FY2014 Feasibility Studies on Joint Crediting Mechanism Projects towards Environmentally Sustainable Cities in Asia

Feasibility Study on Rice Husk Power Generation System for Low-carbon Communities in Ayeyarwady Region, Myanmar

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Executive Summary

The survey examined the possibility of a project to establish an autonomous distributed energy system based on biomass (rice husk) power generation which provides power and heat to the local community in Ayeyarwady region in Myanmar for the prospects of creation of new industries and the improvement of energy access, and the formation of low carbon community in the area. The survey further aims to help formulate large scale JCM projects involving cities and regions for realization of low carbon societies in Asia.

The survey was implemented in cooperation with Myanmar Rice Federation (MRF), Ayeyarwady regional offices, etc., with the processes of local workshops (Ayeyarwardy Low Carbon Community Roundtable: the 1st workshop in Pathien City in Nov, 2014, and the 2nd workshop in Yangon in Feb. 2015), field survey and discussions with local people concerned.

> Ayeyarwady Region
>
> A delta area of Ayeyarwady River located in the west of Yangon. Myanmar's granary producing 30 % of the total national rice harvest.

Current State Analysis (1)

Autonomous distributed power generation system suited to local characteristics is an effective way to strengthen local power provision capacity. In Ayeyarwady where rice farming is the mainstay of the economy, rice husk power generation is promising.

- In Myanmar, enhancing the power supply capacity is a matter of urgency because of its recent rapid economic growth. In Ayeyarwady region in particular, since many of its districts are at the end of national grid, they suffer from chronic power shortage and voltage sag. Since Ayeyarwady is also one of regions with low electrification rate, the expansion of electrified areas is an important policy issue from the viewpoint of regional development and life improvement of local communities.
- While the large scale power source development including the consolidation of national grid is indispensable in the mid to long term perspective, the introduction of distributed power source development making use of local resources as a part of local efforts is also crucial. In Ayeyarwady region where rice farming is extensively conducted, biomass resources such as rice husk are generated in abundance. Therefore the distributed power generation system utilizing rice husk is an effective and productive approach.

> Merits of **Distributed Power Generation System utilizing Rice Husk**
>
> - Small scale distributed systems are easy to introduce in an expeditious manner.
> - Making use of local energy resources contributes to relieving the reliance on energy resources imported from overseas.
> - Renewable energy including biomass power generation makes the carbon-free green power supply possible.
> - Energy conversion from wastes reduces cost burden and environment load involved in waste treatment.

Current State Analysis (2)

Introduction of rice husk power generation would not only contribute to improvement of financial condition and competitiveness of rice mills, but make them as strongholds for energy supply for local communities.

- Securing stable power supply is a challenge for the management of rice mills. The viability threshold of rice mills is considered to be 200 working days. Ensured power supply is indispensable for enhancing rice mills' operation rate, and their scale expansion and equipment modernization.
- While some rice mills introduced in-house power generation facilities which use small scale rice husk gasification system, they have a drawback of low efficiency. The needs for conversion to efficient power generation system is high.
- The creation of new industries such as processing of rice and agricultural products, and product distribution, etc. is important for the promotion of local industries. Securing power supply is vital for this. Power and heat made available by rice husk power generation would be helpful for the creation of new business opportunities.
- Rice quality improvement by drying rice utilizing heat produced by rice husk power generation system.
- Utilization of heat acquired by rice husk power generation system for drying beans.

Development Direction (1) "Horizontal Development to Pursue"
Making use of a variety of potential assistance programs of the Japanese government, we consider the construction of a prototype facilities (less than 2 MW) and starting the trial business (1^{st} step), and implementing the full scale operation including horizontal expansion in the same district and dissemination to other districts, while making the business to suit the local characteristics, based on the results of the prototype (2^{nd} step). We further consider the dissemination to the whole areas of the region in association with the electricity infrastructure development in micro grid areas (3^{rd} step).

The gist of the road map considered in the survey is shown below.

- Step-by-step development
  - 1^{st} Step: Construction of one unit of prototype facilities (less than 2 MW) and trial operation.
  - 2^{nd} Step: Full scale operation including horizontal expansion in the same district and dissemination to other districts based on the results of the prototype.
  - 3^{rd} Step: Dissemination to the whole areas of the region in association with the electricity infrastructure development in micro grid areas.
- In the 1st step, "small scale business model" seems to be appropriate. The model in which a single rice mill with the scale of mid to large power generation facilities purchases rice husk requires the scrap and merge of rice mills as the premise. It might be reasonable to treat it as an option for the future (after the 2nd step).
- In the development in the 2nd and 3rd steps, while applying the results of model operation in the 1st step, and envisaging the operation with the scale of 50 MW in the mid to long term, the horizontal development of autonomous distributed energy system based on the biomass (rice husk) power generation should be realized.

Identification of promising areas for the 1st step

- Based on the result of the survey, out of five shortlisted townships of Ayeyarwady region, namely Pathein, Myaungmya, Pyapon, Kyaikat and Hinthada, we further selected Myaungmya, Pyapon and Kyaikat, considering the current road infrastructure conditions of Myanmar and extremely small gravity of bulk of rice husk, as candidate areas for initiating the project.
- Myaungmya, in particular, is the most active township with regard to rice milling in Ayeyarwady, and is endowed with the national grid. Therefore, we consider it will be the most effective way to initiate an advance model in Myaungmya, and then disseminate rice husk power generation to other areas.
- The project aims to develop a rice husk power generation system with the capacity of 50 MW in total sum by 2021 with the collaboration between governments of Myanmar and Japan. This approach will lead to the reduction of energy-derived CO2 by about 100, 000 t - CO2 / year in estimated total sum by 2021.
- In the nationwide perspective, Bago and Yangon are also promising as project area. The horizontal extension of the project to these areas after establishing plural business models in Ayeyarwady can also be considered.
- In view of the rice husk volume generated in Ayeyarwady region, it is possible to realize 50 MW rice husk power generation. However, taking account of the volume of rice husk made available at the project site, 30MW will be the target for some time to come. After the extension to Bago and Yangon areas, the project can envisage 50 MW power generation in total.

Prospective areas for the project implementation (taking the horizontal development in Step 2 and 3 into consideration)

Myaungmya, Pyarpon, Mawlamyine Kyun, Bokalay, Kyeiklatt and Maubin in Ayeyarwady region, and Konchankone, Kokmhuu, Titegyi and Htantapin in Yangon region, and Lattpatan, Tharyarwaddy, Oaktwin, Taungoo in Bago Region are the promising areas of rice husk power generation.

Development Direction (2) "Specific Business Model"

Taking account of underdeveloped road infrastructure in Ayeyarwady region, the business model of small (2 to 3 MW) to mid-sized power generation instead of large system which requires rice husk collection from many rice mills should be explored. The small system can be easily disseminated to many areas. In addition, the introduction of the Japanese technology with high power generation efficiency is recommended.

(Basic Concept of the Business Model)

- In Ayeyarwady region, trunk roads are paved, though not quite satisfactorily, and passable for large trucks. However, most of branch roads are either with simple pavement or no pavement. Considering the current poor road conditions and small gravity of bulk of rice husk, rice husk is not suitable for long distance transport. Therefore, it seems establishing plural small scale rice husk power generation plants is more appropriate in Myanmar than setting up a large scale power plant collecting rice husk from many rice mills.

- In the first step, the "small scale business model" is recommended. In the model which a mid to large scale rice mill alone secures rice husk independently for power generation requires scrap and merge of existing rice milling businesses. It is considered as an option for future development (after the 2nd step).
- For the operation of the small scale model, the utilization of the system with high power generation efficiency is indispensable. It is advisable to introduce the highly efficient rice husk power generation system of Japan under the scheme of Japanese government (JCM Facilities Subsidy Program of the Ministry of the Environment).

Business Model in Consideration

Two models, namely "small scale model with the facility capacity of 1.8 MW, net capacity of 1.6 MW" and "mid-sized model with the facility capacity of 3.3 MW, net capacity of 3.0 MW" are considered.

- **The small scale model, the most promising one at the moment, is suitable for collaboration between existing large scale rice mills and other neighboring rice mills.**
- **The mid-sized model involves the integrated approach with the construction of a large scale rice mill. It requires scrap and merge of rice milling businesses. (Future development option)**

- While there are common issues between small and mid-sized models such as rice husk procurement, utilization of generated power, heat and ash, etc., the mid-sized model produces power and heat far more than the volume required in the rice mill, and it is necessary to secure the stable purchasers of power and heat. Therefore, the grid consolidation together with the creation of the demand for power and heat (e.g. collective housing, industrial estate development) are the requisites. Furthermore, candidate areas to accommodate mid to large scale power generation facilities which require collection of rice husk from many rice mills are limited. For future grid consolidation, a certain assistance may be available through JICA, ADB or JCM collaboration scheme.
- The actual development may be different depending on the more detailed analysis of individual rice mills and the progress of scrap and merge of rice mills. We would like to further consider the model suited to the local conditions through discussions with MRF officials, etc.

Business Model suited to Local Conditions

The business environment for the project in the area with the national grid access and that without its access is fairly different in terms of situations of rice mills, power supply, local development and infrastructure, etc. Therefore, we are to set up two models, "Development Model with National Grid" and "Development Model with Off-Grid".

<u>"Business Model with Prime Power Utilization in Rice Mills"</u>

- "Rice processing, low carbonization in distribution, energy saving (e.g. drying rice husk and beans,use of power in storage facilities of agricultural products"
- "Collaboration with agriculture (e.g. irrigation pumps, use of power in nursery facilities)"
- "Use of power and heat in adjacent areas" (introduction of varied industries such as low temperature storage of fishery products is possible due to attributes of autonomous distributed energy system.)
- "Low carbon local development" (town development with low carbon collective housing)

(Business Environment under Horizontal Development)

- For the horizontal business development, the business environment consolidation for rice husk power generation with the assistance from the two governments as described below is crucial. For this, nurturing the understanding of significance and effects of the project, in collaboration with people concerned in Ayeyarwady region including MRF, among relevant offices of Myanmar is essential.

Policy options for assisting rice husk power generation project (Examples)

- Easing the restriction of the Foreign Investment Law or its exemption (The power generation less than 10 MW is allowed only to Myanmar enterprises.)
- Preferential treatment or assistance to the scheme of power sales to national grid
- Expeditious document processing and assistance
- Conclusion of the agreement of JCM between governments of Myanmar and Japan, and the system development for JCM implementation.
- Clarification of the power distribution system development in the mid to long term regional development plan of Myanmar. (promotion of autonomous distributed power generation including biomass power generation, and its clear goal setting, etc.)
- Preferential measures and assistance to renewable energy development by the introduction of Feed-in-Tariff (FIT) system, etc.

(Future Development of the Project)

We further consider the followings, in association with the governments of Myanmar and Japan, and in collaboration with MRF, for the realization of autonomous distributed energy system development and its dissemination in Myanmar.

Action plan for realization of model business in the step 1

- Feasibility study in promising areas: It is difficult to get the first-hand figures and details of rice husk utilization of rice mills only by the statistical data. We will conduct actual site visit to plural rice mills for detailed survey, and screen the promising areas.

- Collaboration and coordination with relevant administrative offices of Myanmar: We will further explain the results of the survey and discussion so far to relevant offices (central and local) for nurturing their understanding, and reflect their views to the project plan.

Action plan for horizontal business development in step 2 and 3

- Examination of business development in rice farming regions other than Ayeyarwady: We will examine the possibility of horizontal business development in Yangon and Bago regions.

- Consideration of specific measures for horizontal development: For the progress of horizontal development, the basic strategy (road map) which includes the direction and specific measures for the development is essential. In addition, the clarification of the framework in which the business model established by the advanced approach is disseminated in the project under consideration is also important. Sharing the basic strategy among people concerned is indispensable for facilitating the sustainable

Image of Road Map for the Horizontal Development (Short to Long Term)

- **Clarification of significance: The creation of varied industries is possible due to the attributes of autonomous distributed energy system (rice husk power generation). It also facilitates local electrification.**
- **Clarification in the mid to long term development plan (biomass power generation, autonomous distributed power generation, etc.)**
- **Visualization of business model and collaboration among people concerned (role sharing)**
- **Business environment creation: distribution line consolidation, power tariff setting etc.**

progress of the project (not to end up with a mere model project).

- We therefore select the specific candidate areas (as the model areas for taking initiatives), and consider, taking account of the plan of local power distribution network consolidation as well as mid to long term regional development plan, the concept of low carbon communities which utilize rice mills as local energy supplying centers.
- For the consideration, the integrated approach taking into account the demand side measures including the smart ways of utilization of power and heat generated by rice husk power generation system is essential. Those measures also include power load leveling, energy saving devices for buildings, introduction of facilities with high energy saving efficiency, mechanism for effective utilization of heat in the communities, etc. to name a few.
- For the preparation of this kind of road map for the community, examples of approaches of Japan such as "Environment Conservation Model City", "Concept of Biomass Town Development", "Plan of Creation of Low Carbon Communities", and "Structural Reform Special Zone" will be useful. Experiences and knowhow of local authorities of Japan will be utilized for the work.

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List of Abbreviations

This report uses the following standardized units and abbreviations.

Unit

GWh	gigawatt hour
Ha	hectare
Kg	kilogram
kL	kiloliter
kWh	kilowatt hour
MW	megawatt
MWh	megawatt hour
t	ton
t/ha	ton per hectare
Toe	ton of oil equivalent
USD	U.S. dollar
Kyat	Myanmar kyat

Abbreviations

ADB	Asian Development Bank
ASEAN	Association of South-East Asian Nations
BM	Build margin
BTG	Boiler, Turbine, Generator
CER	Certified Emission Reductions
CDM	Clean Development Mechanism
CM	Combined margin
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FAO	Food and Agriculture Organization
HHV	Higher Heating Value
IEA	International Energy Agency
IEE	Initial Environment Examination
OPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
LDC	Least developed countries
LHV	Lower Heating Value
MAPCO	Myanmar Agribusiness Public Corporation

MIC	Myanmar Investment Commission
MOECAF	Ministry of Environmental Conservation and Forestry
MOEP	Ministry of Electric Power
MRMA	Myanmar Rice Millers' Association
MRF	Myanmar Rice Federation
MRV	Measurement, Reporting and Verification
MSL	minimum service level
OM	Operating margin
SPC	Special Purpose Company
PDD	Project Design Document
UNFCCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture

Chemical Symbol

CO2	Carbon dioxide
NOx	Nitrogen oxide
SOx	Sulfur oxide
SiO2	Silicon dioxide
Al2O3	Aluminium oxide
Fe2O3	Iron(III) oxide
CaO	Calcium oxide
MgO	Magnesium oxide
K2O	Potassium oxide
Na2O	Sodium oxide
P2O5	Phosphorus pentoxide

1 Purpose and Implementation Arrangement

1.1 Purpose

Japan announced its resolution to share the target of at least halving the greenhouse gas emission of the world by 2050 with all the countries, and to reduce Japan's emission by 80 % by 2050 as a long term target. (Basic Environment Plan, Cabinet Decision, April 27, 2012) In order to halve the worldwide GHG emission by 2050, it is necessary to accelerate the creation of sustainable low carbon society in Asia and the Pacific areas by the identification and formation of GHG reduction projects in a large scale. For realizing this, it is necessary to newly establish the Joint Crediting Mechanism (JCM) which properly values Japan's contribution to the reduction of energy-derived CO2.

This survey examined the possibility of a project to establish an autonomous distributed energy system which utilizes biomass (rice husk) power generation in Ayeyarwady region in Myanmar for the prospects of creation of low carbon communities in the area where rice milling plants are located and its adjacent districts. The survey further aims to earn JCM credits, while adjusting the Japanese system and technology to meet the local situations and establishing local operation and management system of the project, and to make a foundation for future formation of large scale JCM projects involving cities and regions for the realization of low carbon societies in Asia.

1.2 Survey items and survey arrangement

We implemented the following survey for the introduction of rice husk power generation system for the creation of low carbon community in Ayeyarwady in Myanmar.

(1) Analysis of the possibility of application of JCM

- Overview of the project area and survey of the local needs
- Examination of effects of emission reduction of energy-derived CO_2 and GHG
- Consideration of the ways of project promotion

(2) Examination of the project feasibility

- Overview of the project and survey of the local needs
- Study of the system to be introduced
- Consideration of the project proposal

< Local Needs >

- Rice husk generated in rice mills is not productively utilized. (Rice husk is promising biomass resources to be utilized as energy source.)
- Many non-electrified areas exist. The improvement of quality of life and industrial development are challenges.

We conduct a feasibility study to establish **autonomous distributed energy system utilizing biomass (rice husk) power generation** in Ayeyarwaddy region of Myanmar and examine the possibility of formulation of low carbon society in the areas of rice mills and their vicinity by the creation of new industries in rural areas making use of power and heat thus generated and the improvement of energy access of local communities.

Area with high potentiality of development of autonomous distributed power generation

Located in the delta area of downstream of Ayeyarwaddy River, south of Myanmar, Ayeyarwaddy region which is the site of this survey is a leading rice farming area of the country. Rural electrification is their pressing need (the area's electrification rate is 10 %.), and they have a high expectation for power generation utilizing rice husk produced in the area.

Expectation to Assistance from Japan

Remarks of Chief Minister Thein Aun, Ayeyarwaddy region : **We are interested in the introduction of Japanese knowhow and industrial technology** in a variety of fields such as industrial promotion (environment technology in agriculture in particular and assistance for agricultural technology transfer), human resources (vocational education and skill training), infrastructure development, energy development (promotion of local electrification), and special economic zone development, etc. in the region, **and we requested the Japanese active assistance for strengthening our relations with Japan.**

Assuming the rice husk power generation system as the center for local energy supply and using it for horizontal development

Electrification of communities, and introduction of facilities and equipment with high energy saving efficiency in newly established communities

Creation of venue of introduction of Japanese technology of energy saving and renewable energy

Win-Win Relations

Realization of Low Carbon Communities

The survey was implemented, in cooperation of Myanmar Rice Federation (MRF), etc., with the processes of local workshops, field survey and discussions with local people concerned.

(Outline of the1st Workshop)

While Japanese members (MRI, Fujita) and Myanmar members participated, the outline and purpose of the survey as well as the project concept were explained by the Japanese participants. Both sides shared the common recognition of the situations of agriculture, local development, electricity and the possibility of project development, and selected the issues to be solved.

The Myanmar officials in charge of agriculture, regional development and electricity made the presentation of the current situations, and questions and answers session including the discussion was also conducted.

Date of the Workshop: Nov. 10, 2014

13:30～17:00

- Venue: Hotel Meeting Room, Pathein
- City, Ayeyarwady
- Participants: People from Rice Milling Plants, People of Rice-Related Businesses, Officers of Ayeyarwady Region, and Japanese members
- Program
  - Opening Address

- Mr. Ye Min Aung / Secretary general of MRF
- Mr. Soe Aung / Director, Department of Trade Promotion - Ayeyarwady Region
- Presentation from Japanese Side : Project Outline and Purpose, Project Concept
- Presentation from Myanmar Side : *Situations of Agriculture* (Mr. Soe Aung / Director, Department of Trade Promotion - Ayeyarwady Region), *Situations of Electricity* (Mr. Than Htun Aung / Electricity Supply Enterprise, Ayeyarwady Division Electrical Engineer, Deputy Chief Engineer), *Situations of Rice Mills* (Mr. Soe Win / MRMA Chairman, Ayeyarwady Region)
- Lecture on Technology : "Technology of Rice Husk Power Generation"
- Panel Discussion with Q and A with Audiences, Comments from Panelists
- Closing Address

(**Outline of the 2nd Workshop**)
People concerned from Japanese and Myanmar sides got together to share the progress of the consideration, to discuss the ways of project promotion and issues, and to solicit opinions for the survey and the project realization.

- Date of the Workshop : Feb. 4, 2015 (Wed) 9:00 - 12:30
- Venue : Meeting Room, MRF, Yangon City
- Participants : People from Rice-Related Industries, Public Officials, People from Rice Milling Plants, Japanese members
- Program
  - Opening Address
  - Welcome Address : Mr. Ye Min Aung, MRF Secretary general
  - Japanese Side : Explanation of the Consideration Status
  - Explanation of Issues (Electricity for rice mills, related facilities, communities; Heat Utilization by rice mills, related facilities and communities; Stable Supply of Raw Materials; Prospects for Project Realization : short term, mid to long term)
  - Discussion (General Matters, Conclusion)
  - Closing Address

2 Project Area Overview and Local Needs

2.1 Overview of Myanmar and Ayeyarwady region

Myanmar has recently been in a rapid economic growth, and is one of the most attention-attracting countries in Asia. Myanmar is composed of 7 Divisions and 7 States. Ayeyarwady is an administrative region located in the west of Yangon, and in the delta area of Ayeyarwady River. Ayeyarwady is the foremost granary area producing 30 % of the total rice output of Myanmar.

	Myanmar	Ayeyarwady
Area	680,000 km^2	35,000 km^2
Climate	Most of the land belongs to tropical or sub-tropical zone with great difference of temperature and precipitation depending on the location. A year can be divided into 3 seasons: wet season (mid May to Oct.), dry season (Oct. to Feb.) and hot season (Mar. to May).	Delta area located in the south of Myanmar
Population	50.2 million	6 million
Household	10.9 million households	1.5 million households
Local Administration System	Composed of 7 Divisions and 7 States. Divisions are mainly inhabited by Burmese, while States are mostly populated by other minority people.	Capital : Pathein City
Economic Trend	Since the Thein Sein administration started at the end of March 2011, democratization and economic revolution have been progressed.	

Source: Ministry of Foreign Affairs, Japan "Basic Data of the Republic of the Union of Myanmar" (http://www.mofa.go.jp/mofaj/area/myanmar/index.html), JETRO Basic Data etc.
Population: Population and Housing Census of Myanmar, 2014, August 2014

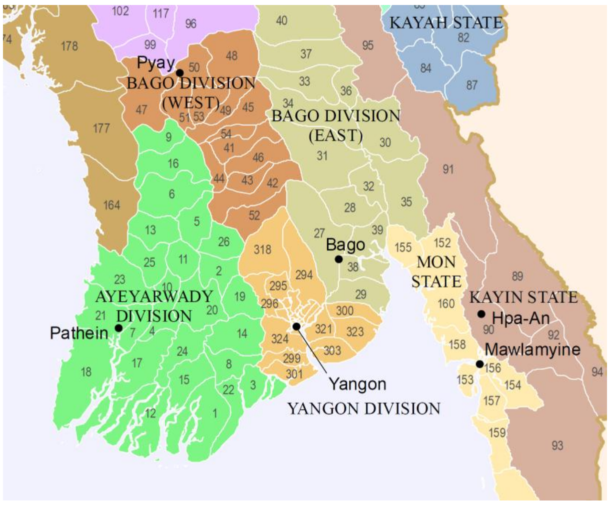


Figure 2-1 Map of Ayeyarwady Region

Source: Myanmar Information Management Unit

Overview of Agriculture and Rice Cultivation

Myanmar is the world's 7th largest rice producing country. According to FAO, Myanmar produces about 29 million tons of rice (with husk, in 2013, Unofficial figure) which is about three times of Japan's rice harvest. Therefore, the effective utilization of the significant volume of rice husk generated in rice mills is a challenge for Myanmar.

Table 2-1 Number of Rice Milling Plants and Treatment Capacity

		2010 - 2011		201 - 2012		2012 - 2013	
		#	Capacity (t/day)	#	Capacity (t/day)	#	Capacity (t/day)
Delta	Ayeyarwady	3,892	19,460	3,927	19,804	3,927	19,804
	Bago	1,508	5,450	1,528	5,632	1,564	5,711
	Yangon	764	2,292	775	2,413	681	2,886
	Subtotal	6,164	27,202	6,230	27,849	6,172	28,401
Dry Zone	Magwe	906	2,716	909	2,723	914	2,742
	Mandalay	1,276	6,380	1,280	6,421	1,275	6,395
	Sagaing	1,504	7,520	1,517	7,635	1,571	7,855
	Subtotal	3,686	16,618	3,706	16,779	3,760	16,992
Coastal	Mon	539	1,364	539	1,364	518	1,295
	Rakhine	1,354	5,246	1,354	5,246	1,354	5,246
	Tanintharyi	1,119	2,238	1,118	2,236	1,117	2,234
	Subtotal	3,012	8,848	3,011	8,846	2,989	8,775
Mountainous	Kachin	1,652	4,956	1,652	4,956	1,652	4,956
	Kayah	44	220	44	220	44	220
	Kayin	21	63	21	63	21	63
	Shan	813	1,647	813	1,647	835	1,669
	Subtotal	2,530	6,886	2,530	6,886	2,552	6,908
TOTAL		15,392	59,554	15,477	60,360	15,473	61,076

Note: Capacity on the condition of 24 hours operation a day.

Source: Myanmar: Capitalizing on Rice Export Opportunities, The World Bank, Report Number 85804, dated 28 February 2014.

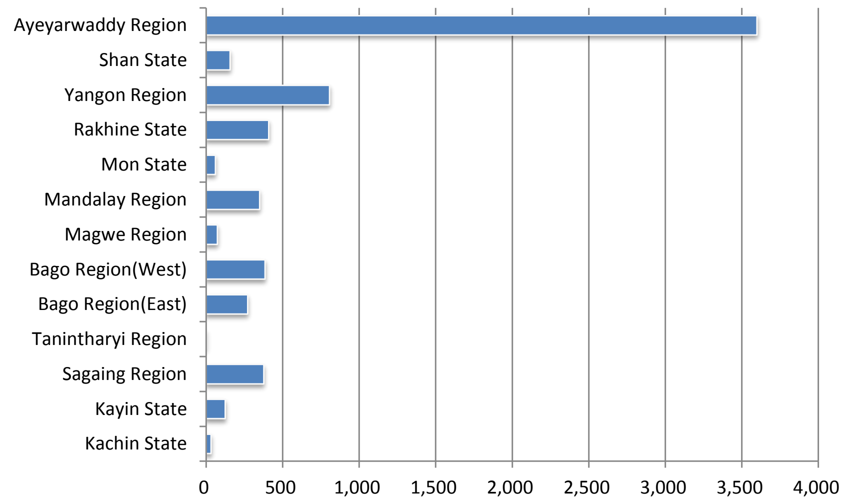


Figure 2-2 Number of Rice Mills by Division and State
Source: MRMA Date

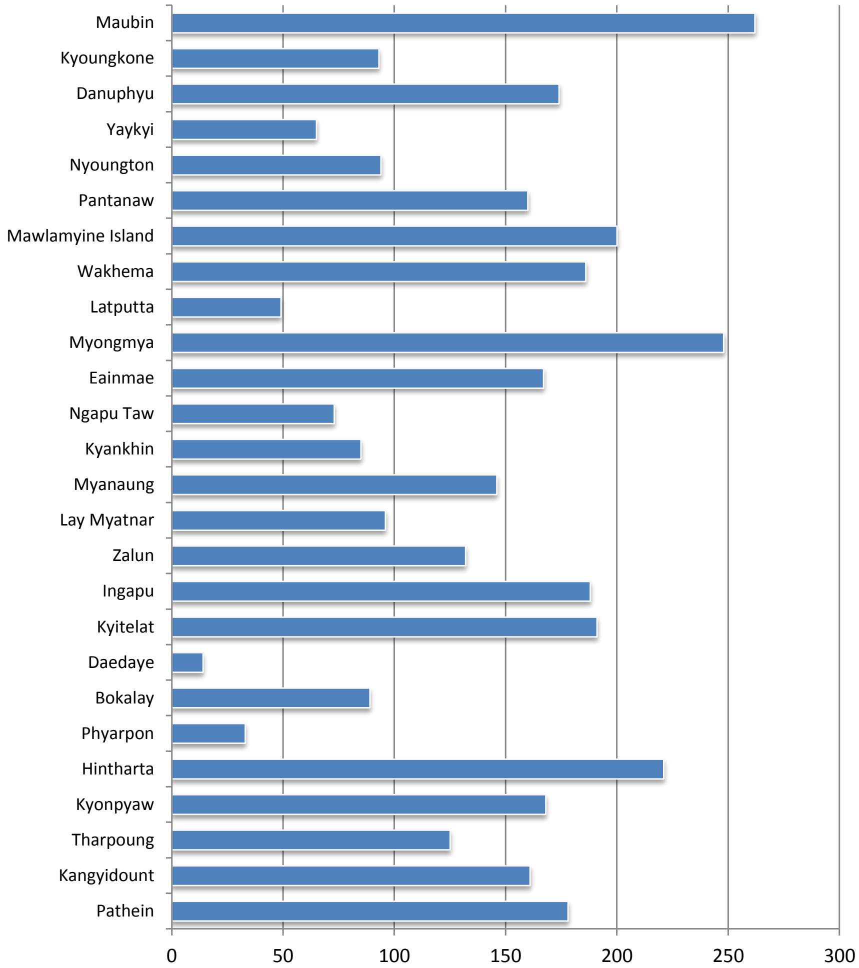


Figure 2-3 Number of Rice Mills in Ayeyarwady Region

Source: MRMA Date

Overview of Electricity Sector

Myanmar's annual per capita power consumption is about 110kWh (in 2011, based on World Development Indicators), which is 1/70 of Japan and 1/6 of India. Therefore the expansion of power supply capacity commensurate with the economic development is crucial. The required power volume in 2030 is estimated to be 11 times of the present capacity owing to population increase and enhanced electrification rate.

Table 2-2 Long Term Target of Power Supply (Up to 2030/31)

Period	Population Forecast (million)	Demand Forecast (MW)	Required Power Volume (GWh)	Target Electrification Rate (Households)
2011/12	60.44	1,806	10,444	27%
2012/13～2015/16	63.14	3,078	17,797	34%
2016/17～2020/21	66.69	5,686	32,872	45%
2121/22～2025/26	70.45	10,400	60,132	60%
2026/27～2030/31	74.42	19,216	111,100	80%

Source: Data of the Ministry of Power, Myanmar "Country Presentation of Myanmar" (July 2013)

Since Ayeyarwardy region holds many areas which are the ends of national grids, they suffer from chronic power shortage and voltage sag. For example, in Pyapon which is located at the end of national grid, most of rice mills are not able to use grid power. Even in the case of partial usage of grid power, voltage sag is a persistent challenge for them.

