Special Assistance for Project Implementation for Energy Efficiency and Renewable Energy Projects throughout Latin America

Final Report

February 2016

Japan International Cooperation Agency

NIPPON KOEI CO., LTD.
SHIKOKU ELECTRIC POWER CO., INC.
PADECO CO., LTD.

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Abbreviation

ABESCO	Brazilian ESCOs Association
ABRACE	Brazilian Association of Large Energy Consumers
ANDI	National Association of Industries
ANEEL	Brazilian Electricity Regulatory Agency
ASI	Integral and Systematic Conservation Program
BEMS	Building Energy Management System
BNDES	Brazilian Development Bank
CCEE	Colombian Council for Energy Efficiency
CCEP	Colombia Clean Energy Program
CCFL	Cold Cathode Fluorescent Light
CCIPJ	Japanese Peruvian Chamber of Commerce and Industry
CENACE	National Load Control Center
CFE	Federal Electricity Commission
CFE-PAESE	Electricity Conservation Program
CNI	National Industry Association
COBEE	Congresso Brasileiro de Eficiência Energética
COFIDE	Corporacion Financiera de Desarrollo S.A
CONAE	National Commission for Energy Conservation
CONPET	National Program for the Rational Use of Natural Gas and Oil Products
COP	Coefficient Of Performance
CRE	Energy Regulatory Commission
CRESESB	Sergio Brito Reference Center for Solar and Wind Energy
DGEE	General Administration of Energy Efficiency
EPM	Empresas Publicas de Medellín
ESCO	Energy Service Company
FIDE	Electricity Conservation Trust Fund
FIESP	State of São Paulo Industrial Association）
FIT	Feed-in Tariff
FTA	Free Trade Agreement
GHP	Gas heat Pump
GWP	Global Warming Potential
ICTSD	International Centre for Trade and Sustainable Development
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation
IFI	Intermediary Financial Institutions
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRR	Internal Rate of Return
ISS	Idling Stop System
JASE－W	Japanese Business Alliance for Smart Energy Worldwide
JCM	Joint Crediting Mechanism

JIS	Japanese Industrial Standards
JPEA	Japan Photovoltaic Energy Association
JRECO	Japan Refrigerants and Environment Conservation Organization
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
MEM	Ministry of Energy and Mines
MSEF	MGM Sustainable Energy Fund L.P.
NEC	National Energy Commission
NK LAC	Nippon Koei Latin America-Caribbean Co.,Ltd.
ODP	Ozone Depletion Potential
OLADE	Organización Latinoamericana De Energia
PAC	Packaged Air Conditioner
PBE	Brazilian Labeling Program
PPA	Power purchase Agreement
PPP	Public-Private Partnership
PROCEL	National Electrical Energy Conservation Program
PROINFA	Programme of Incentives for Alternative Electricity Sources
PROURE	Program for the Rational and Efficient Use of Energy
RPS	Renewables Portfolio Standard
SNI	National Industries Association
SPC	Special purpose company
SPV	Special Purpose Vehicle
UNFCCC	United Nations Framework Convention on Climate Change
UPME	Unidad de Planeación Minero Energética
UPS	Uninterruptible Power Supply
USAID	United States Agency for International Development
VRF	Variable Refrigerant Flow

1 Background and Purpose of the Survey

1.1 Background of the Survey

In Latin America, many countries have made steady economic growth in recent years, but the shortage of electric power is anticipated due to the delay of infrastructure development in the region. It is vital to ensure the electric power for the region's economic growth. The World Bank (WB) predicted that the power demand in Latin America will be more than doubled in 2030 from its amount in 2008. In order to deal with the demand, it is required to expand the new generating capacity significantly. On the other hand, it is becoming apparent that natural disasters and environmental issues have been caused by climate change. In addition, the non-oil producing countries experience the biggest impact of climate change as seen in the trend of crude oil prices for its macroeconomic environment. For these issues, it is required to promote the introduction of renewable energy and energy efficiency products, considering climate change and the environment, to deal with expanding energy demand.

Japanese companies have excellent technologies in energy efficiency and in the renewable energy sector. In order to promote the introduction of energy efficiency and renewable energy in the region, these Japanese high-level technologies (solar panels and air conditioning products) should be utilized. By doing this, it is expected to lead the expansion of business opportunities for Japanese companies.

In such situation, the Japan International Cooperation Agency (JICA) has been working to support the energy efficiency and renewable energy sectors of Latin America and actively considered and granted the loan fund cooperation for geothermal power generation, hydroelectric power, and energy efficiency promotion. In Peru, from October 2012, they implemented the "Energy Efficiency Infrastructure Support Program" (two-step loans), which financed by the Peruvian Development Bank (*Corporacion Financiera de Desarrollo S.A.:* COFIDE) and subleased from the Peruvian government. This program finances private companies medium- and long-term funds which are necessary for sub-projects to promote energy efficiency through the intermediary financial institutions. In addition, in November 2014 they decided to invest in the MGM Sustainable Energy Fund LP (MSEF) with foreign investments and loans, which supports a variety of energy efficiency and renewable energy businesses in Latin America by utilizing their expert knowledge (hereinafter, energy efficiency and renewable energy business).

However, the number of Japanese companies in Latin America is limited and their market share is still small because, generally, Japanese products are expensive compare with other countries' products in a fiercely competitive market with foreign companies operating in an area. And even in the yen loan projects, it is not easy for Japanese companies to contract and join in an international competitive bidding. Also, in the procurement by local private companies, the advantages (quality, durability, etc.) of Japanese products have not been fully recognized by the local companies and this is considered as one of the bottlenecks in expanding business opportunities of Japanese companies.

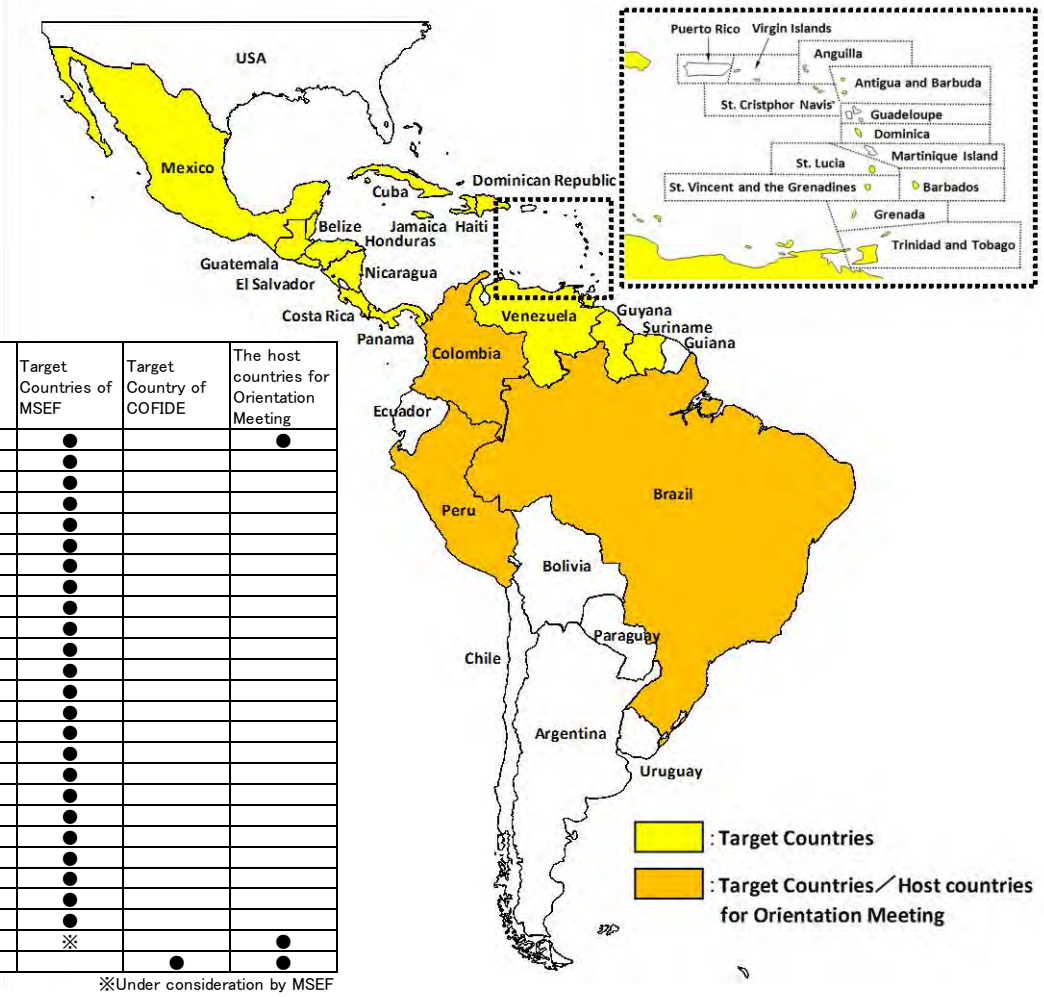
The purpose of this survey is the promotion of further effective utilization of such funds financed or invested by JICA and aim for Japanese technologies and products of energy efficiency and renewable energy to be recognized and utilized with the above fund in Latin America.

