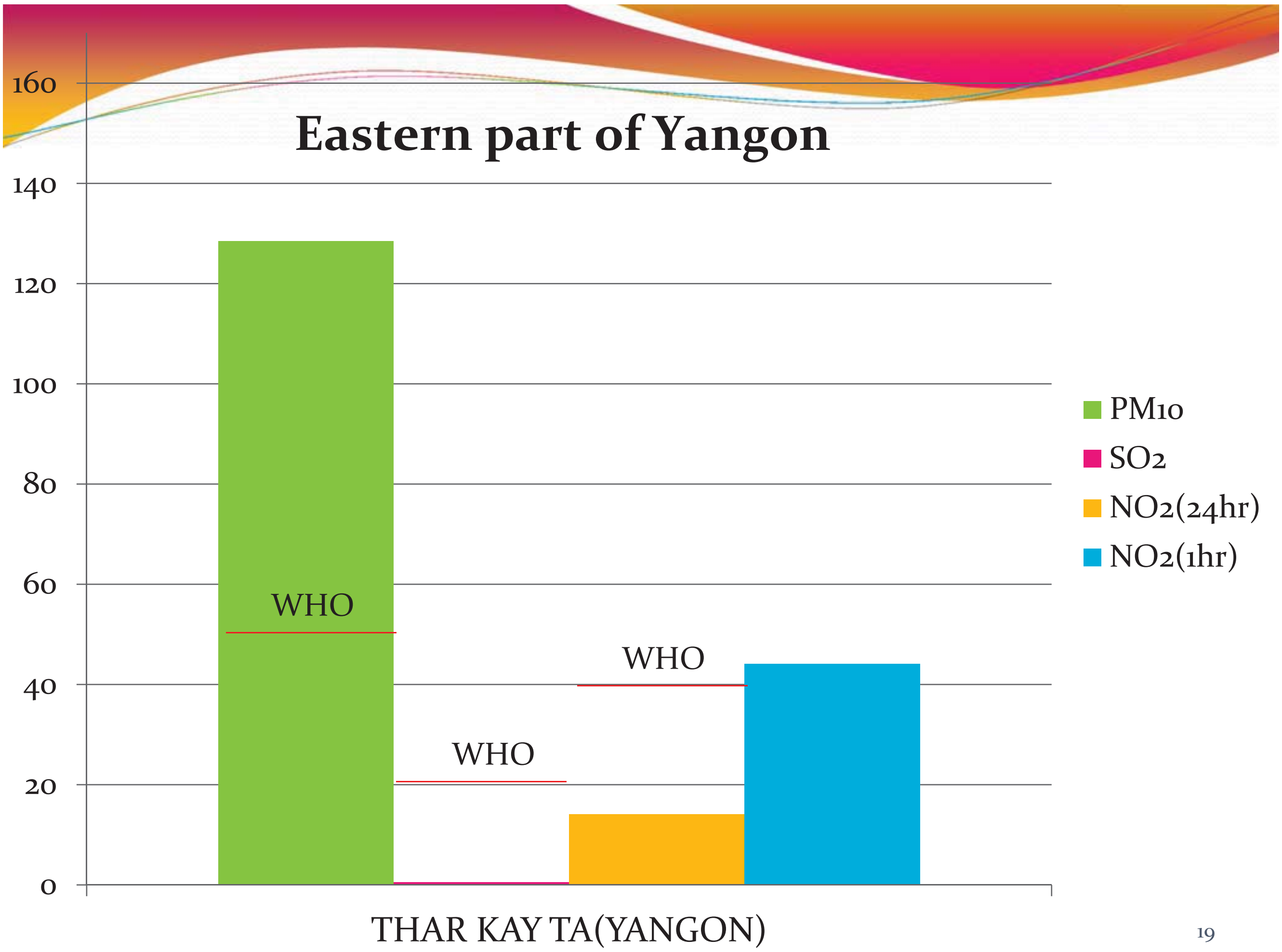
16

Northern part of Yangon



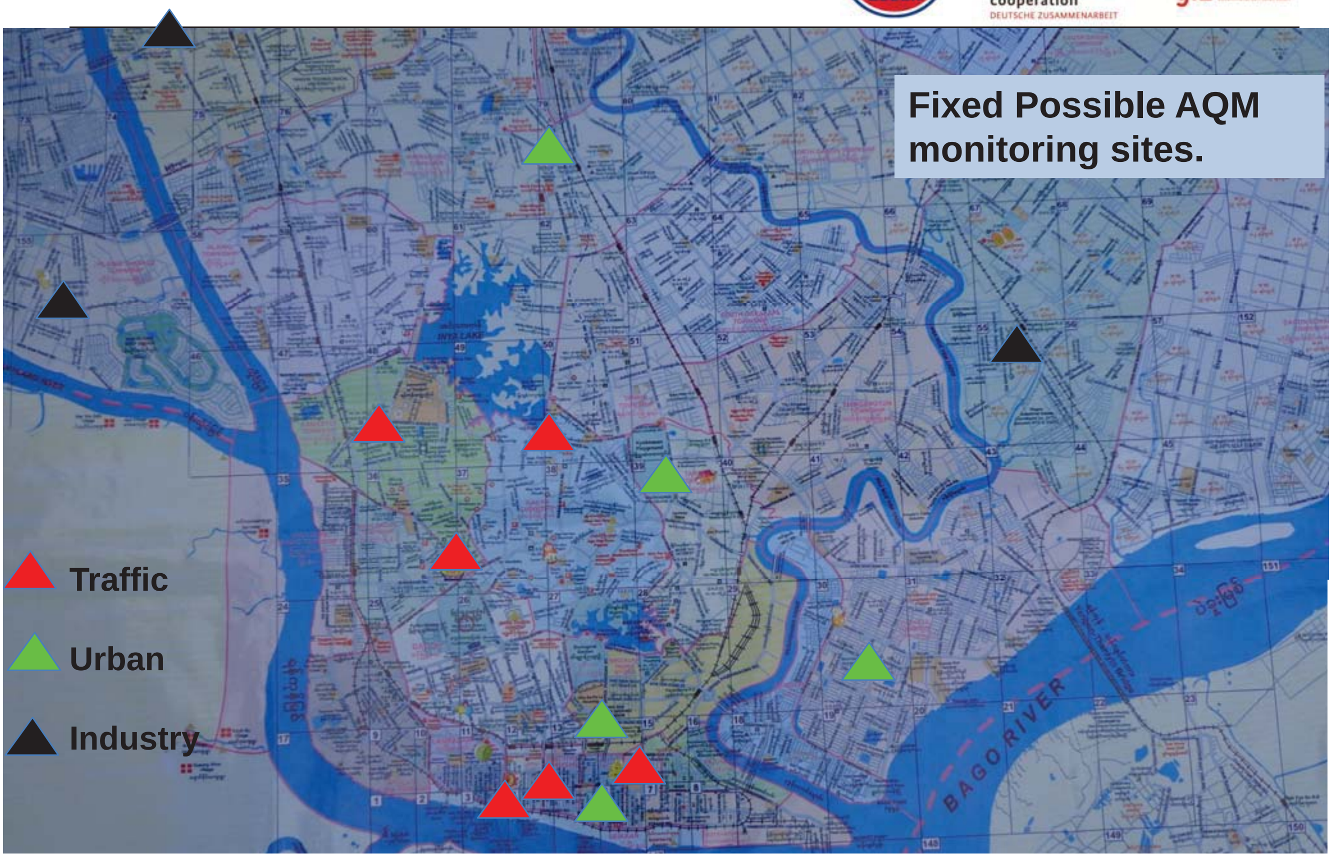
Southern part of Yangon





ASEAN – German Technical Cooperation

"Clean Air for Smaller Cities in the ASEAN Region"



To research and develop on E- Waste Management and information systems that can accelerate the implementation frame works of ASEAN, ASEAN + 3, AWGESC, UNFCCC and UNEP.

21

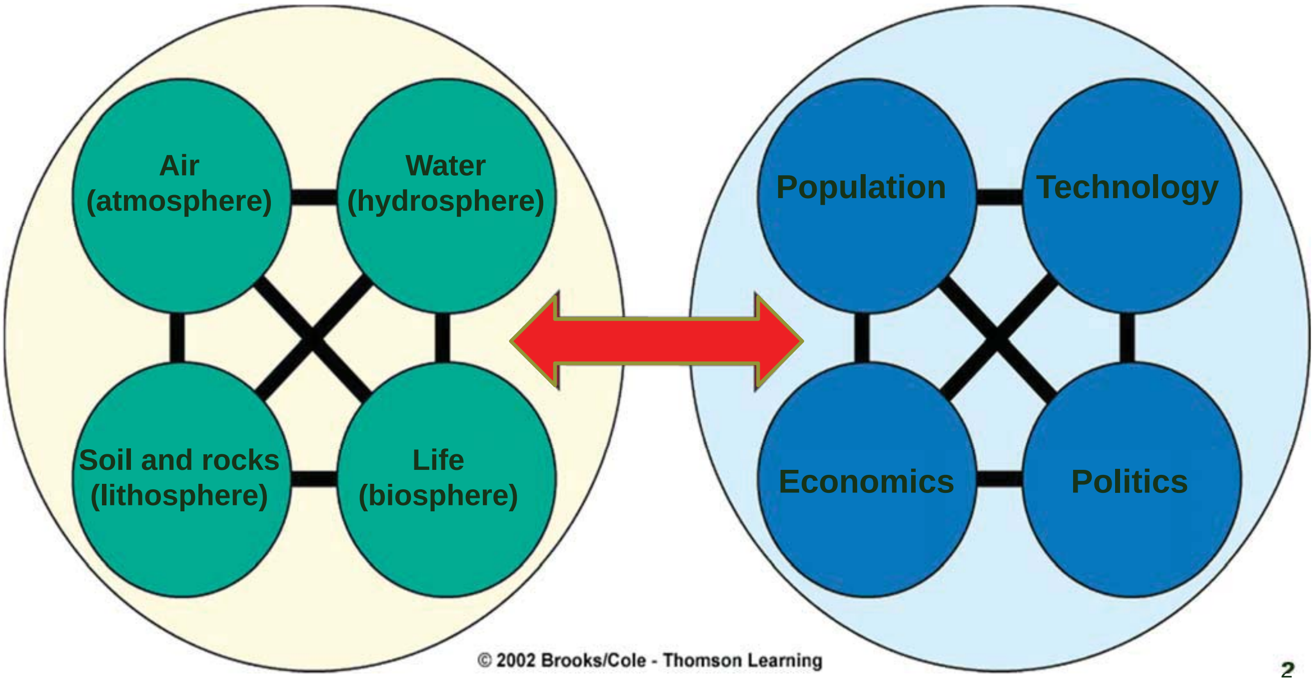
ASEAN – German Technical Cooperation

Cities, Environment and Transport in the ASEAN Region

1. Clean Air for Smaller Cities in the ASEAN Region – 7 (8) Countries - 2009 – 2015
2. Sustainable Port Development – 6 (7) Countries – 2009 – 2015
3. Energy Efficiency and Climate Change Mitigation in the Transport Sector – 5 Countries 2012 - 2015

Environmental Interactions

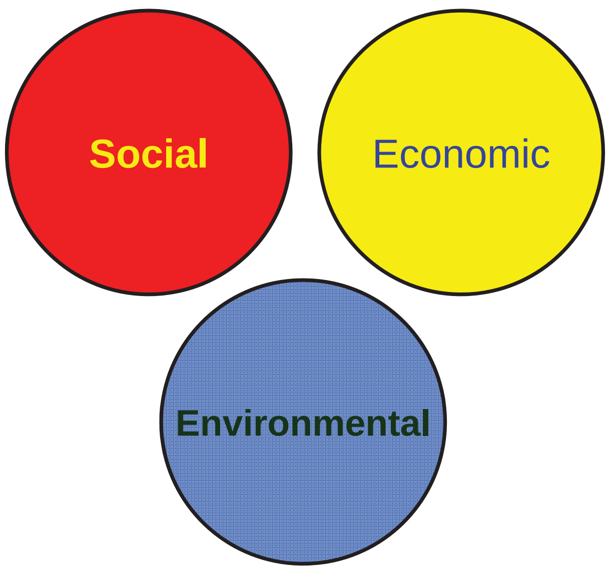
Earth's Life-Support System | Human Culture Sphere



23

Environmentally-Sustainable Economic Development

Globalization: An Integrated World



Traditional Decision Making

Decision Making in a Sustainable Society

24

Key finding of Clean Air

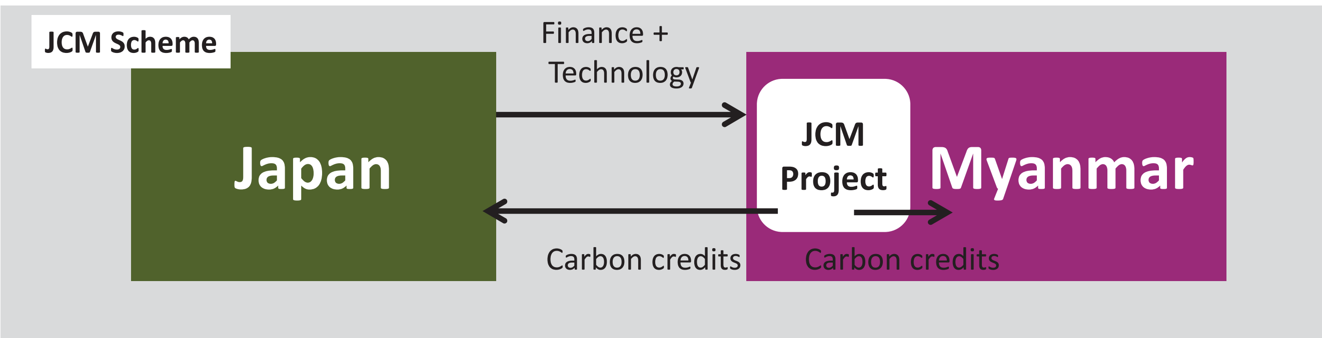
- Weakness of Law, Rules and regulation
- Research and development in AQM
- Capability Building of AQM
- Advanced Technologies and Technology transfer
- Data Inventory
- Lack of the AQM Devices

25

Joint Crediting Mechanism and its opportunities for Myanmar

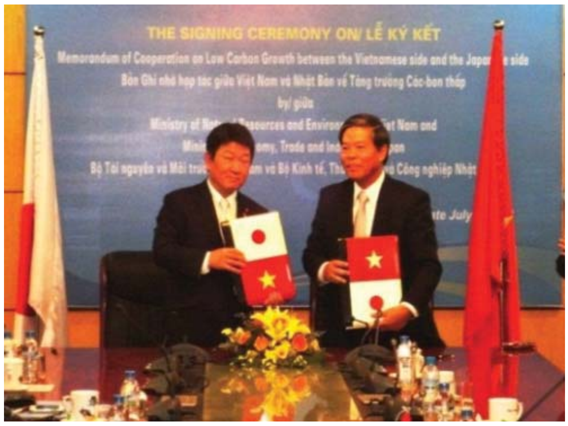
20 December 2013
Kenta Usui
Climate and Energy Area, IGES

How JCM works



Benefits to Japan
- Contribution to global GHG mitigation effort
- Market opportunities for Japanese firms

Benefits to Myanmar
- Advanced Japanese technology made available at significantly lower cost
- Contributes to greener growth
- Contributes to stabilise energy supply



JCM has been signed with 9 countries, including Bangladesh, Vietnam, Indonesia and Laos.