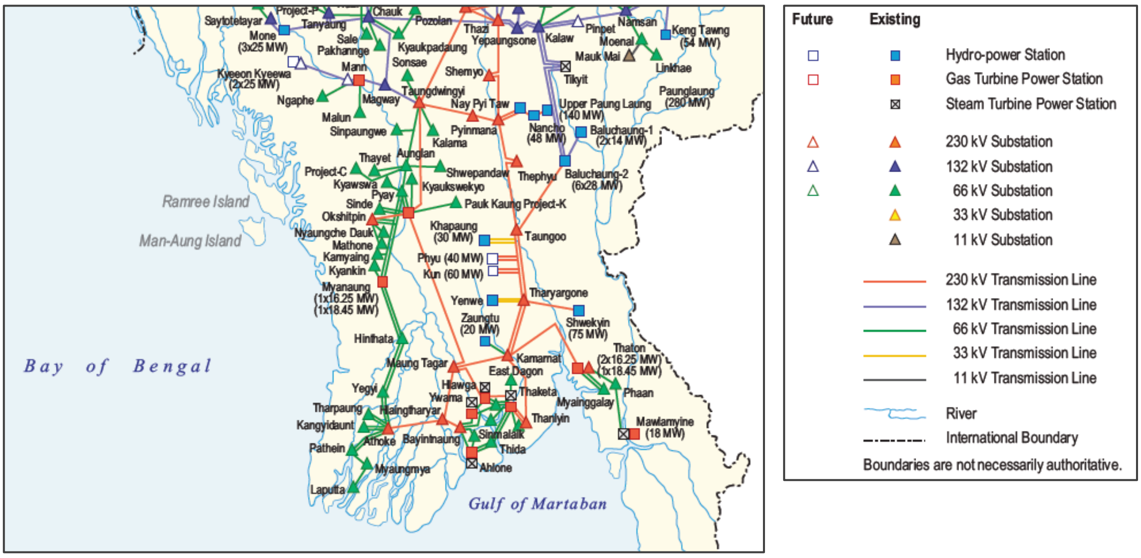


Figure 2-4 Myanmar's Power Distribution Chart

Source: ADB "Myanmar Energy Sector Initial Assessment"

The expansion of electrification in rural areas is an important policy issue from the viewpoint of regional development and life quality improvement of local residents.
Given the expansive land and underdeveloped power distribution network, the realization of electrification requires enormous investment and long period of time. To tackle the issue, although the electrification using diesel generators has been implemented in some areas, it is still limited. For instance, examples of Ayeyarwady show the electrification by diesel generators in eight towns / villages which produced power amounting to 1.5 MW in total (data of 2011). This indicates the existence of the high needs of distributed energy system suited to the local characteristics.

Table 2-3 Electrification Rate by Region

Regions/Province	Electrification ration of household	No. of villages		
		Grid	Off Grid	non-electrified
Kayar State	41%	53	42	416
Mandalay Region	35%	738	189	2,313
Mon State	31%	254	318	628
Kachin State	26%	1	283	2,295
Bago Region	23%	309	2,070	2,416
Kayin State	23%	46	79	1,928
Sagaing Region	22%	624	3,060	2,295
Chin State	16%	-	326	1,026
Ayeyarwady Region	10%	343	2,992	8,602
Shan State	9%	374	786	13,424
Tanintharyi Region	9%	573	1,611	2,588
Rakhine State	6%	-	1,033	2,827

Source: Off Grid Power For-Inter Solar Europe 2014, Jun 2014

2.2 Confirmation of local needs

In addition to the survey on Myanmar's latest situations of measures for climate change and JCM, we tried to confirm the local needs in connection with JCM projects.

2.2.1 Situations of measures for climate change

Myanmar submitted the first national report on climate change in Dec. 2012, and was provided with the emission inventory and measures for GHG emission reduction. Compared to the result of 1990, energy-derived CO2 emission has been in the increasing trend. With the prospects of proliferation of the demand for power, and the consumption of fossil fuel, measures for GHG emission would become an important policy issue.

Table 2-4 GHG Emission Volume

	1990	2000	2010	2000NC
CO2 from fossil fuel combustion	4.1	9.4	8.0	7.7
GO2 from non-energy sources	743.0	455.5	243.6	33.7
methane	84.0	66.9	78.2	26.2
N20	44.2	31.2	26.3	4.0
F-gases	-	-	-	-
Total	875.3	563.1	357.0	71.6

Source: IEA and Myanmar Country Report (2000NC column)

2.2.2 Expectations for rice husk power generation and JCM project

On the basis of the results of the field survey and the local workshops, we summarized the local expectations for rice husk power generation and JCM project and issues for realizing them as followings:

- Since President Thein Sein is interested in biomass utilization, the theme under discussion is timely.
- For rice husk power generation, “secured supply of raw materials” and “price” are the key issues. The scheme in which rice mills provide rice husk, and receive power generated thereof, may be effective from the viewpoint of stable supply of raw materials.
- Combination of rice husk and other non-rice-husk biomass is also important.
- Rice husk gasification which is currently implemented in some rice mills is problematic for the environment. Local people are more interested in power generation based on steam boilers.
- The combined usage of power by households and industries should be considered. The ratio of the share between the two sectors can be varied according to the local conditions.
- For rice mills, if both power and heat are available, it is a great merit.
- The profitability threshold for rice mills is the operation of 200 days a year. If the availability of power is limited, they cannot get enough working days. The power generation project would bring about positive effects to the operation of rice mills.
- In terms of power generation project, the consideration of the power policy (Ministry of Power) is indispensable. Biomass power generation is not viable without the proper pricing system commensurate with the cost.

3 Consideration of Utilization of JCM

3.1 Analysis of emission reduction of energy-derived CO2 & greenhouse gas

We examined methods of emission reduction of CO2 from fuel combustion and greenhouse gas of the target facilities. We then calculated the reduction volume of such energy-derived CO2. The outline of the examination is described below.

(1) CDM (Clean Development Mechanism) in Myanmar

1) Examples of CDM application

CDM has not yet taken roots in Myanmar. The only CDM projects in Myanmar are one registered and one proposed, both of which are hydro-power generation projects.
The sole CDM registered project, Dapein (1) Hydropower Project is of 240 MW in scale, one of the larger CDM project. However, since their registration (Feb. 2013) was after the 1st commitment period, CER has yet to be issued.
It is noted Dapein project aims at electricity export to China.

Table 3-1 Examples of CDM Projects in Myanmar

Project Title	Scale	Annual Expected CER（kt-CO_2）	CER Issuance
Dapein (1) Hydropower Project in Union of Myanmar	240MW	709	Not Yet
Upper Baluchaung No.2 Hydropower Project in Myanmar	10MW	18	Not Yet

Source: UNEP/Risoe CDM Pipeline, as of Sept. 2014

2) Estimate of CO2 emission factor of grid of Myanmar

As mentioned above, there is only one CDM registered project in Myanmar, which is supposed to replace the power supply from China. Therefore, there is no official grid CO2 emission factor for Myanmar which is approved by UNFCCC so far. Under the circumstances, we consider the CO2 emission factor of grid of Myanmar.
According to IEA, power generation volume by power source of Myanmar is as shown below.

Table 3-2 Power Generation Volume by Power Source of Myanmar

	Coal	Petroleum	Gas	Hydro	Others	Total
2009	473	30	1,205	5,256	-	6,964
2010	671	33	1,734	5,105	-	7,543
2011	724	38	1,588	7,518	-	9,868
2012	771	51	2,144	7,766	-	10,712

Source: IEA, Energy Balances of non-OECD Countries:(Unit) GWh

IEA's statistics of energy consumption of power generation sector of Myanmar is as follows:

Table 3-3 Energy Consumption of Power Generation Sector of Myanmar

	Coal	Petroleum	Gas
2009	126	8	374
2010	179	8	538
2011	179	10	493
2012	187	13	665

Source: IEA, Energy Balances of non-OECD Countries: (Unit) ktoe

The source composition of Myanmar's system-supplied power is as shown below. It is evident, as the figure shows, that the hydro-power development is significant after 2000.

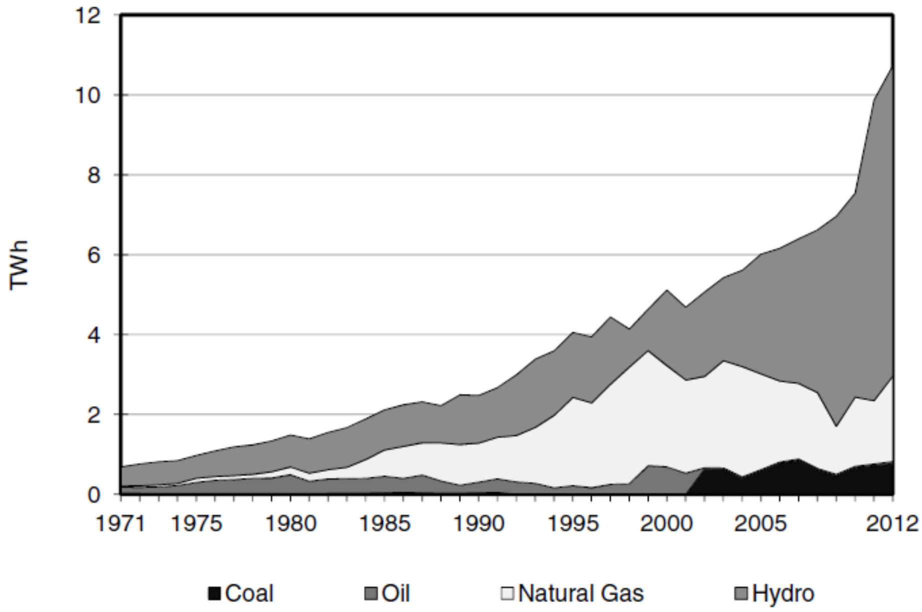


Figure 3-1 Source Composition of Myanmar's System-Supplied Power

Source: IEA, Energy Balances of non-OECD Countries

Based on the above figures, power generation efficiency of thermal power plants in Myanmar can be calculated as shown below.

Table 3-4 Myanmar's Source-Wise Thermal Power Generation Efficiency

	Coal	Petroleum	Gas
2009	32.3%	32.2%	27.7%
2010	32.2%	35.5%	27.7%
2011	34.8%	32.7%	27.7%
2012	35.5%	33.7%	27.7%

By multiplying source-wise emission factor of CO2 emission (IPCC 2006GL) on the above figures, CO2 emission factor of Myanmar's power plants are calculated as shown below.

Table 3-5 Myanmar's Source-Wise Emission factor of CO_2 Emission of Thermal Power Plants

	Coal	Petroleum	Gas	System Average
2009	1.055	0.864	0.729	0.202
2010	1.057	0.786	0.729	0.265
2011	0.979	0.853	0.729	0.192
2012	0.961	0.826	0.729	0.219
Emission factor of fuel (t-CO2/TJ)	94.6	77.4 (Heavy Oil)	56.1	

Therefore, Myanmar's grid emission factor can be calculated as around 0.2t-CO2/MWh. This calculation formula is atypical from the usual method of obtaining CO2 emission factor of grid based on operating margin (OM) and build margin (BM) as required by CDM. However, more than 70 % of the total power generated in Myanmar is from hydro-power plants. According to the method specified in the CDM tool "Tool to calculate the emission factor for an electricity system" 1, the simple operating margin cannot be applied. At this moment, enough data which enable calculation based on simple adjusted dispatch analysis, as well as combined margin (CM) estimation and build margin (BM) estimation, are not available. Therefore, the only available method is Average OM. According to the above-mentioned CDM tool, the Average OM can be a substitute for BM, which means OM=BM=CM.

As mentioned earlier, the only CDM registered project of Myanmar, Dapein (1) Hydropower Project, is to replace the electricity introduced from China. Therefore, it does not include calculation of Myanmar's grid CO2 emission factor. The only project used for the estimation of Myanmar's grid CO2 emission factor, Upper Baluchaung No.2 Hydropower Project 2 (not yet registered) provides the calculation of Myanmar's emission factor of system-supplied power as 0.39459t-CO2/MWh based on the Average OM of 2006 to 2008. However, since the rapid expansion of hydropower generation took place after 2008, it is doubtful if the Baluchaung's figure is still valid.

In the circumstances where such low CO2 emission factor of system-supplied power is provided, we conceived two ways of ensuring enough carbon credits in CDM; 1) consideration of off-grid power source, and 2) consideration of suppressed demand.
The following is our consideration of applicability of the two ways

(1) Consideration of Off-Grid Power Source

Many developing countries have low electrification rate, low electricity access rate, and high ratio of hydropower in the system-supplied power. Because of these characteristics, it is usually difficult for them, in the case of grid-connected power generation projects, to issue CDM credits under the normal concept. Thus the estimation of off-grid power is called for.

[1] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf/history_view
[2] https://cdm.unfccc.int/Projects/Validation/DB/VM2SI67C7Y6Q7GDQXR6297ILUSC50P/view.html

The background is that in African region, for example, where CDM projects are few, the reliability of power system is limited, and they have to estimate the off-grid power volume including mini-scale private power generation. Under these circumstances, “Tool to calculate the emission factor for an electricity system” for estimating CO2 emission factor of system-supplied power was revised to accommodate a scenario to substitute system-supplied power with off-grid power.

This approach is favorable since we can use existing method which use OM, BM, and their combined margin (CM) with reference to CDM tool. However, information on off-grid power is necessary.

The conditions of inclusion of off-grid power into grid CO2 emission factor in CDM tool for emission factor calculation for system-supplied power are shown below.

Table 3-6 The conditions of inclusion of off-grid power into grid CO_2 emission factor in CDM tool for emission factor calculation for system-supplied power

Articles	Outline
Extensive presence of off-grid power	Limited to cases where off-grid capacity is more than 10% of grid-connected capacity or generation.
Verification of users' easy choice and switch between system-supplied power and off-grid power	Implement sampling analysis.
Verification of economic merit of system-supplied power	Show the evidence of higher operation cost (fuel cost, etc.) than the tariff of system-supplied power.
Verification of no existence of restriction other than power generation capacity	Show the unreliability of system-supplied power with frequent power outage and voltage variation, and its responsibility to be owed by the generator (not the distribution).
Generation volume by off-grid	For off-grid sources that fits the above conditions, obtain generation by 1) cumulative generation, 2) fuel consumption and default efficiency, 3) capacity and default load factor.

The extension of this tool is consistent with the enhanced geographical fairness which COP/MOP requested. In addition, CO_2 emission factor of off-grid power source will be more than 0.8t-CO_2/MWh which is attractive from the viewpoint of emission reduction credit. However, as is the case of other countries, off-grid power is mainly diesel engines which is costly. In many cases, they are used only for backup purpose, and are not operated to the extent which influences the CO_2 emission factor of the grid system.

(2) Consideration of Suppressed Demand

Suppressed demand means the demand which should exist under normal circumstances, but in reality remains unfulfilled due to poverty, etc. Marrakesh Accords（decision 3/CMP.1）paragraph 46 “The baseline may include a scenario where future anthropogenic emissions by sources are projected to rise above current levels, due to the specific circumstances of the host Party” is supposed to be exactly the situation like this.
The difference between suppressed demand and the normal baseline scenario in the absence of the project is like what is described below. While the baseline scenario is the

scenario where the fulfillment of expectations are realistically imagined, suppressed demand is not necessarily so.

Table 3-7 Difference of Baseline Scenario and Suppressed Demand

Baseline Scenario	Suppressed Demand
– If the project is not implemented, alternative measures to provide equivalent services will be introduced. – For example, if a geothermal power plant is not constructed, the grid system would introduce any alternative facilities.	– In the absence of the project, alternative measures to provide equivalent services are unlikely to be introduced. – However, the services to be provided is considered to be the requirement from the basic human needs viewpoint. Therefore, it is to be hypothesized that alternative measures would have been introduced.

While the origin of the above-mentioned concept of suppressed demand goes back to Marrakesh Accords in 2001, the detailed analysis method was specified in the Guidelines on The Consideration of Suppressed Demand in CDM Methodologies（EB62 Annex 6：July, 2011） The methodology outline is described below.

Table 3-8 Analysis of Suppressed Demand as Recommended in CDM

Identification of the baseline technology / measure – Identify the various alternative – Identify compliance with local regulations – rank the remaining alternatives remaining in order of decreasing efficiency – Assess the alternatives and eliminate in that sequence alternative which face barriers (e.g. LED, CFLs and incandescent lamps are all restricted by lack of electricity, so in the absence of electricity, the baseline will be lamps)
Determination of the baseline service level – The service level provided prior to the implementation of the project. – The service level provided under the project – Globally applicable conservative thresholds as – minimum service levels by peer review journal, benchmarks,
Identification of the baseline service level – The service level provided prior to the implementation of the project. – The service level provided under the project – Globally applicable conservative thresholds as – minimum service levels

Source: Guidelines on The Consideration of Suppressed Demand in CDM Methodologies

Although suppressed demand is applied to the minimum service level (MSL), it is not applicable to the consumption level of developed or advanced developing countries, for example. In addition, while suppressed demand is applicable to enjoyment of services for basic household life such as power, heat and water / sewage, etc., it seems it is not applied to the industrial sector.

Currently, it has yet to reach the stage of systematic calculation of MSL in CDM. However, it is noted that the suppressed demand concept itself has already been incorporated in some methodologies, especially in the small scale CDM methodology with particular attention to the above-mentioned Guidelines. In *Rationale for Default Factors used in the Proposed Methodology* which was prepared in the course of consideration of *AMS I-L (Electrification of Rural Communities using Renewable Energy)*, MSL related to electricity was discussed. It drew out the figure of 250kWh/user which is said to be equivalent to several hours of use of two fluorescent lamps, a radio and a fan together. Here "user" is the client of electricity, and equivalent to "household". In developing countries, one user is supposed to include four to five people. This is consistent with annual household power consumption 50kWh/person. According to the data of IEA, annual household power consumption is 725 kWh/person for the world average, and 2,275 kWh/person for Japan (both 2012). In this context, 50kWh/person/year is an extremely low figure.

3.2 Calculation of emission reductions

Development of a methodology to calculate emission reductions are shown below.

Grid CO2 emission factor of Myanmar

First step to develop a methodology for rice husk generation in Myanmar is to derive the grid CO2 emission factor of Myanmar. The grid average CO2 emission factor can be calculated by using the fuel consumption data of Myanmar and fuel-specific CO2 emission factor as defined in IPCC 2006GL. This results in fuel-specific and grid average CO2 emission factor as follows.

Table 3-1 CO2 emission factor of electricity generation in Myanmar according to fuel source

(t-CO2/MWh)

	Coal	Oil	Gas	Grid average
2009	1.055	0.864	0.729	0.202
2010	1.057	0.786	0.729	0.265
2011	0.979	0.853	0.729	0.192
2012	0.961	0.826	0.729	0.219
Average 2010-2012				0.222

These results in a grid average CO2 emission factor of 0.222t-CO2/MWh, using methods approved under CDM. This means that the grid average CO2 emission factor of Myanmar is smaller than most countries, the reason being the predominance of electricity generated by hydropower in Myanmar (over 70%).

Introduction of natural gas based generation is planned in Myanmar, and in 2016 it is expected that electricity from gas-fired power plants exceed that from hydropower plants. Therefore it is expected that grid CO2 emission factor will increase in the near future ,suggesting that emission reduction from the project will increase as a result of ex post estimation (as opposed to ex ante estimation). The possible benefit of ex post estimation, however, must be taken into consideration with additional burden of annual calculation and uncertainty. It is likely however that marginal generation in Myanmar is fossil fuel.

According to CDM rules, taking into account possible future installation of gas-fired plants necessitates obtaining detailed generation data. In the absence of such available data, it was not possible to derive a method and calculate the impact of fossil fuel generation in the future.

Elements to be considered.

In addition to grid CO2 emission factor, other elements to be considered are as follows.

Elements	to be considered?	Reasons etc.
Off-grid power	No	In the project region, provision of electricity to areas not connected to the grid is done by charging automobile batteries using grid electricity
Suppressed demand	Yes	Per capita household electricity consumption in the project region is small.
Methane	No	Rice husk is often disposed in ways more aerobic than stockpiling (e.g. discarding to the river) or spreaded onto the surface soil.
Heat utilization	Yes	Rice in Myanmar is normally sun-dried, therefore drying by heat may not result in GHG reduction. However, this is taken into consideration since improvement in quality is expected.

based on the above, the outline of methodology is as follows:

Item	Outline
Eligibility criteria	● Rice husk based power and / or heat generation. ● Technical criteria such as efficiency, environmental soundness are being considered.
Reference emissions	● Multiply the following emission factors to electricity provided – household: 1.0t-CO2/MWh（suppressed demand） – industrial: 0.8 t-CO2/MWh（for facilities not connected to grid） – other: 0.222t-CO2/MWh（substition of grid electricity） ● Heat generated is assumed to substitute HFO boiler with an efficiency of 90%.
Monitoring methods	● Electricity generation: monitored by electricity meters (electricity provided to the grid, industrial facilities and household need to be measured separately) ● Heat: monitored by steam flow meters

Item	Outline
	● In-house fuel consumption (project emissions): monitored by fuel meters (can be substituted by purchase records) ● Transport fuel consumption: the following methods can be considered. – Actual measurement of transport fuel consumption (or purchase) – Use CDM default emission factor of 245g-CO2/t-km. – Can be omitted since projects which transport fuel emission is significant is not viable.

Calculation of emission reductions

<Base case>

Base case is established as follows:

Capacity	1.6MW
Plant load factor	70%
Efficiency	15%
Provision of electricity	grid 80%, off-grid industrial facilities 19%、household 1%
Transport of	10km

For the sake of simplicity, auxiliary fuel is not considered, and existing facility is not taken into account. The resulting figures are as follows:

Reference emissions	3,359t-CO2（Reduction of grid electricity1,742t-CO2, Substitution of off-grid industrial facilities1,491t-CO2、 Substitution of household electricity 98t-CO2）
Project emissions	44t-CO2
Emission reductions	3,287 t-CO2

The resulting figures can be said to be conservative since 1) they do not consider reduction of T&D loss, 2) using a conservative estimate for suppressed demand, and 3) not taking into account methane emissions from stockpiling.

Reduction by heat generation.

Heat generated by combustion of rice husk can be used to industrial facilities in the vicinity of the generation facility. The issue to be considered is what type of heat that would have been used in the absence of the project. Heat can be used to dry rice husk, which in Myanmar is usually sun-dried. Substituting sun-drying with drying by waste heat does not lead to emission reductions. However, if the concept of suppressed demand (which is confined to household sectors in CDM) is expanded to industrial facilities, then emission reduction can be claimed for substitution of sun-drying with drying by biomass heat.

Capacity	1.6MW
Plant load factor	70%
Efficiency	20%
Fuel substituted	HFO（CO2 emission factor at 75.5t-CO2/TJ）
Efficiency of boiler substituted	90%

Assuming the above, emission reduction from heat provision can be calculated at 3,951t-CO2, surpassing emission reduction from electricity generation. It should be noted that this also incorporates conservativeness as CO2 emission factor of HFO is on the lower end of IPCC 2006GL default, and reference boiler is assumed to be highly efficient, in line with current CDM provisions.

Consideration of secondary GHG emission reductions

There is possibility of reduction of methane emissions by arising from dispose of rice husk under anaerobic condition. However, disposes of rice husk are case by case. According to our interview of some rice millers, most of rice husk are used in their miller and/or other factories such as brick factories. Therefore, reduction of methane emissions was not considered with conservative views.

3.3 Economic and social benefits

Securing stable power supply is a challenge for the management of rice mills. The viability threshold of rice mills is considered to be 200 working days. Ensured power supply is indispensable for enhancing rice mills' operation rate, and their scale expansion and equipment modernization. While some rice mills introduced in-house power generation facilities which use small scale rice husk gasification system, they have a drawback of low efficiency. The needs for conversion to efficient power generation system are high.

The creation of new industries such as processing of rice and agricultural products, and product distribution, etc. is important for the promotion of local industries. Securing power supply is vital for this. Power and heat made available by rice husk power generation would be helpful for the creation of new business opportunities:

-Rice quality improvement by drying rice utilizing heat produced by rice husk power generation system.

-Utilization of heat acquired by rice husk power generation system for drying fisheries products, and beans.

Introduction of rice husk power generation would not only contribute to improvement of financial condition and competitiveness of rice mills, but make them as strongholds for energy supply for local communities.

4 Feasibility Study for the Project

We examined the feasibility of the rice husk power generation project from three viewpoints; 1) overview of the candidate community situation and their needs, 2) the system to be introduced, and 3) the project proposal.

4.1 Overview of the candidate communities and their needs

We conducted the document research and hearing survey to local knowledgeable people in Ayeyarwady region, which is the candidate place for the project implementation. In the course of the survey, we studied the local development plan, the local socio-economic conditions including rice-related industry promotion measures, power generation & distribution network and its future plan, electrification plan, rice husk generation situation and its usage, environmental regulations, the system to be introduced, and the feasibility of the project implementation as well as the examination of local needs (for power, heat, silica and charcoal, etc.).

4.1.1 Overview of rice milling plants and its business environment

For the examination of the project feasibility, we describe hereunder the situation of rice milling plants in Ayeyarwady region, and Myanmar's business environment for foreign capital.

(1) Rice milling plants in Ayeyarwady region

Ayeyarwady region harvests almost half of Myanmar's total rice production, and it has lots of rice milling plants. The current power sources of rice milling plants are grid power, diesel engines making use of heavy oil, gasification power and boiler steam from rice husk burning. In areas with no access to national grid, while their major power source was boiler steam in the past, small-scale gasification power and diesel engines have been increasing. Even in areas with access to national grid, since their power supply is not enough, small-scale gasification power or diesel engines are complimentarily used by local rice milling plants.

(2) Business environment in Myanmar

In Myanmar, there are varied constraints on business initiated by foreign capital, one of which is the Foreign Investment Law. The most serious bottleneck is the bylaw of the Article 4 of the Foreign Investment Law, "Manufacturing and Service Industries allowed only for Myanmar Nationals to Undertake". It specifies the prohibition of foreign capital's participation in "Power Generation below 10 MW". It is necessary to confirm with relevant government offices if the restriction applies to individual power generation units or individual investors.

4.1.2 Confirmation of local needs

We have confirmed, by the field survey and at the local workshop, that many local rice milling business people are keenly interested in rice husk power generation system (a system to use steam turbine with direct combustion). The background of their strong interest is considered as follows.

- There exist strong needs for securing stable power sources required for rice mills.
- They have strong motivation for modernizing rice mills and business expansion.
- They have problems in small-scale gasification power generation.

The situations are different depending on areas and existing power sources they use. Some areas have riverside rice mills, whereas mills are located far from rivers in other areas. In riverside areas, some are with access to national grid even if the available power volume is limited, while others have no power grid. The needs and their quality are different depending on the characteristics of the location of rice mills, and their power sources.

4.2 Consideration of the system to be introduced

In view of the relationship between scales of rice mills and power generation, it can be organized in the segments as described below.

Table 4-1 Relationship between Scales of Power Generation and Rice Mills

Rice husk collection facility	Generation capacity		
	Small	Medium	Large
	～2MW	2～3MW	>3MW
Multiple rice mills			
Stand-alone rice mill			Special conditions

High potential
Medium potential
Low potential

As for rice husk ash generated after combustion, we further consider the following four ways of effective utilization.

Table 4-2 Reuse Methods of Rice Husk Ash

Reuse methods	Merit	Demerit
Cement material	No treatment necessary	Limited destination
	Potentially large demand	Long transport distance
Silica board material	No treatment necessary	No industry yet
	Potentially large demand	
Industrial feedstock	Can command high price	Need refining
		Need additional facilities
Silicic acid fertilizer	No treatment necessary	Need examination on transportation and dispersion
	Potentially large demand	

Considering the situations of Ayeyarwady region, we propose the following directions.

- A cement plant is located in the northern part of Ayeyarwady which makes the economical shipment difficult. Therefore, a model of local cement use for building materials by means of board manufacturing is proposed.

- The increased demand for cement in Ayeyarwady is expected in the mid to long term. The promotion of cement use in accordance with the construction of new cement plants is proposed. The sea transport of products from Pyapon to cement plants located in the southern part of Yangon can also be considered.