1.2 Purpose of the Survey

The purpose of this survey is to understand the actual situation of COFIDE and MSEF which JICA financed or invested and to carry out the consolidation and analysis of the performance and energy saving effect of the Japanese technologies and products of energy efficiency and renewable energy then consider the outlook for the expansion and utilization of these technologies and products in Latin America. These gathered information and considered results should be provided to the fund manager; and orientation meetings should be held in three countries namely: Peru, Colombia, and Brazil for the expansion, promotion, and recognition of the funds and Japanese technologies and products.

1.3 Target Areas of the Survey

The target countries of this survey are the investment target countries of MSEF and Peru which COFIDE is located. The investment target countries of MSEF are shown below. In these countries, the field survey should be conducted in three countries namely: Colombia, Brazil, and Peru and additionally, an orientation meeting should be held in these three countries to introduce Japanese technologies of energy efficiency and renewable energy.



	Target Countries of MSEF	Target Country of COFIDE	The host countries for Orientation Meeting
Colombia	●		●
Mexico	●		
Costa Rica	●		
Dominican Republic	●		
Panama	●		
Honduras	●		
Guatemala	●		
El Salvador	●		
Nicaragua	●		
Belize	●		
Cuba	●		
Jamaica	●		
Dominica	●		
Grenada	●		
St. Lucia	●		
Barbados	●		
St. and the Grenadines	●		
Antigua and Barbuda	●		
St. Cristphor Navis	●		
Haiti	●		
Trinidad and Tobago	●		
Venezuela	●		
Guyana	●		
Suriname	●		
Brazil	※		●
Peru		●	●

※Under consideration by MSEF

Source: JICA Study Team based on the map; http://www.freemap.jp/

Figure 1.1 Target Countries of the Survey

1.4 Items of the Survey

The items of this survey are shown below. Each expert made a research for each items.

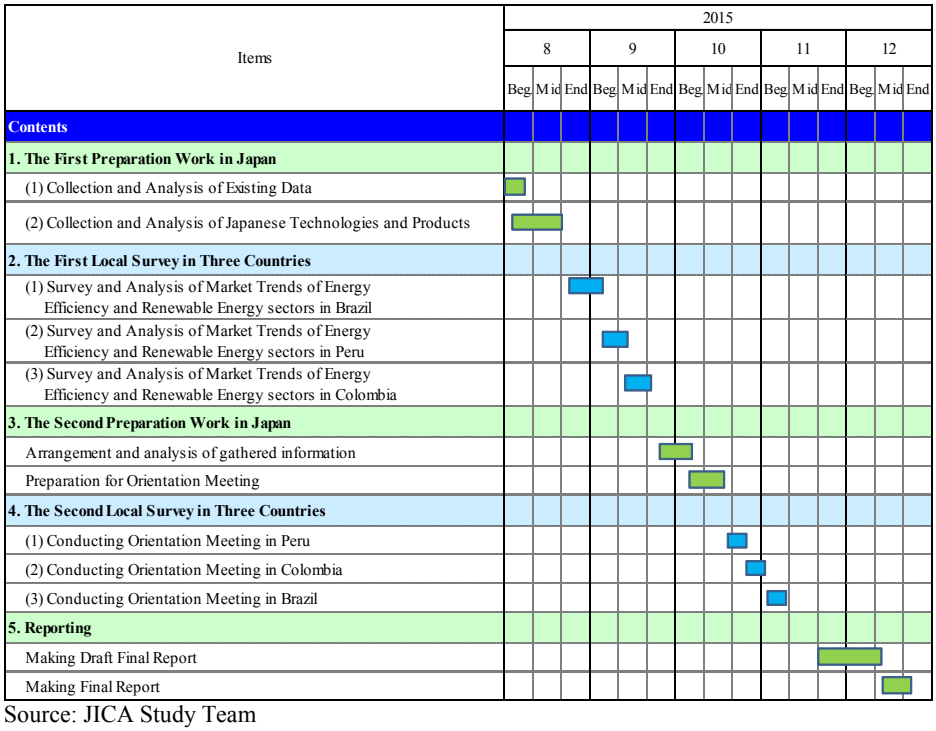
Table 1.1 Items of the Survey

Members	Items	Contents
1	Electricity Market	Supplying Organizations, Competition Tariff (average, residential, non-residential, etc.) Capacity and Source, Peak Demand, Load Factor, Others
2	Energy Efficiency and Renewable Energy	Law, Subsidies, and Incentives Regulation, Feed in Tariff for Renewable Energy Market Size and Forecast, Others
3	Economic Situation and Market	MSEF and COFIDE Business Associations including Chamber of Commerce Potential Customers in Each Country, Others
4	Air Conditioning	Centrifugal Water Chiller, Chiller, VRF, RAC
5	Industrial Refrigeration System	Industrial Refrigerator
6	LED Light and other products	LED Light, Wind Power Generation, Geothermal Power Generation, BEMS, and Others
7	Photovoltaic Generation, Battery	Photovoltaic Generation, Battery

Source: JICA Study Team

1.5 Overall Workflow of the Survey

The survey was conducted from the beginning of August 2015 up to the end of December 2015. The overall schedule of the survey is shown below.



Source: JICA Study Team

Figure 1.2 Overall Workflow of the Survey

2 Electricity Market

2.1 Introduction

There are four important key words about the electricity market in Latin American area:

1) Achieving Universal Access to Electricity

Approximately 34 million (approximately 5%) people in Latin America still lack access to electricity. Renewable energy has the ability to provide reliable, affordable, and sustainable modern energy services to those who currently remained non-electrified.

2) Meeting Future Electricity Demand

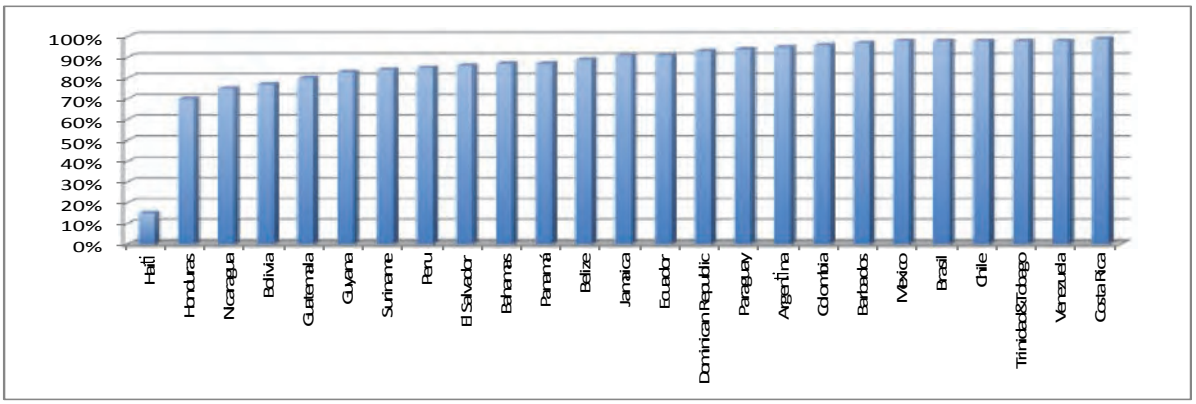
To meet the rapidly growing electricity demand, Latin America will need to double its installed power capacity by 2030.