JCM-funded projects

Mongolia
- Introduction of energy-efficient heat boilers

Cambodia
- Small-scale biomass power generation using sterling engine

Vietnam:
- High-efficiency heat pumps in seafood processing

Bangladesh:
- Coal-free brick making

Indonesia
- Introduction of energy-efficient industrial air conditioner
- Energy use improvement in retail shops
- High-efficiency freezers

Possible JCM projects in Myanmar

Currently being studied

- Waste-to-Energy power generation (JFE Engineering)
- Microscale hydropower generation (Seabell International)
- Geothermal power generation (Nippon Koei)
- Solar-diesel hybrid power generation system (Hitachi Zosen and Mizuho Bank)
- Rural electrification using off-grid energy supply (IGES-TERI)

Other possible projects

- Landfill methane recovery
- Composting
- Wastewater treatment
- Transport
- Energy efficient buildings

International workshop on sustainable waste management in Yangon

ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT:
BUILDING LOCAL CAPACITIES ON SOLID WASTE MANAGEMENT IN MYANMAR

DECEMBER 2013

Partners

CITTA' DI TORINO

In collaboration with

amiat

cesvi

Donors

Cooperazione Italiana allo Sviluppo
Ministero Affari Esteri

This project is funded by the European Union

ပတ်ဝန်းကျင်ကာကွယ်ရေးနှင့် ရေရှည်တည်တံ့သော ဖွံ့ဖြိုးတိုးတက်မှု:
မြန်မာပြည်တွင် စွန့်ပစ်ပစ္စည်းစီမံခန့်ခွဲမှုအား ဒေသတွင်းစွမ်းရည်မြှင့်တင်ခြင်း

Partners

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Cooperazione Italiana allo Sviluppo
Ministero Affari Esteri

This project is funded by the European Union

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Dry and wet solid waste are not separated
Missed opportunity to produce compost

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Recycling can be improved and become more profitable

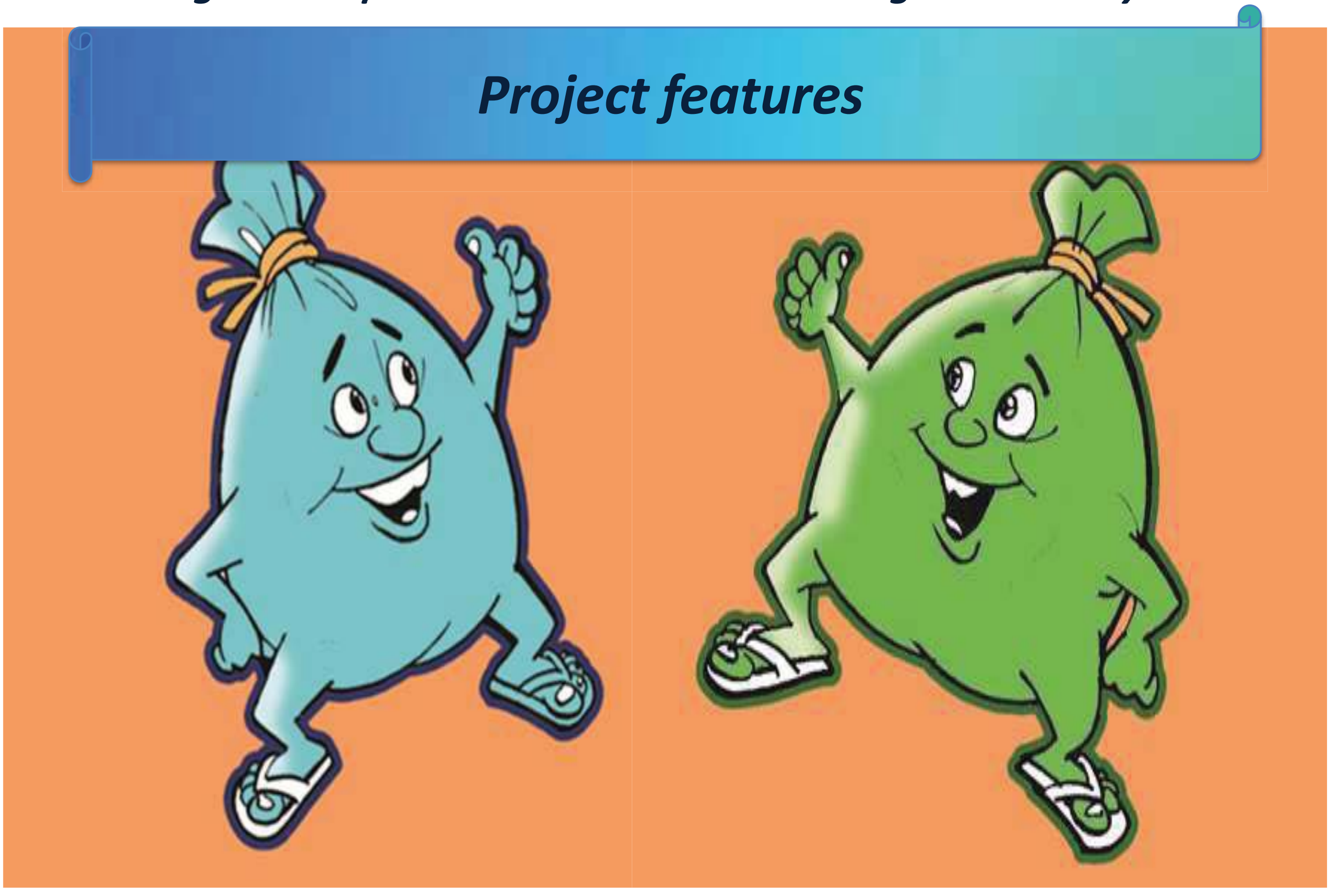
Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Appropriate technologies can strengthen the efficiency of SWM

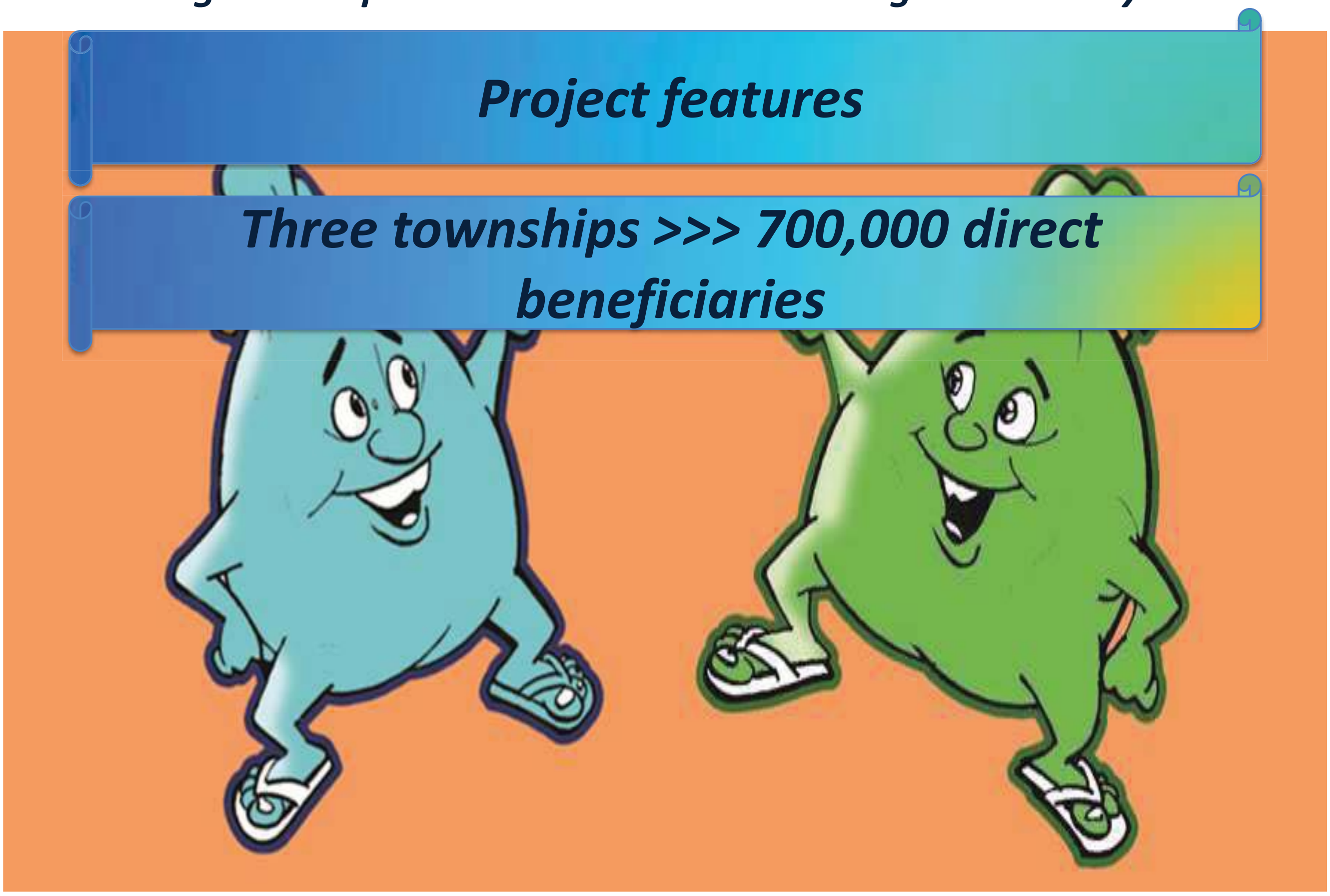
Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Increase the awareness of the citizens on best practices in SWM helps SWM

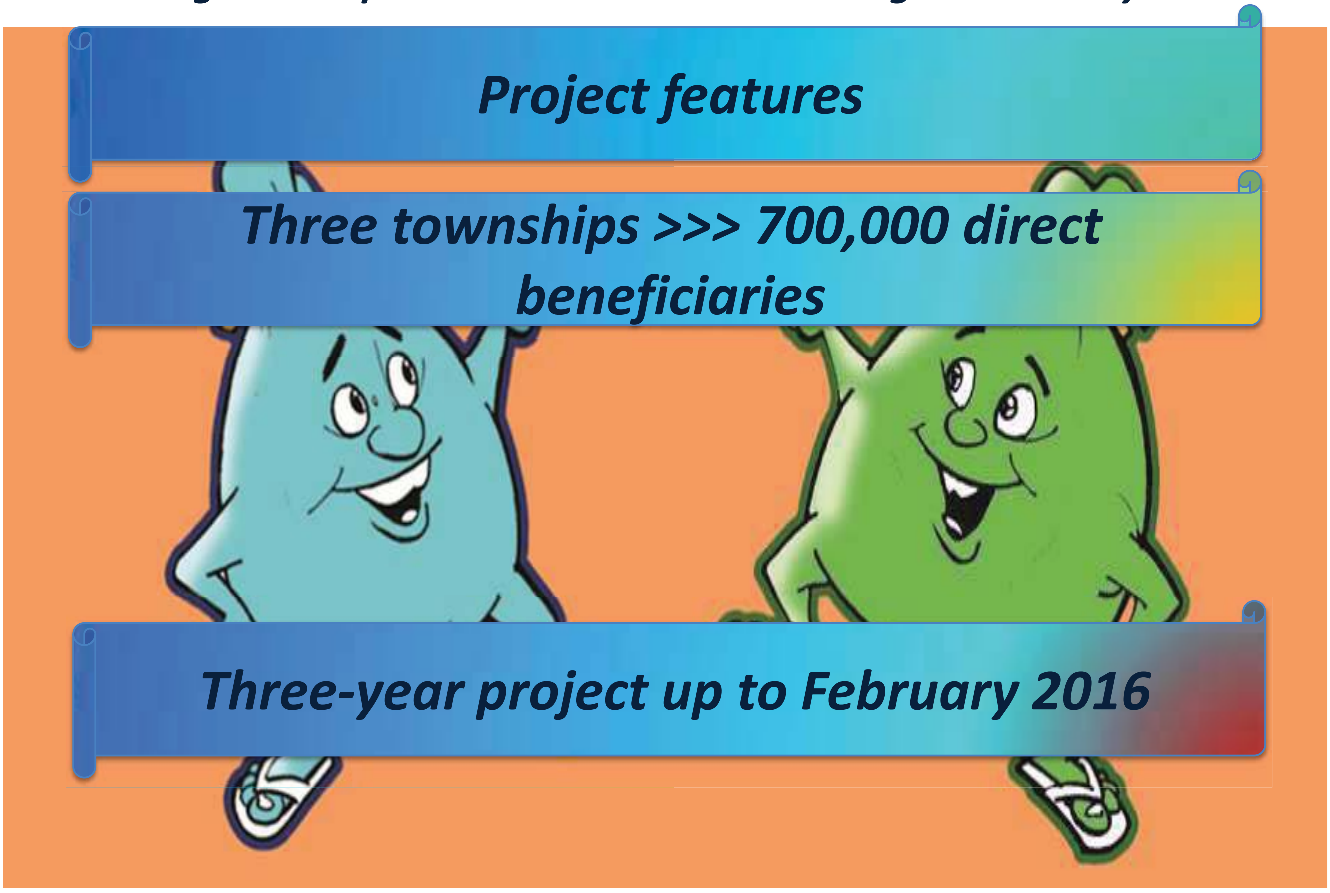
Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar



Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar



Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar



Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Global framework

Population increase

Wealth increase

Need for increased capacity in SWM

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

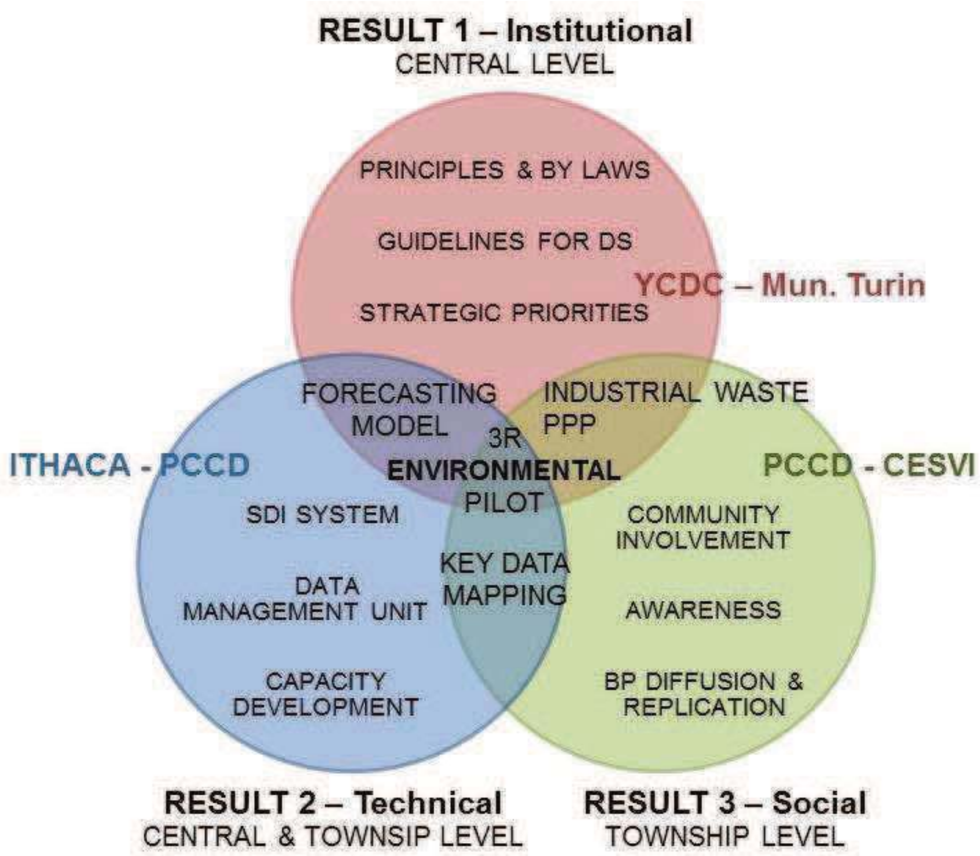
Project components

Strengthening institutional and technical capacities of PCCD on environment quality management

Developing an information system for SWM in Yangon

Increasing community awareness of the value of SWM

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar



Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Participatory drafting of guidelines to detail existing long term strategy and to improve existing Solid Waste management

Exposure visits of key officers PCCD to best practices on identified topics of SWM

Design of Database and Forecasting model

Provision of equipment, training and technical assistance on data collection, management (and digitalization), reporting and forecasting

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Awareness campaigns on protection of the environment and SWM best practices

Value chain and market analysis of recycled materials

Value chain and market analysis of green compost

Pilot working groups, set up of support system (training and start up materials) for pilot project implementation on SWM

Training to the Industrial Zone Committees in ISWM practices

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

- **OWNERSHIP**
- **INVOLVING COMMUNITIES**
- **MULTI-STAKEHOLDERS APPROACH**
- **LEARNING BY DOING and TOT**
- **INNOVATION**
- **REPLICATION OPPORTUNITY**

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Solid Waste Management

Environmental protection and sustainable development: building local capacities on solid waste management in Myanmar

Partners

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In collaboration with

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Cooperazione Italiana allo Sviluppo
Ministero Affari Esteri

ITHACA

cesvi

This project is funded by the European Union

Presented by Gaetano ROMANO, Project Operational Coordinator, MA.Eng, Adv.St IWRM

myanmar.wash@cesvioverseas.org

6. 能力構築

2014 年 2 月 24 日～31 日にかけてヤンゴン市開発委員会汚染管理清掃局から職員を日本へ招聘し、日本自治体との政策対話、先進施設の見学、連絡会への参加等を行った。これにより日本の政策、技術に対する理解を深めた。

6.1 訪日研修概要

（1）日本政府環境省への表敬訪問

(2) 練馬区、川崎市等自治体との面談

(3) 上記自治体の管轄する地域における廃棄物関連施設の視察

(4) IGES の運営するミャンマー連絡会を通した、民間企業等とのバイ会談

(5) IGES におけるセミナーの開催

招聘者：ヤンゴン開発委員会（YCDC）汚染管理清掃局（PCCD）職員 2 名

（1）U Ko Ko Kyaw Swar, Divisional Head of Pollution Control and Cleansing Department

（2）U Khin Ohn Thein, Sectional Head of Pollution Control and Cleansing Department

日程：2014 年 2 月 24 日（月）—　3 月 1 日（土）

日時	日程・訪問先
2 月 24 日（月）	東京着
2 月 25 日（火）	環境省　国際協力室・廃棄物リサイクル部等訪問 第３回ミャンマー連絡会参加
2 月 26 日（水）	施設訪問・自治体面談（東京都練馬区）
2 月 27 日（木）	施設訪問・自治体面談（川崎市）
2 月 28 日（金）	IGES におけるインハウスセミナー
3 月 1 日　（土）	東京発、帰国

6.2　訪日研修記録

訪日研修総括 日時：2 月 28 日　11:00-12:15 参加者　：ヤンゴン市職員二名、碓井研究員

訪日研修に関するアンケートという形で、議論しながらパワーポイントに書き出していく作業を行った。ヤンゴン市側による主な感想と、それらに対する評価（本研修をコーディネートした碓井研究員による）は以下のとおり。

・練馬区での研修が最も良かった。職員の職業意識は非常に高く、地域や学校等での普及啓発活動も非常に良い。

→ヤンゴン市側職員が廃棄物収集の担当者であることもあり、同様の活動を行っている練馬区の活動は特に有用だったと思われる。また、朝早くから実際の収集現場に同行したことも非常に良かった。

・廃棄物発電は、最終処分場への体積を減らし、発電もできるため有用。

→ヤンゴン市がすでに廃棄物発電導入を決めていることもあり、廃棄物発電への関心は非常に高い。

・日本とミャンマーではごみの組成に大きな違いがあり、リサイクルにも影響を及ぼす。日本では容器に入った食品が多く売られているためプラスチックゴミが多く、これをリサイクル可能である。対してヤンゴンでは有機廃棄物（台所ゴミ、木の葉、草等）が多く、これらのリサイクルは困難であり、悪臭も放つ。

→正しい理解であり、有機廃棄物の有効利用を考える必要がある。

日本には不法投棄がなく、定められた場所にゴミがされているため、街は非常に清潔である。ヤンゴンでは小川や小道、鉄道路線の脇などにゴミが投棄されていることが多く、収集が困難である。

→日本でも不法投棄がないわけではないが、ヤンゴンにおいてゴミが衛生問題としても重要であることを再確認。

日本では廃棄物管理に十分な予算がついているが、ヤンゴンではそうではない。例えば一つの Township では車は 30 台必要なところが、9 台しかない。対して練馬区は 150 台の車両を使っている。民間企業や国からの資金が入っている。

→「民間企業」に対する考え方に若干の誤解がみられる。ヤンゴン市は、民間に任せれば市の負担は減り、様々なことがうまくいくようになると考える傾向にあるようだ

が、日本の場合、自治体が廃棄物管理にかかる費用を民間企業に支払っていることを十分に理解していない可能性がある。

→予算の不足とそれに伴う運搬車両の不足が、収集担当車にとって最も大きな課題のようである。

IGES 研究員との意見交換

日時：2 月 28 日　13:00-14:00
参加者　：ヤンゴン市職員二名、大塚副所長、IGES　佐野バンコク事務所長、King 上級アドバイザー、吉田タスクマネージャー、十時研究員、Manikupura 研究員、碓井研究員

ヤンゴン市職員から、ヤンゴンにおける廃棄物管理の現状についての発表があり、IGES 研究員との議論が行われた。

質疑応答

（IGES）ヤンゴン市は、有機廃棄物の利用については関心があるか。

→（ヤンゴン市）コンポスト等の取り組みを行っている。

・（IGES）東京都ですら、廃棄物発電の電力の殆どは焼却炉自体で消費する。さらにこれは、プラスチック等熱量の高いゴミが多い日本での事例である（横浜ではプラスチックゴミが 36%）。ヤンゴンにおいて有機廃棄物が多いはずであり、水分も多く、燃焼カロリーは低いと考えられる。廃棄物発電の発電量については慎重に検討する必要がある。

・（ヤンゴン市）最終処分場での分別も考えている。最終処分場には多くのスカベンジャーがいる。

→（IGES）最終処分場での分別は難しい。リサイクル可能なものがあっても輸送の過程で汚れてしまうなどするため、リサイクルしにくい。メタンガス等も含めた最終処分場での廃棄物発電はあり得るかもしれない。

Toward the 3R-oriented society

—Advantage of Source Separation and Separated Collection—

Mr. Sho Okuno
Sanitation and Recycling Business Department,
Nerima City

1

Contents

2

1. Overview of Nerima City

3

1 Overview of Nerima City

The profile of Nerima City

- Population 709,262 people
  As of January 1, 2013
  (Foreign residents make up 12,740 of the total)
- Number of households 344,228
  As of January 1, 2013
- Area 48.16 km^2
- Amount of waste 498 t/d
- Features
  - Located in the central area of Tokyo but full of greenspace
  - Residential area
  - Population increasing slightly

4

The view of Nerima City

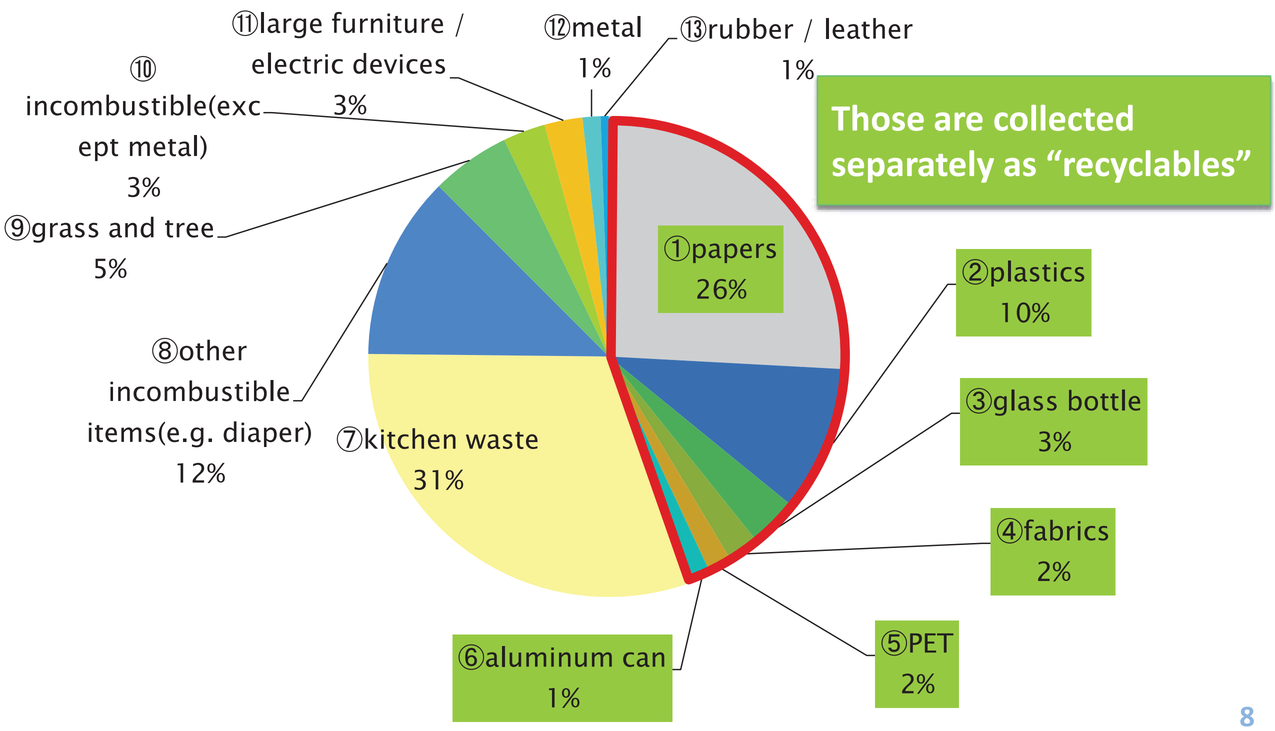
View from the Hikarigaoka Incineration plant