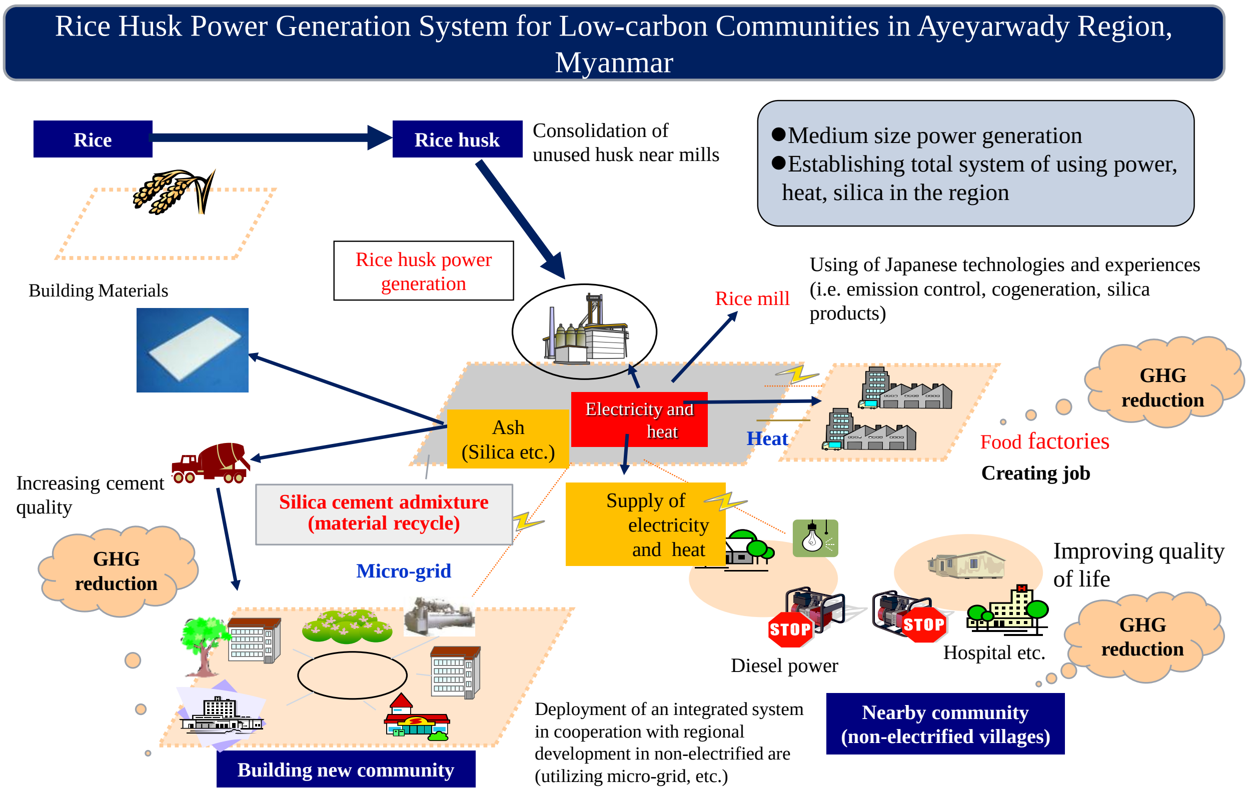


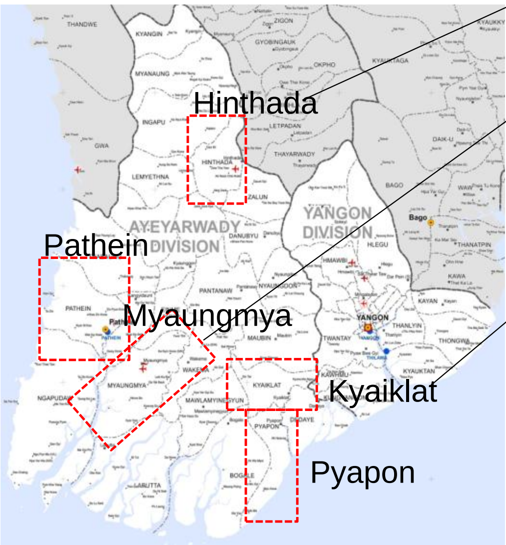
Figure 4-1 Image of Business Operation

4.2.1 Identification of target facilities to be introduced

We have identified prospective candidate locations for introduction of rice husk power generation system in Ayeyarwady in consideration of power generation sources, demand for power and heat, local understanding of the system and motivation, and availability of biomass such as rice husk, etc.

(1) Characteristics of candidate townships for the project

Based on the number of rice mills, milling capacity and the advice from Myanmar Rice Federation (MRF), we have selected five candidate townships in Ayeyarwady, namely Pathein, Myaungmya, Pyapon, Kyaikat and Hinthada.
They have their own characteristics as outlined in the figure below. Taking account of the current road infrastructure of Myanmar, and the extremely small gravity of bulk of rice husk, Myaungmya, Pyapon and Kyaikat, all of which are located along the river, can be prospective townships to start with.



Small scale of rice mills
Inland, overland transport

Rice mills are adjacent along the river
Ship transport
Close to urban areas, also expected to increase in the future power demand
Construction of the grid are also relatively advanced.

Rice mills are adjacent along the river
Ship transport
The end of the national grid, the power supply is weak, also delays Construction of the grid.
Pyapon is less generation amount per unit of rice husk than Kyaiklat.
From the difference of the breed characteristics
High rice husk of utilization

Figure 4-2 Characteristics of Candidate Townships

(2) Identification of candidate townships for the project

We have further compared the above three townships. Pyapon and Kyaikat are particularly prolific areas in rice production in Ayeyarwady. However, since the national grid is underdeveloped in these areas, power sources of rice mills are limited to boilers and small-scale gasification power generation, and rice milling capacity is small compared to their rice production volume. Out of unhusked rice produced in their areas, the portion that cannot be husked locally is shipped to other areas for rice milling. In that sense, there is a potentiality that rice husk power generation makes milling facilities viable, and subsequently the availability of rice husk also increases.

On the other hand, Myaungmya is the most active township with regard to rice milling. They receive unhusked rice shipped from other areas for rice milling. Their rice milling volume is bigger than their own rice production volume, and rice husk is easily available.

In Ayeyarwady region, trunk roads are paved, though not quite satisfactorily, and passable for large trucks. However, most of branch roads are either with simple pavement or no pavement. Considering the current poor road conditions and small gravity of bulk of rice husk, rice husk is not suitable for long distance transport. Therefore, it seems establishing plural small scale rice husk power generation plants is more appropriate in Myanmar than setting up a large scale power plant collecting rice husk from many rice mills.

Since national grid has been consolidated in Myaugmya, though not with satisfactory power volume, selling electricity to national grid is not difficult. It will be a reasonable idea to initiate an advance model in Myaungmya, and then adjust the model with due consideration of the situation of other areas to disseminate rice husk power generation in Ayeyarwady region.

4.2.2 Consideration of the technology to be introduced

We have examined an autonomous distributed type rice husk power generation system suited to Ayeyarwady in Myanmar. Supposing a medium scale power generation (around 2 MW / station), we conceived a sequential components from procurement of raw materials, facility characteristics, operation and maintenance, and to effective local utilization of power, heat and silica (contained in burned husk ash) in the region. We also considered the possibility of application of Japanese technology and experience to biomass burning boilers and related facilities, etc. in Myanmar.

(1) Comparison of power generation systems

Considering the characteristics of rice husk, possible choices of power generation systems are direct burning type and gasification type. The former is the type to change heat gained from rice husk burning into steam with which steam turbine is rotated for power generation. Since its structure is simple, it is inexpensive and easy for maintenance. The latter is to change rice husk with high temperature, and through decomposition or recomposition, into combustible gas with which gas engine is activated for power generation. Tar produced upon gasification is a challenge which requires frequent engine maintenance.

In the areas we have surveyed, there were plural rice mills that had introduced small scale gasification power generation system individually. However, no consideration was paid to their environmental aspects, and charcoal generated was accumulated in mills' premises, and there were even cases of spillage into rivers. In addition, tar generated is also discharged without any treatment. In the circumstances, the aspiration for direct burning system, not for gasification system, is high in the public offices of Ayeyarwady.

Therefore, we have decided to consider the direct burning system in the project.

Table 4-3 Analysis of the Proposed System

	Direct Combustion	Gasification
Initial Cost	Cheap for simple structure	Expensive for many process
Running Cost	・Water treatment for boiler water is necessary	・Expensive by cleaning many times ・Need waste water treatment cost ・Lifetime of equipment is short by produced tar
Maintenance	・Shutdown of 2 or 3 days/month for periodic inspection ・Operation time is 24 hour a day, 330 days/year except periodic inspection day	・Unestablished tar removal technology ・Many tar removal operations are necessary ・Need frequent removal of tar from system ・Cleaning wastewater comes into each cleaning ・Wastewater treatment system is necessary
Environmental	・Rice husk ash is available for sale as a cement admixture ・Contains dust in the exhaust gas (Dust collector in can be processed)	・Rice husk coal is available for use ameliorate in farm lands, but the coal is stocked in backyard because it is not sold well. ・There is a possibility of leakage of fuel gas, which is a greenhouse gas

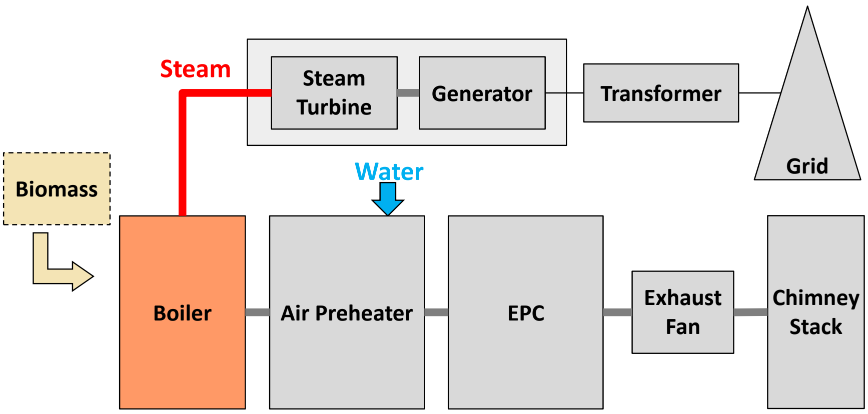


Figure 4-4 Direct Combustion System

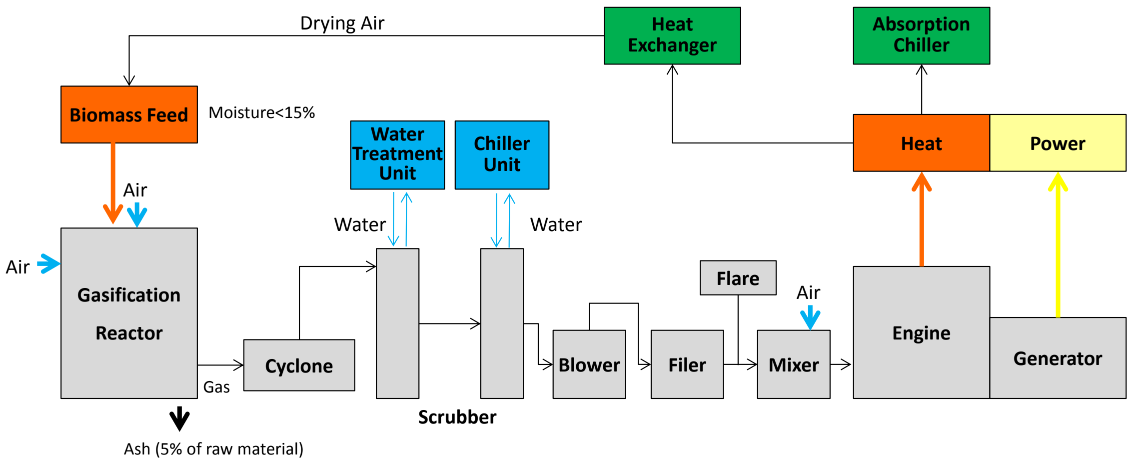


Figure 4-5 Gasification System

(2) Consideration of specification of power generation system

In the case of direct burning system, the bigger the scale, the more efficient, and the lower the initial cost from the viewpoint of boiler efficiency. Although it is the bigger, the better, what is crucial is the stable supply of rice husk which is the fuel for power generation. In Ayeyarwady, since the power supply is not enough even in the areas with national grid, the rate of operation is less than 60 % in many rice mills. If the milling capacity is more than 100 t / day per rice mill, it is a fairy large scale mill. Therefore we have specified the boiler's capacity in accordance with the procurement volume of each rice mill or combined volume with neighboring rice mills.

On the supposition that stable rice milling and improved operation rate is made possible due to the introduction of power generation plant, we have conceived a rice mill with the capacity of 240 t / day (10 t / h). Since rice husk weighs about 20 % of the weight of unhusked rice, rice husk produced is 48 t / day (2 t / h). This volume of rice husk enables the power generation of net 1.6 MW. Since this is small scale, we specified the facilities to allow burning with high temperature to attain high boiler efficiency. In addition, we included husk drying facilities in order to create demand for heat and to produce better quality rice. The heat supply capacity is set to be equivalent to husk drying capacity in accordance with milling capacity.

BTG & PADDY DRYING SYSTEM

Spec sheet for plant

No.	ITEM DESCRIPTION	UNIT	VALUE
POWER GENERATION PLANT			
1	POWER GENERATION	KW	1816
2	POWER CONSUMPTION OF PLANT	KWH	182
3	POWER SELLING	KWH	1,634
4	RICE HUSK CONSUMPTION	TON/H	2
5	WATER CONSUMPTION	TON/H	7.96
PADDY DRYING			
6	MOISTURE OF PADDY BEFORE DRYING	%	18
7	MOISTURE OF PADDY AFTER DRYING	%	14
8	WEIGHT OF MOIST PADDY TO BE DRIED UP PER HOUR	KG/H	10,488
9	PADDY WEIGHT AFTER DRYING TO 14% MOISTURE	KG/H	10,000
10	STEAM REQUIRED TO PROVIDE HEAT TO THE AIR	TON/H	1.288

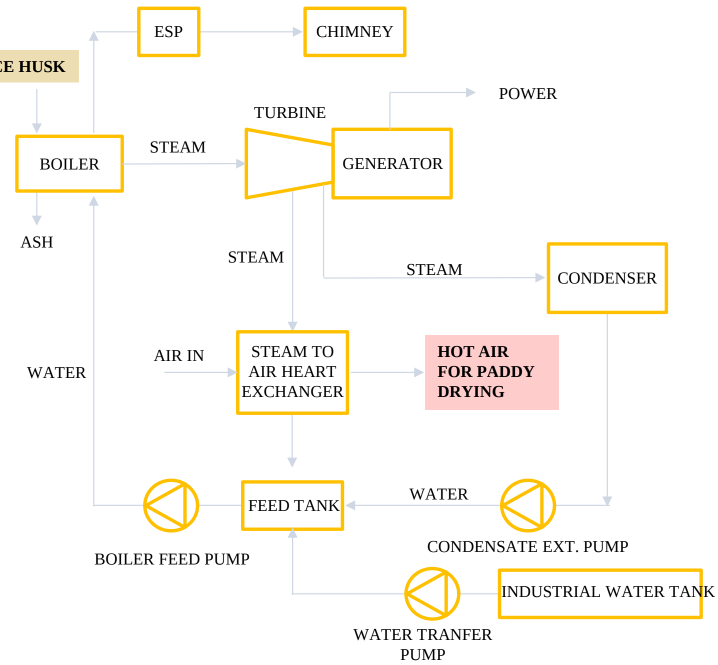


Figure 4-6 BTG and Husk Drying Facilities

4.3 Consideration of project proposal

Upon the confirmation of matters to consider in socio-environmental aspects, and based on the survey results and the local needs, we considered the project proposal.

4.3.1 Confirmation of matters to consider in environmental and social aspects

We analyzed the possibility of environment impact caused by rice husk power generation (eg. air pollution, water contamination) and its countermeasures, requirements and procedures of EIA, social impact of the project location and its countermeasures, etc. with reference to relevant local laws and regulations.

(1) Environment-related legal framework of Myanmar

In principle, it is required to obey the local legislation of the owner of the project. However, in the case of Myanmar, it is said it is necessary to individually negotiate with relevant organizations including the Investment Committee because of its underdeveloped legislation. Therefore, at this moment, it might be appropriate to consider in accordance with international standards (such as JICA socio-environment consideration guideline, IFC Performance Standards, ADB Safeguard Policy Statements 2009).

Myanmar's basic law on environment is “Environmental Conservation Law 2012” (Law 2012). Following the prescription of this law, the Ministry of Environmental Conservation and Forestry; MOECF), as the competent authority of environment management and harmony with environment of Myanmar, drew up the draft of laws as listed below.

1) Stipulation of environment standards (exhaust gas, water discharge)
2) Restriction of exhaust gas, drainage and water discharge methods
3) Legislation of EIA for proposed projects
4) Evaluation of compliance and compensation for damages by environment polluters

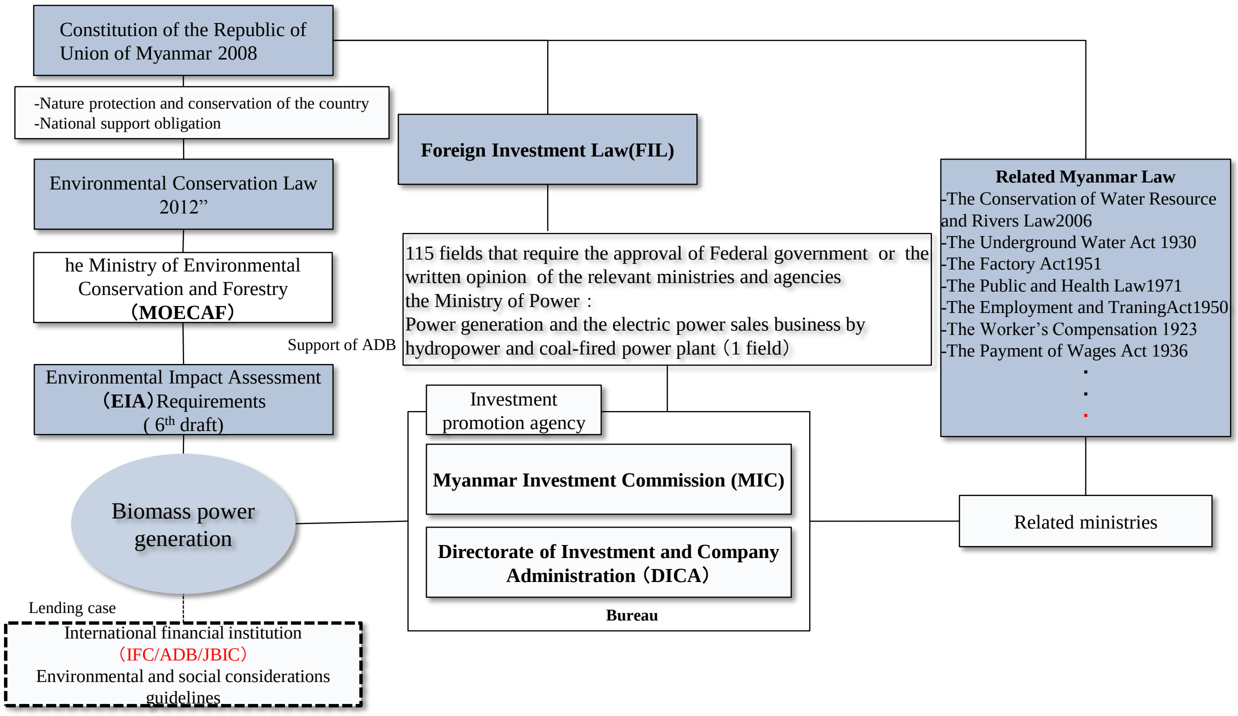


Figure 4-7 Consideration of Project Proposal (Care for Socio-Environment Aspects)

However, at the time of preparation of this report, the EIA procedures and the national environment standards (air pollution, water quality, noise, exhaust gas control, etc.) are yet to be formulated, and are still in the stage of draft.
Recently, the prescription of project categorization was added to the draft EIA law, and the requirements of initial environmental examination (IEE) or EIA are now stipulated. It seems that only IEE will be required for biomass projects with less than 50 MW capacity. In reality, it is supposed that relevant ministries, etc. would evaluate the necessity of EIA and review its results.

(2) Environment standards to be applied

In terms of individual environment standards such as ambient air quality, industrial effluent, water contamination and noise, we are to comply with the guideline of exhaust gas emission from small scale combustion facilities in the IFC EHS Guideline (International Finance Corporation Environmental Health and Safety) (Thermal Power Generation) and IFC EHS Guideline (General).

Small scale combustion process means the system designed to supply electricity, machinery power, steam, heat and / or the combination of these equivalent to 3 - 50 MW in thermal output derived from the total of rated value heat capacity, irrespective of types of fuel.

In addition, it is necessary to build the local support system for management and maintenance of facilities in order to operate the power generation system as planned.

Environmental protection of power plant

<Exhaust emission>

- IFC EHS Guidelines (general)
- Assuming compliance with "Exhaust gas guidelines of small-scale combustion facility (Heat output3-50MW, Solid fuel)"
  - Particulate matter : Cyclone dust collector
  - NOx and SOx : Since nitrogen and sulfur component of rice husk is small, special processing is unnecessary
  - Dioxin : Although rice husk hardly contain chlorine, it is assumed that it is shifted to rice hulls by absorbing dioxin of soil (no guideline value)

<Ash>

- Fry ash: Considering the introduction of bag filter or electrostatic precipitator (include assume dioxin measures also)
- Main ash: Study multiple reuse (Cement, fertilizer, Building material, other)

Local support system for the maintenance, etc. of equipment

Local support system related to maintenance etc. of the equipment in order to operate the plant as configured is important

- Considering the support system from neighboring countries, for it cannot establish that system in Myanmar.
- Considering of local system, if it are expected to increase in the business operator.

4.3.2 Consideration of commercialization scheme

We also analyzed the requirements of facilities and their operation and maintenance system, feasibility (construction cost, OM cost, expected revenue), fund raising plan making use of MOE/JICA Collaboration Fund, ADB's contribution and facility subsidy fund, etc., and the project implementation framework.

In addition, we further consider the measures to implement the project in an integrated manner with the regional development in the non-electrified areas adjacent to micro grid. For this purpose, we make consideration in a chronological basis, namely the first phase (roughly 1 to 2 years later from now), and mid to long term phase (roughly 3 to 8 years later from now).

(1) Business development

We imagine the following step-by-step development taking account of the possible assistance programs of the government of Japan.

- 1st Step: Construction of 1 unit of prototype facilities (less than 2 MW) and trial operation
- 2nd Step: Full scale operation including horizontal expansion in a same district and dissemination to other districts based on the results of the prototype.
- 3rd Step: Dissemination to the whole area of the region in collaboration with the electricity infrastructure development in micro grid areas.

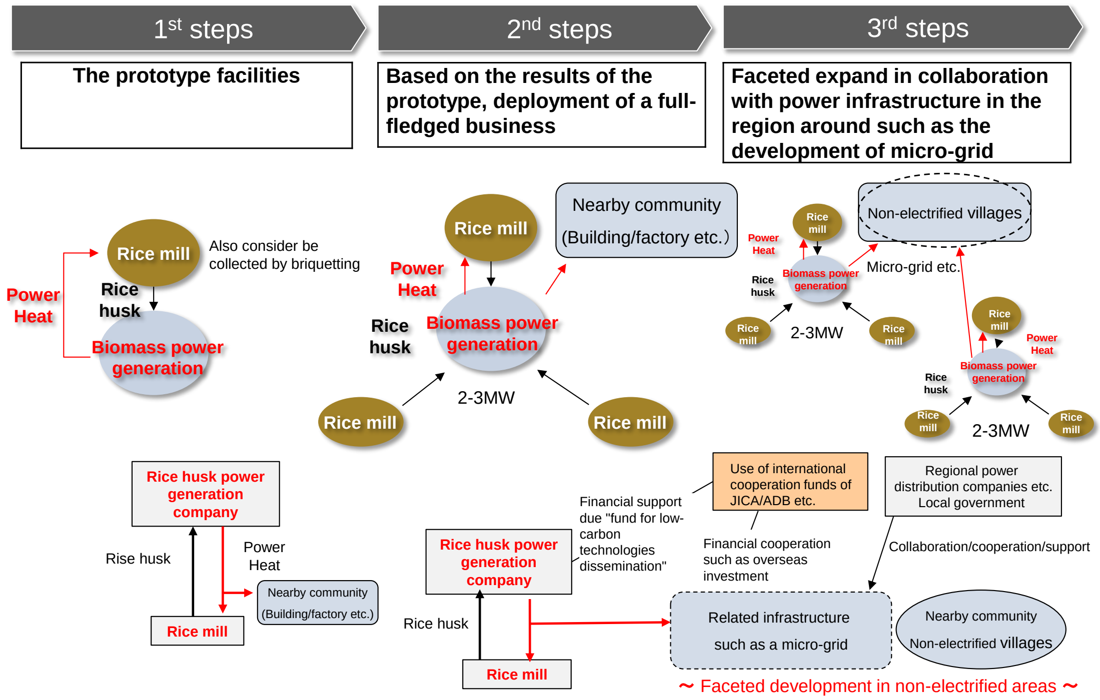


Figure 4-8 Business Development (Concept)

(2) Business model for the 1st step

Basic Concept

The consolidation of facilities should be emphasized in the first step. In this stage, the consideration of rice husk collection and transport should be virtually needless. In other words, the plan should be that the project collects enough rice husk from one or adjacent two or three rice mills in addition to the advantage of proximity to national grid. If the project can buy enough rice husk from one rice mill, it provides 60 % of the generated power to the mill and the rest for sale for electrification of neighboring villages.

Specific Business Model

Two business models are considered, namely "small scale model (facilities capacity : 1.8 MW, net capacity 1.6 MW)" and "mid-sized model (facilities capacity : 3.3 MW, net capacity 3.0 MW)". Depending on the rice husk procurement methods, there are two types of models, namely "type of stand-alone rice mill" (including integrated operation with adjacent rice mills) and "type of collaboration with plural rice mills".

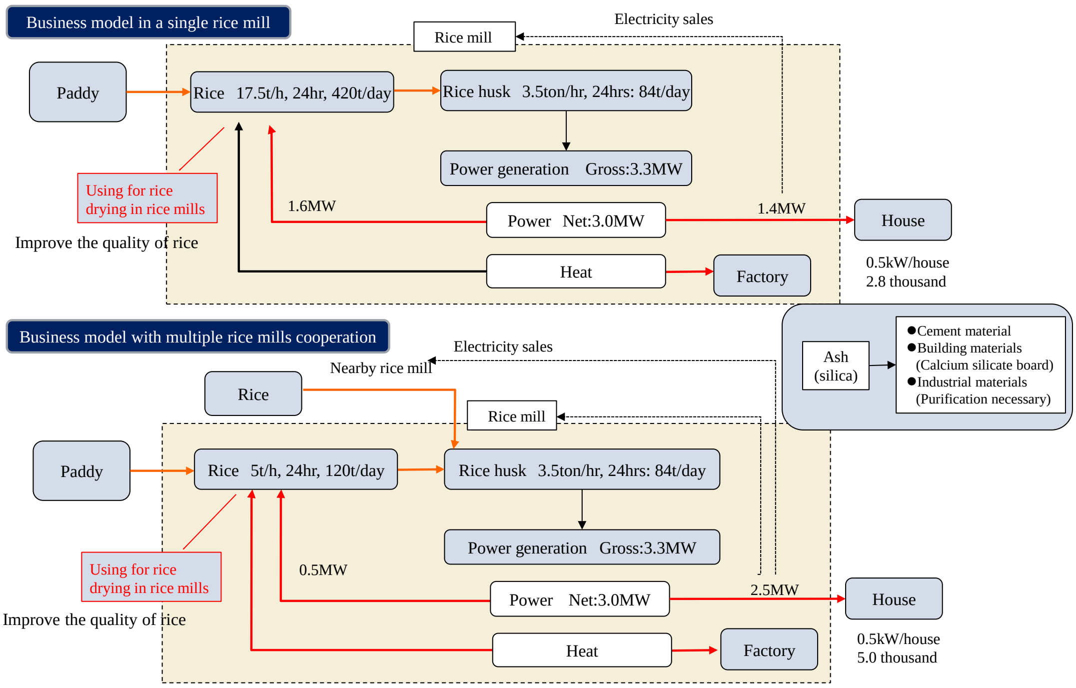


Figure 4-9 Consideration of Business Model (3.0MW)

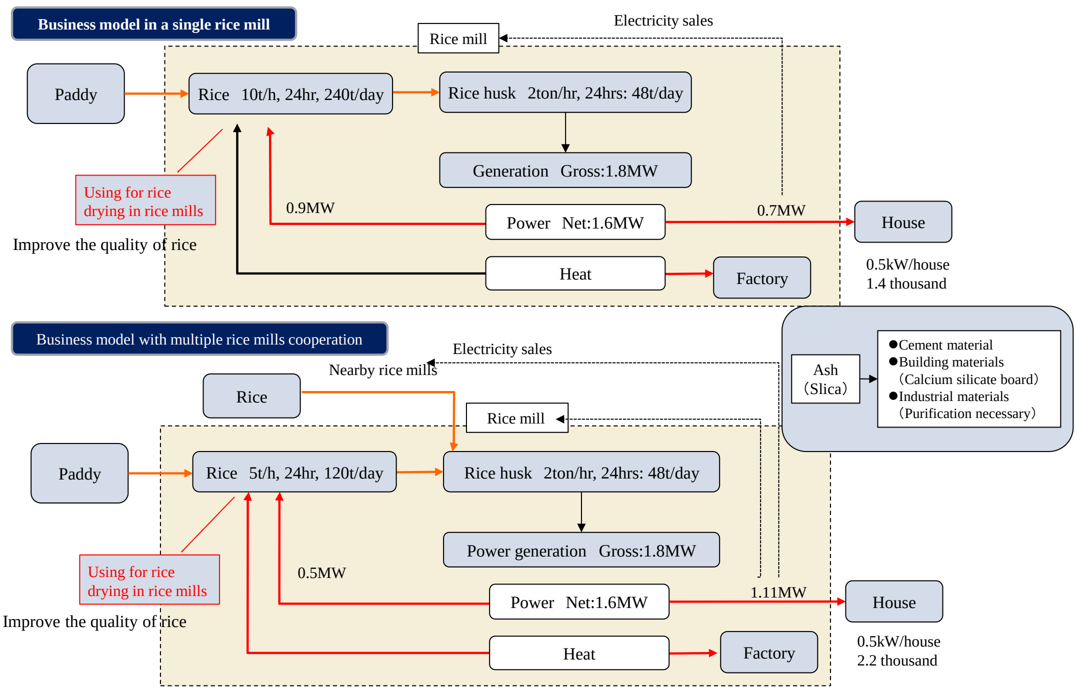


Figure 4-10 Consideration of Business Model (1.6MW)

Considering the commercialization of the project, the viewpoints of power generation efficiency and facility operation ratio are quite important. These factors not only influence annual power generation output, but affect viability and CO2 emission reduction effect in the end.