3) Transforming the Electricity System

In most parts of Latin America, the grid infrastructure is outdated and in need of significant modernization and expansion. This creates a unique opportunity to build an electricity system through integrated, system-wide national and regional energy planning that can support growing shares of renewable energy, increase energy efficiency, and provide reliable service at the least cost in the long term. This development must be based on thorough analysis of the technical and socioeconomic potentials of the full spectrum of renewable technologies and result in a coherent policy consisting of ambitious goals and concrete support mechanisms, supported by effective governance and administrative structures and processes as well as the international supports from developed countries.

4) Adapting to Climate Change

Climate change is already occurring, and will continue to experience profound impacts on the regional economy, ecosystems, and human well-being in Latin America. Climate change and the power sector are closely related given that power is a contributor in greenhouse gas emissions and that the sector itself is vulnerable to the negative impacts of climate change.



Source: IDB

Figure 2.1 Population Rate with Access to Grid Electricity 2012

The output of the survey shall be explained in the following chapters and we should understand that the shares of Brazil and Mexico are very big in this region. For example, the shares of generating capacity of these 2 countries is about 70% of the total capacity of this region (Figure 2.2), and the shares of electricity consumption are the same (Figure 2.3). So, in this chapter, the JICA Study Team categorized the target 26 countries as follows (Table 2.1) and discuss the topic for each categorized zone.

1. Brazil
2. Mexico
3. Central America
4. Caribbean
5. Andean Zone

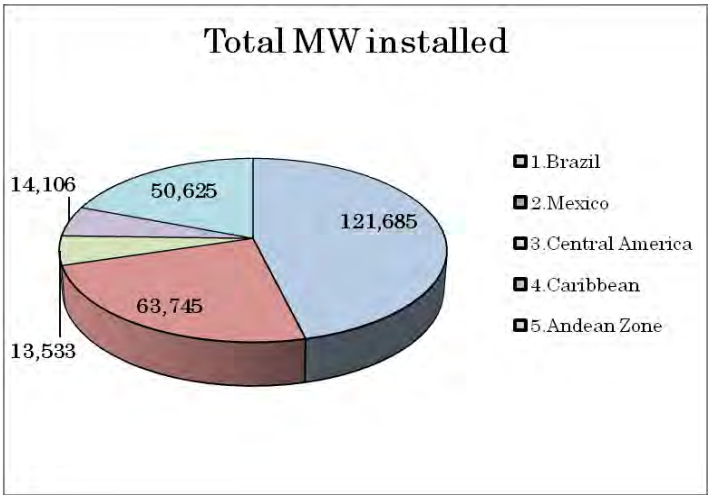
Then, discussions about the topics below will follow.

1. Electricity Industry Structure
2. Electricity Tarriff
3. Subsidies
4. Implication for the Promotion of Energy Efficiency and Renewable Energy Technologies

Table 2.1 Category of the 26 Countries

	Group	Country Names
1	Brazil	Brazil
2	Mexico	Mexico
3	Central America (7)	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama
4	Caribbean (14)	Barbados, Dominican Republic, Guyana, Haiti, Jamaica, Suriname, Trinidad and Tobago, Antigua and Barbuda, Cuba, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent/Grenadines
5	Andean zone (3)	Colombia, Peru, Venezuela

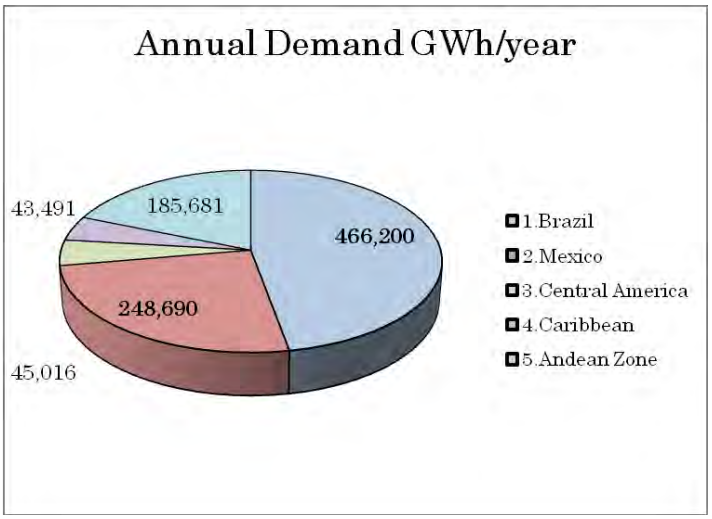
Source: JICA Study Team



	Total MW installed	
1.Brazil	121,685	46%
2.Mexico	63,745	24%
3.Central America	13,533	5%
4.Caribbean	14,106	5%
5.Andean Zone	50,625	19%
Total	263,693	100%

Source: Study Team from the MIF and other materials

Figure 2.2 Generating Capacity of the Target 26 countries



	Annual Demand GWh/year	
1.Brazil	466,200	47%
2.Mexico	248,690	25%
3.Central America	45,016	5%
4.Caribbean	43,491	4%
5.Andean Zone	185,681	19%
Total	989,078	100%

Source: Study Team from the MIF and other materials

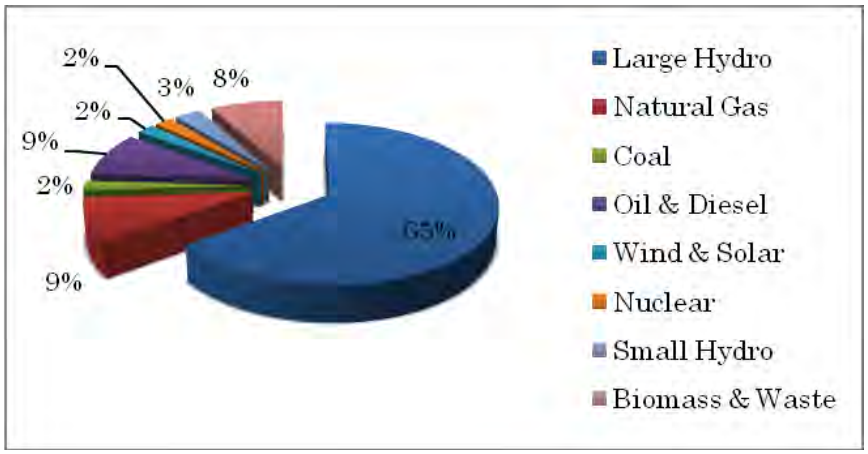
Figure 2.3 Annual Electricity Consumption in the Target 26 Countries

2.2 Outline of Target Countries

(1) Brazil

Brazil is the largest economy in Latin America and has an installed capacity of 123 GW (2013), approximately twice the capacity of the region's next largest economy, Mexico. Its power generation is dominated by large hydropower, which, at 80 GW approximately represents 65% of the total generating capacity (see Figure 2.4). However, concerns about dry seasons that have led to energy shortages are pushing Brazil to move from hydro. Only 20% of power capacity comes from fossil fuel sources, mainly fuel oil, natural gas, and coal. Nevertheless, the share of natural gas is expected to increase. Brazil currently has two nuclear plants, with a third under construction. In all of Latin American countries, Brazil has had by far the largest levels of clean energy investment, most of which has gone to wind. However, the largest contributor to non-conventional power capacity at the moment continues to be biomass and waste.

Brazil had a series of electricity reforms in 1990 and 2000, prior to which the government controlled most of the power sector as in the rest of Latin America. In the first reform, the sector was liberalized and some state-owned utilities were privatized, except for transmission. The second reform happened as a result of the energy crisis of 2002 and resulted in the "modelo novo"or New Power Sector Model. This model has an independent system operator in a deregulated wholesale market; however, market forces set prices in the regulated market and not by the government via competitive auctions. There is also a functioning energy trading system. While Electrobras, the largest utility in Brazil, controls most of the electricity generation via its subsidiaries as well as all of transmission, it is not a purely state-owned company. Electrobras is majority owned by the government but is a public traded company.