Taken the view of the Hikarigaoka Incineration plant from the city hall

2. Significance of Source Separation and Intermediate treatment

2 Significance of Source Separation and Intermediate Treatment

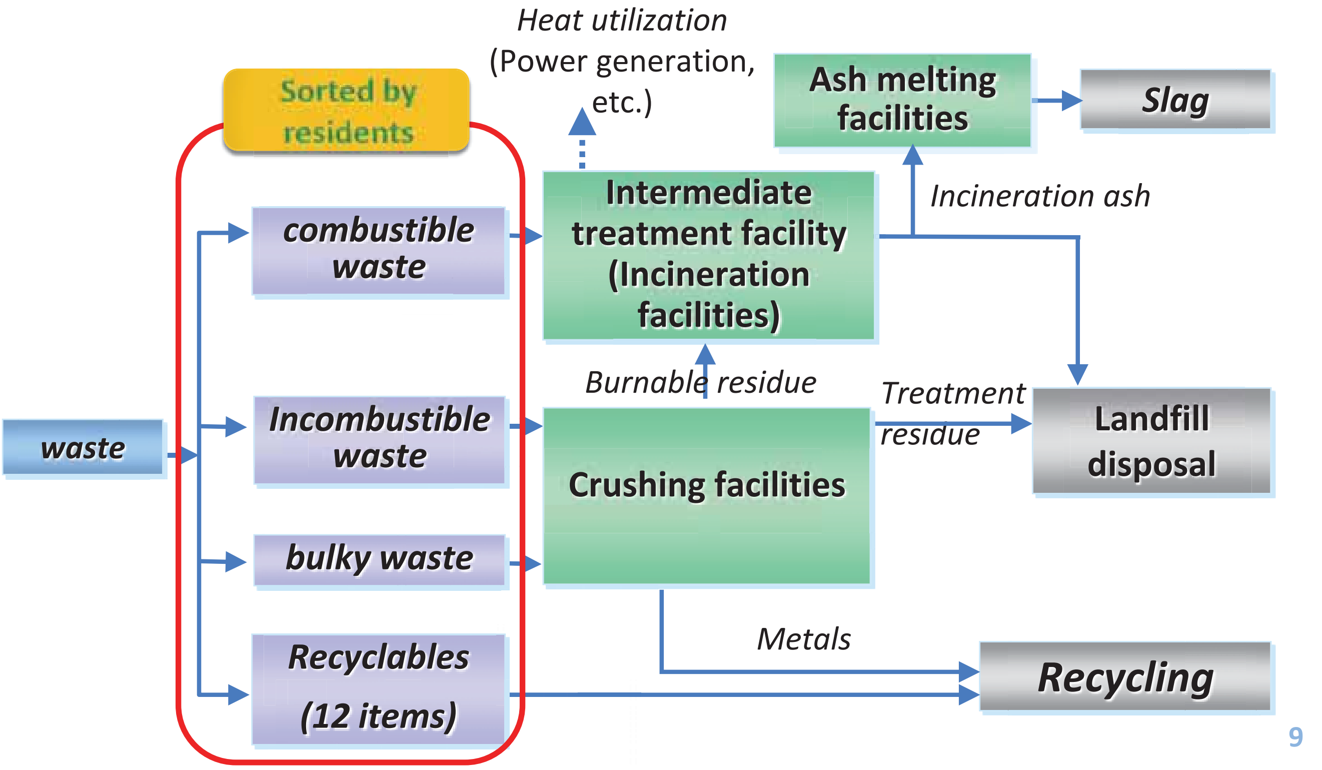
Waste Composition Ratio



8

2 Significance of Source Separation and Intermediate Treatment

Flow of Waste Treatment (Overview)



9

2 Significance of Source Separation and Intermediate Treatment

How to tackle the problem against the lack of space for landfilling

(1)Source separation (for reuse and recycling)

- Zero landfill is available because recyclables is not dumped
- Save for natural resource is possible because recycled material replaces.

(2)Incineration treatment is efficient

- Can reduce to 1/20 of volume
- Ash can also be recycled
- Can treat hygienically

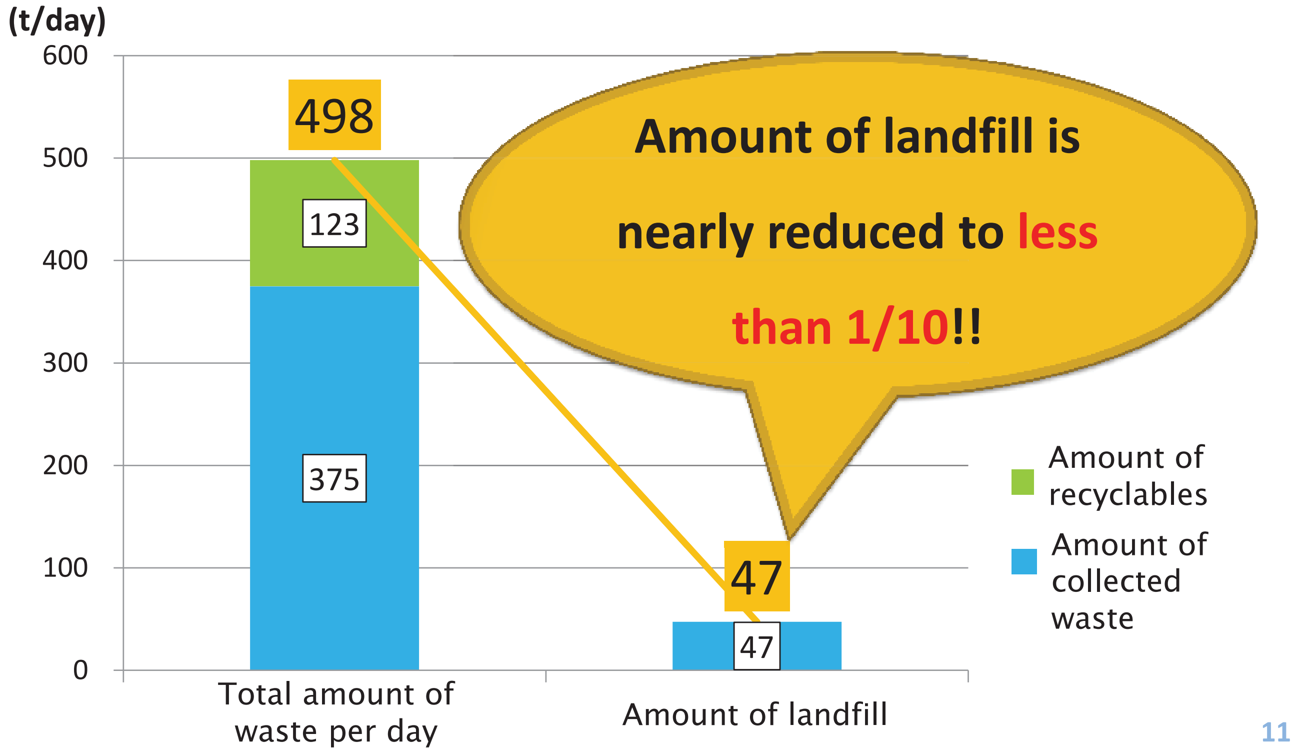
Not all things can be incinerated

- Items unsuited to incineration
- Large items

10

2 Significance of Source Separation and Intermediate Treatment

Advantages of Source Separation, Separated Collection and Intermediate treatment



11

2 Significance of Source Separation and Intermediate Treatment

Source Separation of "RECYCLABLES"

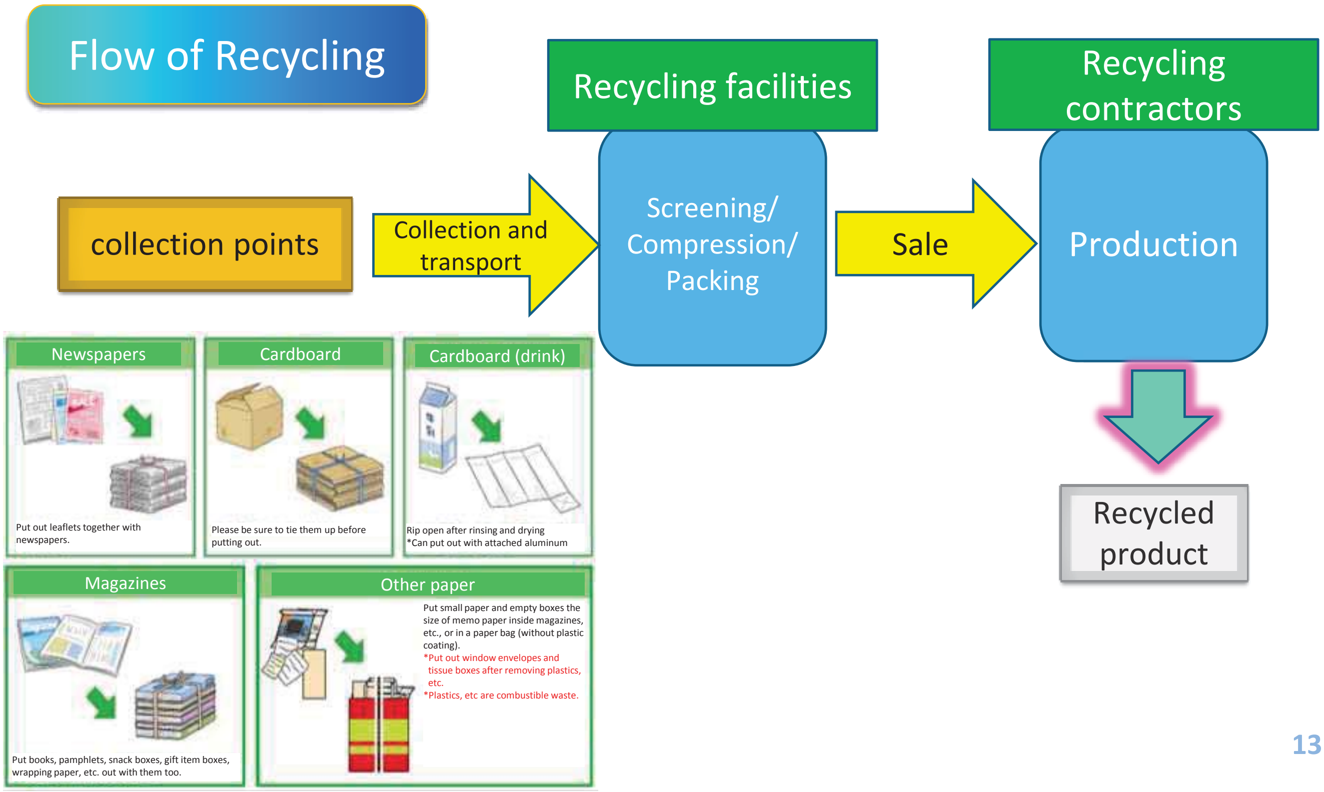
(In the case of Nerima city)

	Categories	Recovery locations	Amount of recyclables 2012
(1)	Newspapers	waste collection points (Approx. 30 thousand locations)	4,273 t
(2)	Magazines		6,216 t
(3)	Cardboard		6,152 t
(4)	Cartons		67 t
(5)	Plastic Packaging and Containers		5,275 t
(6)	Bottles	Collection points (Approx. 12 thousand locations)	5,359 t
(7)	Cans		2,060 t
(8)	PET bottles		1,987 t
(9)	Used clothes/Old fabric	Public facilities	507 t
(10)	Used edible oil		19 t
(11)	Small household appliances		2 t
(12)	Used dry-cell batteries	Public facilities + shops&retailers	27 t

12

2 Significance of Source Separation and Intermediate Treatment

Recycling Flow of “Recyclables” (1)Waste Paper



13

2 Significance of Source Separation and Intermediate Treatment

Collection Points (1)Waste Paper

14

2 Significance of Source Separation and Intermediate Treatment

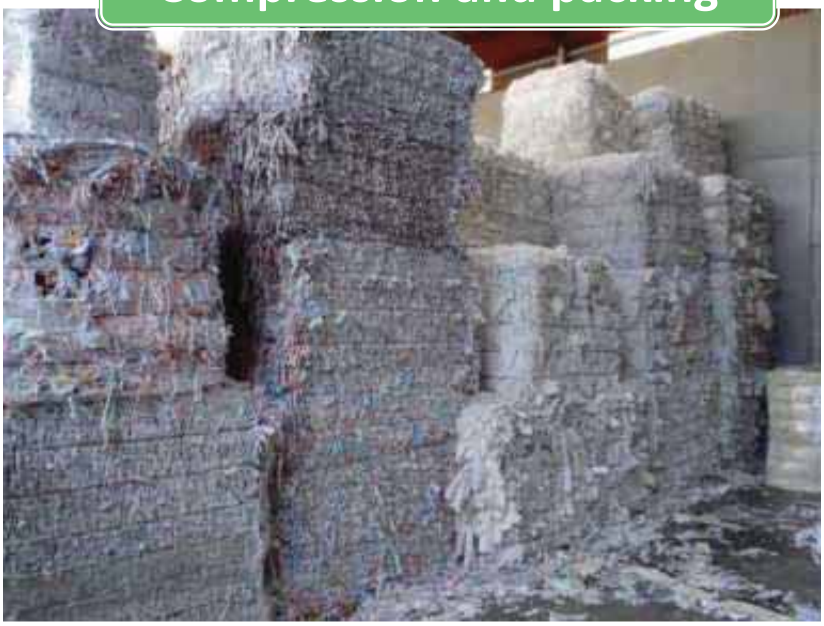
Collection and Transport
(1)Waste Paper

15

2 Significance of Source Separation and Intermediate Treatment

Recycling
(1)Waste Paper

Compression and packing



Recycling

Recycled product

16

2 Significance of Source Separation and Intermediate Treatment

Recycling Flow of “Recyclables” (2)Plastic Packaging and Container

80% of plastics are plastic packaging and containers
Plastic packaging and container recycling routes are institutionalized by national law