Bearing these factors in mind, we compared the two options, small and mid-sized business models, and synthesized them as described below.

(Issues and Measures for Realization of the Project)
Issues and measures for the realization of the project are synthesized individually for the two models "small scale business model" and "mid-sized business model".

For the realization of the small scale model, the use of high power generation efficiency system is indispensable. There exist many suppliers of rice husk power generation facilities in the world including Japan and China. Whereas Chinese manufacturers are advantageous in the price factor, Japanese makers have advantages of technology to maintain high power generation efficiency in the small scale system (of the scale of 1.5 to 2 MW). (It is noted the cost of facilities of Japan is higher.)

Hence, it is advisable to introduce the small scale business model with the rice husk power generation system supported by the Japanese technology with high power generation efficiency under the JCM facilities subsidy program of the Ministry of the Environment of Japan. Although business entity may be different depending on whether the rice supplier is single or plural, facilities to be introduced are the same. Therefore, it does not affect JCM subsidy program.

There are common issues between the small scale model and the mid-sized model in terms of rice husk procurement, utilization of power, heat and ash, etc. For the mid-sized model, the volume of power and heat unused by the rice mill itself is so large that identifying the stable purchasers of power and heat is critically important. Therefore, the approach from the viewpoint of consolidation of distribution lines, creation of the demand for power and heat (e.g. development of collective housing and industrial estates) is necessary. Among afore-mentioned five candidate areas, those where the rice mills with the scale of mid-size or more can collect rice husk from plural rice mills are limited. Furthermore, another requirement is the availability of well-developed grid or assistance for its development. If necessary, we may consider the possibility of usage of JCM collaboration scheme through JICA or ADB.

Table 4-3 Comparison of Small and Mid-Sized Business Models

	Small Scale Business Model	Mid-Sized Business Model
Characteristics of Business Models		
Capacity of Power Generation	Facility Capacity : 1.8MW Net Power Generation Capacity : 1.6MW	Facility Capacity : 3.2MW Net Power Generation Capacity : 3.0MW
Operation Rate	Initially expensive. However, as the operation rate grows, the total viability will improve.	Initially advantageous. However, considering the uncertain supply of rice husk, there exists the risk of low operation rate.
Project Effect	Electrification in the Neighborhood. Phase out of small scale gasification power generation. (which contributes to environment load reduction.)	Electrification in Adjacent Areas (Extensive)
Issues for Business Promotion		
Scale and Method of Rice Husk Procurement	48 t / day (24hr) ・In addition to the purchase from the core rice mill, supplementary purchase from adjacent rice mills will be conducted. ・If a large scale rice mill is in the close neighborhood, the single-mill type operation may be possible.	84 t / day (24hr) ・Basically collect rice husk from plural rice mills. ・In case of newly constructed large scale rice mills, in addition to the purchase from the core rice mill, supplementary purchase from adjacent rice mills will be done.
Power Utilization	Use at Rice Mills and Other Factories. Clients of Night-Time Power (e.g. eco ice, combination with power storage technology)	
	Power Supply to the Neighborhood.	Power Supply to the Extensive Neighborhood (basically through grid). Association with Local Electrification Measures and Regional Development Plan (Collective Housing, etc.).
Heat Utilization	Production of Building Materials from Ash, Drying Farm Products (Beans, etc.)	
		Identification of Large Scale Purchasers (e.g. Use for Absorption Chillers)
Ash Utilization	Use as Raw Materials for Production of Building Materials is Promising.	Use as Raw Materials for Production of Building Materials and Cement.
Development Direction	Collaboration between the Existing Large Scale Rice Mill and Adjacent Rice Mills.	Integrated Development with the Construction of a New Large Scale Rice Mill.
Measures for Project Realization	Collaboration with Local Administrative Offices for Power Supply to Adjacent Villages and the Extensive Neighborhood. (Preferential Measures : Power Tariff Setting & Conditions, Easing Restrictions on Foreign Capital Investment, Expeditious Approval Procedures)	
	Use of the Subsidy System for Facility Investment (Adoption of Japanese Technology with High Power Generation Efficiency)	
		Use of JCM Scheme through JICA or ADB.

(3) Development in the 2nd and 3rd Steps (Horizontal Development)

Based on the result of model project in the 1st step, and eyeing the long term target of 50 MW, the business of the 2nd and 3rd steps is conducted to realize the horizontal development of autonomous distributed energy system which utilizes biomass (rice husk) power generation. The gist of the road map to the horizontal development is described below.

(The Concept of Horizontal Development to Pursue)

- Judging from the volume of rice husk recorded as "unused", rice husk power generation with the scale of 50 MW seems possible. However, considering the volume made available at the project site, we set 30 MW as the reasonable target level for the time being.
- Looking at other major rice farming areas of Myanmar, the combined rice production of Bago region (which produces around 60 % of Ayeyarwady's harvest) and Yangon region (which lies in another delta area) is almost equivalent to that of Ayeyarwaddy region. MRF officials requested to make horizontal development of rice husk power generation system into these two regions. We may think about the possibility of horizontal development, after establishing plural business models in Ayeyarwady region, to the two regions in the 2nd and 3rd steps. If we combine all the three regions, a total of 50 MW rice husk power generation is possible.

(Course of Action for Horizontal Development)

- We target the consolidation of rice husk power generation plants equivalent to 50 MW in total by 2012 in collaboration with governments of Myanmar and Japan. The cumulative total volume of the reduction of energy-derived CO2 by 2021 caused by this project is estimated about 100,000 t- CO2 / year.
- The actual chronological development will be different depending on the coming detailed analysis of individual rice mills in candidate areas, and the progress of scrap and merge of rice milling businesses. In consultation with MRF officials, we establish the model project suited to the local characteristics, which will serve as the foundation for future horizontal development.
- The course of action for the creation of the standard business model which works as a package is as described below.
    1) The business environment for the project in the area with the national grid access and that without its access is fairly different in terms of situations of rice mills, power supply, local development and infrastructure, etc. Therefore, we are to set up two models, "Development Model with National Grid" and "Development Model with Off-Grid".
    2) The reduction of cost of facilities and construction by optimizing the design and procurement.
    3) The reduction of operation cost by accumulating business knowhow.
    4) The reduction of the burden on the project owner by streamlining the JCM monitoring system.
    5) The creation of fund raising scheme. While the initial stage is on the premise of JCM facility subsidy, we consider, in the stage of full operation, the gradual level down of JCM subsidy, and the application for preferential measures by Myanmar local government (e.g. power tariff setting, etc.)

(Image of Chronological Business Development)

- Two images of business development namely the one with attaining 50 MW with plural 1.6 MW power plants, and the other with the combination of 1.6 MW and 3 MW power plants are considered. The former constructs 31 plants while the latter builds 24 plants in Ayeyarwaddy region. This means each of 5 candidate areas will have 5 to 6 rice husk power generation plants, and they will provide power to 87,000 to 155,000 local households.
  - The image of plural 1.6 MW plants corresponds to the case with no positive factors such as the scrap and merge of rice milling businesses, etc. are available.
  - The image of the combination of 1.6 MW and 3 MW plants is applicable to the case with significantly positive factors such as rice yield increase per unit area, scrap and merge of rice milling businesses, establishment of the system of the long term and stable rice husk supply, etc. are available.
- At this stage, we assumed the 50 % of the required facility cost to be subsidized. However, the total project cost is expected to decrease by streamlining design and procurement processes, improved operation and maintenance, etc. in the full scale operation stage. If it happens, the gradual level down of subsidy rate will also be in sight.

Table 4-4 Image of Business Development (Draft) (-1.6MW model)

		2016	2017	2018	2019	2020	2021	Total	Remark
Scale of operation	New (Nunmber)	1	2	4	6	8	10	31	
	Total (Number)	1	3	7	13	21	31		
	New (kW)	1,600	3,200	6,400	9,600	12,800	16,000	49,600	
	Total (kW)	1,600	4,800	11,200	20,800	33,600	49,600		
Annual energy production	New (MWh/year)	11,520	23,040	46,080	69,120	92,160	115,200	357,120	
	Total (MWh/year)	11,520	34,560	80,640	149,760	241,920	357,120		
Rice husk amount	New (ton/year)	14,400	28,800	57,600	86,400	115,200	144,000	446,400	
	Total (ton/year)	14,400	43,200	100,800	187,200	302,400	446,400		
Total project cost	New (1,000 USD)	4,500	9,000	18,000	27,000	36,000	45,000	139,500	
	Total (1,000 USD)	4,500	13,500	31,500	58,500	94,500	139,500		
Subsidy	New (1,000 USD)	1,650	3,300	6,600	9,900	13,200	16,500	51,150	
	Total (USD)	1,650	4,950	11,550	21,450	34,650	51,150		
Reduction of CO2 from fossil fuel combustion	New (t-CO2/year)	3,360	6,720	13,440	20,160	26,880	33,600	104,160	2,100t-CO2/MW・year
	Total (t-CO2/year)	3,360	10,080	23,520	43,680	70,560	104,160		

Note: 1) Other GHG reduction: there is possibility of reduction of methane emissions by arising from dispose of rice husk under anaerobic condition. However, disposes of rice husk are case by case. Therefore, reduction of methane emissions was not considered.
2) These data were based on model condition.

Table 4-5 Image of Business Development (Draft) (-1.6MW+3MW combined model)

		2016	2017	2018	2019	2020	2021	Total	Remark
Scale of operation	New (Number)	1	1	3	5	6	8	24	
	Total (Number)	1	2	5	10	16	24		
	New (kW)	1,600	3,000	6,200	10,800	12,400	17,000	51,000	
	Total (kW)	1,600	4,600	10,800	21,600	34,000	51,000		
Annual energy production	New (MWh/year)	11,520	21,600	44,640	77,760	89,280	122,400	367,200	
	Total (MWh/year)	11,520	33,120	77,760	155,520	244,800	367,200		
Rice husk amount	New (Ton/year)	14,400	25,200	54,000	93,600	108,000	147,600	442,800	
	Total (Ton/year)	14,400	39,600	93,600	187,200	295,200	442,800		
Total project cost	New (1,000 USD)	4,500	5,420	14,420	24,340	28,840	38,760	116,280	
	Total (1,000 USD)	4,500	9,920	24,340	48,680	77,520	116,280		
Subsidy	New (1,000 USD)	1,650	2,040	5,340	9,030	10,680	14,370	43,110	
	Total (USD)	1,650	3,690	9,030	18,060	28,740	43,110		
Reduction of CO2 from fossil fuel combustion	New (t-CO2/year)	3,360	6,300	13,020	22,680	26,040	35,700	107,100	2,100t-CO2/MW・year
	Total (t-CO2/year)	3,360	9,660	22,680	45,360	71,400	107,100		

Note: 1) Other GHG reduction: there is possibility of reduction of methane emissions by arising from dispose of rice husk under anaerobic condition. However, disposes of rice husk are case by case. Therefore, reduction of methane emissions was not considered.
2) These data were based on model condition.

(Business Environment under Horizontal Development)

For the horizontal business development, the business environment consolidation for rice husk power generation with the assistance from the two governments as described below is crucial. For this, nurturing the understanding of significance and effects of the project, in collaboration with people concerned in Ayeyarwady region including MRF, among relevant offices of Myanmar is essential.

- Easing the restriction of the Foreign Investment Law or its exemption (The power generation less than 10 MW is allowed only to Myanmar enterprises.)
- Clarification of the power distribution system development in the mid to long term regional development plan of Myanmar. (promotion of autonomous distributed power generation including biomass power generation, and its clear goal setting, etc.)
- Preferential measures and assistance to renewable energy development by the introduction of Feed-in-Tariff (FIT) system, etc.

(4) Business implementation scheme

We suppose the formation of SPC by businesses of Myanmar and Japan for the implementation of the project. Based on the existing legal framework of Myanmar, the ratio of capital contribution between businesses of Myanmar and Japan would be 25 % and

75 % each. While the possibility of partial contribution by Myanmar businesses cannot be excluded, their main contributors are supposed to be rice milling businesses.

It is said one of the major factors for the success of rice husk power generation is the stable procurement of necessary volume of rice husk at a reasonable price level for a long period. A semi-closed system to which rice milling businesses contribute capital by themselves, provide rice husk produced by themselves, and get electricity required for their operation, seems to make the project stable for a long period.

Benefits of Myanmar side by JCM scheme

-Financial burden down by investment from Japanese companies
（50% of the equipment cost）
-Stable and inexpensive power supply
-Load reduction of environment with the latest equipment introduced
-Monetization of rice husk
-dividend income

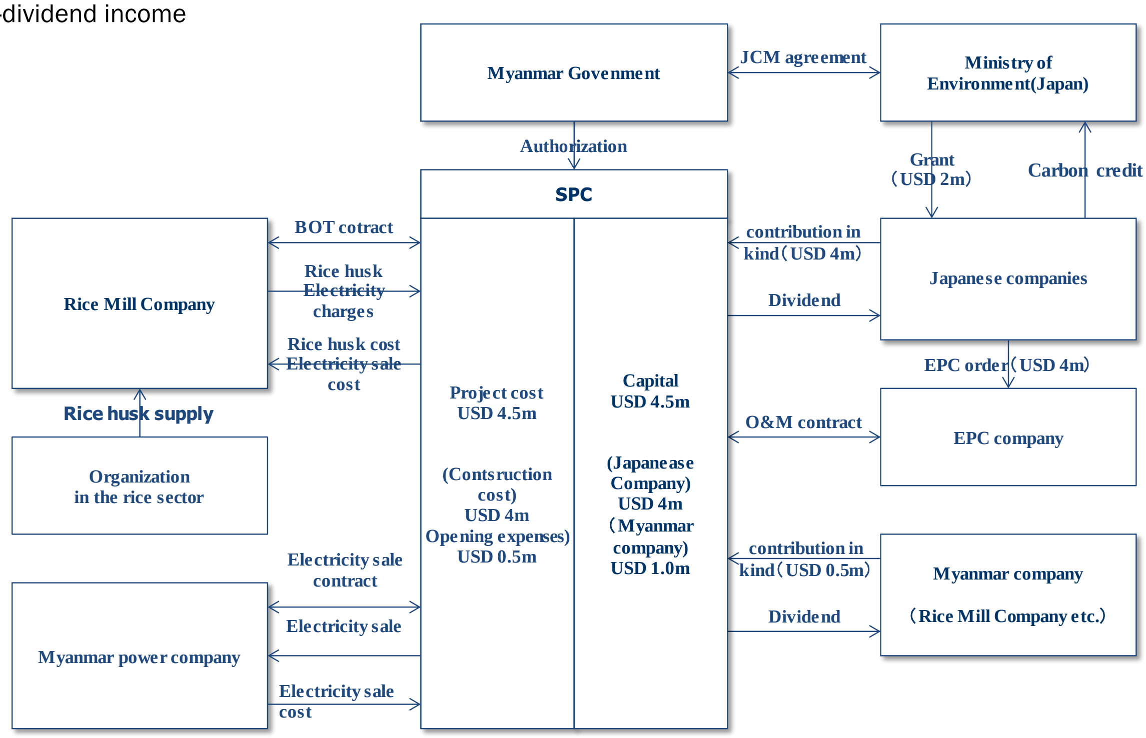


Figure 4-11 Business Implementation Scheme (Tentative Draft)

(5) Schedule for business implementation

The schedule for business implementation through the 1st step and up to the beginning of the 2nd step is described hereunder. It is scheduled to have the detailed survey in the fiscal 2015, and to start and complete the construction work within the fiscal 2016. However, the time required for consultation with relevant government offices is merely supposition.

It is noted the Myanmar's fiscal year starts from April 1, and ends at March 31.

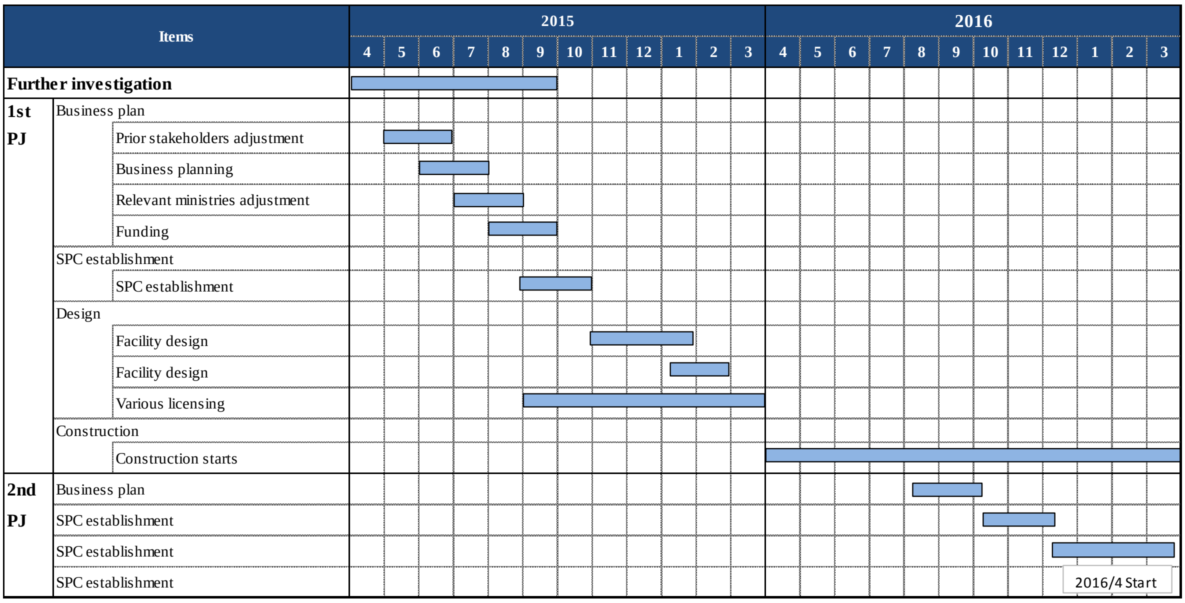


Figure 4-12 Business Implementation Schedule (Supposition)

5 Future Development

We have discussed with local rice milling business people through the two local workshops with the assistance of MRF to explain the possibility of the project formulation as a large scale JCM and the vision and points of consideration of the Japanese side, and to confirm the needs, ideas and intention of the Myanmar side. As the result, the Myanmar side presented the following proposal for the future development.

- Since it is difficult to know the correct situations of rice husk utilization of rice mills only with statistical data, it is necessary to visit plural actual rice mills to get detailed information which is essential for the selection of prospective project areas.
- The result of the discussion made so far should be presented to the Myanmar government offices concerned (central and local) to get their understanding.
- Myanmar side proposed six townships as prospective candidate areas for rice husk power generation in Ayeyarwady region, namely Myaungmya, Pyapon, Mawlamyinegyun, Bogale, Kyaiklat, and Maubin. They also proposed not to limit only to Ayeyarwady, but to include other regions for discussing the possibility of project implementation, and suggested four townships in Yangon region, namely Kungyangon, Kawhmu, Taikkyi, and Htantabin and another four townships of Letpadan, Thayarwady, Oktwin, and Taungoo in Bago region.

The joint efforts between Japan and Myanmar are so important for the realization of the project that MRF established the system for the joint consideration by setting up a team of Myanmar experts in March 2015.

In response, the Japanese side, in collaboration with MRF, and in close association with governments of Japan and Myanmar, would consider the realization of autonomous distributed energy system based on biomass (rice husk) power generation, and take necessary actions in accordance with the following plan.

Action plan for realization of model business in the step 1

- Feasibility study in promising areas in Ayeyarwady region: It is difficult to get the first-hand figures and details of rice husk utilization of rice mills only by the statistical data. We will conduct actual site visit to plural rice mills for detailed survey, and screen the promising areas. Specific candidate areas in our mind are Myaungmya, Pyapon, Mawlamyinegyun, Bogale, Kyaiklat, and Maubin.

- Collaboration and coordination with relevant administrative offices of Myanmar: We will further explain the results of the survey and discussions made so far to relevant offices (central and local) for nurturing their understanding which is indispensable for the project realization.

Action plan for horizontal business development in the step 2 and 3

- Examination of business development possibility in rice farming regions other than Ayeyarwaddy: We will examine the possibility of horizontal business development in Yangon and Bago regions. Earmarked areas are Kungyangon, Kawhmu, Taikkyi, and Htantabin in Yangon region, and Letpadan, Thayarwady, Oktwin, and Taungoo in Bago region.

- Consideration of specific measures for horizontal development: For the progress of horizontal development, the basic strategy (road map) which specifies the direction and specific measures for the development is essential. In addition, the clarification of the framework in which the business model established by the advanced approach is disseminated in the project under consideration is also important. Sharing the basic strategy among people concerned is indispensable for facilitating the sustainable progress of the project (not to end up with a mere model project).

- We therefore select the specific candidate areas (as the model areas for taking initiatives), and consider, taking account of the plan of local power distribution network consolidation as well as the mid to long term regional development plan, the concept of low carbon communities which utilize rice mills as local energy supplying centers.

- For the consideration, the integrated approach taking into account the demand side measures including the smart ways of utilization of power and heat generated by rice husk power generation system is essential. Those measures include power load leveling, energy saving devices for buildings, introduction of facilities with high energy saving efficiency, mechanism for effective utilization of heat in the communities, etc. to name a few.

- For the preparation of this kind of road map for the community, examples of approaches of Japan such as “Environment Conservation Model City”, “Concept of Biomass Town Development”, “Plan of Creation of Low Carbon Communities”, and “Structural Reform Special Zone” will be useful. Experiences and knowhow of local authorities of Japan will be utilized for the work.

Appendix

Appendix 1: Project overview

Feasibility Study on Rice Husk Power Generation System for Low-carbon Communities in Ayeyarwady Region, Myanmar	Mitsubishi Research Institute, Inc. Fujita Corporation

The project aims to establish a distributed regional energy supply system in the Ayeyarwady region in Myanmar based on rice husk biomass generation in rice mills, supplying electricity to the surrounding community whose electrification rate is low. The expected outcome is the formation of a low-carbon community centering on the rice mill, including new industries based on electricity and heat generation, and improved energy access of the local residents.

【Project Description】

- ●Designing rice husk power generation system
- ●Proposing implementation of the project
- ●Analysis of project effects (GHG reduction etc.)
- ●Proposing promotion system for Low-carbon Communities

Current situation of rice husk

Implementation strategy

【Japan】

- Mitsubishi Research Institute, Inc. — *Overall project management*
- Fujita Corporation

【Myanmar】

- Organization in the rice sector
- Administrative organizations

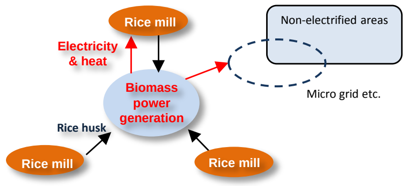
Discussing plan in the "Roundtable on Ayeyarwady low-carbon community"

Work shop in Ayeyarwady

Needs in target area

- ●Unutilized rice husk in rice mills
- ●Necessity of electrification of quality of life, and industry promotion

Rice husk power generation system, as "energy supply center" in rural community



Expected effects

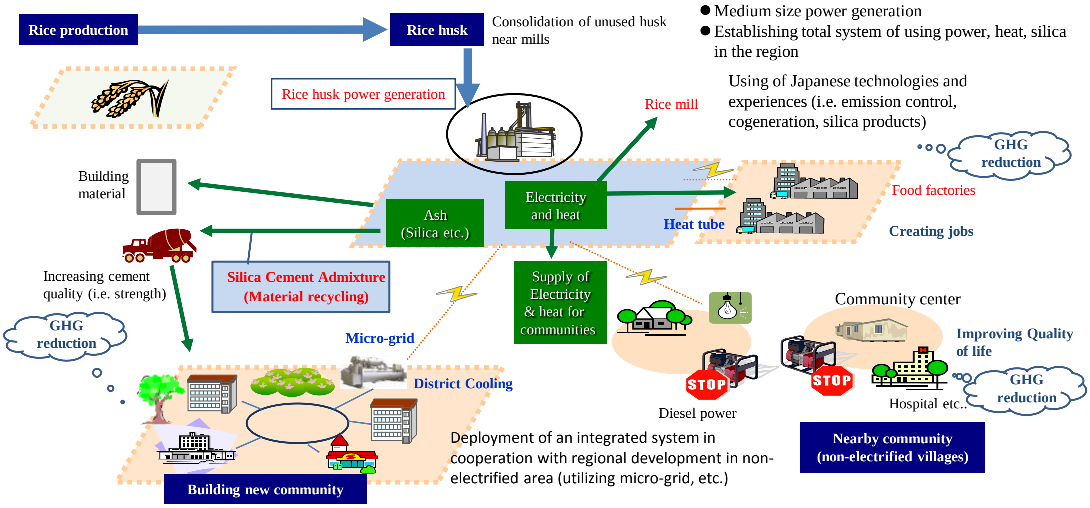
- ●Reducing GHG from energy use (i.e. reduction of fossil fuels for power generation)
- ●Supplying electricity & heat for industry and communities
- ●Improving quality of life by electrification
- ●Job creation

Potentiality of large-scale project

Business model in Ayeyarwady Region, rice producing center n Myanmar

- Expanding in whole regions in Ayeyawady, and Myanmar
- Expanding other regions in Asia (Rice is major agricultural crop in Asia)

Concept of Rice husk power generation system for low-carbon communities



Appendix 2: Myanmar and Ayeyarwady region overview

Geographical situation (Rivers of Ayeyarwady region)

The Ayeyarwady River is the largest river in Myanmar and has a length of approximate 2,170km. The river originates in northern Myanmar, flows southward through the country and splits into nine river mouths which forms the delta. The westernmost distributary is the Pathein
River whilst the easternmost stream is the Yangon River. In total, the distributary comprises:

- Pathein River
- Pyinzalu River
- Bogale River
- Ywe River
- Ayeyarwady River
- Thande River
- Pyamala River
- Myitmaka River
- Yangon River

The rivers are reported to be heavily silted. The river, networks and water bodies in the Ayeyarwady region can be seen in Figure 5.4 (water ways shown in blue and roads in yellow). Discharge parameters are reported12 as follows:

- Average: 13,000 m3/s;
- Maximum: 32,600 m3/s; and Minimum: 2,300 m3/s.

Monsoon rains occurring from May to October result in large variations in the volume of water within the Ayeyarwady River and its tributaries.