Source: MIF

Figure 2.4 Generating Capacity in Brazil

(2) Mexico

Mexico is the second largest country in Latin America after Brazil in terms of population and the size of its economy. It has an installed capacity of 62 GW (2013), which is more than that of Andean Zone as a whole. In 2013, Mexico generated 258 TWh of electricity, mostly from thermal power plants, being the largest oil and natural gas producer in the region, but it is also a net importer of refined fuels, mainly from the United States. The majority of its electricity is generated from natural gas, with a significant portion generated from oil and diesel (See Figure 2.5). It is one of only three countries in the region with nuclear energy plants, along with Brazil and Argentina.

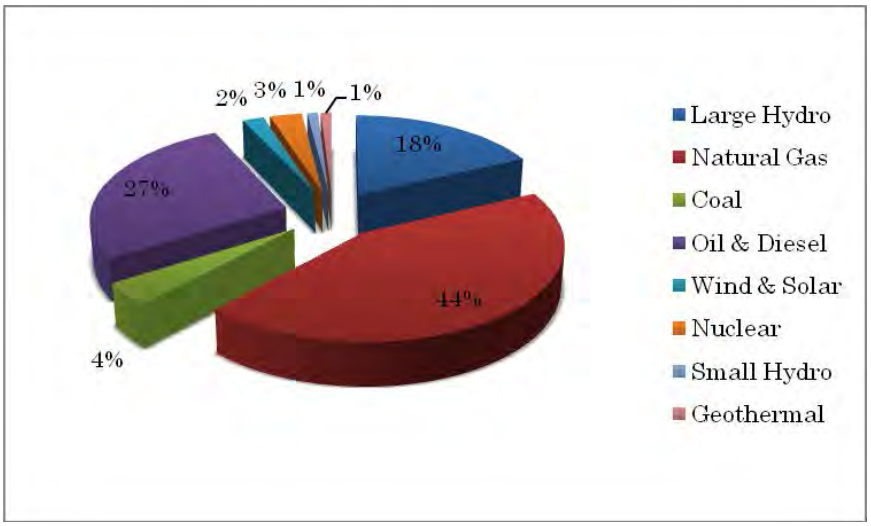
Mexico has the highest carbon dioxide (CO_2) emissions from electricity and heat production in the region and released a total of 133 million metric tons of CO_2 in 2011, or 1.1 million tons per capita. Mexico's total emissions are more than twice those of the region's next largest emitter, Argentina. Yet, Mexico has established a voluntary target for reducing emissions by 30% by 2020 under the United Nations Framework Convention on Climate Change (UNFCCC).

Mexico has a renewable energy share of 22%, with large hydro being its largest source of renewable. The country is also fourth in the world in geothermal production, and, more recently, it has begun developing other renewable energy resources, mainly wind. Mexico currently has 1.992 MW of wind capacity installed, most of which was added recently.

The *Comisión Federal de Electricidad* (CFE), a state-owned, vertically integrated utility, have controlled three-quarters of Mexico's generating capacity and has a monopoly on electricity transmission and distribution. Since 1992, Mexico has allowed private participation in generation for certain categories of power generation: self-supply, cogeneration, independent power producers (IPP), small production (under 30 MW), and import/export. As of June 2013, a total of 1,500 GW of installed capacity came from private generators, which is equivalent to 2.5% of total capacity. The majority of it was wind power (89%). There was also some hydropower (8%), biogas (3%), and solar PV (1%). Of these, the majority was produced under self-supply, but wind power was also produced

under IPP and small production permits.

In December 2013, Mexico passed 9 bills[1] for a landmark energy reform for hydrocarbons and electricity. Secondary legislation is still under way; however, it seems that the reform will result in a more open electricity sector through the creation of an electricity market that will be operated separately from CFE. All generation will be open to private participation, and the operator will grant impartial access from the grid to generators. These changes will provide greater transparency to the market and should result in growth in renewable energy investments in the near future. The new market rules – still in draft form – are intended to open up power generation to all participants and guarantee nondiscriminatory access to the electric grid. They also aim to promote energy efficiency and renewable energy through new market incentives.



Source：MIF

Figure 2.5 Generating Capacity in Mexico

(3) Central American Countries

Central America is composed of seven countries of varying sizes. The sub-region has a total installed generation capacity of 12 GW (2013). Guatemala and Costa Rica have the largest capacity with approximately 3 GW each, followed by Honduras and Panama with just over 2 GW each, El Salvador and Nicaragua with 1 GW each, and Belize with 0.1 GW (see Figure 2.6). As a whole, they generated 43 TWh in 2011. Historically, Central America has been powered mostly by hydropower, but in 1990, hydro's share dropped as it began to be replaced by oil. In 2000, increasing shares of renewable, such as wind in Costa Rica, Honduras, and Nicaragua, and biomass in Belize decreased somewhat the sub-region's dependence on oil.

[1] The nine new bills introduced by President Peña Nieto are the following; Law of Hydrocarbons, Law of Hydrocarbon Revenues, Law of the Electric Industry, Law of Geothermal Energy, Law of the Coordinated Regulating Agencies of the Energy Sector, Law that creates the National Agency of Industrial Security and Environmental Protection of the Hydrocarbon Sector, Law of Petroleos Mexicanos (PEMEX), Law of the Federal Electricity Commission (CFE), and Law of the Mexican Petroleum Fund for Stabilization and Development

Today, the electricity mix is split mostly between hydropower (30% large hydro plus 12% small hydro) and oil and diesel (39%). However (see Figure 2.7) concerns about the environment and energy security have prompted the region to develop other renewable resources. While hydropower is a source of renewable energy, the development of large hydro dams through flooding can result in high levels of greenhouse gas emissions. In addition, large hydropower development can have adverse local social and environmental impacts such as changes in water quality and flow patterns, fish migration and biodiversity, and population displacement. Panama, Costa Rica, and Belize have higher hydropower capacity than that of fossil fuels. El Salvador, Nicaragua, Guatemala, and Honduras depend on fossil mostly. Nicaragua is the only country in Central America without significant amounts of hydropower.

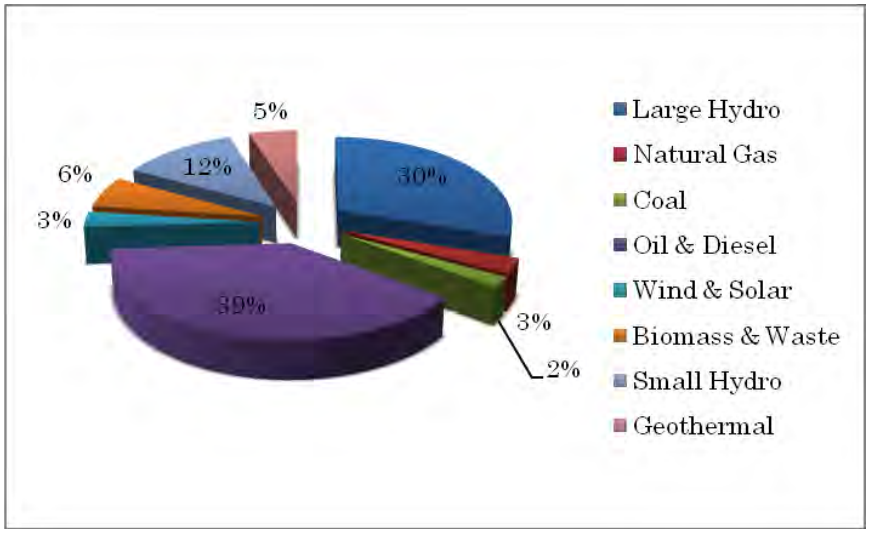
The region's dependence on hydropower has led to concerns about energy security, especially given the recent extreme dry events that have resulted in electricity shortages. In response, the Central American countries commissioned the creation of a regional grid (Sistema de Interconexión Eléctrica de los Países de América Central: SIEPAC) that would enable international power exchanges. They also established a regional electricity market and a regulatory commission. To reinforce this interconnection and to enable access to North American and South American markets, a Mexico-Guatemala interconnection was completed and a Colombia-Panama interconnection is under negotiations.