Flow of recycling

Intermediate processing

Recycling contractors

waste collection points

Collection and transport

Screening/ Compression/ Packing

Consignment

Production

Recycling Recycle

17

2 Significance of Source Separation and Intermediate Treatment

Collection Points (2)Plastic Packaging and Container

18

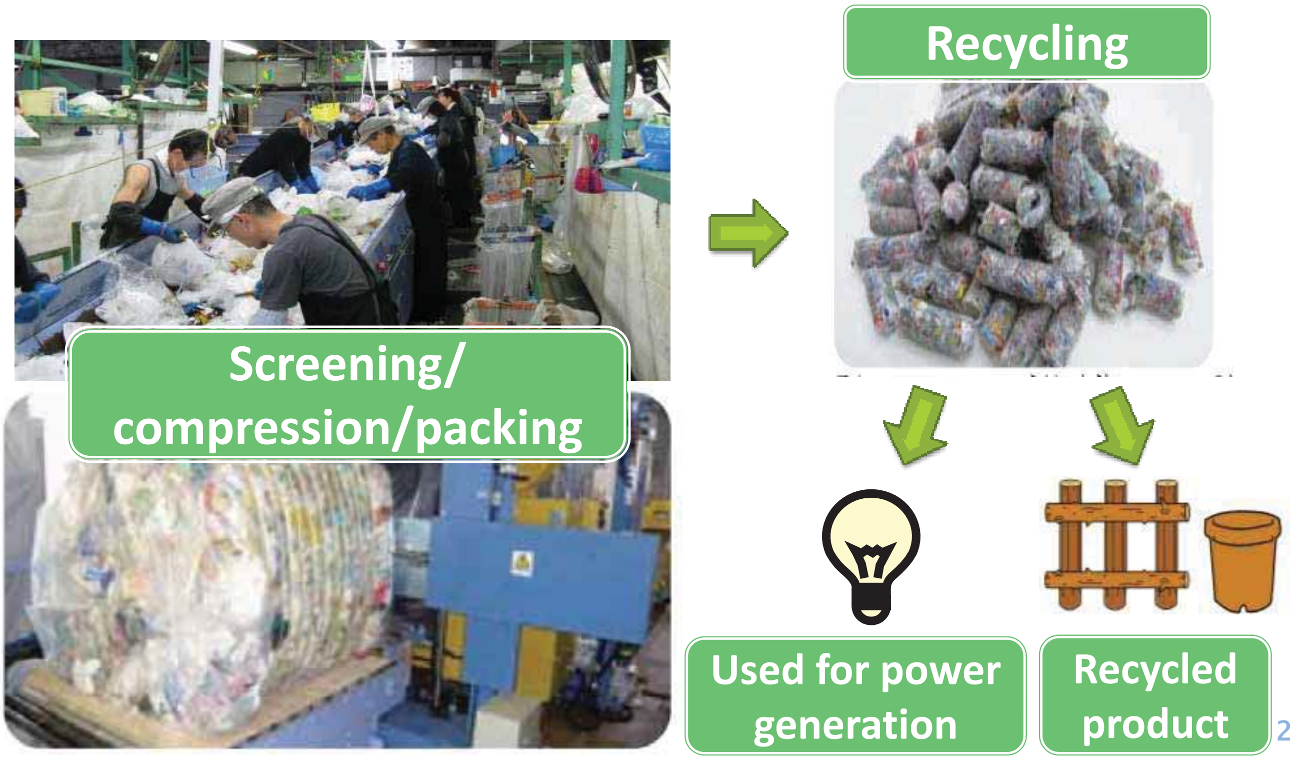
2 Significance of Source Separation and Intermediate Treatment

Collection and Transport
(2)Plastic Packaging and Container

19

2 Significance of Source Separation and Intermediate Treatment

Recycling
(2)Plastic Packaging and Container



20

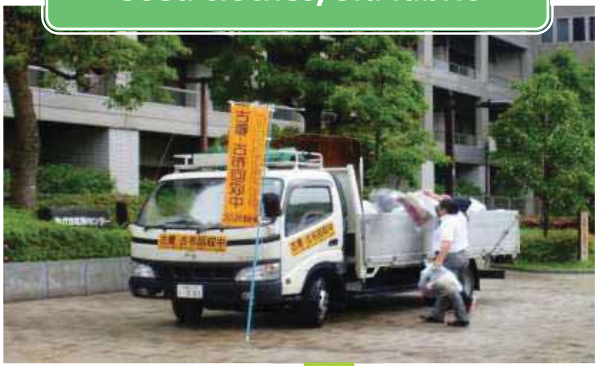
2 Significance of Source Separation and Intermediate Treatment

Other Cases of Recyclable Recovery

Bottles/cans/PET bottles

Recycle

Used clothes/old fabric



Reuse

21

2 Significance of Source Separation and Intermediate Treatment

Other Cases of Recyclable Recovery

Dry-cell batteries

Steel

Small household appliances

Metal

Waste edible oil

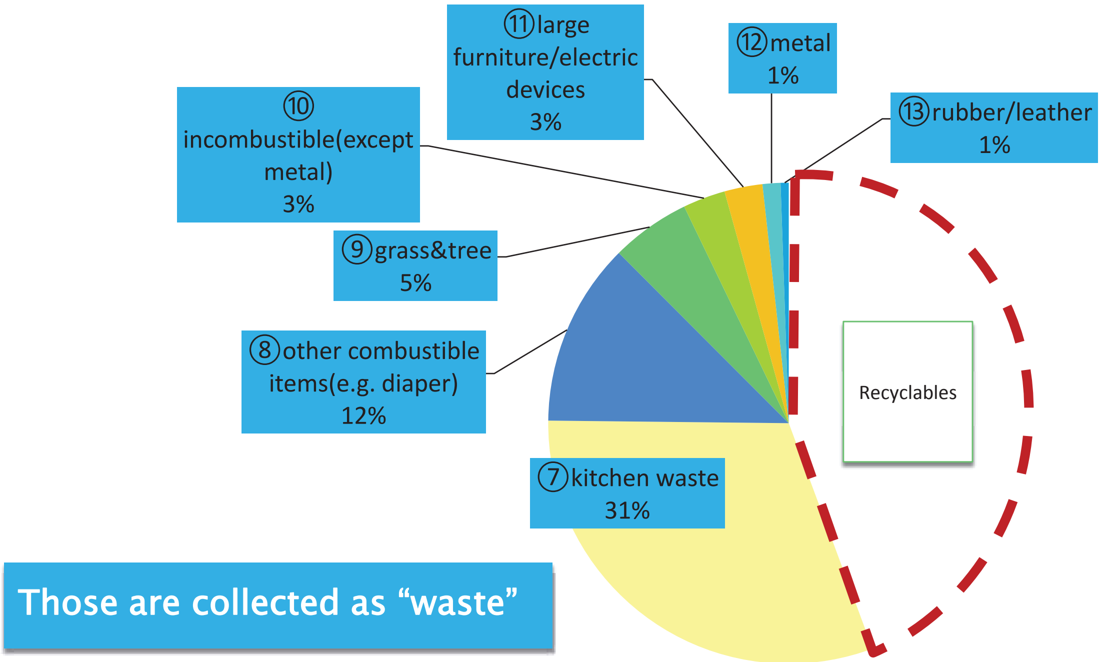
Bio Diesel Fuel

22

2 Significance of Source Separation and Intermediate Treatment

Source Separation of "WASTE"

(In the case of Nerima city)



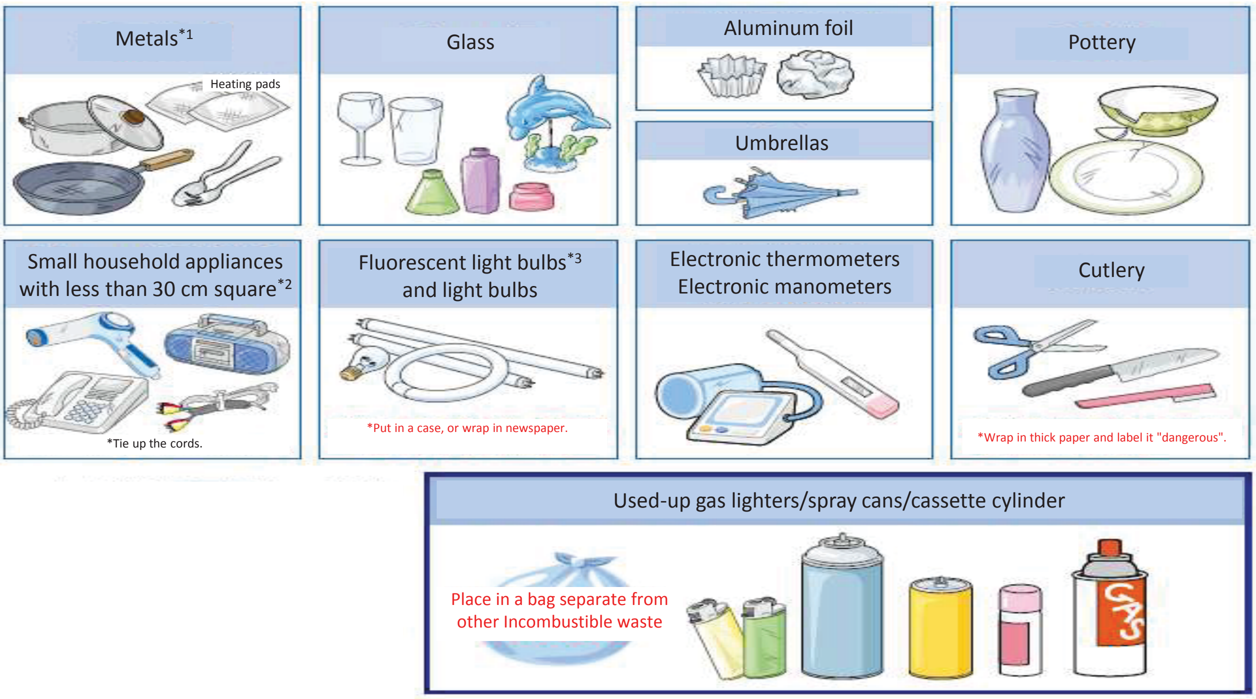
Composition of waste & recyclables

23

2 Significance of Source Separation and Intermediate Treatment

Type-A) Incombustible waste

Items that cannot be input to incineration plants (1)

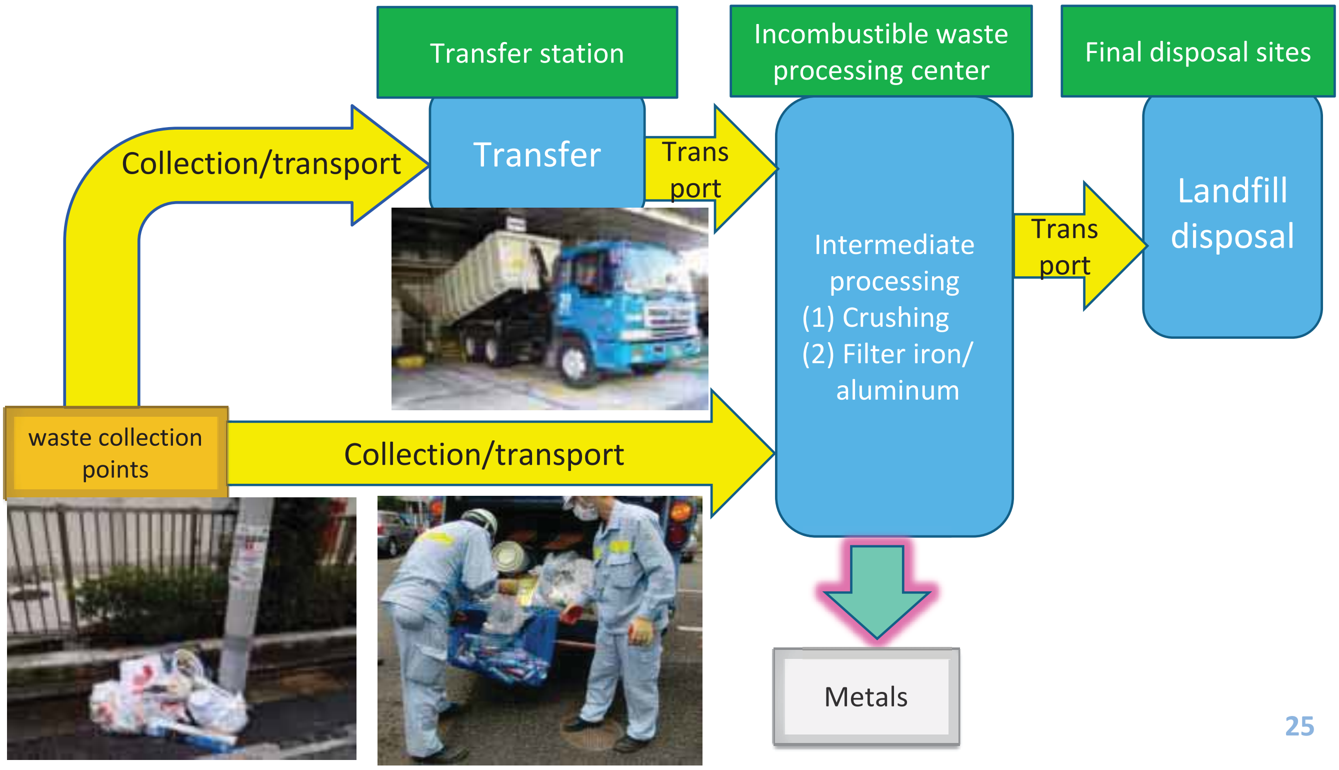


24

2 Significance of Source Separation and Intermediate Treatment

Type-A) Incombustible waste

Flow of Processing

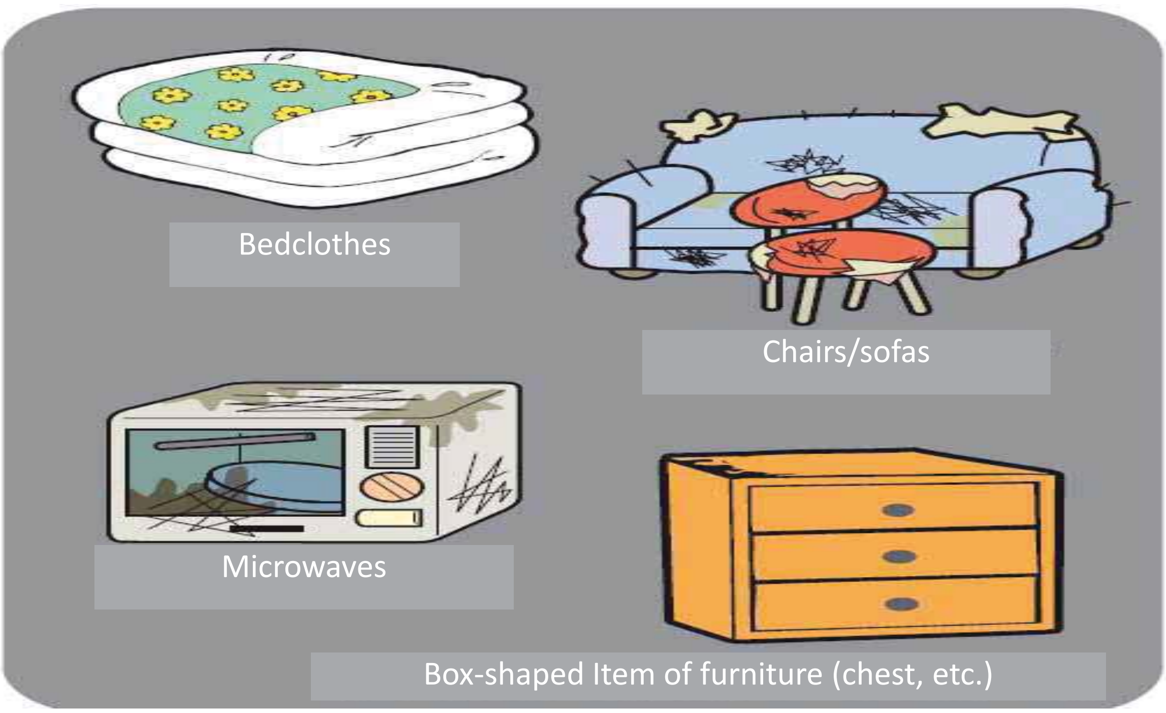


25

2 Significance of Source Separation and Intermediate Treatment

Type-B) Bulky waste (Large-sized waste)