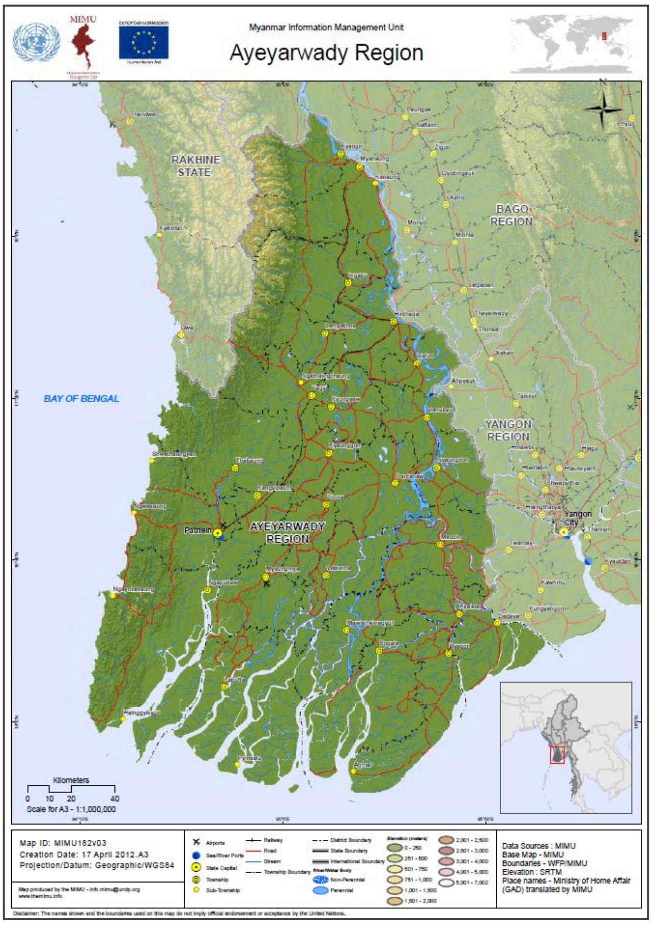
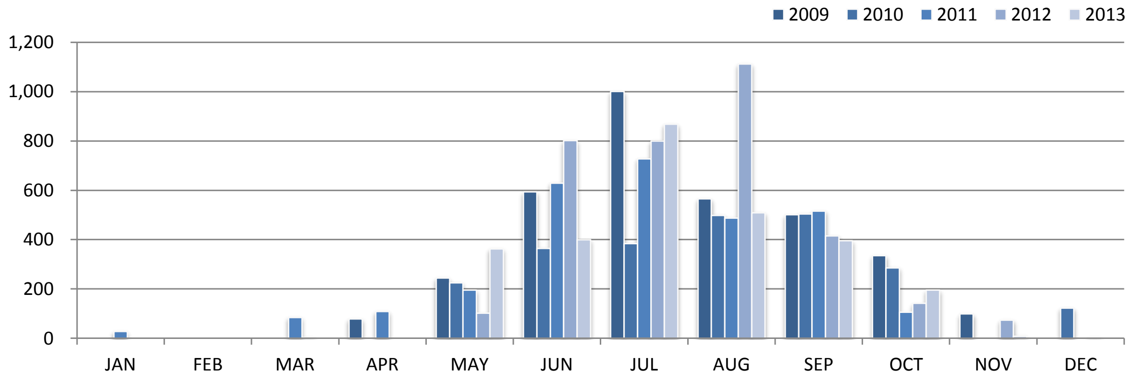


Figure 1 Ayeyarwady's water bodies

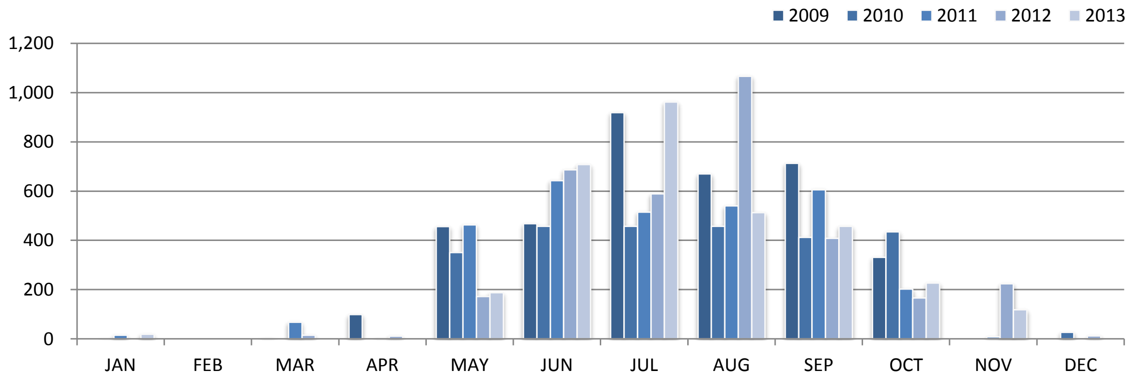
Source: Myanmar Information Management Unit

Climate

Pathein



Pyapon



Myaungmya

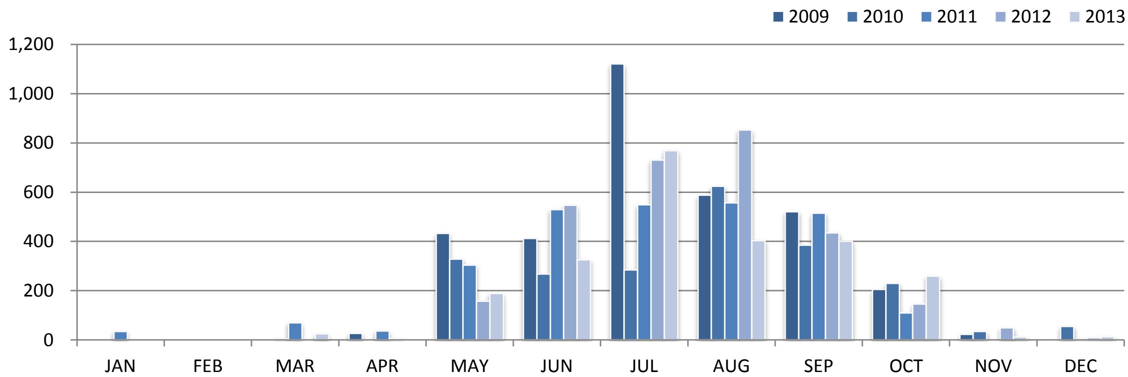
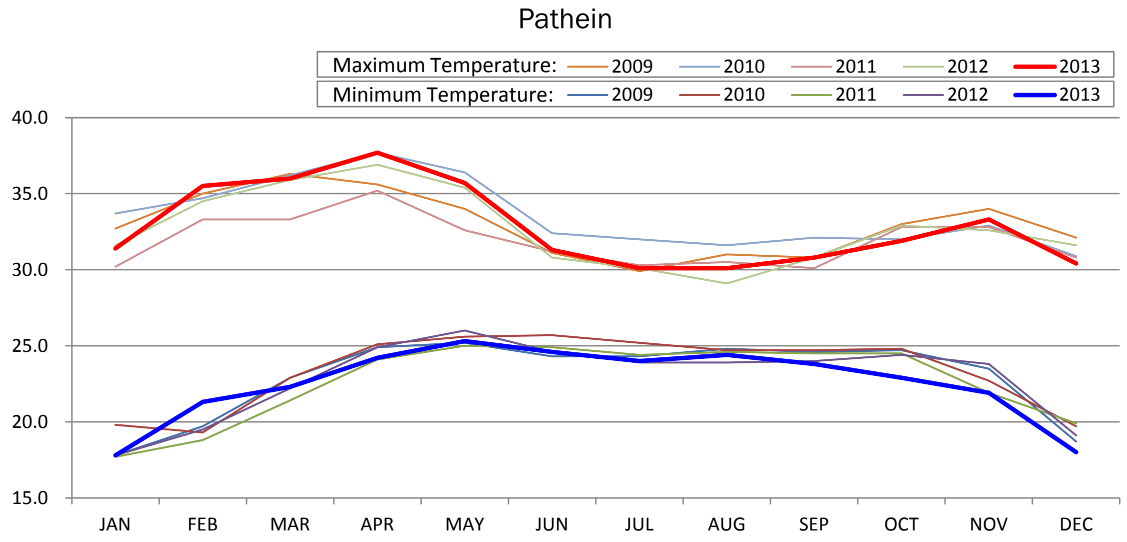
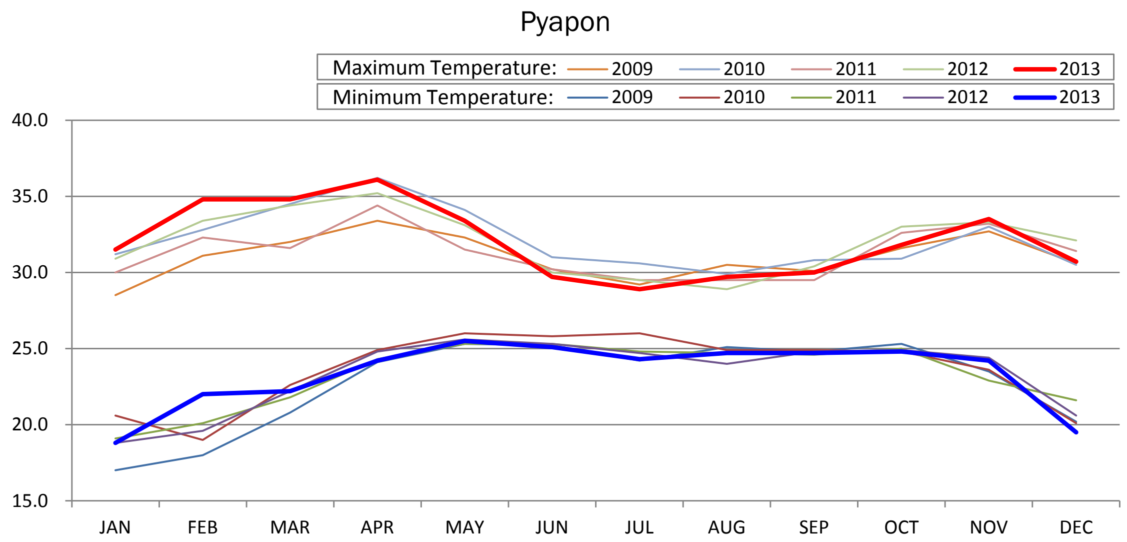


Figure 2 Annual rainfall inAyeyarwady (Unit: mm)

Source: Government of Myanmar, Department of Meteorology and Hydrology





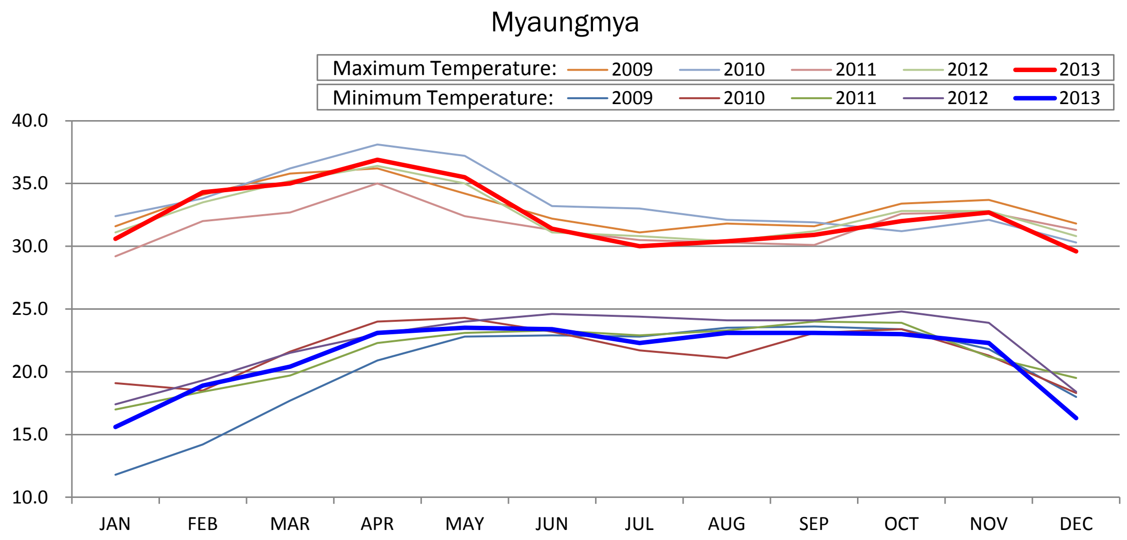


Figure 3 Monthly average temperature in Ayeyarwady (Unit: degree C)

Source: Government of Myanmar, Department of Meteorology and Hydrology

Regional administration

Divisions	States
Ayeyarwady	Kachin
Sagaing	Kayah
Tanintharyi	Kayin
Bago	Shan
Magway	Chin
Mandalay	Mon
Yangon	Rakhine

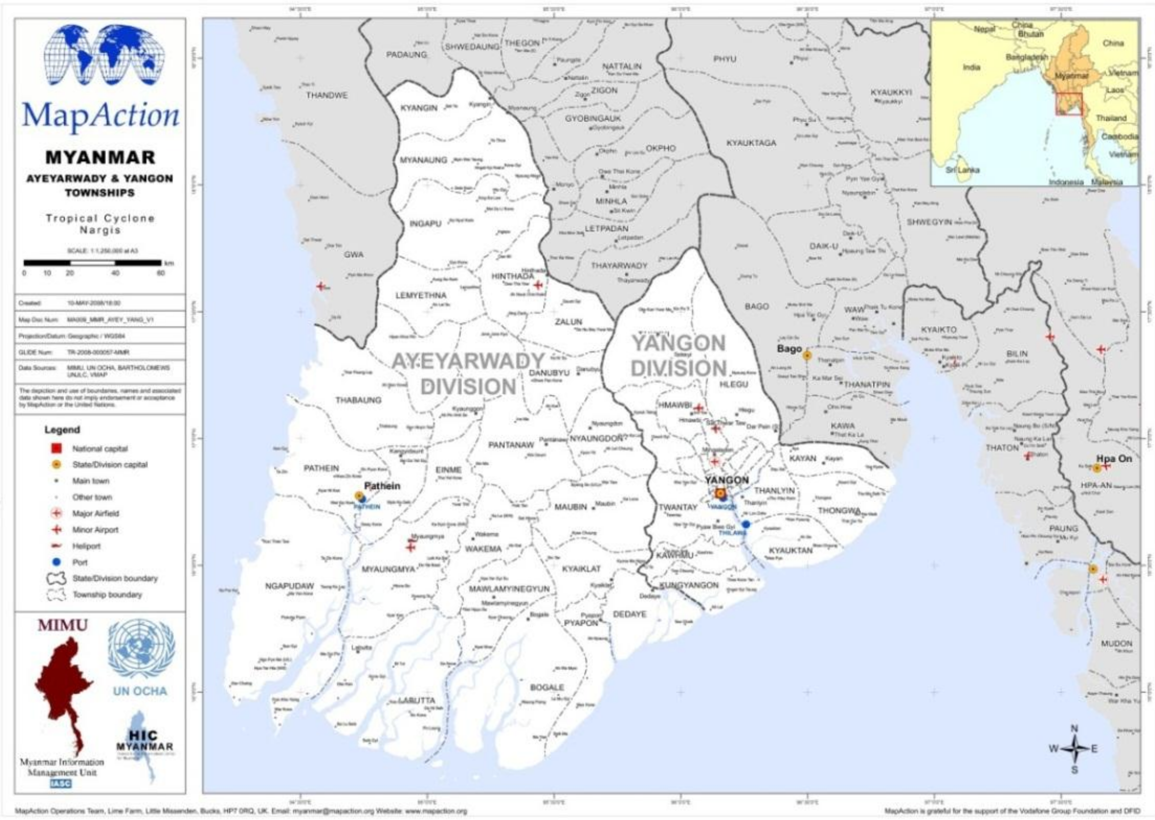


Figure 4 Map of Ayeyarwady Division and Yangon Division

Source: Myanmar Information Management Unit

Appendix 3: Situation of rice milling industry in Myanmar

According to the Food and Agriculture Organization of the United Nations, rice is the top commodity being produced in Myanmar at 28,080,000 tons as of 2012. Rice paddies in Myanmar are understood to be cultivated during the monsoon months and hence availability would be seasonal. The quantity of rice produced and exported can be used as a proxy to demonstrate seasonal availability.

Table 1 Myanmar: Paddy production by month, avg. 2003-2007, (%)

Rainy Season								Dry Season			
May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
3	2	3	1	1	6	36	36	4	1	4	5

Source: Myanmar: Capitalizing on rice export opportunities, The World Bank, Report number 85804 dated 28 February 2014.

Table 2 Myanmar: Rice exports by month, average for 2007/08-2011/12 (%)

Rainy Season								Dry Season			
May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
7	7	7	3	7	7	4	8	12	8	14	11

Source: Myanmar: Capitalizing on rice export opportunities, The World Bank, Report number 85804 dated 28 February 2014.

Paddy production in Myanmar is reported at 2.5 tons per hectares and is rated as one of the lowest in ASEAN region. This suggests potential increases in production as the country develops.

The majority of rice paddy in Myanmar is cultivated by small farm with average size of 5 acres contracting with individual farmers for feedstock supply would therefore not be foreseen as possible.

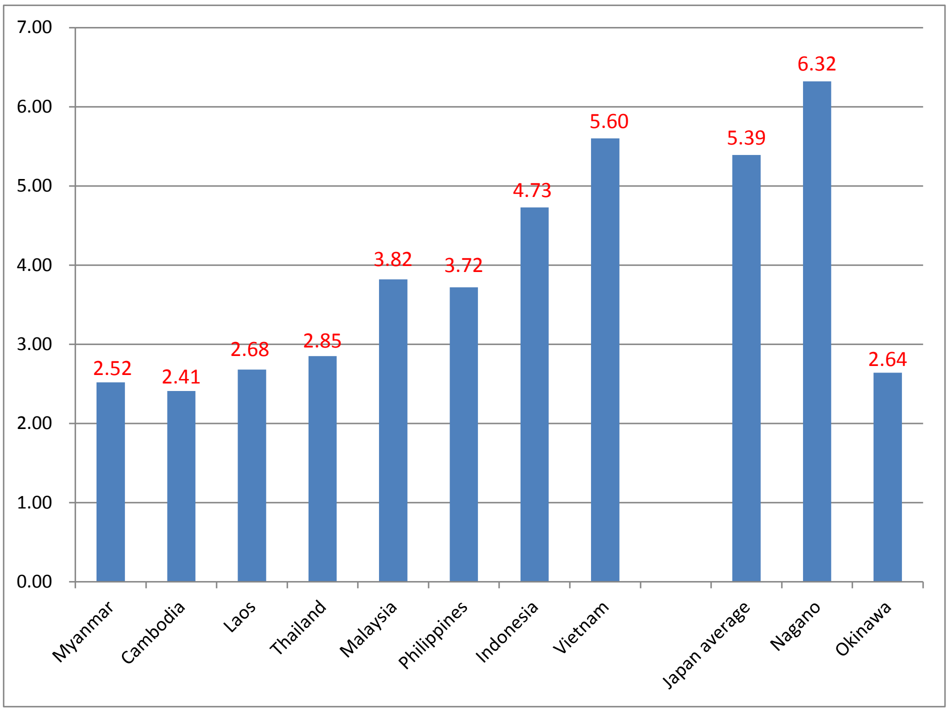


Figure 5 Paddy yields in selected ASEAN countries avg. 2010-2012

Source: Myanmar: Capitalizing on rice export opportunities, The World Bank, Report number 85804 dated 28 February 2014. Add Japan data: Ministry of Agriculture, Forestry and Fisheries "harvest of 2013 annual production water upland rice"

Table 3 Paddy production by Crop and province, 2004/05-2011/12

Regions/Province		2004/05 - 2008/09			2009/10			2010/11			2011/12		
		Wet	Dry	Total	Wet	Dry	Total	Wet	Dry	Total	Wet	Dry	Total
DELTA	Ayeyarwady	5,563	2,303	7,866	5,944	2,563	8,507	5,944	2,563	8,507	5,972	2,510	8,482
	Bago	4,259	585	4,844	4,790	791	5,581	4,790	791	5,581	4,803	630	5,433
	Yangon	1,625	283	1,908	1,709	333	2,042	1,709	333	2,042	1,710	320	2,030
	subtotal	11,447	3,171	14,618	12,443	3,687	16,130	12,443	3,687	16,130	12,485	3,461	15,946
DRY ZONE	Naypyitaw	NA	NA	NA	NA	NA	NA	NA	34	34	287	43	329
	Magwe	1,162	271	1,433	1,467	262	1,729	1,501	322	1,823	1,524	332	1,856
	Mandalay	1,401	435	1,836	1,298	346	1,644	1,307	369	1,675	993	331	1,324
	Sagaing	2,746	751	3,497	3,131	874	4,005	3,179	865	4,044	3,109	745	3,855
	subtotal	5,309	1,457	6,766	5,896	1,482	7,378	5,986	1,590	7,577	5,913	1,451	7,364
COASTAL	Mon	1,213	181	1,394	1,278	222	1,500	1,278	222	1,500	1,294	206	1,500
	Rakhine	1,638	31	1,669	1,825	31	1,856	1,825	31	1,856	1,697	29	1,726
	Taninthary	534	43	577	544	24	568	544	24	568	510	25	535
	subtotal	3,385	255	3,640	3,647	277	3,924	3,647	277	3,924	3,501	260	3,761
MOUNTAIN-OUS	Chin	103	*	103	120	*	120	120	*	120	127	*	127
	Kachin	680	27	707	925	45	970	925	45	970	945	18	963
	Kayah	123	15	138	137	17	154	137	17	154	140	17	157
	Kayin	595	173	768	721	215	936	721	215	936	755	217	972
	Shan	2,099	171	2,270	2,394	160	2,554	2,394	160	2,554	2,409	154	2,563
	subtotal	3,600	386	3,986	4,297	437	4,734	4,297	437	4,734	4,374	407	4,781
TOTAL		23,742	5,269	29,010	26,283	5,883	32,166	26,373	5,991	32,365	26,273	5,579	31,852

Source: Myanmar: Capitalizing on rice export opportunities, The World Bank, Report number 85804 dated 28 February 2014

Situation of rice milling industry

The Ayeyarwady region, referred to as the "granary of Bruma" is reported to grow half of the country's rice production. Rice husk can be combusted in boilers at industries and rice mill plants to raise steam. It is therefore important to assess competing demand from boilers and power plants within the catchment area of the proposed site and preferably to secure the feedstock covering the majority of the plant consumption.

Myanmar already uses rice husk for steam and power generation, notably at rice mill facilities. The registered rice mills power sources include the capacities in Ayeyarwady.

Table 4 Registered rice mills power source Ayeyawady 2012/2013 and 2013/2014

Power Source	2012/2013		2013/2014		Increase/Decrease	
	Number	Capacity(t/day)	Number	Capacity(t/day)	Number	Capacity(t/day)
Electric Power	57	1,485	102	1,962	45	477
Boiler	278	8,856	238	6,878	-40	-1,978
Gasifier	137	3,014	927	8,715	790	5,701
Diesel Engine	115	2,299	2,025	10,918	1,910	8,619
Total	587	15,654	3,292	28,473	2,705	12,819

Source: Myanmar: Capitalizing on rice export opportunities, The World Bank, 28 February 20146

Looking at the trend of the power source, Old, Boiler facility mainly in no national grid region is judged to have been replaced by gasification power generation or Diesel engine. Although rice capacity Increase of degrees about 1.8 times, the number of facilities increase to 5.6 times. Since gasification power generation or Diesel engines are entered in areas without a grid if they are small, it is assumed that it became such a result.

On the other hand, in Myanmar, Rice relationship facility has various incentives by registering.

In it is a factor, it is pointed out as considered sufficient potential rice facility number of actual and statistics are dissociated

There have been reports that some gasification projects were poorly engineered and resulted in excessive environmental pollution of land, water and air[1].* This is understood to be due to the lack of enforcement of environmental compliance requirements as well as drive to complete projects at the lowest possible cost. The Myanmar Times in March 2012 reported that Myanmar Engineering Society was working to develop an industry standard for the erection and operation of power projects using gasification technology with a view to mitigate the problem. Efforts by authorities to clamp down on polluting plants could prove beneficial for biomass plants developers that propose the application of modern facilities equipped with efficient pollution control technology.

Site(s) near rice mills or hullers that utilize diesel and electric power and/or inefficient boilers may present viable opportunities for development of rice husk-fired power plants.

[1] Myanmar Times website: http://www.mmtimes.com/index.php/business/1021-engineering-society-preparingcode

Table 5 Myanmar: Registered rice hullers

Regions/Province		Electric Power		Boiler		Gasifier		Diesel Engine		Total	
		#	Capacity (t/day)	#	Capacity (t/day)	#	Capacity (t/day)	#	Capacity (t/day)	#	Capacity (t/day)
DELTA	Ayeyawady	57	1,485	278	8,856	137	3,014	115	2,299	587	15,654
	Bago	138	3,076	99	2,788	43	721	5	80	285	6,665
	Yangon	52	1,894	40	2,404	45	847	88	1,537	225	6,682
	subtotal	247	6,455	417	14,048	225	4,582	208	3,916	1,097	29,001
DRY ZONE	Mandaly	21	315	0	0	0	0	0	0	21	315
	Sagaing	51	1,326	77	1,716	19	371	16	329	163	3,742
	subtotal	72	1,641	77	1,716	19	371	16	329	184	4,057
COASTAL	Mon	1	15	23	472	1	15	7	105	32	607
	Tanintharyi	0	0	0	0	1	25	3	45	4	70
	subtotal	1	15	23	472	2	40	10	150	36	677
MOUNTAINOUS	Kachin	0	0	6	90	0	0	0	0	6	90
	Kayah	19	380	0	0	0	0	20	400	39	780
	subtotal	19	380	6	90	0	0	20	400	45	870
TOTAL		339	8,491	523	16,326	246	4,993	254	4,795	1,362	34,605
ASH(%)		25	25	38	47	18	14	19	14	100	100

Note: Capacity basis tons per day output assuming 24 hours of operation.

Source: Myanmar: Capitalizing on rice export opportunities, The World Bank, Report number 85804 dated 28 February 2014.

Appendix 4: Overview of power sector in Myanmar

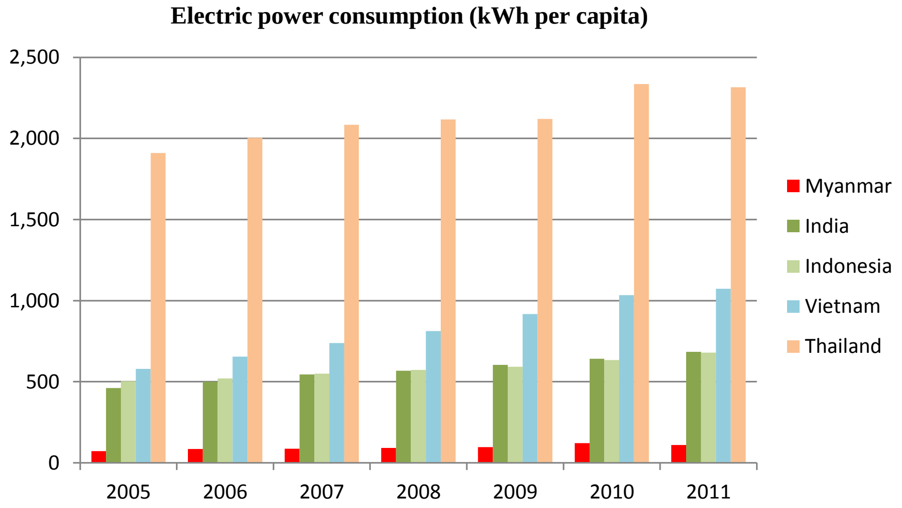


Figure 6 Trend of Electric power consumption per capital

Source: World Development Indicators

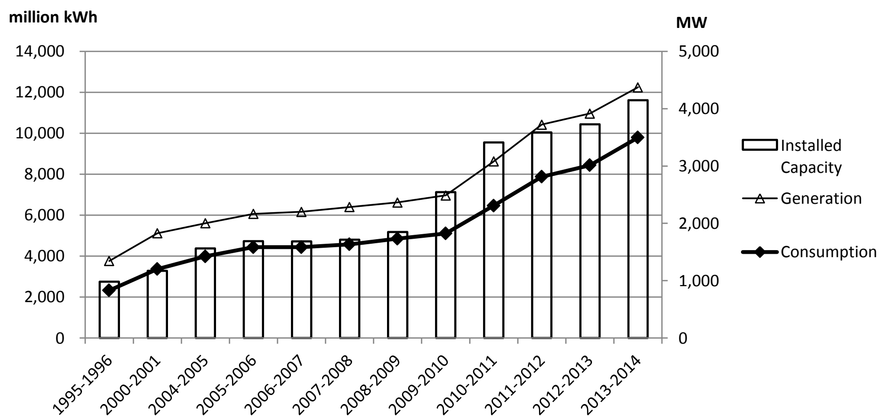


Figure 7 Installed capacity, electric power generation, and consumption in Myanmar

Source: Ministry of Electric Power, Myanmar

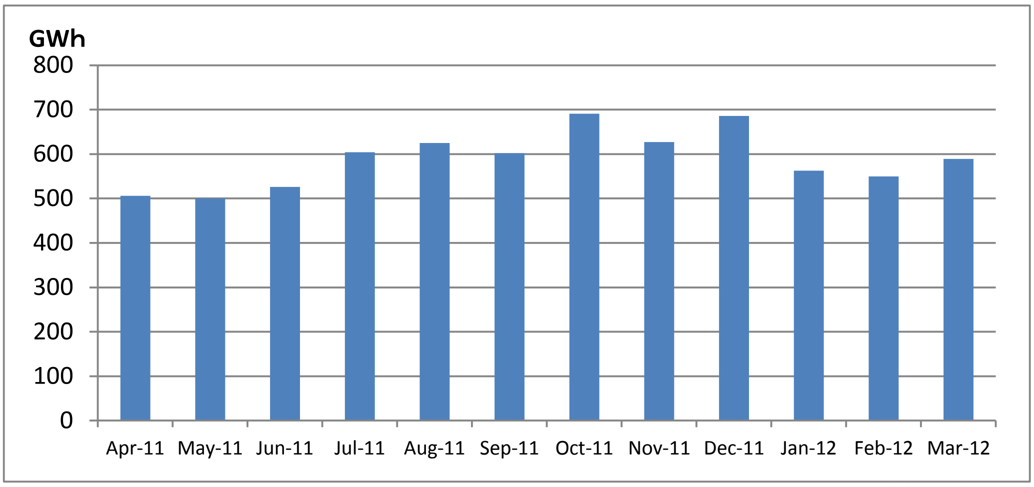


Figure 8 Power Generation of Hydropower Generation Enterprise (2011-2012)

Source: Regional Workshop on GMS Country Experience in Achieving Performance Target, 2012

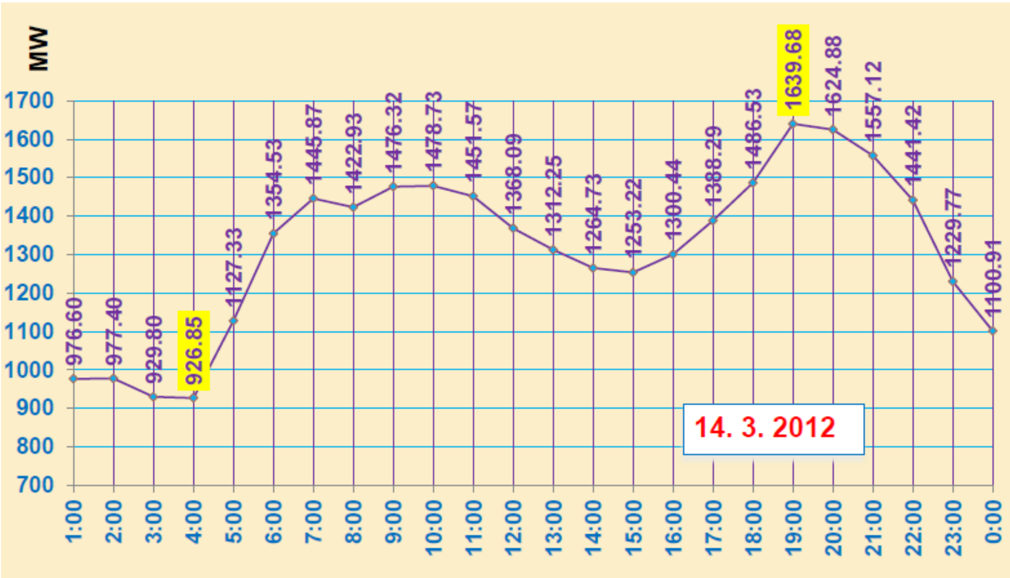


Figure 9 Hourly Generation of Power Plants under MOEP -1 and 2

Source: Regional Workshop on GMS Country Experience in Achieving Performance Target, 2012

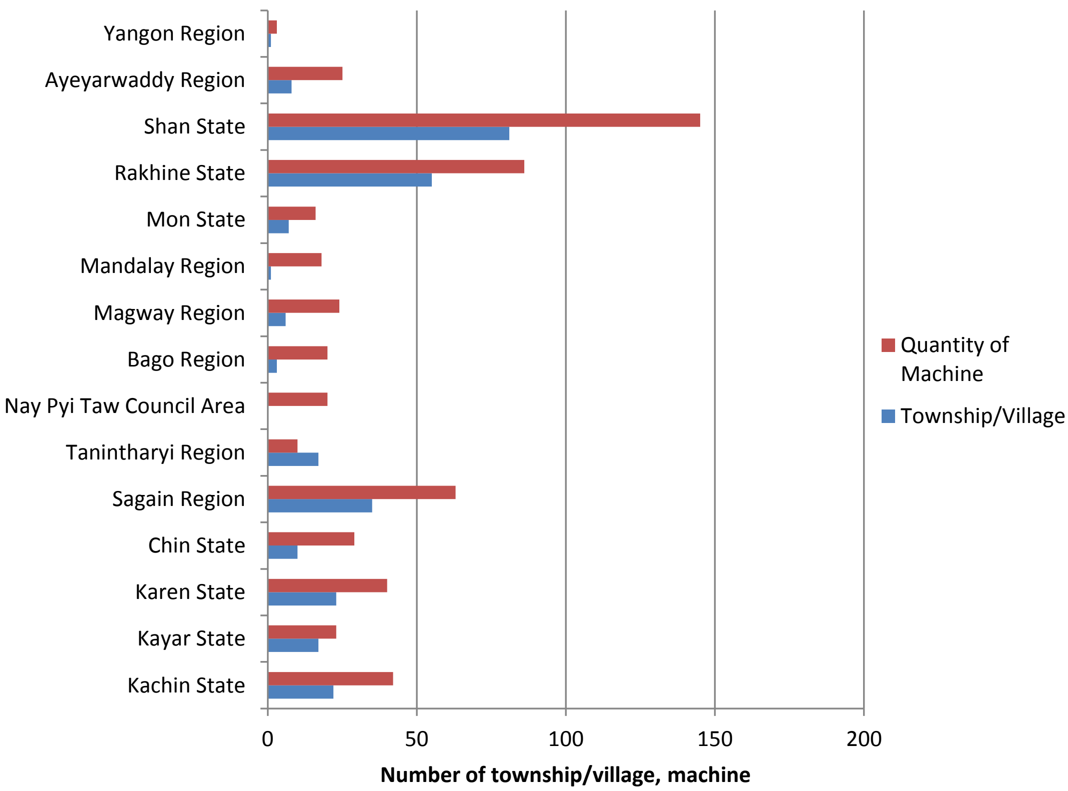


Figure 10 Regional electrification rate by diesel generator (2011)

Source: Ministry of Electric Power, MOEP

Appendix 5: The business environment and investment environment in Myanmar

Ease of Doing Business

For investors, knowing where their country's economy stands in the aggregate ranking on the ease of doing business is useful. The economy's rankings on the topics included in the ease of doing business index provide another perspective. The following describes the constraints of business by foreign capital

Business of foreign capital

No regulations as law（Foreign Investment Law, FIL, Article 9) with respect to foreign investment in Myanmar (Possible investment in foreign capital 100%). But in Enforcement Regulations of the Foreign Investment Law, their associated circulars and their administrative operations (licensing), there are many fine individual regulations as such industry regulation, joint venture stake regulation, minimum investment regulations, regulations with specific conditions, and approval permit system by individual authorities, there exists a practically foreign entry regulations.