The biggest challenge facing SIEPAC has been the creation of a regulatory framework for trade given the region's different power market structures. Central America experienced a wave of market liberalization reforms in the 1990s. El Salvador, Guatemala, Nicaragua, and Panama liberalized their entire electricity markets, unbundled their vertically integrated utilities, and opened segments of generation, transmission, and distribution to private competition. Honduras unsuccessfully attempted to follow them, so its state-owned utility still operates as a single buyer. Costa Rica preserved its vertically integrated utility (Instituto Costarricense de Electricid: ICE), which is state owned and operates as a single buyer as well. In both countries, additional generation is purchased from IPP. Belize's primary utility, nationalized in 2011, has an effective monopoly on generation, transmission, and distribution.

As a sub-region, Central America has the largest share of renewable (56%) and the most diverse mix of renewable generation with biomass, geothermal, wind, and hydro. Costa Rica, El Salvador, Honduras, and Nicaragua have developed some of their geothermal resources. Costa Rica, Honduras, and Nicaragua have about 350 MW in wind farms, and Panama has 158 MW of wind energy in the pipeline. Given its high share of renewables, Central America is a relatively small source of CO2 emissions. Yet, emissions vary by country. Panama, Honduras, and Guatemala are the highest CO2 emitters in Central America, given their relative size and high use of oil, as well as Guatemala's use of coal. Belize and Panama's per capita CO2 emissions exceed the regional average.

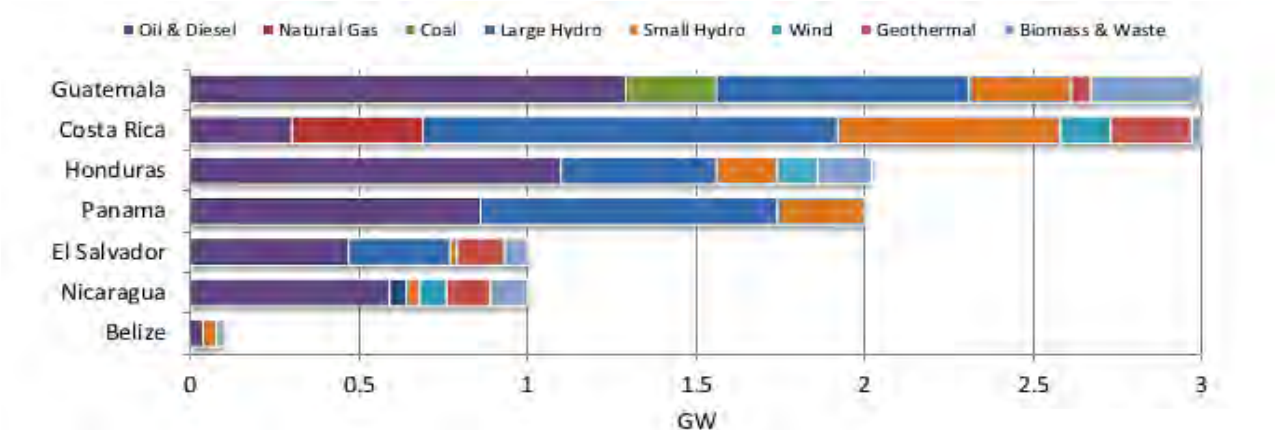
Electricity access is a major challenge for Central America. An estimated 8 million people still do not have access to electricity throughout the region, with the highest numbers in Guatemala, Honduras,

and Nicaragua. The majority of these people live far from urban centers and electrical grids. Because expanding the grid for long distances is economically prohibitive, distributed generation is the most affordable option, especially given the region's rich renewable resources.



Source：MIF

Figure 2.6　Generating Capacity in Central American Countries



Source：MIF and BNEF

Figure 2.7　Generating Capacity in Central American Countries by Source

(4)　Caribbean Countries

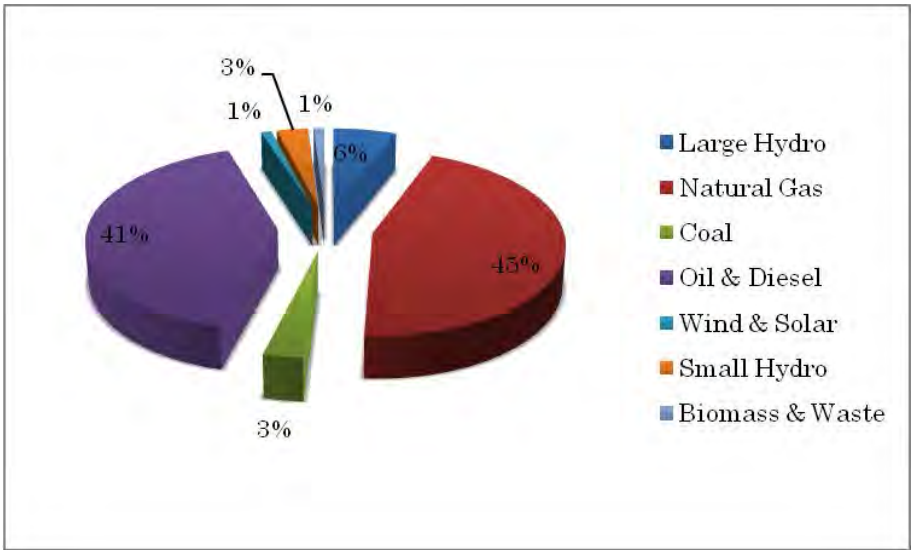
The Caribbean is a sub-region with the largest economic disparity in Latin America. It includes the Bahamas, Barbados, and Trinidad and Tobago, the three countries with the highest per capita GDP[2] in the region, as well as Haiti, the poorest country in the region, which has been plagued by political violence and a devastating 2010 earthquake from which it has not fully recovered. The Caribbean has a total installed electricity capacity of 20 GW (2013), a third of which is located in Trinidad and Tobago and the Dominican Republic.

[2] Gross Domestic Product

Electricity access ranges widely in the Caribbean. Haiti has the lowest electrification rate in the region and the largest number of people without access to electricity—over 8 million. Distributed generation is the most favorable way to increase electricity access in Haiti and in many of the other countries in the sub-region given their geographies. The Caribbean is rich in solar resources, and falling prices make solar PV an ideal choice to address this challenge. Some countries in the sub-region have good wind, biomass, and small hydropower resources, providing more alternatives.