Items that cannot be input to incineration plants (2)

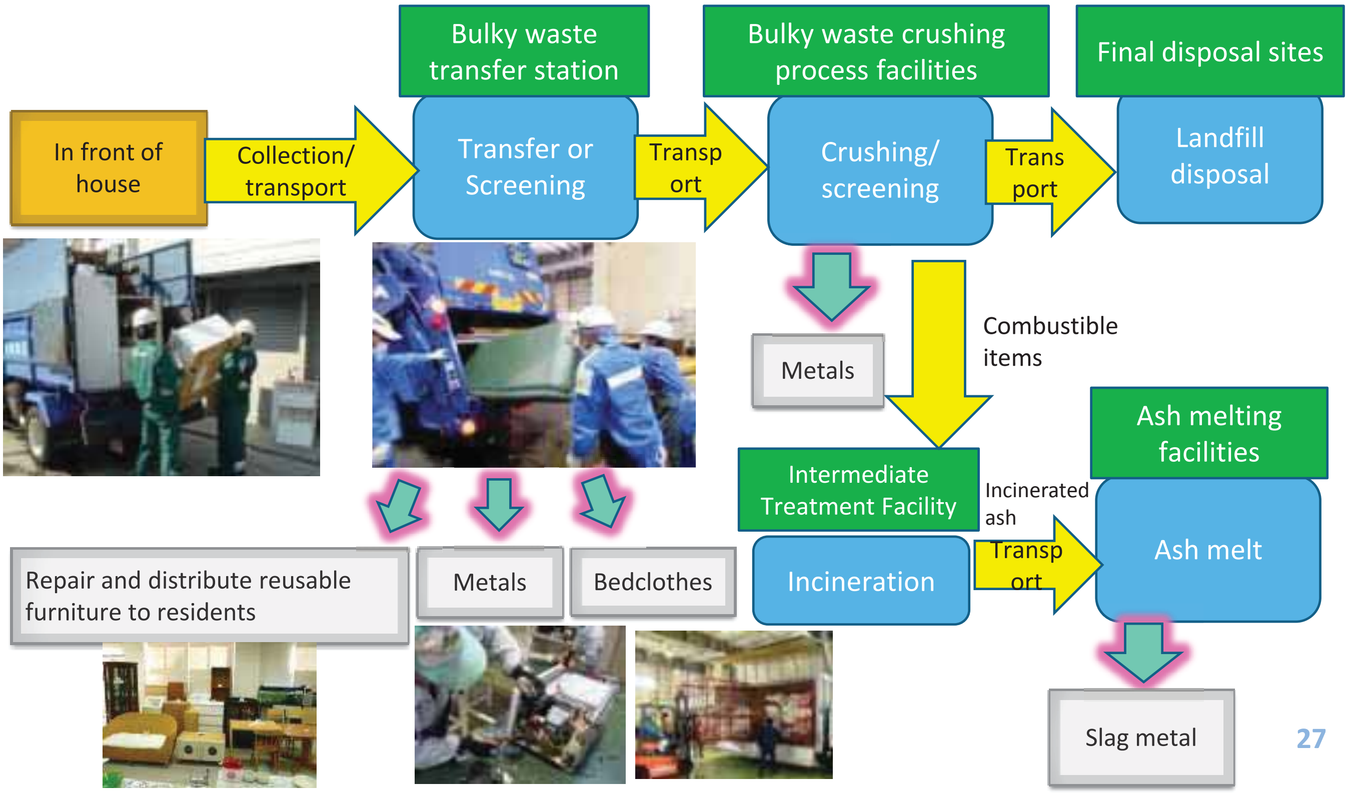


26

2 Significance of Source Separation and Intermediate Treatment

Type-B) Bulky waste (Large-sized waste)

Flow of Process



27

2 Significance of Source Separation and Intermediate Treatment

Type-C) Combustible waste

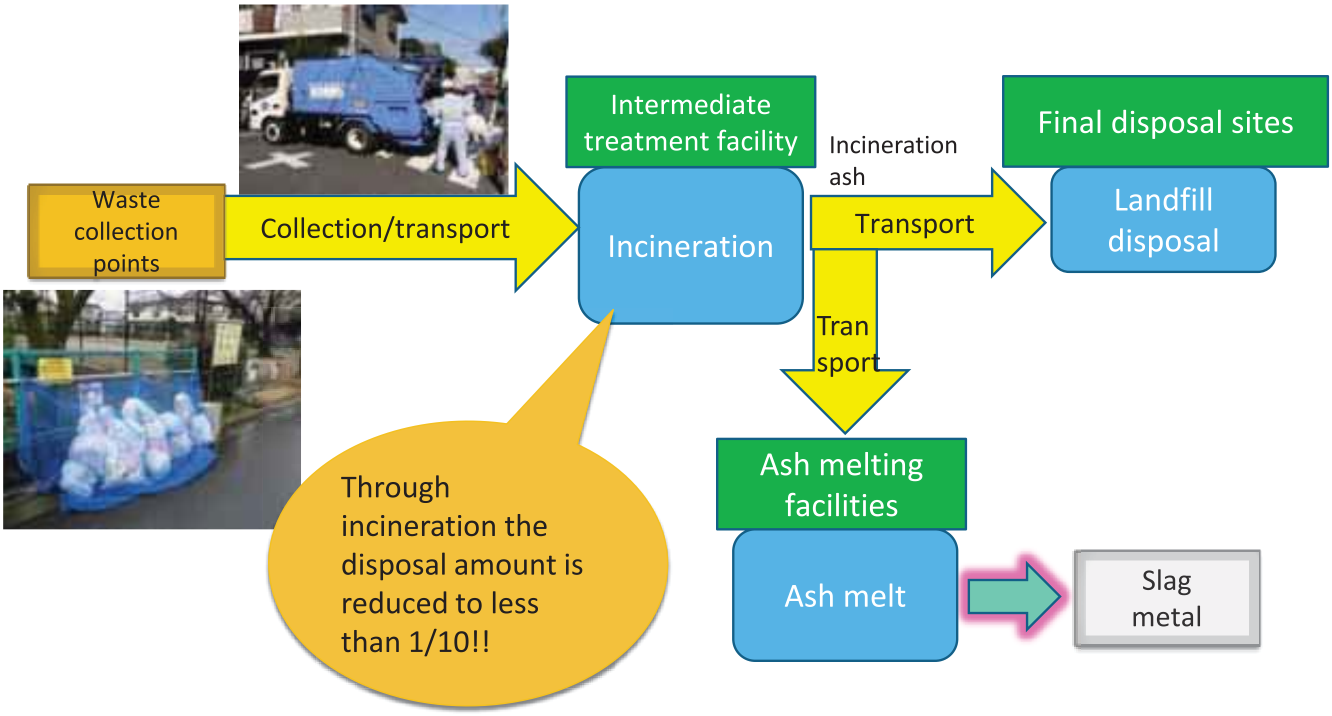
Waste can be input to incineration plants

28

2 Significance of Source Separation and Intermediate Treatment

Type-C) Combustible waste

Flow of Processing

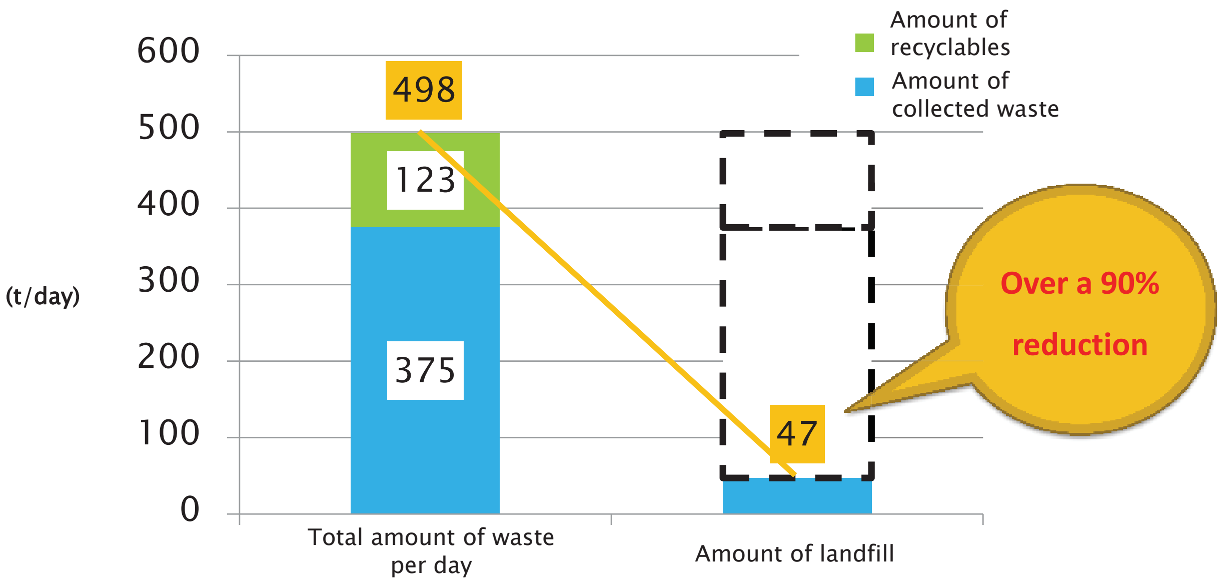


29

2 Significance of Source Separation and Intermediate Treatment

Final Disposal Amount Reduction

- In order to make the reduction of final disposal amounts, **recycling**/**intermediate processing** is introduced.
- The city has been changing the number of category of source separation every certain period **by reflecting the available capacity and technology of recycling and disposal, and social system and regulations.**

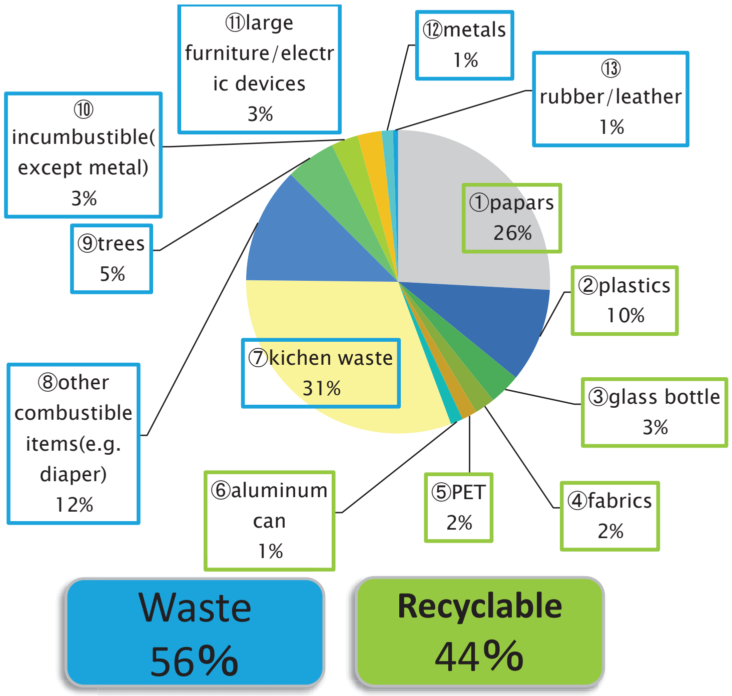


30

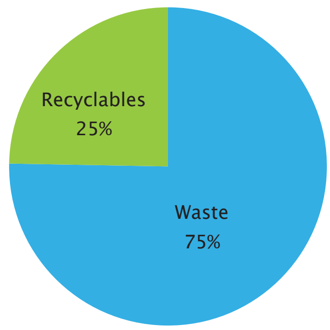
２　分別の意義と目的

Challenge of Nerima city today

Total composition of waste & recyclables



Ratio of collected waste and recyclables in real



There is still more potential to increase the recycling rate by the further cooperation by residents toward source separation.

31

3. Gaining the Cooperation of Residents

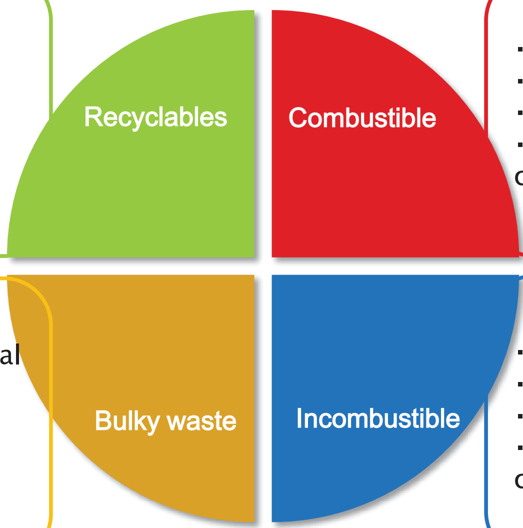
32

3 Gaining the Cooperation of Residents

Source separation & Separate Collection

Cooperation of resident is strongly required ⟷ **Source separation is the burden of residents**

・There are 12 items.
・Designated collection points
・Once a week ~
・There are different instructions in each item too.