Foreign Investment Legislation and Considerations

For Overseas company's business activities in Myanmar, it must comply with the Foreign Investment Law. Describes the matters related to the following.

Forms of Investment:

- 100% foreign investment is allowed in permitted business, joint venture (JV) with Foreigners/ Local individual or entity/ government entities.
- Business performing under contract as agreed by parties.

Investment Requirements:

- The investor has to form a company under existing laws.
- If it is a joint venture company, the capital ratio shall be agreed to by both parties.
- The minimum capital shall be determined by the Myanmar Investment Commission (MIC) based on the nature of business.
- If business activities are in restricted areas, it must be carried out with a local Partner and the foreign capital must be in accordance with the ratio prescribed by Foreign Investment Rules.

Formation of Myanmar Industrial Commission (MIC):

- MIC Chairman is the Union Minister.
- MIC Members are experts from the relevant ministries, government departments/ organization, non-governmental organizations.
- The MIC Vice Chairman, Secretary, Joint Secretary will be appointed from the members of MIC.
- The establishment and nature of the MIC will be broadened with the involvement of experts from non-governmental organizations and entrepreneurs from the business sector

Restricted Activities:

- Foreigners are prevented from holding 100% of a venture in certain sectors. The following activities are included in these restricted sectors.

A) Activities that can affect traditional culture, or customs of ethnic, public health, natural resources and the environment.

B) Activities related to manufacturing and services that can be done by Myanmar citizens that will be specified in the FI rules.

C) Activities that involve agriculture, livestock breeding or fisheries (also the activities specified in FI Rules are included).

D) Activities within at least ten miles of the boundary demarcation within the state territory except economic zones specified by the Union Government. Electricity Generation is considered a 'Reserved Industry" and therefore would require Government Approval. 100% foreign ownership may be possible but would need discussion/negotiation with MIC, DICA, and Relevant Ministries and ultimately Government (as part of the MIC application).

Foreign Employees:

- Investors must appoint and employ staff based on the percentage which has been determined in the formation of the company with the local partner for skilled workers, technicians and staff as follows:

A) At least 25% local staff during the first two years.

B) At least 50% of local staff within the next two years.

C) At least 75% of local staff in the third two year.

D) However, the regulator may amend the above time limit for knowledge-based enterprises.

Tax incentives and guarantees:

- 5 years tax holiday is applicable to all investors, plus additional tax incentives may be granted by the MIC.
- An exemption of Commercial Tax for export activity
- Exemption of customs duties for 3 years on machinery and raw materials, if granted by the MIC.
- An additional customs duty and other internal tax exemption in case of the expansion of an existing investment.

Use of Land:

- Lease of land from the government or private sector is allowed for a period of land use or grant for (50) years initially which is necessary for the economic or industry depending on type and volume of investment.
- It can be extended twice additionally with 10 years period consecutively after expiration of the previously allowed under section 31, depending upon volume and type of investment.

Foreign Capital & Rights to Transfer:

- The commission will register the name of investor according to the foreign currency accepted by the bank as foreign capital. The type of foreign capital must be described when it is being registered.
- Repatriation or remit out the foreign capital will be designated by the commission within stipulated period upon termination.
- The investor has the right to remit abroad through a local bank which has the right to deliver service for foreign banking activity at the prevailing exchange rate for the relevant currency.

Administrative penalty

MIC may award the following administrative penalties to investors who violate the provision of the law, rules, regulations, procedure, notification, order or directive or any condition of the permit:

A) Warning
B) Temporary suspension of tax exemption and relief
C) Revocation of permit
D) Black listed with the punishment of no further issue of permit

Application of the law of foreign investment regulation of this rice husk power generation business

Law applicable on foreign investment regulations of this rice husk power generation business

Within the framework of foreign investment regulations, such as the above, describe the formal law applied to the Rice husk power generation business.

First, there is "power generation business" in some state monopoly 11 industries of state-owned Enterprise Law ("except for the private and co-generation projects").

There is provision "Manufacturing and service industries that can Myanmar foreigners only do" in Foreign Investment Law Article 4, and hence foreign capital cannot be entered. This is the maximum of the neck.

There is "Management of electricity distribution network, commercial trading of electricity, electrical-related inspection services" in the "11 foreign entry prohibition industries" as regulations related to the peripheral business areas.

Furthermore, In MIC Notice, "Large-scale power generation business, transmission line construction" are required environment assessment. But 50MW smaller power generation business does not fall into the category of large-scale power generation. In advancing the commercialization of this project, Individual hearing is essential to the Ministry of Power and relevant ministries and agencies.

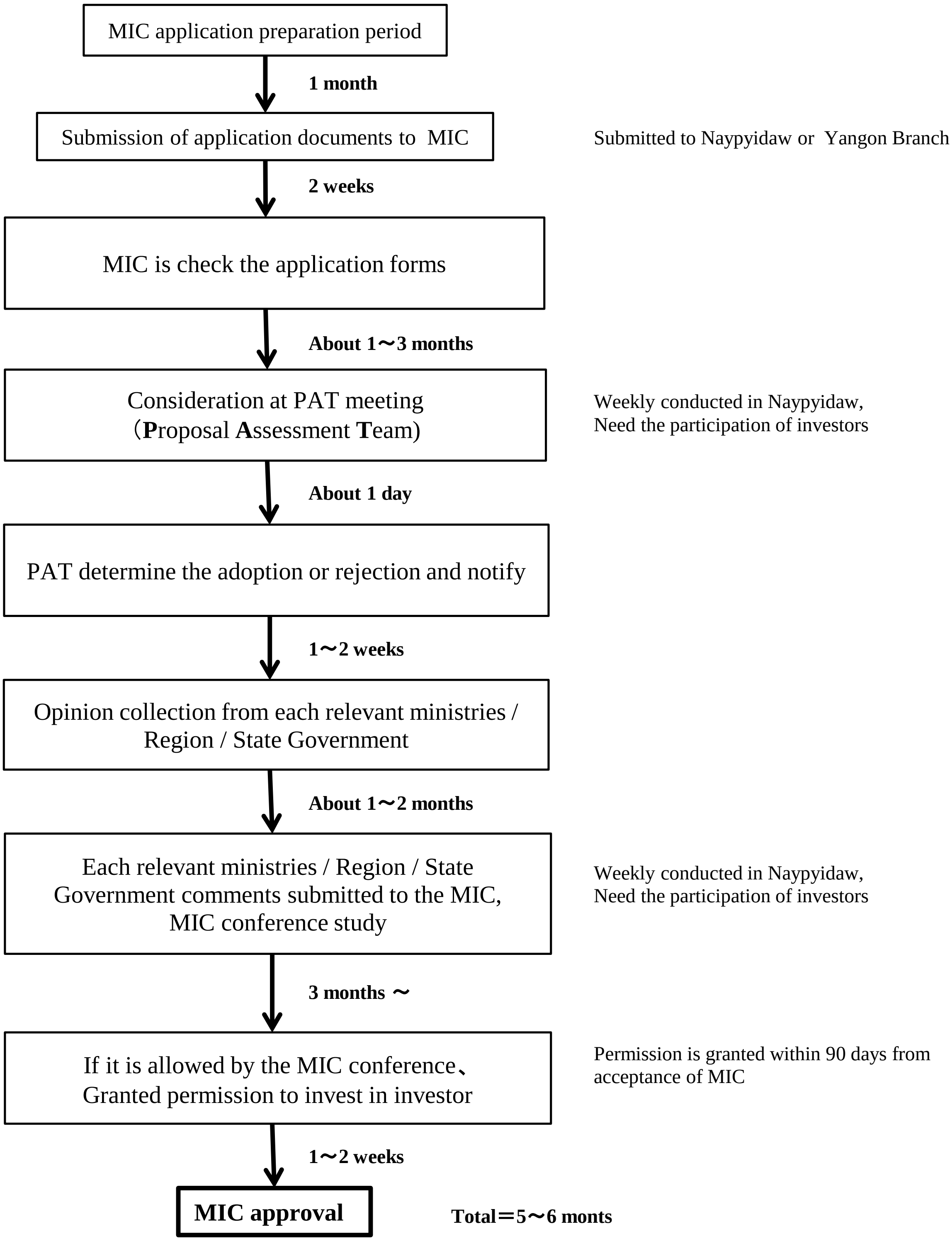


Figure 11 Procedure and the required period of MIC application

Appendix 6: Rice husk power generation system

(1) Items to be considered in the selection of the power generation system

1) Erosion, abrasion and fouling

Biomass fuels include significant levels of inorganic mater as impurities with can result in ash-related problems including:
Formation of fused agglomerates and slag deposits within furnaces;
-Accelerated metal wastage of boiler component due to gas-side erosion or corrosion; and
-Formation and emission of sub-micron aerosols and fumes.

It is therefore important that the power plant be designed in consideration of the feedstock to be combusted. In general, rice husk has a high ash melting temperature of about 1500°C signifying that sintering, slagging or fouling are typically not such an issue.

The high silica content of rice husk can give rise to abrasion problems in the fuel and ash handling systems and erosive wear of boiler components. Typical methods for reducing potential erosion impact includes:
-Reducing flue gas velocity;
-Co-blending with other fuels such as coal or other non-erosive biomass; and
-Application of erosion resistant materials for boiler parts such as for the super heaters.

2) Pollution control technology

Subject to environmental limits determined as part of the EIA and project specific environmental compliance requirements, adequate systems will need to be implemented to treat the flue gas and effluents.
Typically for rice-husk fired projects, an Electro-Static Precipitator (ESP) is installed to control the level of particulate emissions. Bag filters can be installed for more stringent emission control.

3) Processing and Wastes handling

Project wastes are foreseen to include hazardous wastes (examples oils), non-hazardous wastes, waste water and ashes.
All wastes typically require disposal in accordance with the requirements of the EIA and project specific requirements.

4) Water availability

Power plants and in particular Combined Heat and Power plants can consume significant quantities of water for cooling purpose, steam generation and sales and demineralized water production.

Plant designs will typically be constrained subject to water abstraction limits as determined during the Environmental Impact Assessment.

Typically biomass power projects will be located nearby a source of available water such as a river, and would often include a dedicated water storage area (water pond) to collect rain water during the rainy season, for uninterrupted operations during the dry season.

5) Electrical and Steam Demand

The financial viability of the project will be dependent upon the sufficiency of nearby demand for electrical power and steam demand.

Typically, the largest individual consumers with the most stable demand are preferable. Proximity to the proposed project is also important with a view to mitigate costs associated with electrical and steam distribution network.

6) Plant Reliability

High plant reliability would be expected to be required due to the proposed geographical location of the project where replacement parts may not be readily available. Furthermore subject to the requirements of the users at the industrial estate, dependable electrical and steam supply may be necessary.

This would therefore suggest requirement for implementation of proven plant design by an international contractor, and application of a high degree of redundancy. Back up facilities may also be required such as provision of an auxiliary boiler, or alternatively multiple units so as to maintain generation during maintenance periods.

(2) Characteristics of the fuel required in order to consider the power generation system

1) Moisture Content

Moisture content of biomass feedstock can vary significantly subject to composition and storage. It should be noted that the efficiency of a combustion system decreases as the moisture content of the fuel increases. Unlike other biomass feedstock, the moisture content of rice husk is generally not prone to large variation (12 - 14%)..

2) Heating Value

The energy of biomass per mass unit of fuel can be defined in term of Higher Heating Value ("HHV") or in term of its Lower Heating Value ("LHV"). The higher heating value takes into account the latent heat of vaporization of water in the combustion products. The LHV assumes that the latent heat of vaporization of water in the fuel and the reaction products is not recovered. The difference in value for the LHV and HHV of fuel vary significantly and a consistent approach needs to be applied in the assessment of fuel composition and plant design. Rice husk can be expected to have a heating value of around 13 – 14 MJ/kg (LHV) which makes it suitable for biomass power generation.

Slagging and fouling, if in the presence of Chlorine, is also dependent on the feedstock content of Zinc, Mercury. Tin, Copper and Lead which can form low melting point chlorides and should therefore be included in the ash analysis.

3) Feedstock storage

Outdoor storage of most biomass feedstock in Southeast Asia is expected to lead to moisture changes in the material. In wet conditions it usually involves water absorption into at least the surface layers of the heaps. This will reduce boiler efficiency; lead to an inhomogeneous fuel supply which can lead to emissions problems, and most importantly promote exothermic rotting of the material and self-combustion.

(3) Use study of rice husk ash

Rice husk ash as cement raw material

As of late 2012, a total of 15 cement production factories, 7 government-owned and 8 privately-owned, are operating in Myanmar and the country's maximum gross production capacity is 4 million ton per annual. However, the actual rice production is reported to reach below 3 million ton, and 70% of the country's demand is supported by imports. The largest state-run plant in Ayeyarwady region, Kyangin Cement Plant (Myanmar Ceramic Industries: MCI), produces 1,050 ton per day under a management of Ministry of Industry, although its installed capacity is 1,600 ton per day. Cement manufactured under Ministry of Industry is dedicated to public facilities and civil works including roads and bridges, dams, schools, and hospitals[2].

Provision of infrastructure is essential for Myanmar to drive its economic growth, and manufacture of cement which will be utilized in such development is a significantly important mission to achieve. MIC has permitted to build 9 cement manufacture plants which are planned to be operational in 2015 – 2016, and Ministry of Industry estimates their aggregated production capacity to be 1,000 million ton per annual.

The composition of rice husk ash is particularly high in silicon dioxide (SiO2) content than silica (Si) which can be an ingredient for a production of cement. The study on using rice husk ash as a concrete ingredient has begun in 1970s, and its parameter, enforcement of concrete's strength for example, has been understood. However, a small scale trade of rice husk is thought to be challenging as a large amount is required to manufacture cement.

We have estimated the power generation ability of the biomass plant, subject to a hypothesis that Kyangin Cement Plant (180 km north of the project site) produces 2,000 ton per day as reported by MIC. If 10 % of the total cement ingredients were substituted by rice husk ash, 200 ton rice husk ash would be required for daily operations. Hence, 1,000 tons rice husk per day (200 / 20% ton per day) would be needed, and rice milling facility would be envisaged to process 5,000 ton (1,000 / 20%) of rice every day. Since the current annual gross production in Ayeyarwady is reported to be 750 million ton, hence 20,000 ton per day, 25 % of the amount is available as rice husk ash. In such scenario the installed capacity of the biomass plant would be about 33 MW.

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[2] JICA, Urgent Rehabilitation and Upgrade Project (Renovation of the Kyangin Cement Factory), Projects Overview document, 2013

Rice husk ash can be exploited not only as a cement ingredient, but also as calcium silicate board. The calcium silicate board is manufactured via reacting silicic acid with calcium hydroxide and mixed with reinforcement fibers and water. Due to its high resistance to fire and light relative density, the calcium silicate board has various uses in a construction field.

Rice husk ash as a paddy field for silica fertilizer

Silicic acid is important for paddy production: more than 50 kg of silicic acid is absorbed by 10a of paddy rice whereas only 10 kg of nitrogen is absorbed by the same area, and hence paddy rice actively requires silicic acids unlike other plants. Enrichment of paddy soil results in strengthened roots stems and leaves, reduction of adverse impacts by rice blast, and an increased harvest and improved quality.

However, only water-soluble silicic acids can be absorbed by rice, and the solubility of silicic acids in rice husk ash is dependent on temperature during the incineration. Generally, rice husk incinerated at a high temperature (900 degrees C) has an extremely low solubility. In contrast, rice husk ash attains a relatively high solubility at the incineration temperatures below 800 degrees C, and the highest solubility is reportedly achieved at temperatures between 400 to 500 degrees C [3] . A proposed incineration system is set to a high temperature (870 degrees C) for an efficient power generation, producing ineffective rice husk ash for a silicate fertilizer due to the low solubility.

We then estimated adverse effects on the growth of rice, assuming an insufficient silicate content in paddy soil on the grounds that rice husk ash is not restored to the soil. The restoration of rice husk ash is not necessary as 60 % of straws can be restored to the soil to balance out the silica content unless irrigated by low-silicate rivers.

Rice husk ash as industrial product raw materials

When increased purity of the silica by purifying the rice hull ash, they can used as an industrial product ingredient it Is different from their using method by the difference in the type of silica and SiO_2 concentration. Rice hull ash can be used as raw materials for industrial products by raising the purity above about 90 to 97% the SiO_2 concentration by removing impurities

[3] http://www.naro.affrc.go.jp/org/narc/seika/kanto16/12/16_12_06.html

Ash composition examples

Table 6 Ash composition examples

Parameter	W-%			
	Wheat straw	Rice straw	Rice husk	Bagasse
SiO2	59.9	69.9	95.4	73.0
Al2O3	0.8	0.3	0.1	5.0
Fe2O3	0.5	0.2	0.1	2.5
CaO	7.3	3.4	0.4	6.2
MgO	1.8	1.6	0.3	2.1
K2O	16.9	15.3	1.8	3.9
Na2O	0.4	0.4	0.0	0.3
P2O5	2.3	1.5	0.5	1.0
Other	10.1	7.4	1.4	6.0

Source: Combustion of Different Types of Biomass in CFB Boilers, Foster Wheeler, Presented at 16th European Biomass Conference Valencia Spain

Fuel-Specific ash content of biomass fuels

Table 7 Fuel-Specific ash content of biomass fuels

Biomass	Ash content (%)
Rise husk	15.0-25.0
Bark	5.0-8.0
Woodchips (industrial)	0.8-1.4
Sawdust	0.5-1.1
Straw and cereal	4.0-12.0
Misicanthus	2.0-8.0

Source: The Handbook of Biomass Combustion & Co-firing, Sjaak van Loo and Jaap Koppejan, 2008.

Appendix 7: Environmental regulations and other regulations in Myanmar

(1) Environmental regulations

Atmospheric Emissions (for 3-50MW Boiler – Solid Fuel)

Table 12 Atmospheric Emissions (for 3-50MW Boiler – Solid Fuel)

Parameter	Emission Guideline((in mg/Nm3) for Dry Gas @ 6% Excess Oxygen
Particulate Matter (PM)	50 or up to 150 if justified by environmental assessment
Sulphur Dioxide (SO2)	2,000
Nitrogen Oxides(NOx)	650

Note: Higher performance levels than these in the Table should be applicable to facilities located in urban / industrial areas with degraded air sheds or close to ecologically sensitive areas where more stringent emissions controls may be needed. Nm3 is at one atmosphere pressure, 0°C. Of note, emissions from a single project should not contribute more than 25% of the applicable ambient air quality standards to allow additional, future sustainable development in the same air shed.

Source: International Financial Cooperation (IFC). IFC General EHS Guidelines, April 2007 – Table 1.1.2.

Effluent Guidelines

Table 8 Effluent Guidelines

Parameter	Guideline Value	unit
ph	6 - 9	
Total Suspended Solids (TSS)	50	mg/L
Oil and Grease	10	mg/L
Total Residual Chlorine	0.2	mg/L
Chromium- - Total	0.5	mg/L
Copper (Cu)	0.5	mg/L
Iron (Fe)	1.0	mg/L
Zinc (Zn)	1.0	mg/L
Lead (Pb)	0.5	mg/L
Cadmium (Cd)	0.1	mg/L
Mercury (hg)	0.005	mg/L
Arsenic (As)	0.5	mg/L
Temperature increase by thermal discharge from cooling system	Site specific requirement to be established by the environmental assessment (EA). Elevated temperature areas due to discharge of once-through cooling water (e.g., 1 Celsius above, 2 Celsius above, 3Celsius above ambient water temperature) should be minimized by adjusting intake and outfall designthrough the project specific EA depending on the sensitive aquatic ecosystems around the discharge point.	

Note: To be applicable at relevant wastewater stream: e.g., from FGD system, we ash transport, washing boiler / air preheater and precipitator, boiler acid washing, regeneration of demineralizers and condensate polishers, oil separated water, site drainage, coal pile runoff, and cooling water. Applicability of heavy metals should be determined in the environmental assessment. Guideline limits in the Table are from various references of effluent performance by thermal power plants.

Source: International Financial Cooperation (IFC). IFC EHS Guidelines for Thermal Power Plants, December 2008 – Table 5

Indicative Values for Treated Sanitary Sewage Discharges

Table 9 Indicative Values for Treated Sanitary Sewage Discharges

Parameter	Guideline Value	Unit
ph	6 - 9	
Biological Oxygen Demand (BOD)	30	mg/L
Chemical Oxygen Demand (COD)	125	mg/L
Total Nitrogen	10	mg/L
Total Phosphorus	2	mg/L
Oil and Greece	10	mg/L
Total Suspended Solids	150	mg/L
Total Coliform Bacteria	400	MPN/100mL

Note: a. MPN = Most Probable Number.
Source: International Financial Cooperation (IFC). IFC General EHS Guidelines, April 2007 – Table 1.3.1

Noise Level Guidelines

Table 10 Noise Level Guidelines

Receptor	Table17	
	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential, Institutional, educational	55	45
Industrial, Commercial	70	70

Note: Guidelines values are for noise levels measured out of doors.
Noise impacts should not exceed the levels presented in the above Table, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.
Source: International Financial Cooperation (IFC). IFC General EHS Guidelines, April 2007 – Table 1.7.1.

(2) Pending EIA Legislation
In accordance with Environmental Conservation Law 2012, the "Environmental Impact Assessment Procedure 2013" was drafted by technical experts from ADB and MOECAF to provide the guiding framework and procedure for the EIA system.
This procedure is still in its draft form, with the 5th revision currently under review.

Depending on the above timeline, a project could be affected by the new legislation to a varying extent. Indicatively, based on the 4th revision made publicly available, potential impacts could be:
-For existing or commenced projects to undertake environmental and/or social compliance audit;
-For projects under construction prior to the procedure promulgation, shall develop an Environmental Management Plan (EMP) under MOECAF's prescribed timeframe;
-The preparation of Initial Environmental Examination (IEE) and/or EIA can only be undertaken by an organization or person that/who is registered with MOECAF4 ;

-An Environmental Compliance Certificate (ECC) with appended conditions will be issued upon approval of IEE and/or EIA.

Within the Annex of the draft EIA procedures, a categorization of projects was provided. This shows the requirement for either an IEE or EIA, based on a project's nature and scale. For a biomass plant of <50MW, it appears that only an IEE will be required under the proposed new procedures.

Likewise, for auxiliary facilities only an IEE is required provided that:
-Transmission line =230kV is less than 50km in length;
-High Voltage Transformer Substation is less than 10 ha.

(3) Rice husk power generation-specific environment considerations (Disposal of rice hull ash)
The silica component of rice husk ash that was burned at high temperature is crystallized into tridymite and cristobalite. These crystalline silica are listed in the causative agent of pneumoconiosis same as asbestos (asbestos). Since the bulk density of rice husk ash is very small, they are easily fluttering in the air by the wind. Therefore appropriate processing is required during disposal. For transport of rice husk ash require special attention, they should be re-used at source nearby. Considering from this point of view, rather than applied to paddy as cement and silicate fertilizer that must be transported a long distance, it is considered as a promising direction to launch a calcium silicate board manufacturing plant

(4) Other Myanmar domestic law to be considered
Describes the Myanmar various national laws to be considered when performing the project

Applicable National Standards

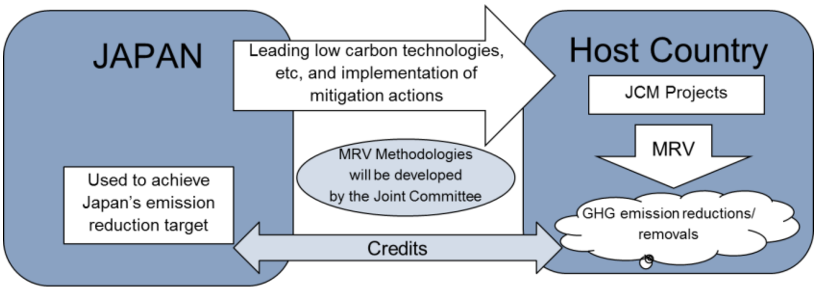
Table 11 Applicable National Standards

Aspect	Legislation
Environment management assessment	Environmental Conservation Law 2012
	The Conservation of Water Resources and Rivers Law 2006
	The Underground Water Act 1930
Cultural and Heritage	The Protection and Preservation of Cultural Heritage Region Law 1998
Forestry and Biodiversity	Burma Wild Life Protection Rule 1941
	The Forest Law 1992
	The Protection of Wild Life, Wild Plants and Conservation of Natural Areas Law 1994
	The Forest Department Notification No. 583/94
Occupational Health and Safety	The Factory Act 1951
	The Employment and Training Act 1950
Community/Public Health	The Penal Code of Offences Affecting the Public Health, Safety, Convenience, Decency and Moral 1861
	The Public Heath Law 1972
	The National Drug Law 1992
	The Narcotic Law 1993
	The Prevention and Control of Communicable Disease Law 1995
	The Traditional Drug Law 1996
	The National Food Law 1996
	Private Health Act 2007
Labor	The Worker's Compensation 1923
	The Payment of Wages Act 1936
	The Minimum Wage Act 1949
	The Employment and Training Act 1950
	The Factory Act 1951
	The Shops and Establishment Act 1951
	The Leave and Holidays Act 1951
	The Social Security Act 1954
	The Labor Organization Law 2011
	The Settlement of Labor Dispute Law 2012
Land Acquisition	The Land Acquisition Law 1894
Land Use	The Town Act 1907
	The Village Act 1907
Industrial	The Factory Act 1951
	The Private industrial Enterprise Law 1990
	Myanmar Special Economic Zone Law 2011
	Dewey Special Economic Zone Law2011
Transportation/Logistics	The Obstruction in Fairways Act 1881
	The Canal Act1905
	The Yangon Port Act 1905
	The Ports Act 1907
	The Defile Traffic Act 1908
	The Inland Stream Vessels Act1917
	The Myanmar Aircraft Act 1934
	The Motor Vehicle Law 1964
	(The Law Amending the Motor Vehicles Law of 1964 enacted in 1989)
	The Highways Law 2000

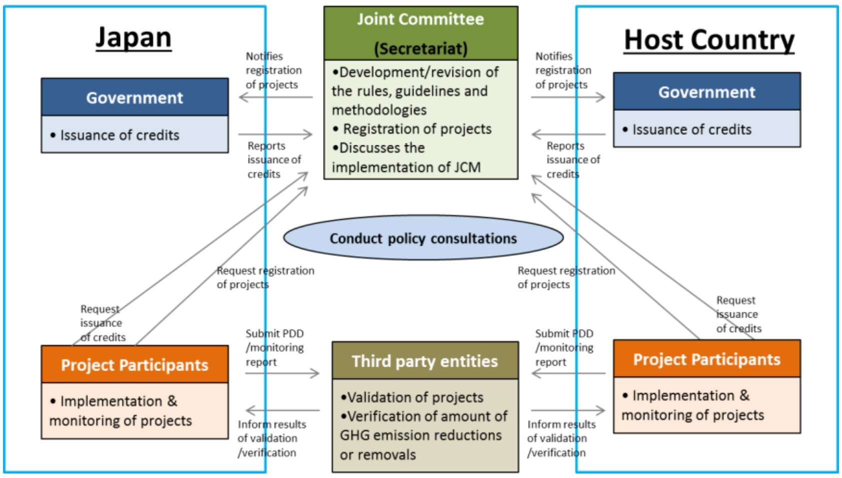
Appendix 8: Concept of the JCM[4]

Basic Concept

- Facilitating 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.
- Appropriately evaluating contributions from Japan to GHG emission reductions or removals in a quantitative manner, by applying measurement, reporting and verification (MRV) methodologies, and use them to achieve Japan's emission reduction target.
- Contributing to the ultimate objective of the UNFCCC by facilitating global actions for GHG emission reductions or removals, complementing the CDM.