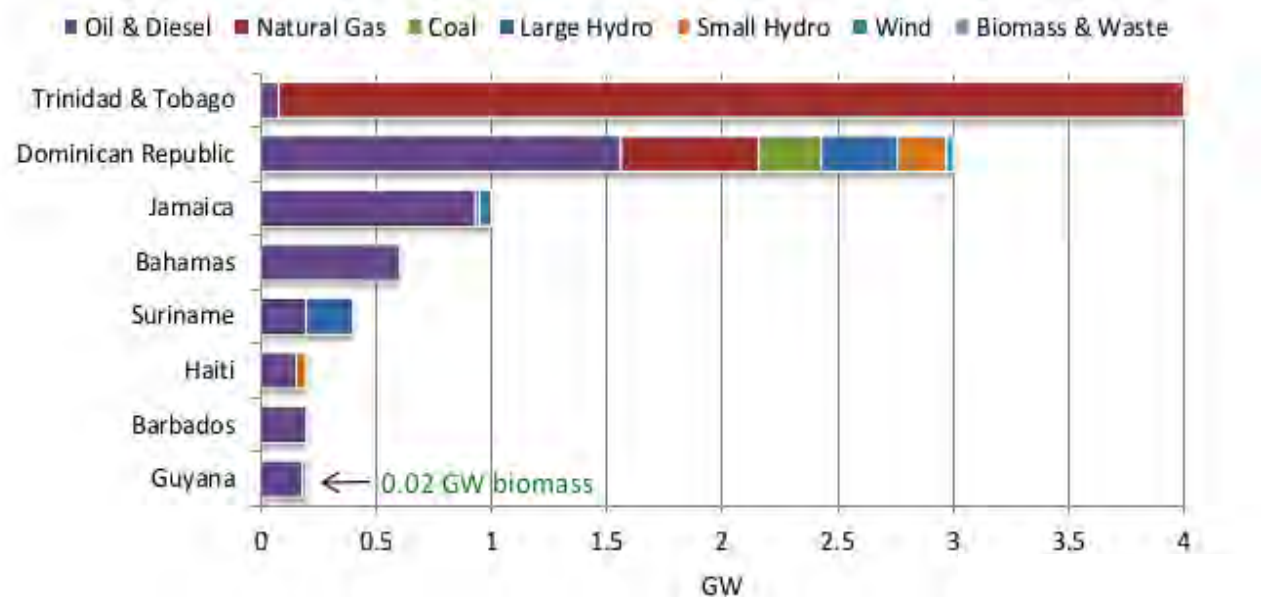
Nevertheless, Caribbean countries are dominated mainly by oil and diesel power generation. Because most of these countries do not have local oil or natural gas resources and are too small to burn coal cost effectively, they are subject to oil and diesel imports with volatile prices that result in high electricity tariffs. This characteristic makes renewable energy especially attractive in the sub-region, yet such development is limited due to fossil fuel subsidies with high fiscal costs and to a lack of economies of scale. Meanwhile, some Caribbean nations—including Trinidad and Tobago, Barbados, and Suriname have fossil fuel resources that have suppressed the development of renewable energy and have kept electricity tariffs low.

Hydropower is the main renewable resource in the Caribbean and accounts for just over 6% of the sub-region's installed capacity of 10 GW (see Figure 2.8). Half of Suriname's installed capacity is large hydro; Haiti has 23% renewable, all from small hydro; the Dominican Republic has 19% renewable energy capacity, of which 11% is large hydro and 7% small hydro; and Jamaica has 2% small hydro. (see Figure 2.9). Jamaica and the Dominican Republic have also developed their wind resources, with 50 MW and 30 MW, respectively. Guyana is the only country in the sub-region to have developed its biomass resources, at 0.02 GW.



Source: MIF

Figure 2.8 Generating Capacity in Caribbean Countries



Source: MIF and BNEF

Figure 2.9 Generating Capacity in Caribbean Countries by Source

(5) Andean Zone

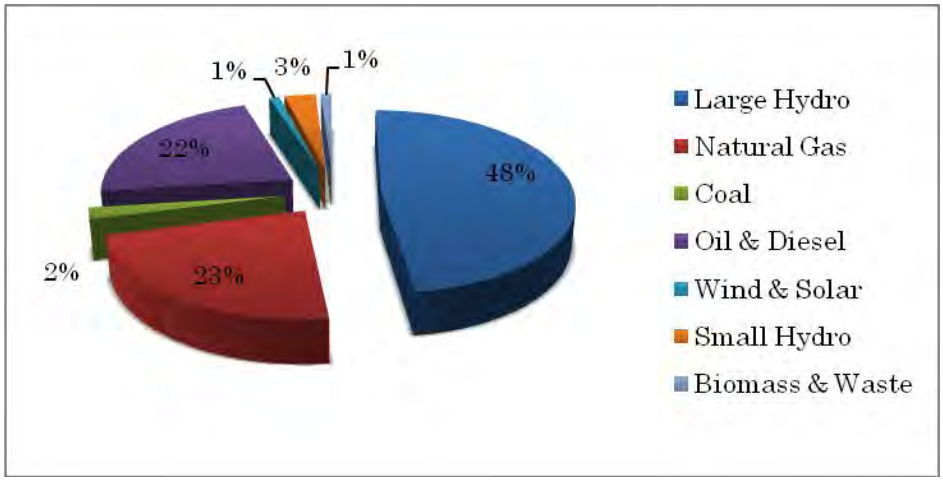
The Andean Zone, formed by Bolivia, Colombia, Ecuador, Peru, and Venezuela, all located in the northwest of South America, is composed of major oil and natural gas producers, a factor that has shaped its electricity mix. The Andean Zone has an installed capacity of 58 GW (slightly smaller than Mexico or the Southern Cone), of which, approximately half is large hydropower, one-quarter oil and diesel, and one-quarter natural gas. (see Figures 2.10 and 2.11) There is only 4% of renewable other than large hydro. (see Figure 2.11). This consists mostly of small hydro (3%), but there is some biomass capacity (263 MW), solar capacity in Peru (90 MW), and wind capacity in Colombia (18.5 MW) and Ecuador (19 MW). Venezuela is the only country in the Andean Zone with no renewable development outside of large hydro.

In the early 1990s, the Andean Zone followed the global trend of power market liberalization pioneered by neighboring Chile and emulated globally from the United Kingdom and some in the United States and Australia. Recently, however, many countries in the Andean Region including Bolivia, Venezuela, and Ecuador have implemented reforms championing a reversal to more regulation and further state control of the energy sector. After the California Power Crisis in the early 2000, many electricity markets around the world (particularly in the United States) were experimenting with power market liberalization and opted to go back to deregulation. However, the trend in the Andean Region reflects a broader nationalistic trend rather than structural problems with power market liberalization and deregulation reforms.

Colombia and Peru still have liberalized power markets with significant private participation and unbundled electricity generation, transmission, and distribution; however, Bolivia, Ecuador, and Venezuela have shifted relatively recently toward resource nationalization. In Colombia, electricity is

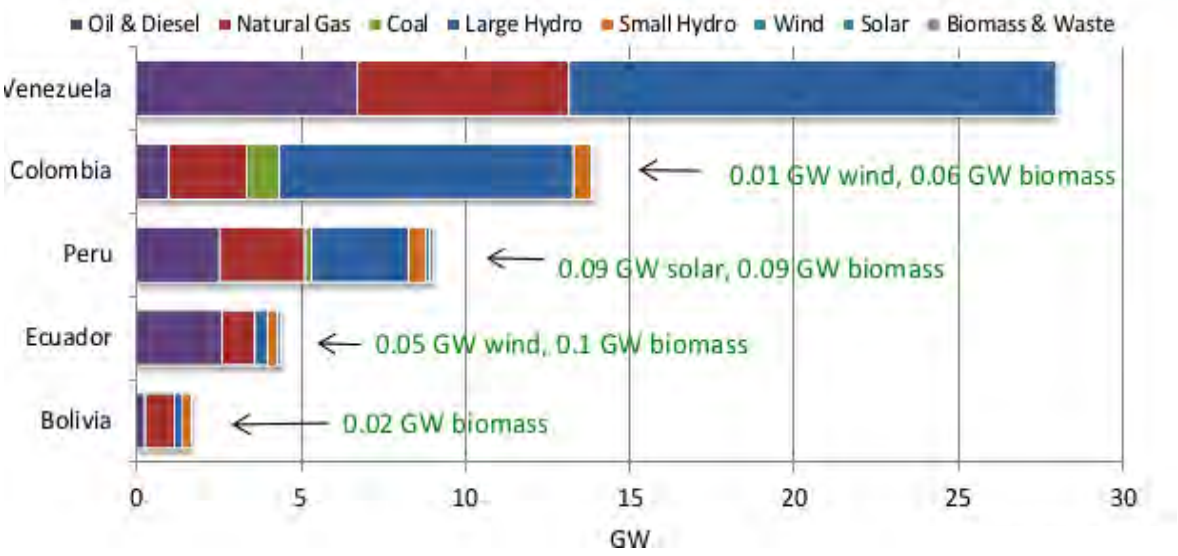
centrally dispatched by a system operator based on day-ahead bids made by generators. In Peru, electricity is commercialized by public and private utilities, as well as by some generation companies directly. Since 2006, Bolivia has nationalized the energy sector, along with mining and telecommunications, with the goal of offering "equitable" service. In 2012, two private distribution companies were expropriated. In 2007, Ecuador created new centralized national energy companies to consolidate electricity distribution. Centralized, state-owned companies have controlled the electricity market in Venezuela since 2007.