・Designated collection points
・Twice a week
・Require to put it by 8am
・Require to use plastic bas or container for discharging

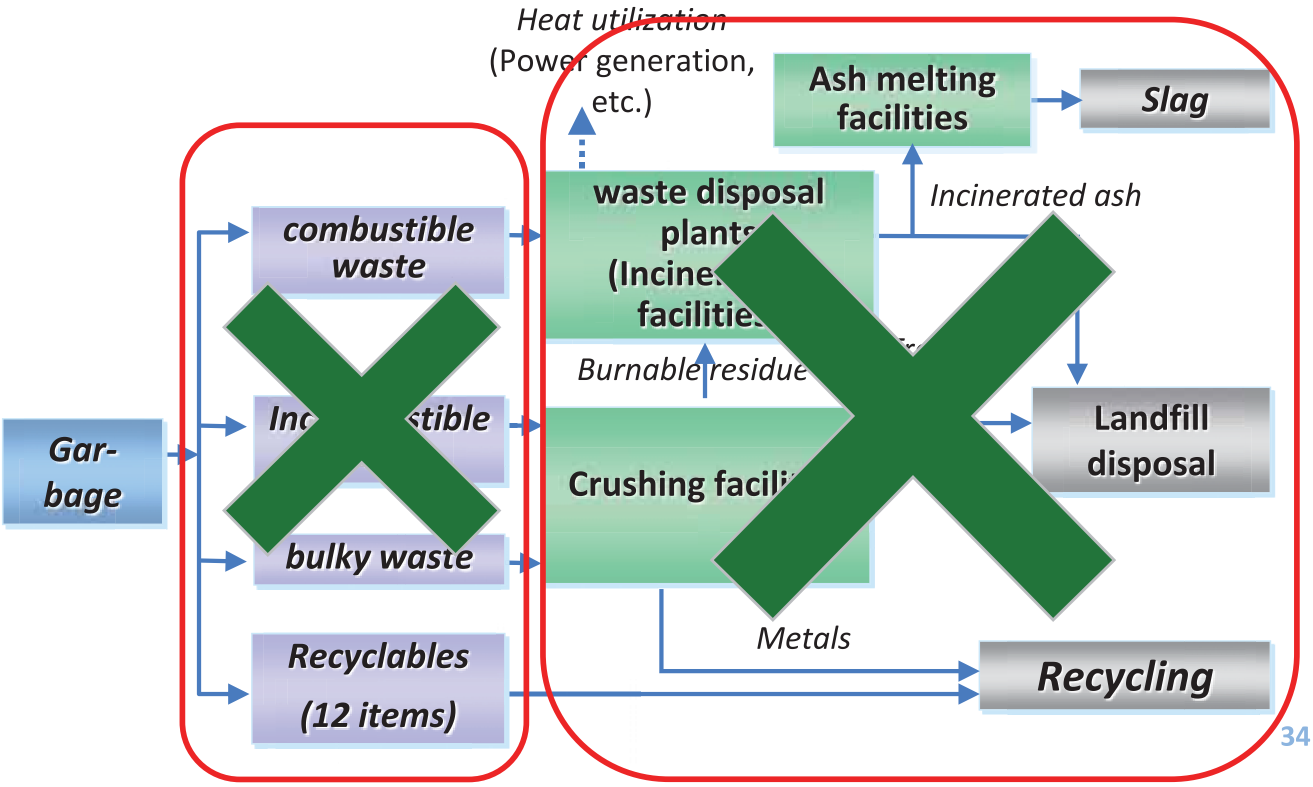
・In front of house or special storage
・On-call
・Require to put it by 8am
・Require to pay fee

・Designated collection points
・Twice a month
・Require to put it by 8am
・Require to use plastic bas or container for discharging

33

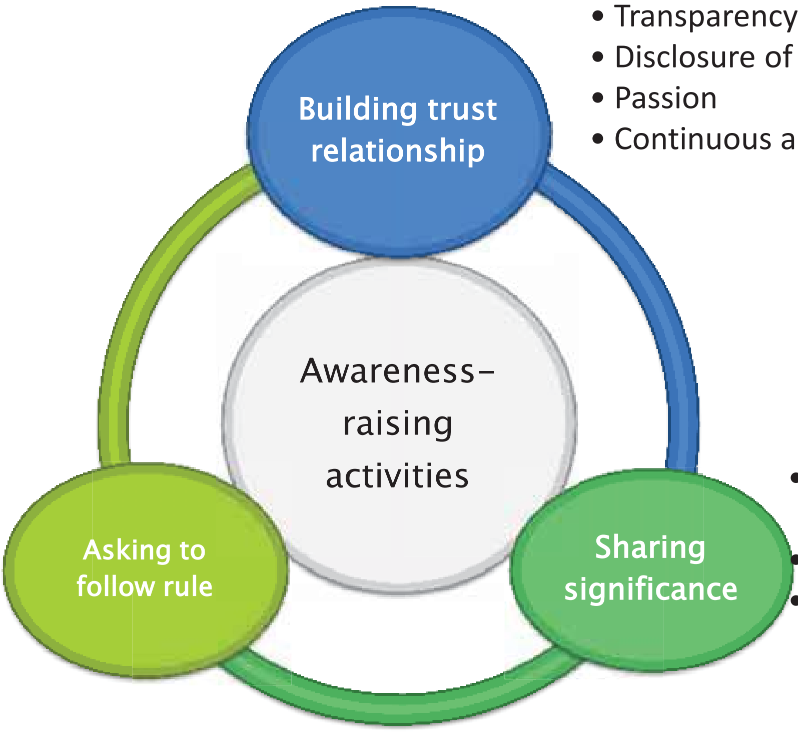
3 Gaining the Cooperation of Residents

Waste flow and source separation



34

Gaining the Cooperation of Residents



- Transparency
- Disclosure of information
- Passion
- Continuous approach

- How to separate and discharge
- Day of the week
- Location
- Fee

- Final disposal amount reduction
- Resource saving
- What will the recyclables you separated be used for?

Nerima City's Dissemination and Awareness-raising Activities

A) Distribution materials

B) DVDs

C) Environmental education

D) Outside assembly

E) Warning sticker

F) Improvement instructions of waste collection points

G) Supporting the voluntary recycling activity

H) Instructions to companies

3 Gaining the Cooperation of Residents

A) Distribution Materials (Distributed to All Households)

37

3 Gaining the Cooperation of Residents

B) Awareness DVDs (For Residents, Staff Training)

38

3 Gaining the Cooperation of Residents

C) Environmental Education

— 2012 result —
Elementary schools　60 schools
Nursery schools, etc.　65 schools
Total　9,891 children

Collection workers

39

3 Gaining the Cooperation of Residents

D) Outside Assembly

— 2012 result —

38 times　in total　2,167 participants

Collection workers

40

3 Gaining the Cooperation of Residents

E) Warning Stickers

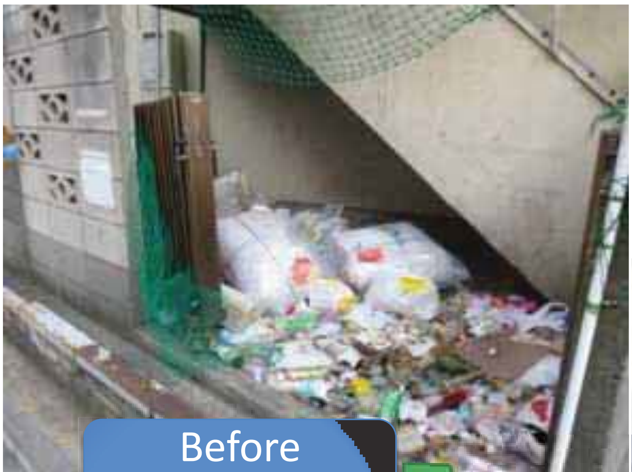
Collection staff give warnings by attaching stickers to bags that don't follow the rules.

41

3 Gaining the Cooperation of Residents

F) Improvement Instructions of Waste Collection Points

For waste collection points with undesirable usage situations, improvements are made by giving advice about countermeasures to illegal dumping and resident instruction.



42

3 Gaining the Cooperation of Residents

G) Supporting the Voluntary Recycling Activity

- Supply of goods
- Supply of financial incentive according to recovery amount

43

3 Gaining the Cooperation of Residents

F) Instructions to Companies

Training session for businesses on proper waste management

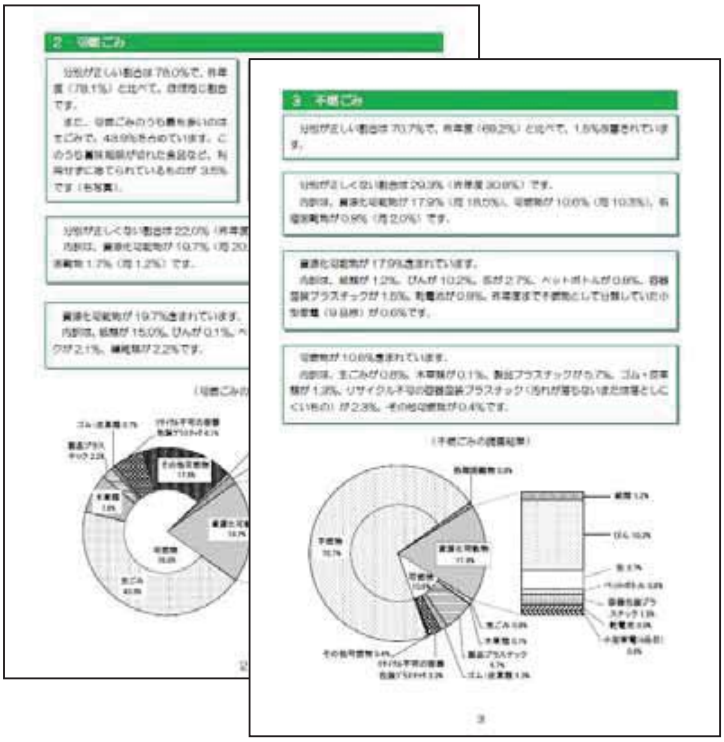
On-site inspections of large-scale commercial buildings

44

3 Gaining the Cooperation of Residents

For Effectual Dissemination and Awareness-raising Activities

A) Survey of Actual Discharge Conditions



45

3 Gaining the Cooperation of Residents

For Effectual Dissemination and Awareness-raising Activities

B) Staff Cultivation/Raising Awareness

Daily meetings

Training

Staff recognition

Safety activities

46

3 Gaining the Cooperation of Residents

[Case Study]
Awareness-raising Activities

—Changes the separation category of plastic—

47

3 Gaining the Cooperation of Residents

The Change of category in Plastics

Incombustible waste

Plastics

First changes in separation categories in 30 years

Plastic for Recycling

combustible waste

48

3 Gaining the Cooperation of Residents

Introducing process of the change

I. Start of pilot program in model areas
(From October 2007 to September 2008)
- Covered 12% of all City residents (92,208 people)
- Preliminarily 22 public meetings were held

II. Awareness-raising activities in preparation for implementation in all area in Nerima (April 2008)
(1) Public Meetings
(2) PR events
(3) PR public newsletter and pamphlet
(4) Stickers on Collection Vehicles&Public Buses
(5) Cable Television Broadcast
(6) Staff Training

III. Start in all of Nerima City (October 2008)
- Instruction/continuation of survey

49

3 Gaining the Cooperation of Residents

I. Start of pilot program in model areas

Period: 1 year (From October 2007 until September 2008)
Target : 12% of the City (92,208 people ,759 households)

Preliminary public meetings : 22 times
(715 people participated)

- **Collection of questions from residents**
Exchange of opinions, voices

Collected amount of plastic for recycling: 764.22 tons
Public cooperation rate : 93.1%

- **Survey the pilot result such as collected amount of plastic for recycling**
- **Confirmation of easy-to-confuse plastic items**

50

3 Gaining the Cooperation of Residents

II. Awareness-raising activities in preparation for implementation in all area in Nerima

(1) Public Meetings

Number of times held : 335 times
Participants : 17,972 people

51

3 Gaining the Cooperation of Residents

II. Awareness-raising activities in preparation for implementation in all area in Nerima

(2) PR events

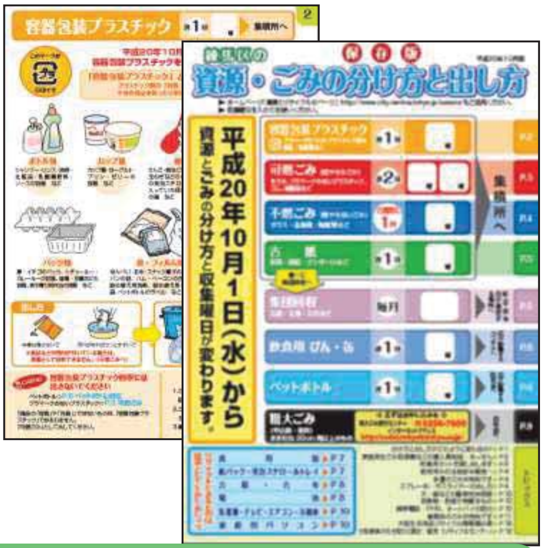
Number of days implemented : 33 day
Participants : 63,193 people