Scheme of the JCM



Features of the JCM

(1) The JCM starts its operation as a non-tradable credit type mechanism.

(2) Both Governments continue consultation for the transition to a tradable credit type mechanism and reach a conclusion at the earliest possible timing, taking account of implementation of the JCM.

(3) The JCM aims for concrete contributions to assisting adaptation efforts of developing countries after the JCM is converted to the tradable credit type mechanism.

(4) The JCM covers the period until a possible coming into effect of a new international framework under the UNFCCC.

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[4] Government of Japan Ministry of the Environment, "Recent Development of Joint Crediting Mechanism (JCM)"

Appendix 9: Case analysis of CDM examples of biomass (rice husk) energy projects

There has been no biomass energy projects proposed or registered under JCM. It is therefore necessary to analyze CDM case examples before discussing the methodology of CO2 emission reduction. The outline of the analysis is given below.

(1) Status of Biomass (Rice Husk) Energy Projects in CDM

A total of 7,538 projects have been registered in CDM as of September 2014, out of which 638 are biomass projects, covering 8.5 % of the total. Of the biomass projects, the total CDM credits (CER) effective as of the end of 2012 is 41 Mt-CO2, which covers only 2.9 % of the total. The reasons are that biomass projects are small in scale in terms of the volume of CO2 emission reduction compared to other projects such as the projects of industrial gas (e.g. HFC-23) recovery and destruction, and the risk of stable supply of biomass. This is the background of the low issuance of CER (roughly 1/3 of the initially expected volume of 117 MT-CO2).

Although CDM biomass projects include sugar production wastes (bagasse) and sawdust, the number of projects utilizing rice husk as major source of energy amounts to 129, out of which 82 in India, 21 in China, 8 in Thailand. Other than Asia, there are a few projects in Latin America such as Brazil and Dominican Republic. CER derived from rice husk projects reaches 7.5Mt-CO2 which is about 1/5 of that of the total biomass projects.

Outline of Biomass Methodology in CDM

The outline of biomass methodology adopted and applied in CDM is described below.

(1) AMS-I.C (biomass co-generation)

In accordance with AMS.I-C (small scale CDM methodology for biomass co-generation), some 300 projects (4 % of the total CDM registered projects) have been registered so far. About 90 of them have issued CER (2.7Mt-CO2).

(2) AMS-I.D (Grid-Connected Renewable Energy Power Generation)

The outline of AMS.I-D (small scale CDM methodology for grid-connected renewable energy power generation) is shown below. In terms of the number of projects, 2,091 projects, which is more than 1/4 of the total registered projects, use this methodology. This number is fairly large, just next to that of ACM0002 which is a large scale CDM methodology for similar type of projects.

(3) ACM0006 (Biomass Co-Generation)

The methodology for biomass co-generation and power generation ACM0006 “Consolidated methodology for electricity generation from biomass residues in power and heat plants” has been strictly pointed out because of its drawbacks of complexity and ever increasing scenarios. In early 2008, its revision was decided, but the final drastic revision was actually made as late as mid-2010. Major factors of the revision were while the former ACM0006 adopted the approach which required many scenario settings of baseline conditions of power, heat and co-generation, the new one starts from the estimation of available biomass volume to be followed by the estimation of "theoretically" feasible biomass power generation volume as baseline conditions, and then estimate the power supply volume from fossil fuel (in-house power generation) and grid-connected line. The new method saves the enumeration of so many scenarios.

(4) ACM0018 (Biomass Power Generation)

As mentioned above, ACM0006, the methodology for biomass co-generation and power generation, was revised, at the request of the CDM Board Meeting, and created ACM0018 which is the integrated methodology for the exclusive power generation facilities using biomass residue as fuel.

ACM0018 estimates the available biomass volume first, based on which it estimates the theoretically feasible biomass power generation volume as baseline conditions. In addition, when it further estimates the power supply volume from fossil fuel (in-house power generation) and grid-connected line, since the former's CO2 emission coefficient is higher than that of the latter, it intentionally makes lower emission coefficient estimation for the former, and higher emission coefficient estimation for the latter. By doing this, it ensures the conservative estimation.

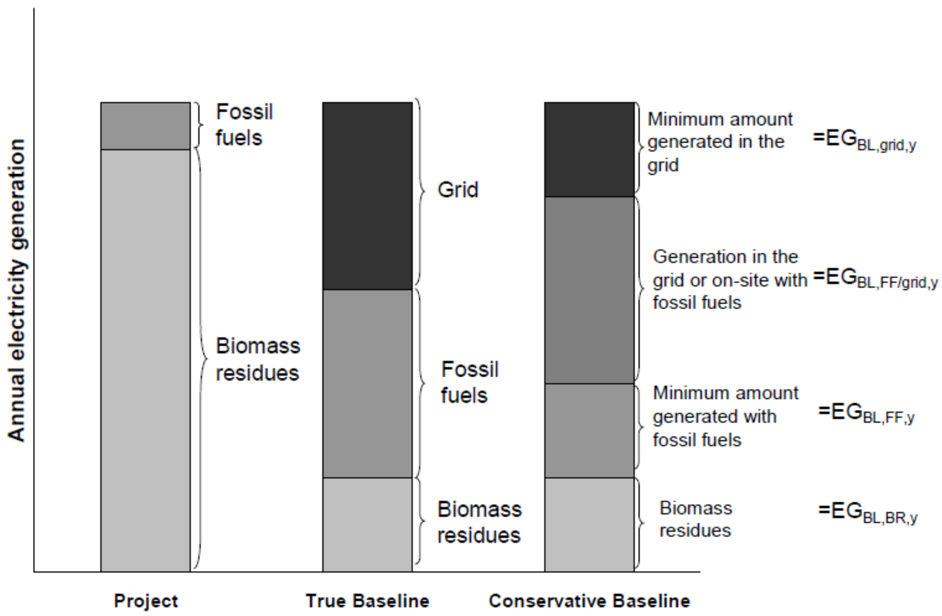


Figure 12 Categorization of Baseline Power by ACM0018 (Methodology Fig.1)

Source: CDM Methodology : ACM0018

55 ACM0018-based projects have already been registered, and 52 out of them are Chinese projects. Those projects that have issued CDM credit (CER) remain only two. The reason of this scarcity of CER issuance might be that when the methodology was established, the market for CDM credit had already died down.

(5) Standardized Baseline for Rice Husk Power Generation (Cambodia)

CDM Modalities and Procedures stipulates that a baseline shall be established on a project-specific basis. (para 45) Therefore, the methodology was prepared to be established on baseline-scenario-specific as well as project-specific bases, and to estimate the baseline emission volume. This type of methodology enables to take into account the project-specific circumstances. On the other hand, since it makes baseline emission estimation so complex that the emission volume estimation of projects composed of many similar small scale subprojects could be difficult. There were persistent opinions that the methodology of baseline scenario setting and emission volume estimation should somehow be standardized.
Under the circumstances, the CDM Board Meeting considered the standardized baseline.

As the result, "Guidelines for the Establishment of Sector Specific Standard Baselines"5 was prepared at the end of 2011. This was to categorize target projects into several technology groups (measures), and separately set up emission factors one for the basis for the project eligibility (additional) and the other for the basis for baseline emission volume calculation. For example, in cases of fuel conversion projects, surveys of fuel used in similar projects are conducted, and if emission factor is more than Xa %, it is regarded as additional, and the baseline of such projects is Xb %.

In connection with the application of standard baseline, the standard baseline for rice mills in Cambodia was proposed. This is to standardize baseline for efficiency improvement of rice mills of Cambodia, and was supported by IGES of Japan. There are 27,000 rice mills in Cambodia whose milling capacity is diverse from 1 to 48,000 tons a year. Since their emission reduction volume is small in scale, and multiplication of small subprojects is possible, they are suitable for the standard baseline.

This survey concluded that most of rice milling plants in Cambodia utilize power generated by diesel engines. Cambodia's rice production volume is estimated around 6 million ton (polished rice base) a year. Assuming that 10 % of the polished rice by diesel engines is replaced by polishing by rice husk power generation, the estimated CO_2 emission reduction is around 320,000 tons a year.

5 Guidelines for the Establishment of Sector Specific Standard Baselines. The draft version of the document "Draft Framework for the Establishment of Sector Specific Standard Baselines" was discussed at the 62nd CDM Board Meeting in July 2011.

Appendix 10: Business model of project

1) Project Requirements

The biomass project should satisfy the following 4 requirements:

1. The project area or undertaker should be able to produce more rice husk than the amount required to generate electricity for the plant operation, in order to evade a risk of price hike arising from a competition for rice husk.
2. Acquisition and transportation of rice husk should be carried out within a reasonable catchment of the project site to reduce the feedstock procurement cost (purchase and transportation).
3. Rice milling facility undertaking the project should have vacant lots of reasonable areas. If possible, a free lease agreement of the power plant site should be made via negotiations in order to avoid costs and regulations associated with securing the project site.
4. The power plant facilities should be proven to pose minimal harm upon the environment in order to proceed without hindrance the future expansion of the biomass plant undertaking and a competitive procurement of the feedstock.

2) Business Scheme

BOT Scheme

BOT scheme is utilized in implementing the biomass plant project to remove necessities of the initial costs, design and construction, and maintenance imposed upon subject rice mill operators.

3) Project Plan

Management of a Local Subsidiary

The biomass plant is managed by a joint venture with a Myanmar company (SPC).

Capitals and Initial Investment

EPC cost: Design and construction of the biomass plant and procurement of required equipments are awarded to an EPC (Engineering, Procurement, and Construction) contractor.
Preliminary expenses: Consultation with related authorities, fees associated with an SPC commencement, and overhead during a construction period will be appropriated, and hence a summation of the EPC cost and the above preliminary expenses will be the total capital (gross operating cost) of the project.

Financing

JCM scheme is implemented, by which the project is funded solely by Fujita's capitals except for a subsidy covering 50 % of the cost of equipment.

Contract

Any works associated with construction the biomass plant will be awarded to an EPC contractor.

Fuel Procurement Plan

Feedstock Procurement Cost

Procurement of Rice Husk on the Premise of BOT Scheme:

The price of rice husk is determined by a supply and demand mechanism. One needs to expect a sudden price hike of a hitherto cheap rice husk when it is widely exploited as a feedstock for biomass power. Since income and expenditure of this business is largely influenced by the price of rice husk, long-term contracts should be agreed by the supplier to mitigate price fluctuation.

An implementation of BOT system provides merits including cheap electricity, maintenance-free operation, and voluntary transfer of the plant after the contract period, and hence a long-term, stable supply of rice husk can be attained. Establishing such mutual trade agreements with local rice millers builds a feedstock procurement system which can be invulnerable to an adverse impact inflicted by an external rice husk market environment. For example, in Thailand, where a biomass power investment has gained popularity since 2000s and the total installed capacity of more than 100 MW is provided by rice husk fired power, an intense competition for rice husk increased its price from 28 USD/ ton in 2000s to a peak value of 46 USD/ ton in 2008, and the current price is recorded 39 USD / ton. A similar phenomenon is likely to happen in Myanmar as well.

Long term contract should be made with the rice husk suppliers to alleviate a price fluctuation as income and expenditure of this business is significantly affected by the price of rice husk.

If 100 % of rice husk required for the generation of power cannot be obtained from a single rice mill, acquisition from other rice mills in the vicinity is necessary. A contract with an SPC investor, a major rice husk supplier of this project, should be made specifying a provision of rice husk at a reasonably affordable price during the project period in exchange of power supply during the BOT period and voluntary transfer of the plant after the period. This rice-husk-procurement contract should be stipulated in the articles of the BOT contract to sustain the supply at a constant price as a requirement for the transfer of the biomass plant to the SPC investor after the project period. Incentives in an acquisition price should be given to auxiliary rice husk suppliers as they are not entitled to the transfer of the plant after the BOT.

Electricity tariffs

The electricity tariff in Myanmar is subject to subsidy. Electricity is first sold to Myanmar of Electric Power (MOEP) at a constant price then supplied to Yangon City Supply Board (YESB) and Electricity Supply Enterprise (ESE). As of January 2012, a household electricity tariff is generally set to 35 MMK/kWh and an industrial use to 75 MMK/kWh. The tariffs of electricity supplied outside an electric grid are, depending on the power generation cost (e.g. diesel, solar power, hydro), set to 100 – 300 MMK/kWh (Myanmar Energy Sector Initial Assessment, ADB, October2012.).

However, since April 2014, the government of Myanmar has decided to adopt a pay-as-you-go system based on monthly use to compensate for a deficit due to a significant increase of demand for electricity.

Table 12 Revised Electricity Tariff in Myanmar

	- March/2014		March/2014 -			
	Price		Month usage		Price	
	MMK	USD	kwh/month		MMK	USD
Household	35	0.03395	1	– 100	35	0.0340
			101	– 200	40	0.0388
			201	–	50	0.0485
Industry	75	0.07275	1	– 500	75	0.0728
			5,001	– 10,000	100	0.0970
			10,001	– 50,000	125	0.1213
			50,001	– 200,000	150	0.1455
			200,001	– 300,000	125	0.1213
			300,001	–	100	0.0970

Source: https://www.digima-japan.com/news/22679/20140708-5.html

Although the generation of electricity within the grid can be challenged by a competition with the subsidized electricity tariffs, high-priced electricity supplies may be accepted by industries which require constant, stable power sources.

Operation and maintenance plan

Operation Time

Daily operation time is set to 24 hours.

Annual Operation Days

Annual operation days are set to 300 days, taking into consideration a month of a yearly maintenance period, Sundays, and Myanmar's national holidays.

O&M Design of Plant

Works associated with daily operation, maintenance, and parts-replacement of the biomass plant is wholly awarded to an O&M contractor. A candidate O&M contractor for this project is an experienced Japanese company, having implemented operation and management of rice-husk-fired plants based on direct combustion of biomass and steam turbines in nearby countries such as Thailand.

Table 13 Project Plan Overview

Site area	2ha (20,000m2)
Power system	BTG: : Boiler Turbine Generator
Fuel	Rice husk 100%
Heating volume	Low heating volume 13,000kJ/kg-wet
Power generation capacity	1,816kw（Gross capacity）, 1,634kw（Net capacity）
Power efficiency	15%
Fuel consumption	2 ton/hour
Capital costs	4.5 million USD (including Opening & development costs）
Operation hour	24 hours/day
Operation day	300 day/year
Operation hour	7,200 hours//year
Power requirements for rice mill	285,000 kWh/year
Annual sale power	2,052,200 kWh/year
Annual rice husk	14,400 ton/year
Project period	15 years

4) Risk Analysis

3 primary risks are envisaged in this project: feedstock availability, fluctuation of currency exchange rate, and downward adjustment of electricity price.

Feedstock Availability

On one hand, the cheap supply of electricity and grant of the biomass plant after the project period to a partner rice mill as incentives can allow us to exclusively acquire a sufficient amount of rice husk at an affordable price, avoiding the competition between biomass plant operators. On the other hand, reliance upon a particular rice mill as a source of feedstock may lead to a necessity of obtaining rice husk, expectedly at higher price, from the surrounding facilities in case of inadequacy or failure of supply by the partner mill as stipulated by the BOT contract. In this report, feasibility of this project in the event of the above mentioned feedstock shortage is assessed to comprehend the associated risks.

Risk of Currency Exchange Rate

Although Myanmar's national currency is KKM (Burmese Kyat), US dollars are also prevalent. In this project, returns and expenses for rice husk, electricity, the EPC and O&M are processed in US dollars. However, the subsidy from JCM is expected to be yen-based and granted upon the completion of construction of the plant, which introduces a risk associated with the exchange rate between USD and Yen. The exchange rate during the construction period (about 1 year) should be taken into consideration in the project design.

Risk of Electricity Sales Price

Developments of large scale power plants and power grids are envisaged in Myanmar. Currently, power generation is carried out primarily by small-scaled, inefficient facilities and thus electricity is supplied at extraordinarily high prices in areas without connections to the grid. One should take into consideration the downward price change of the electricity as the electrification continues in future.

Appendix 11: Photos

Myaungmya (2014/11/9)


Village and rice mill


Rice mill cluster


Rice mill cluster along the river


TV and DVD player in village house


Refrigerator in village house


LED in village house

Hinthada(2014/11/11)


Downdraft gasifier in rice mill


Secondhand truck engine for generation


Rice husk


Rice husk briquette machine


Ash from rice husk gasifier


Rice milling machine

Kyaiklat(2014/11/12)

 Rice mill under construction	 River for rice transportation	 Rice mill lies along river

Appendix 12: 2nd Workshop “Ayeyarwardy Low Carbon Community Roundtable” Handouts

2nd Workshop “Ayeyarwardy Low Carbon Community Roundtable” in Yangon, Myanmar

Feasibility Study on Rice Husk Power Generation System for Low-carbon Communities in Ayeyarwady Region, Myanmar

2015/2/4

Mitsubishi Research Institute, Fujita Corporation

Background History and Aims

Subject

- **Rice husk, a byproduct from rice mill** isn’t used beneficially. (rice husk is a biomass resource which can be used to produce energy.)
- **Distribution of power in non-electrified area** (Necessity of electrification of quality of life, and industry promotion)

Rice husk power generation system, as “energy supply center (independent, distributed energy system)” in rural community; Ayeyarwady Division, Myanmar.

The expected outcome is the formation of a low-carbon community centering on the rice mill, including new industries based on electricity and heat generation, and improved energy access of the local residents.

Establishing a distributed regional energy supply system in the Ayeyarwady region in Myanmar based on rice husk biomass generation in rice mills, supplying electricity to the surrounding community whose electrification rate is low.

From Ayeyarwady division to many other areas of Myanmar.

Other Asian countries.

1

Estimated Outcomes

Implementation of rice husk-fueled Electric Energy System with the purpose of becoming a Low-carbon Communities

Economic Section (Utilization of Electricity and Heat)

- Supplying electricity & heat for industry and communities
- Job creation by new industries
- Improving quality of life by electrification in local communities.

Economic Section (Byproducts)

- Ash (Silica) : Construction Materials (Board) ,and mixture with Cement.

Less Carbon Emission (Environmental Sector)

- To reduce CO2 emission from from fossil fuel combustion (Reduction of the use of fossil fuel)
- Reduction of CO2 from non-energy sources

2

Conducting Research

JCM's Analysis on probabilities

Analysis of the benefits

- **Analysis of the reduction amount of GHG (Greenhouse Gas)**

Analysis for the development of JCM project

Analysis for Low-carbon Communities in Ayeyarwady Region

- **Realizing the actual situation and knowing the critical necessities**
- **Analyzing and confirming the socio-economic situations**
- **Analyzing the benefits from the project**

Analysis for the possible situations for the implementation of the project

Analyzing the best system

- Current condition/situation
- Candidate sites
- Best technologies/system

Analyzing the capability of implementing the project

- Realizing the actual situation and knowing local needs
- Finding environmental and social considerations
- Confirming the implementation of the system and project formation

3

Conducting Workshop Meetings

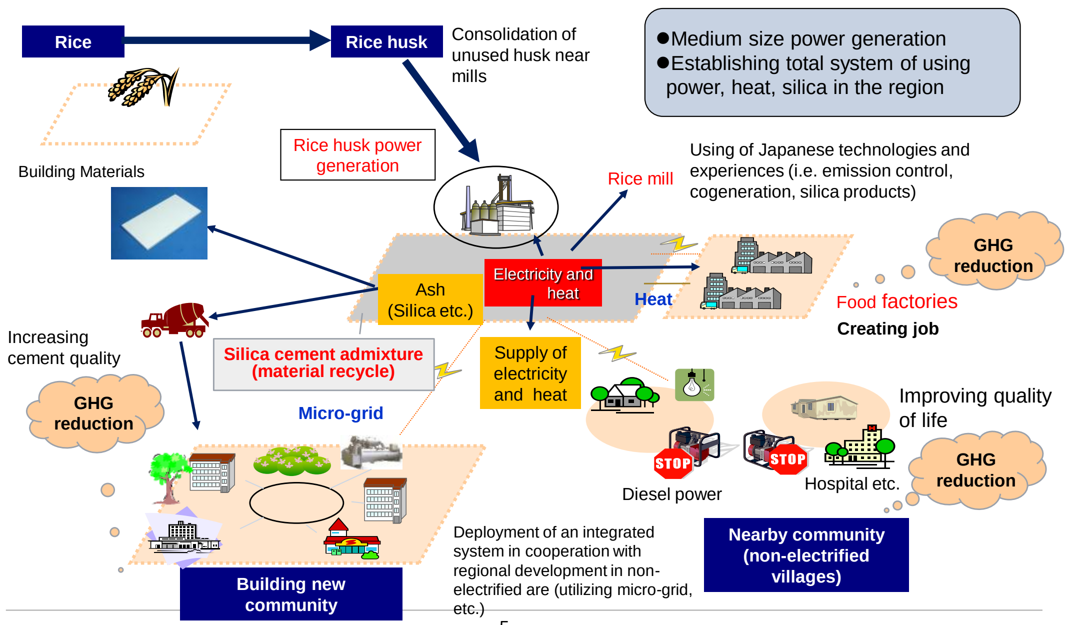
Discussing plan in the "Roundtable on Ayeyarwady low-carbon community"
Sharing idea and discussion for finding Best Rice Husk Power Generation System for Low-carbon Communities in Ayeyarwady Region

● Designing rice husk power generation system ● Proposing implementation of the project ● Analysis of project effects (GHG reduction etc.) ● Proposing promotion system for Low-carbon Communities	● Establishing a distributed regional energy supply system based on rice husk biomass generation in rice mills ● Supplying electricity to the surrounding community whose electrification rate is low. ● The expected outcome is the formation of a low-carbon community centering on the rice mill, including new industries based on electricity and heat generation, and improved energy access of the local residents.

4

Business image

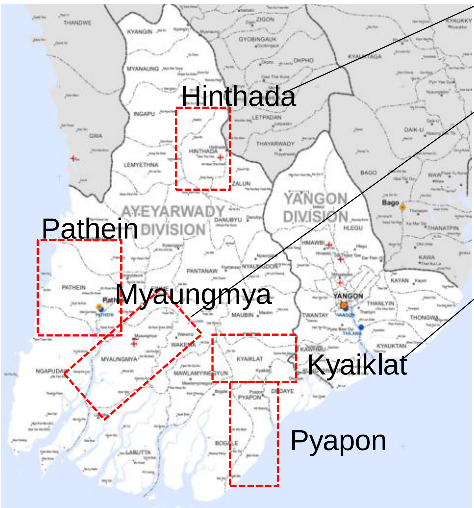
Rice Husk Power Generation System for Low-carbon Communities in Ayeyarwady Region, Myanmar



5

Analysis of the candidate area

Five candidate region：Pathein, Myaungmya, Pyapon, Kyaiklat, Hinthada



Small scale of rice mills
Inland, overland transport

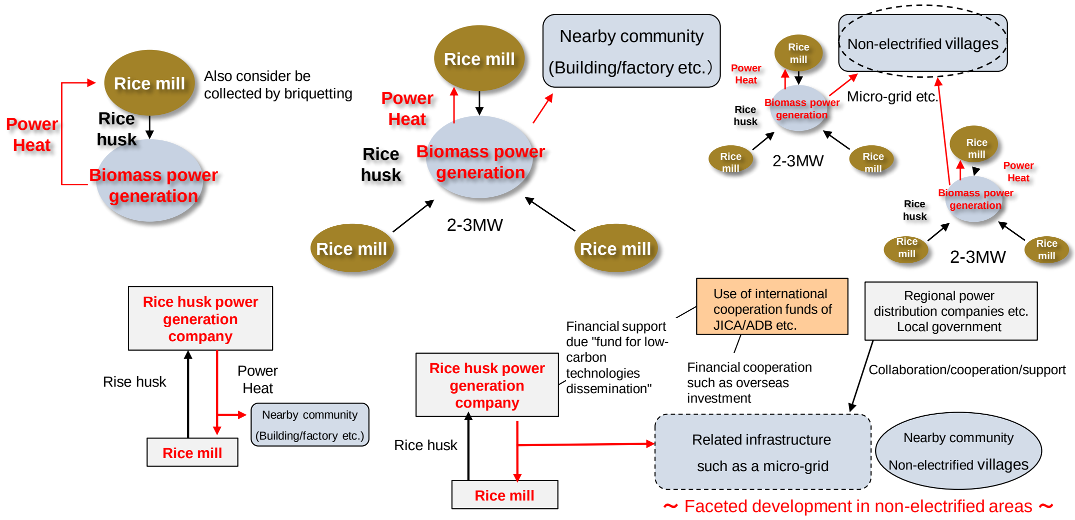
Rice mills are adjacent along the river
Ship transport
Close to urban areas, also expected to increase in the future power demand
Construction of the grid are also relatively advanced.