The Andean Zone faces challenging circumstances for renewable energy development given its rich fossil fuel resources and low (mostly subsidized) electricity tariffs. However, the shifting attitudes toward resource nationalization and the priority for energy security may incentivize some of these countries to develop their renewable sources. In addition, the Andean Zone includes two countries with below-average electricity rates, Bolivia and Peru, and is home to over nine million inhabitants without electricity access. Bolivia and Peru have already started providing rural electrification through PV systems while the demand for small-scale renewable projects should increase.



Source: MIF

Figure 2.10 Generating Capacity in the Andean Zone



Source: MIF and BNEF

Figure 2.11 Generating Capacity in the Andean Zone by Source

2.3 Outline of the Electric Power Industries and Markets

(1) Outline and Structure of Electric Power Industries

Table 2.2 shows the electric power market for the selected countries, in terms of installed capacity and demand (peak and annual) and so on. The total amount is also described in Figure 2.2 and Figure 2.3. It is necessary for electricity suppliers to own enough generating capacity. It means that generating capacity should be bigger than that of peak demand. We can point out that the surplus capacity varies from country to country. For example, Peru and Costa-Rica have more than twice as much capacity as peak demand. In El Salvador and Honduras they have 30% surplus of the peak demands. Generally speaking, this figure is not decided by policy of the country. In Japan it is 46%, but some generating facilities are out of work in peak season. The figure with this consideration will be 17 % in 2014.

Another index for electricity demand is load factor. It is the index for load leveling and is calculated as follows; Annual demand / (Peak demand x 24hrs x 365 days)

In countries where the difference of demand between ‘summer/winter’ and ‘spring/fall’ is big and other way round. In Japan this figure is around 65%. In selected countries in LAC are relatively big, like in Peru it is 86% and in most of selected countries it is more than 70%. Main reasons may include the lack of electric-driven devices for heating and cooling because of poverty and moderate weather conditions. This figure describes the performance of utilization of assets and is bigger the better.

Table 2.2 Electric Power Industries of 26 Countries (Installed Capacity and Demand)

Country Category	Country	Total MW installed	Max Demand (MW)	Reserve Margin	Annual Demand (GWh/year)	Load Factor (%)
1	Brazil	121,685	69,900	1.74	466,200	76.14
2	Mexico	63,745	38,000	1.68	248,690	74.71
3	Belize	194	76	2.55	473	71.05
3	Costa Rica	3,039	1,497	2.03	9,236	70.43
3	El Salvador	1,507	1,300	1.16	11,800	?
3	Guatemala	3,113	1,500	2.08	8,015	61.00
3	Honduras	1,877	1,351	1.39	5,500	46.47
3	Nicaragua	1,407	525	2.68	3,100	67.41
3	Panama	2,396	1,154	2.08	6,892	68.18
4	Barbados	239	168	1.42	1,024	69.58
4	Dominican Republic	3,166	1,850	1.71	11,613	71.66
4	Guyana	377	---	---	---	---
4	Haiti	268	---	---	---	---
4	Jamaica	918	644	1.42	4,141	73.40
4	Suriname	412	160	2.58	1,190	84.90
4	Trinidad and Tobago	2,104	1,300	1.62	8,890	78.06
4	Antigua and Barbuda	118	50	2.36	315	71.92
4	Cuba	6,241	3,156	1.98	15,530	56.17
4	Dominica	33	---	---	---	---
4	Grenada	49	30	1.62	197	74.96
4	Saint Kitts and Nevis	46	34	1.34	206	68.36
4	Saint Lucia	89	60	1.48	385	73.25
4	Saint Vincent/Grenadines	47	---	---	---	---
5	Colombia	14,611	9,290	1.57	55,965	68.77
5	Peru	9,705	4,322	2.25	32,696	86.36
5	Venezuela	26,309	18,000	1.46	97,020	61.53

Source: Compiled by the JICA Study Team, based on National Renewable Energy Lab. + CEPAL

The structures of electric power industries are well understood by categorizing them as shown in Table 2.3, Table 2.4, and Table 2.5.

Table 2.3 Structure of Electric Power Industry (Part One)

National	The central government runs utility businesses on their own or by a national company (100% state-owned).
Public	The local government runs utility businesses on their own or by a public company (100% public-owned).
Private	Neither for the case of national nor public. This includes the case where the central government or local government owns certain amount of shares. (For example, more than half of shares of Tokyo Electric Power Co. Inc. (TEPCO) in Japan is owned by the central government of Japan and Tokyo Metropolitan Government owns a little share of TEPCO for many years. But still, TEPCO is not a national or public company.)

Source: JICA Study Team

Table 2.4 Structure of Electric Power Industry (Part Two)

Competitive Market	Any company can sell electricity to anyone in this market. In Japan, competitive market in higher voltage has been gradually realized since 2000 and all of the electricity market will be liberalized in April 2016.
Regional Monopoly	Only the designated organizations can sell electricity in this market. In Japan, electricity market had been monopolized by ten regional electric power companies before the year 2000. This market will be fully liberalized in April 2016.

Source: JICA Study Team

Table 2.5 Structure of Electric Power Industry (Part Three)

Vertical Integration	One organization takes care of the “generation”, ”transmission”, ”distribution” and ”sales” of electricity. This is one of the most traditional business models of electricity supply.
Horizontal Split	Independent organizations for “generation”, ”transmission”, ”distribution” and ”sales” of electricity will play their role in supplying electricity. Competitive electricity market requires this business model.

Source: JICA Study Team

Table 2.6 shows the structure of each country. Colored column in this Table means “YES”. For example, all of the selected countries have state-owned or public electric power supply organizations and some countries have private electric power supply companies in addition. This Table also shows the existence of whole sale electricity market and that of market monopoly.