52

3 Gaining the Cooperation of Residents

II. Awareness-raising activities in preparation
for implementation in all area in Nerima

(3) PR public newsletter and pamphlet



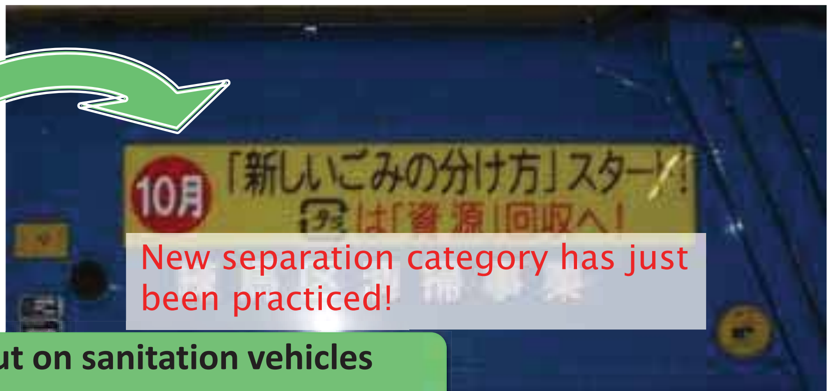
- Nerima City Newsletter
  520,000 copies, 2 times in a year

- How to separate and discharge
  Distributed to all households
  (400,000 copies)

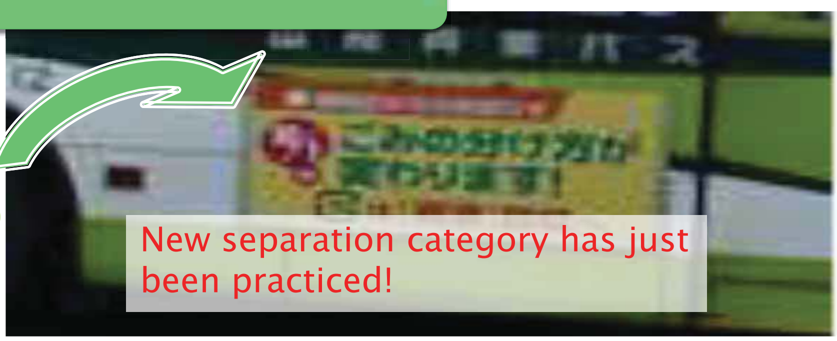
3 Gaining the Cooperation of Residents

II. Awareness-raising activities in preparation
for implementation in all area in Nerima

(4)Stickers on Collection Vehicles&Public Buses



- Attachment of decals put on sanitation vehicles and public buses



3 Gaining the Cooperation of Residents

II. Awareness-raising activities in preparation for implementation in all area in Nerima

(5) Cable Television Broadcast

- Cable television broadcast
  Period　3 months

55

3 Gaining the Cooperation of Residents

II. Awareness-raising activities in preparation for implementation in all area in Nerima

(6)Staff Training

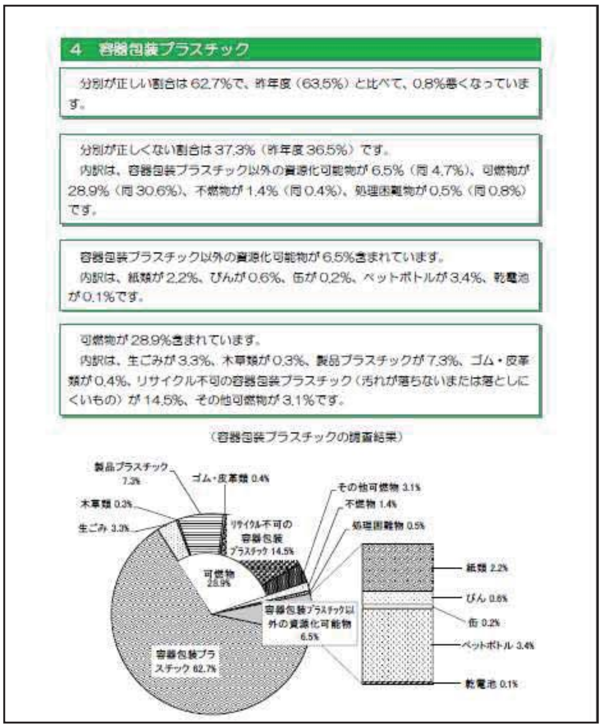
- Staff training
  Participants　1,181 people

56

3 Gaining the Cooperation of Residents

III. Start in all of Nerima City

Survey and Awareness-raising Activities after Implementation



4　容器包装プラスチック

分別が正しい割合は62.7%で、昨年度（63.5%）と比べて、0.8%悪くなっています。

分別が正しくない割合は37.3%（昨年度36.5%）です。
内訳は、容器包装プラスチック以外の資源化可能物が6.5%（同4.7%）、可燃物が28.9%（同30.6%）、不燃物が1.4%（同0.4%）、処理困難物が0.5%（同0.8%）です。

容器包装プラスチック以外の資源化可能物が6.5%含まれています。
内訳は、紙類が2.2%、びんが0.6%、缶が0.2%、ペットボトルが3.4%、乾電池が0.1%です。

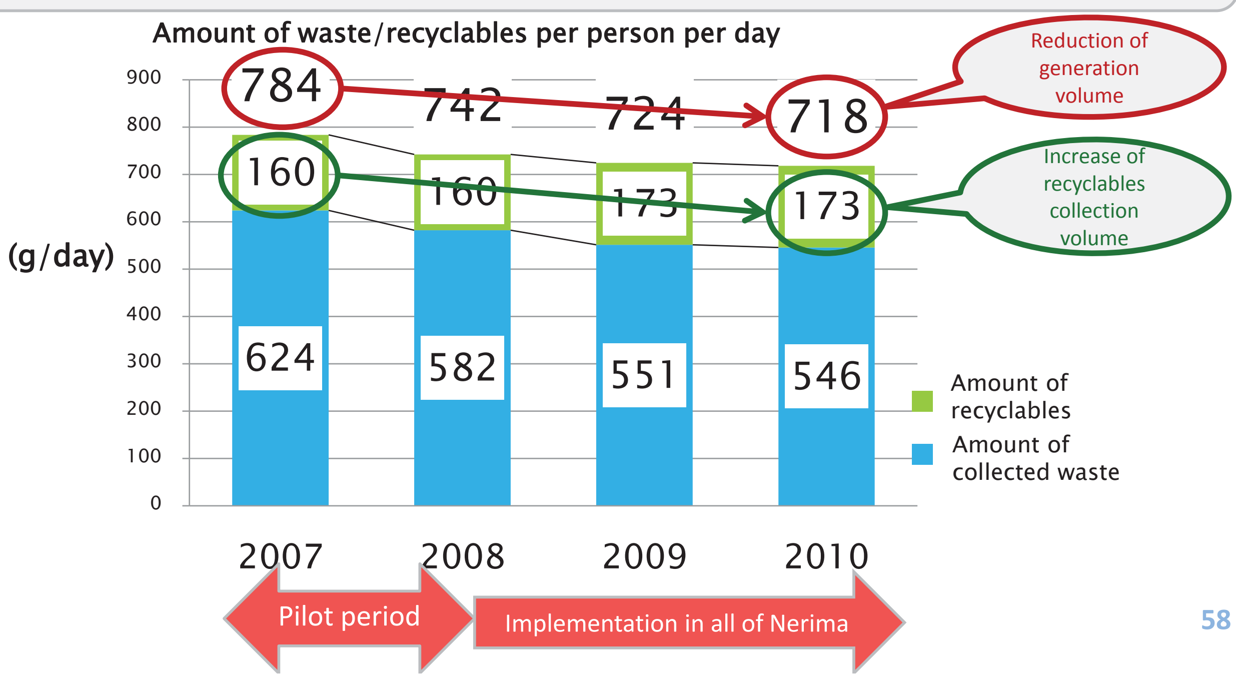
可燃物が28.9%含まれています。
内訳は、生ごみが3.3%、木草類が0.3%、製品プラスチックが7.3%、ゴム・皮革類が0.4%、リサイクル不可の容器包装プラスチック（汚れが落ちないまたは落としにくいもの）が14.5%、その他可燃物が3.1%です。

（容器包装プラスチックの調査結果）

3 Gaining the Cooperation of Residents

Result of Plastic Packaging and Container Recycling

Through the process of the change with various awareness-raising activity, the residents got more aware of waste. As a result, not only increase of recycling rate but also reduction of generation were achieved.



Gaining the Cooperation of Residents

- Asking public cooperation on source separation continuously, carefully and patiently.
- Not only the rules, but the "why significant" of source separation must be disseminated to all residents.
- The imposition by government is not effective to succeed. The opinions of residents must be listened to carefully. Work together with residents.
- Involve residents and get them excited.

The passions of staffs will definitely make change!!

Wrap-up for Japan Study Tour for YCDC-PCCD Staff

28 February 2014

1. What was the most interesting part of today’s visit?
2. What do you think you can learn from cities and facilities in Tokyo and Kawasaki for Yangon?
3. Which part of your visit is NOT useful for Yangon?
4. How was the logistical arrangements?
5. Any additional request for the study tour?
6. Any other comments?

What was the most interesting part of the tour?

- Cleaning program of Nerima city
  - Waste collection system. Nerima city is clean everywhere. Nerima's staff were very active and punctual in work.
  - Staff are outstanding in their work. They are knowledgeable about their work.
  - Awareness-raising programe is very good (e.g. waste separation system, waste collection system, school awareness system and public awareness system, etc.)
  - Incineration plant is very good because it reduces the waste that goes to final disposal site and produces electricity.

What do you think you can learn from cities and facilities in Nerima and Kawasaki for application in Yangon?

- Solid waste management system
- Private sector of solid waste management
- Waste –to-energy (e.g. many incineration plants)
- Recycle factories and export-quality products
- In Japan, a lot of recyclable materials. (e.g. plastics, construction waste, wood furniture and sofa).
  - In Japan, people mostly use ready-made food.
  - In Yangon, most people do not eat ready-made food. So they do not get much recycling waste and food waste smells bad.
  - In Yangon, recyclable waste in mostly plastics.
  - In Yangon, in summer, a lot of tree leaves and grass waste
  - Cities of Japan do not have the illegal collecting points, but in Yangon, many illegal collection points because of many streams pass through the townships where they cannot control their place and this place has very narrow street, difficult for collecting waste.
  - In Yangon, beside the railways, a lot of illegal houses and illegal waste.
  - In Yangon, no more expense for budget of solid waste management, but in Japan, fully budget for solid waste management because of Japan changed to many private waste management companies.
  - In Yangon, one township has 9 vehicles, but this township have to use 30 vehicles, but they do not buy the rest (21) vehicles because they cannot use full budget. In Japan, one township has 150 vehicles. So they can use 150 vehicles because of the expense from companies' budget and then the government is also supporting the companies.

Which part of your visit is NOT useful for Yangon?

- The number vehicles in Yangon and Nerima are very different (9:150)
- Yangon cannot do the waste collection time because Yangon collects waste everyday, all the time.

How was the logistical arrangements?

- Good (everything ok)
- No need for Myanmar-Japanese translator
  - Listening English is ok, but need to speak slowly.
  - Mr. Khin understood 50% of conversation (may speak more with translator).
  - Mr. Koko understood 90%.

Any additional request for the study tour?

- Would be good to have 10-days – 2 weeks.
  - Monday-Friday for lecture,
  - Weekends for sightseeing
- 5 people
  - 1 Leader, 1 section head and three supervisors

7.　案件事業化に向けた検討

本年度事業においては国内連絡会、現地ワークショップ、技術調査等を通し、下記 2 つの案件の事業化についての検討を行った。

小型焼却炉の導入（JFE エンジニアリング社）

ヤンゴン市では最終処分場が不足しており、ヤンゴン市汚染清掃局（PCCD）は焼却炉の導入及び廃棄物発電に意欲的である。

JFE エンジニアリング社は環境省 FS を 2012—2013 年度にかけて実施。本 FS は大規模案件形成事業の一貫として行ったわけではないが、同地域を対象としていることから、国際連絡会、現地 WS 等を通して緊密に連携してきた。メタン排出回避、発電による燃料代替等による GHG 削減が見込める。ただし詳細な GHG 削減量の算定はこれからであり、これについては IGES が支援する用意がある。

オフグリッド再エネ案件

本案件は、ソーラーランタンなどオフグリッド再エネに高い知見を持つインド TERI と協力しつつ実施した。TERI 所長、ラジャンドラ・パチャウリ博士も本調査には高い関心を示しており、引き続き IGES、環境省等の日本との協力を進めて行きたい旨を確認済みである。日本企業が参画する形での、ミャンマー・インド・日本の三角協力という絵を作ることが可能である。

本調査はプレ FS に近い位置づけであり、オフグリッド再エネに関する政策、既存のプログラム、導入モデル等の検討を行った、次のステップとしてはより詳細な場所、技術、日本企業等を特定したより詳細な FS の実施が必要である。その際に、既存のプロジェクトとどう差別化・連携を図るか、どのように大規模展開へ向けた資金を調達するかといったことが課題になる。

ミャンマーにおいてはアジア開発銀行もオフグリッド再エネ開発に取り組んでいる。環境省が設立を予定している ADB 信託基金の利用の可能性も高いと思われる。

その他案件

上記とは別に、ヤンゴン近郊のミンガラドン工業団地における省エネ案件を検討している。本団地は日系企業が運営しており、特に縫製業の工場が入居している。労働集

約型の縫製業は日本企業などにとって最も進出が進んでいる分野であるため、大規模展開の可能性が大きい。

ミャンマーにおけるJCM推進について

ミャンマーはJCMでは署名国ではないため、GEC設備補助等の資金を用いることが難しい。そのため、JFEエンジニアリング社等とも連携しながらミャンマー環境保全森林省（MOECAF）に対してJCMの早期署名を働きかけており、政府を対象としたJCMに関するワークショップなども開催している（別事業枠）。MOECAF側では環境保全局(Environmental Conservation Department -ECD)がJCMにおけるフォーカルポイントになる動きとなっている。また、IGESはMOECAFと協力へ向けたMoUを2014年3月に締結予定であり、ミャンマーにおけるJCMの推進にも有用と思われる。

加えて、ミャンマーにおいてはJICA、ADB等も活発に活動しているため、JICA基金、ADB信託基金等との連携の可能性も高い。上述のように、オフグリッド再エネはADBとの連携の可能性が特に高い。