Rice mills are adjacent along the river
Ship transport
The end of the national grid, the power supply is weak, also delays Construction of the grid.
Pyapon is less generation amount per unit of rice husk than Kyaiklat.
From the difference of the breed characteristics
High rice husk of utilization

6

Business deployment (Idea stage)

1st steps	2nd steps	3rd steps
The prototype facilities	**Based on the results of the prototype, deployment of a full-fledged business**	**Faceted expand in collaboration with power infrastructure in the region around such as the development of micro-grid**



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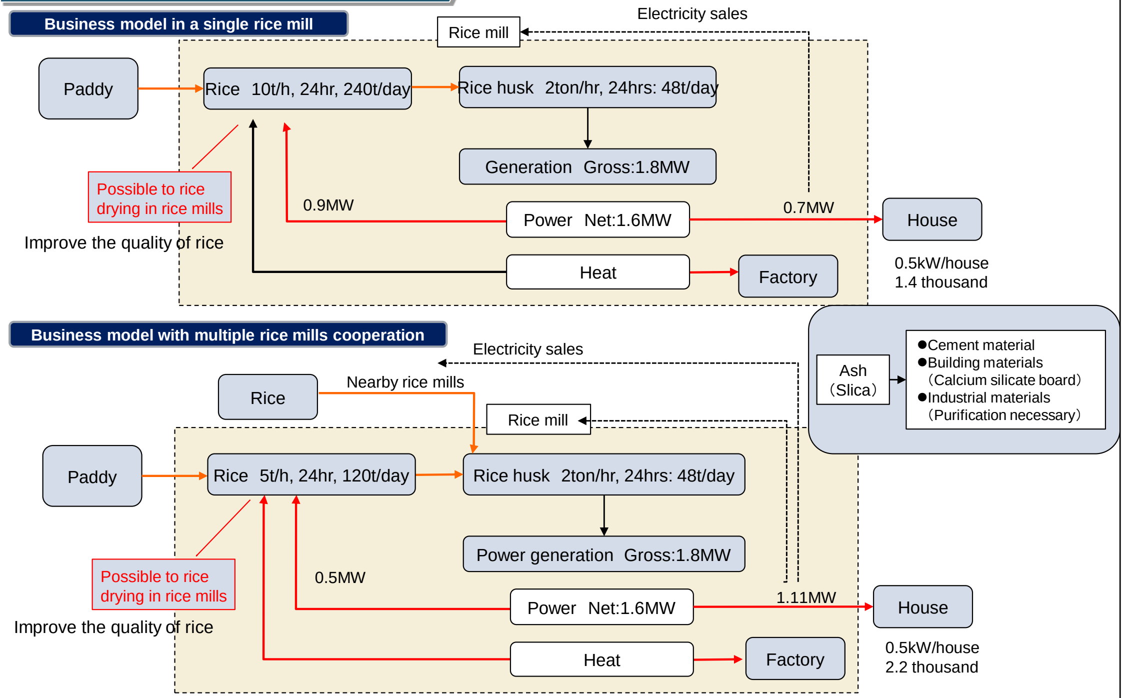
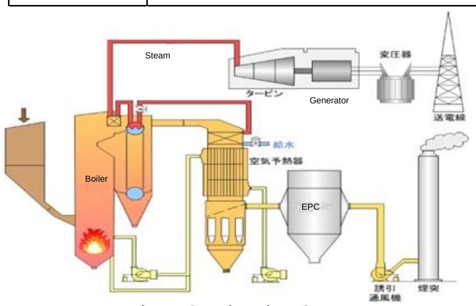
Study of business models



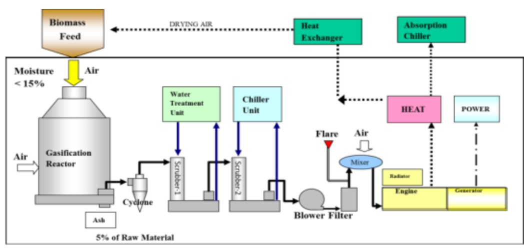
8

Study the introduction technology

	Direct Combustion	Gasification
Initial Cost	Cheap for simple structure	Expensive for many process
Running Cost	・ Water treatment for boiler water is necessary	・ Expensive by cleaning many times ・ Need waste water treatment cost ・ Lifetime of equipment is short by produced tar
Maintenance	・ Shutdown of 2 or 3 days/month for periodic inspection ・ Operation time is 24 hour a day, 330 days/year except periodic inspection day	・ Unestablished tar removal technology ・ Many tar removal operations are necessary ・ Need frequent removal of tar from system ・ Cleaning wastewater comes into each cleaning ・ Wastewater treatment system is necessary
Environmental	・ Rice huskash is available for sale as a cement admixture ・ Contains dust in the exhaust gas (Dust collector in can be processed)	・ Rice husk coal is available for use ameliorate in farm lands, but the coal is stocked in backyard because it is not sold well. ・ There is a possibility of leakage of fuel gas, which is a greenhouse gas



Direct Combustion System



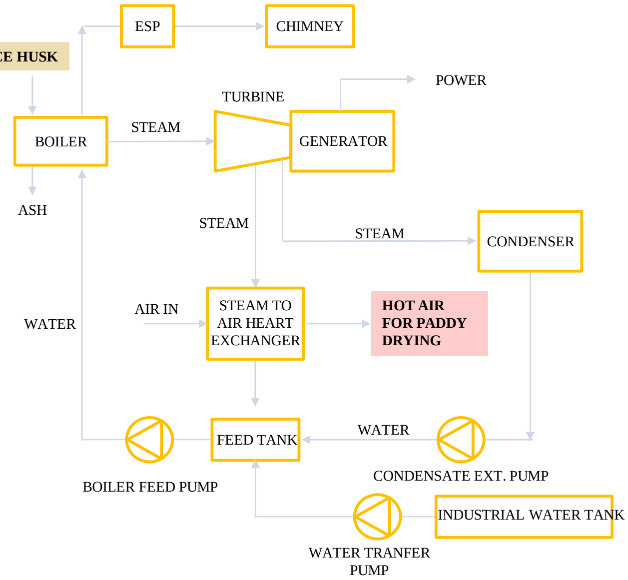
Gasification System

Study the introduction technology

BTG & PADDY DRYING SYSTEM

Spec sheet for plant

No.	ITEM DESCRIPTION	UNIT	VALUE
POWER GENERATION PLANT			
1	POWER GENERATION	KW	1816
2	POWER CONSUMPTION OF PLANT	KWH	182
3	POWER SELLING	KWH	1,634
4	RICE HUSK CONSUMPTION	TON/H	2
5	WATER CONSUMPTION	TON/H	7.96
PADDY DRYING			
6	MOISTURE OF PADDY BEFORE DRYING	%	18
7	MOISTURE OF PADDY AFTER DRYING	%	14
8	WEIGHT OF MOIST PADDY TO BE DRIED UP PER HOUR	KG/H	10,488
9	PADDY WEIGHT AFTER DRYING TO 14% MOISTURE	KG/H	10,000
10	STEAM REQUIRED TO PROVIDE HEAT TO THE AIR	TON/H	1.288



Business image (draft)

Target in 2020: establishment of rice husk power plant of total 50MW

Cooperation of the Government of Myanmar (draft)

-Construction of power grid
-Establishment of FIT（Feed-in Tariff）
-Clarification of promotion measures in the long-term urban development planning field
（Promotion of Biomass power generation and regional autonomous distributed power development）
-Relaxation of restrictions on foreign investment law

		2016	2017	2018	2019	2020	2021	Total	Remark
Scale of operation	New（Nunmber）	1	2	4	6	8	10	31	
	Total（Number）	1	3	7	13	21	31		
	New（kW）	1,600	3,200	6,400	9,600	12,800	16,000	49,600	
	Total（kW）	1,600	4,800	11,200	20,800	33,600	49,600		
Annual energy production	New（MWh/year）	11,520	23,040	46,080	69,120	92,160	115,200	357,120	
	Total（MWh/year）	11,520	34,560	80,640	149,760	241,920	357,120		
Rice husk amount	New（ton/year）	14,400	28,800	57,600	86,400	115,200	144,000	446,400	
	Total（ton/year）	14,400	43,200	100,800	187,200	302,400	446,400		
Total project cost	New（1,000 USD）	4,500	9,000	18,000	27,000	36,000	45,000	139,500	
	Total（1,000 USD）	4,500	13,500	31,500	58,500	94,500	139,500		
Subsidy	New（1,000 USD）	1,650	3,300	6,600	9,900	13,200	16,500	51,150	
	Total（USD）	1,650	4,950	11,550	21,450	34,650	51,150		
CO2 from fossil fuel combustion	New（t-CO2/year）	3,360	6,720	13,440	20,160	26,880	33,600	104,160	2,100t-CO2/MW・year
	Total（t-CO2/year）	3,360	10,080	23,520	43,680	70,560	104,160		

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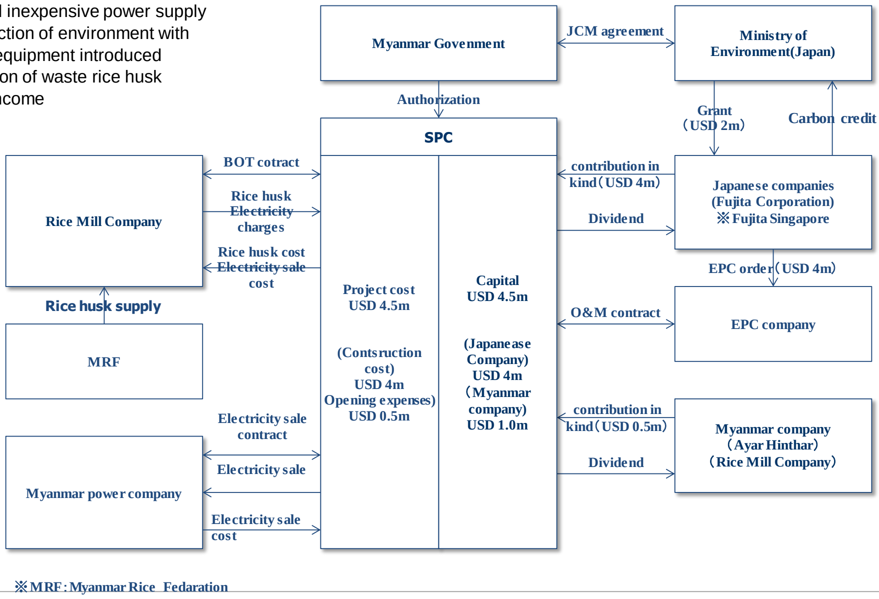
Business scheme (assuming)

Benefits of Myanmar side by JCM scheme

-Financial burden down by investment from Japanese companies
（50% of the equipment cost）
-Stable and inexpensive power supply
-Load reduction of environment with the latest equipment introduced
-Monetization of waste rice husk
-dividend income



Main Topics of the Discussion

Implementation of the system in the targeted regions

(Vision on utilization of heat and electric energy)

~In electricity production; economic and regional development is capable due to electrical and heat energy from rice husk-fueled electricity plants (Expectation Sector)~

- Utilization of electrical energy(Rice Mill and relation factories and region)
- Utilization of heat energy(Rice Mill and relation factories and region)

※Utilization of Ash(Silica), Construction materials (Board/Building Material), Utilization in mixing with cement

(Problems and Processes concerning with the gathering of raw materials) Regional Specifications ?

- Competition with the current system, have to depend on paddy growing seasons, to further develop the system, transportation charges
- Have to adapt for long-term support

Practical Implementation of the system (Preparation of the Project Environment)

～ Strategy for producing electricity from rice husk, Procedures for strategically use of the system. ～

<Steps for implementation of the system(Long-term, Short-term)>

- Electricity Production from rice husk : Various production farms can be developed due to access of regional owned electricity. Possibility of speed up distribution of electricity within a region. And the system will become important.
- Establishing networks for distribution of electricity and infrastructures, declaring pricing for electricity, establishing business environment within electricity production and relation fields
- Realizing the vision to continuing as long-term and mid-term city development projects (Producing energy from waste materials, to produce own electricity within a region)
- Joint development between two countries
  (To promote better cooperation in preparing for the investment environment, relating fields of business and regional development)

Economic Potentials and Probabilities

Economic Potentials and relation with responsible personals of a region, Presentation of Vision and System to the society

A System conducted with Japanese Techniques and Expertise (Know How)(Technology + Relating System, Vision)

Topics to Analyze	Analysis
Analyzing the capability to establish a Mid-ranged Electricity Production Plant (5MW/per place) (Sourcing raw materials, stating standard for infrastructures, maintenance)	● Gathering of rice husk(Unused rice husk from nearby rice mills, efficient transportation measures to get rice husk from nearby rice mills and to get usual rice husk supply (E.g. - contracting) ● Biomass Boiler System ● To analyze whether the dusting machine can be used or not with lower cost-efficient Japanese maintenance method
Analyzing the regionally beneficial system which can store electrical and heat energy.	● Required electricity within rice mill and requirement for maintenance of heat energy ● Requirements for newly attaining electricity and heat energy ● Ash (Silica): Construction Materials (Board) Mixture with concrete ● Stating visions concerning with Electrical Power and Heat Energy.
Analyzing the steps for distribution electricity to places without electricity with a goal of further development of the region.	● Preparation of the network necessary for the small power plants to distribute electricity to nearby regions.

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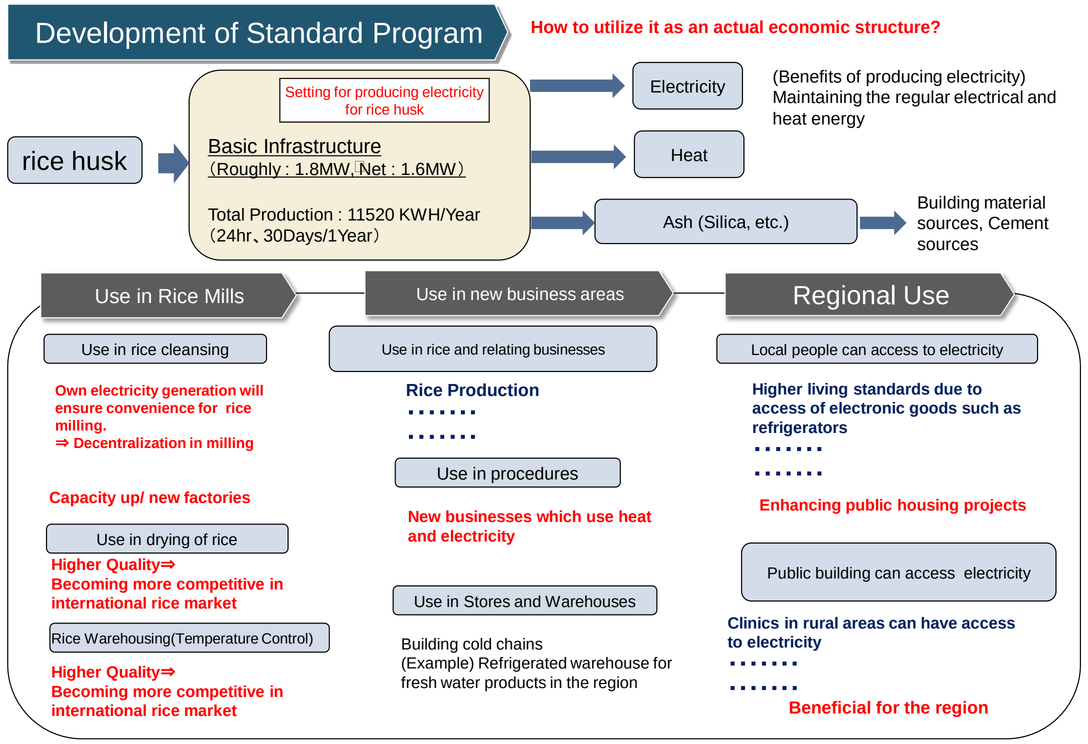
Development of Standard Program



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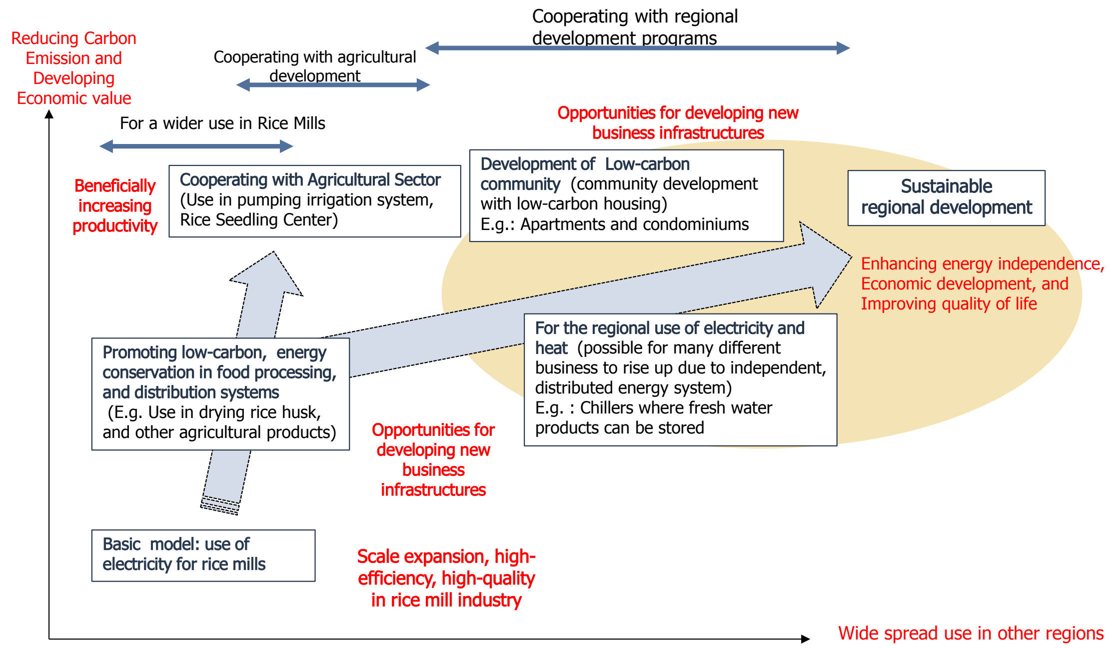
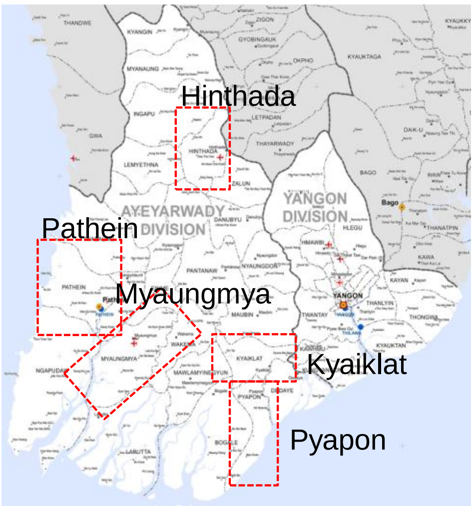
Business models



Strategies for spreading the system to other regions

Local Challenges and Probabilities



Conditions and problems concerning with resource materials such as rice husk, and byproducts from rice mills

- The use of rice husk and byproducts from rice mills
- Expanding rice production

Management problems common to rice mills

- Becoming a bigger mill
- Quality control of rice

Possible problems for the use of electricity and heat

- Utilizing in rice mills
- Utilizing in relating facilities
- Local Use

Probable problems concerning with building materials and cement

Probable problems concerning with the use of electricity in agricultural sector

Probable problems concerning with the adaption of the use of electricity in the region

JCM's Capabilities

What is JCM?

Japan is actively promoting the establishment and implementation of the "Joint Crediting Mechanism (JCM)" in which Japan facilitates the diffusion of leading low carbon technologies, products, systems, services, and infrastructure as well as implementation of mitigation actions, and contributes to sustainable development of developing countries. After an appropriate evaluation of the contribution to GHGs emission reductions or removals in developing countries, Japan will use the generated JCM credits toward achieving its emissions reduction target.

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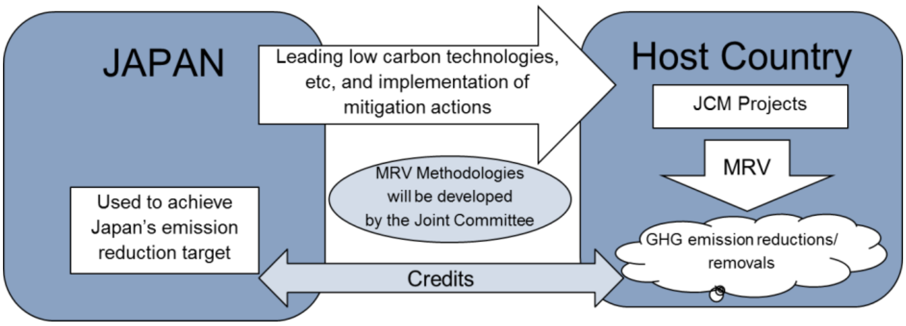
Basic Concept of JCM

- Facilitating 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.
- Appropriately evaluating contributions from Japan to GHG emission reductions or removals in a quantitative manner, by applying measurement, reporting and verification (MRV) methodologies, and use them to achieve Japan's emission reduction target.
- Contributing to the ultimate objective of the UNFCCC by facilitating global actions for GHG emission reductions or removals, complementing the CDM.



MRV: Measurement, Reporting and Verification

Source: Government of Japan Ministry of the Environment, Recent Development of Joint Crediting Mechanism (JCM)

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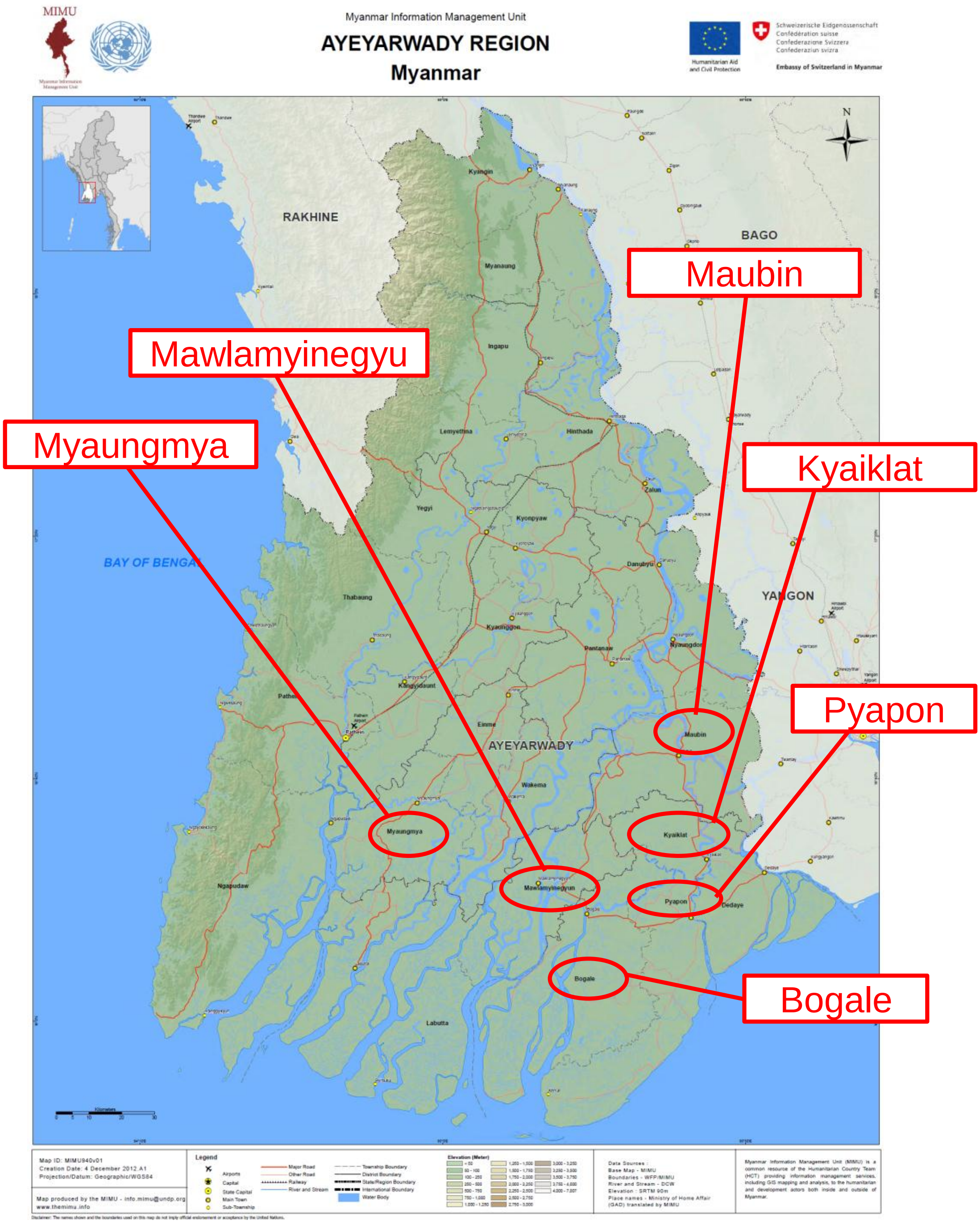
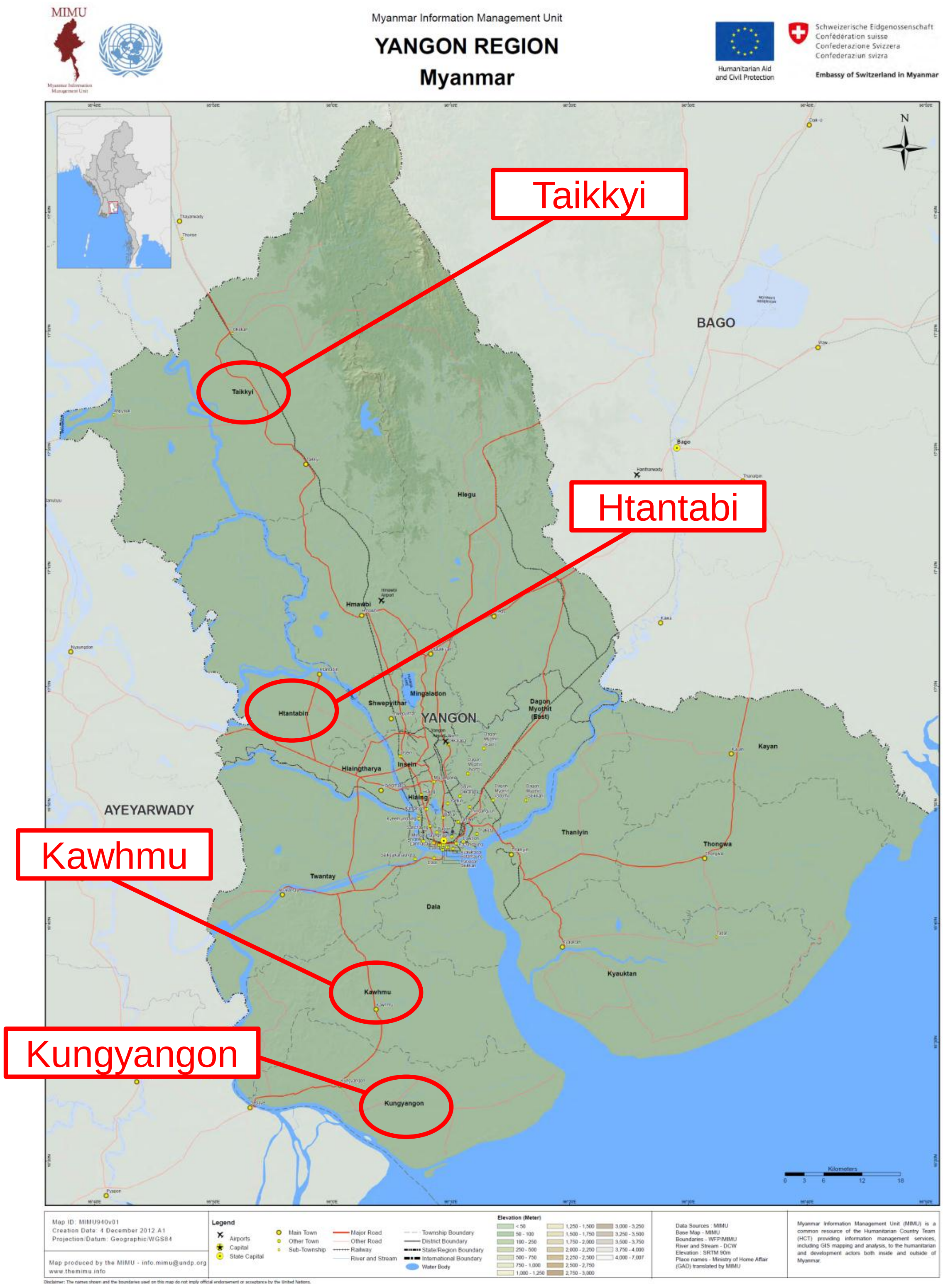
Appendix 13: Maps of prospective areas[5]

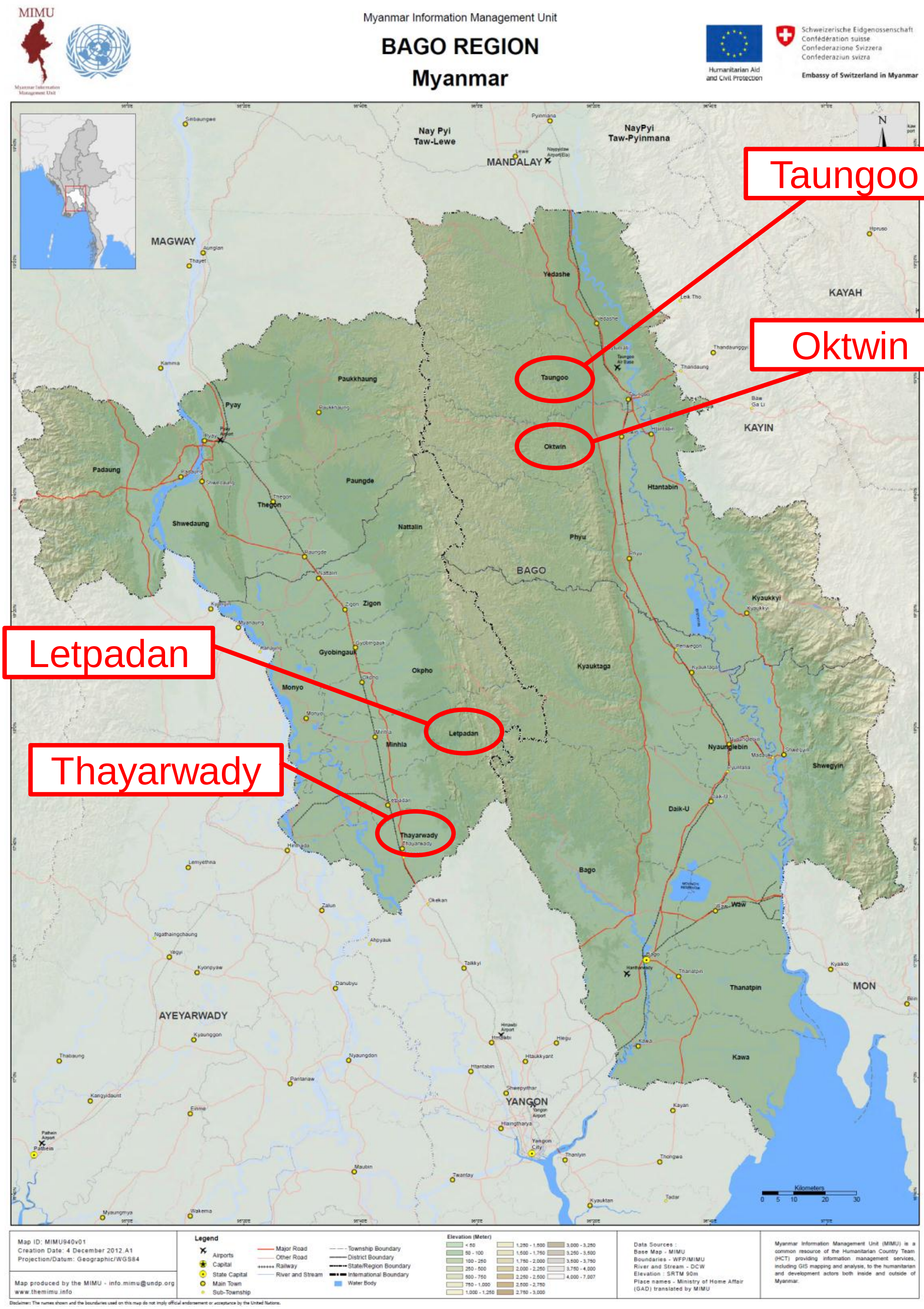


Township	Population (thousand persons)
Myaungmya	298
Mawlamyinegyun	311
Maubin	314
Pyapon	314
Bogale	322
Kyaiklat	193

5 Myanmar Information Management Unit



Township	Population (thousand persons)
Taikkyi	277
Htantabin	146
Kawhmu	119
Kungyangon	111


MIMU
Myanmar Information Management Unit
BAGO REGION
Myanmar
Humanitarian Aid and Civil Protection
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Embassy of Switzerland in Myanmar
Taungoo
Oktwin
Letpadan
Thayarwady
Nay Pyi Taw-Lewe
NayPyi Taw-Pyinmana
MANDALAY
MAGWAY
KAYAH
KAYIN
BAGO
AYEYARWADY
YANGON
MON
Paukkhaung
Pyay
Padaung
Paungde
Shwedaung
Thegon
Nattalin
Phyu
Yedashe
Htantabin
Kyaukkyi
Zigon
Gyobingauk
Okpho
Monyo
Minhla
Kyauktaga
Nyaunglebin
Shwegyin
Daik-U
Bago
Waw
Thanatpin
Kawa
Legend

FY2014 Feasibility Studies on Joint Crediting Mechanism Projects towards Environmentally Sustainable Cities in Asia - Feasibility Study on Rice Husk Power Generation System for Low-carbon Communities in Ayeyarwady Region, Myanmar-

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Mitsubishi Research Institute, Inc.

Fujita Corporation