Table 2.6 Structures of Electric Power Industry of 26 Countries

country categoly	country	state owned or public	private	key actors	wholesale electricity market	public monopoly	public monopoly + IPP	private monopoly including IPP
1	**Brazil**			Agencia Nacional de Energía Electrica ANEEL Centro de Pesquisas de Energía Eléctrica Operador Nacional del Sistema Eléctrico Câmara de Comercialização de Energia Elétrica Comissão Nacional de Energía Nuclear (CNEN) Associação Brasileira das Empresas Generadoras de Energía Eléctrica (ABRAGE)				
2	**Mexico**			Secretaría de Energía Subsecretaría de Electricidad Comisión federal de Energía Ródano #14 Col. Cuauhtemoc, Comisión Federal de Electricidad (CFE) Comisión Nacional para el Uso Eficiente de la Energía (CONUEE) Comisión Reguladora de Energía (CRE) Fideicomiso para el Ahorro de Energía Eléctrica (FIDE) Instituto de Investigaciones Eléctricas Instituto Nacional de Investigaciones Nucleares ININ				
3	**Belize**			Ministerio de Energia				
3	**Costa Rica**			Instituto Costarricense de Electricidad ICE				
3	**El Salvador**			Dirección de Energía Eléctrica (DEE) Consejo Nacional de Energía				
3	**Guatemala**			Comisión Nacional de Energía Electrica Instituto Nacional de Electrificación Dirección Nacional de Hidrocarburos				
3	**Honduras**			Direccion General de Energía Empresa Nacional de Energía Eléctrica – ENEE Comisión Nacional de Energía		complete monopoly		
3	**Nicaragua**			Ministerio de Energia y Minas Instituto Nicaragüense de EnergíaEléctrica ENEL				
3	**Panama**			Ministerio de Economía y Finazas Secretaría de Energía Vía Ricardo J. Alfaro, Plaza Edison, Piso 13, Autoridad Nacional de Servicios Públicos AES Panamá (Bayano, La Estrella y Los Valles, Estí)		Transmission Sector (ETESA)		
4	**Barbados**			The Barbados Light & Power Co. Ltd				
4	**Dominican Republic**			Comisión Nacional de Energía Ministerio de Energía y Minas				
4	**Guyana**			GUAYANA ENERGY AGENCY GUYANA POWER & LIGHT – GPL				
4	**Haiti**			Ministere de Travaux Publics, Transports et Communications				
4	**Jamaica**			Ministry of Energy Government Electrical Inspectorate Electricity Division (Electricity Authority) Petroleum Corporation of Jamaica PCJ		Distribution Sector		
4	**Suriname**			Ministry of Natural Resources EBS				
4	**Trinidad and Tobago**			Ministry of Energy and Energy Industries The Trinidad and Tobago Electricity Commission Powergen				
4	**Antigua and Barbuda**			Ministerio de Energia				
4	**Cuba**			Ministerio de Energia y Minas		complete monopoly		
4	**Dominica**			Ministerio de Energia				
4	**Grenada**			Ministry of Finance, Planning, Economic Development, Energy and Foreign Trade Grenada Electricity Services Limited (GRENELEC)				
4	**Saint Kitts and Nevis**			Ministry of Energy and Utilities SKELEC NEVLEC				
4	**Saint Lucia**			LUCELEC				
4	**Saint Vincent/Grenadines**			VINLEC		Generation & Distribution		
5	**Colombia**			Ministerio de Energia y Minas Unidad de Planeación Minero Enérgetico – UPME Comisión de Regulación de Energía y Gas		Transmission sector (ISA)		
5	**Peru**			Ministerio de Energia y Minas Direccion General de Electricidad Electroperu Organismo Supervisor de Inversión en Energía y Minería Adinelsa Empresa de Administración de Infraestructura Eléctrica				
5	**Venezuela**			Ministerio del Poder Popular para la Energía y Petróleo Dirección General de Energía Eléctrica Corporación Eléctrica Nacional Oficina de Operación de Sistemas Interconectados CA Administración y Fomento Eléctrico-CADAFE Cámara Venezolana de la Industria Eléctrica (CAVEINEL) Comité de Electricidad, Electrónica y Telecomunicaciones (CODELECTRA) C.A. de Administración y Fomento Eléctrico (CADAFE) C.A. Energía Eléctrica de Venezuela (ENELVEN) C.A. Energía Electrica de la Costa Oriental (ENELCO)		complete monopoly		

Source: JICA Study Team

(2) Electricity Tariff

Table 2.7 shows typical electricity tariffs in selected countries. It is impossible to describe the electricity tariff of any country in one value, and the value itself has little meaning. It is highly recommended to recognize the value in order to identify the level of electricity tariff of each country: high, low, or intermediate. Table 2.8 shows the output of this concept.

Table 2.7 Electricity Tariff of Each Country

	ENERGY TARIFFS (USD cents / kWh)			
	2012 VARIOUS REPORTS INDUSTRIAL TARIFF	2013 WEF REPORT INDUSTRIAL TARIFF	CEPAL 2012 REPORT RESIDENTIAL TARIFF	JICA/J-POWER REFERENCE-SEMINAR EE&C
Antigua and Barbuda				
Argentina	2		5	
Aruba				
Bahamas			67.6	
Barbados			29.88	
Belize			22.3	24,5
Bolivia	10.6			
Brazil	8.7	16	26.14	20
Cayman Islands				
Chile	10.4	15	26	
Colombia	13.5	10		15
Costa Rica	9.9	11	11.72	18
Cuba				
Dominica				
Dominican Republic		21	19.6	20
Ecuador	7.6	6		10
El Salvador	18.6	16	26.28	17
Malvinas				
French Guiana				
Grenada			31.74	
Guadeloupe				
Guatemala	17.6	18.4	23.86	23
Guyana			23.73	32
Haiti		11	35	
Honduras	15.7		14	22
Jamaica			34	42
Martinique				
Mexico		9		
Montserrat				
Netherlands Antilles				
Nicaragua	21.9	19	10.3	24
Panama	15.2	14		18
Paraguay	4.1	5		
Peru	7.4	8		8,3
Puerto Rico			27	
Saint Kitts and Nevis				
Saint Lucia				
Saint Vincent/Grenadines				
Suriname				7

Source: JICA Study Team

Table 2.8 Level of Electricity Tariff of Selected Countries

High	Brazil、Belize、El Salvador、Guatemala、Nicaragua、Barbados、Dominican Republic、Guyana、Haiti、Jamaica、Grenada
Medium	Costa Rica、Honduras、Panama、Colombia
Low	Mexico、Suriname、Trinidad and Tobago、Peru

Source: JICA Study Team

(3) Subsidies

Like the rest of the world, Latin American countries have seen pressures to subsidize energy.

Energy subsidies, if large and persistent, can have serious economic costs. They can exacerbate budget deficits, add to public debt, give rise to payment delays, and compromise fiscal and external sustainability. When used to smooth volatile energy prices, subsidies can drive large swings in the fiscal balance, complicating efforts to meet fiscal targets. Subsidies may take the form of outright fiscal transfers, but also of forgone fiscal revenues or weaker balance sheets of companies in the energy value chain, including state-owned enterprises. They are often non-transparently financed, and in practice, are usually regressive. The price distortions they create lead to inefficiencies and negative environmental effects and may negatively impact growth.

Energy subsidies for the average LAC countries, cost about 1.8% of GDP annually in 2011–2013, about 1% of GDP for fuel, and 0.8% of GDP for electricity (Table 2.9).

Although there are wide variations across countries, patterns can be identified for different country groupings. In particular, energy subsidies appear correlated to a country's degree of "institutional quality" and oil-richness. These characteristics can be used to assign LAC countries in four groups, depending on whether they were oil producers (or importers), and on whether they ranked above (or below) the regional median in measures of "institutional quality". In addition to these categories, the analysis will focus on specific groups based on income per capita (low-income countries, LIC), and geography (Central America and the Caribbean).

Energy subsidies (as a percent of GDP) were largest in oil producing countries while ranked lower in "institutional quality[3]" (Venezuela, Belize and Suriname.), and were lowest in oil importing countries while ranked higher in "institutional quality"(Costa Rica and Dominica).

[3] Institutional quality is a qualitative measure of a country's institutions stability related to socio-political risks, like in Venezuela, Haiti, Nicaragua, or even Cuba. Institutional Quality or Economic and Investment Risk cannot be calculated with some variables.

Table 2.9 Energy Subsidies as Percentage of the Gross Domestic Product
(International Atomic Energy Agency, 2013)

Low Ranked & Producers	Total	Fuel	Electricity
Venezuela	8,9	7,1	1,8
Ecuador	7,5	7,0	0,5
Bolivia	6,2	6,1	0,1
Argentina	3,9	2,1	1,8
Belize	2,7	0,0	2,7
Suriname	1,7	0,0	1,7
Low Ranked & Importers			
Guyana	3,0	1,7	1,3
Haiti	2,9	0,2	2,7
El Salvador	2,2	0,7	1,5
Nicaragua	2,1	0,0	2,1
Dominican Republic	2,0	0,1	1,9
Honduras	0,9	0,0	0,9
Grenada	0,9	0,4	0,5
Guatemala	0,4	0,0	0,4
Jamaica	0,1	0,0	0,1
Paraguay	0,1	0,0	0,1
High Ranked & Producers			
Trinidad & Tobago	2,7	2,0	0,7
Mexico	1,8	1,1	0,7
Brazil	1,2	1,2	0
Colombia	0,4	0,2	0,2
Peru	0,2	0,2	0
High Ranked & Importers			
Antigua & Barbuda	1,2	0,5	0,7
Bahamas	1,0	0,4	0,6
Panama	0,8	0,3	0,5
Barbados	0,8	0,6	0,2
Saint Kitts and Nevis	0,6	0,1	0,5
Saint Lucia	0,3	0,3	0
Dominica	0,1	0,0	0,1
Uruguay	0,0	0,0	0
Chile	0,0	0,0	0
Costa Rica	0,0	0,0	0
Saint Vincent/Grenadines	0,0	0,0	0
Total Latin America & Caribbean	1,8	1,0	0,8
Excluding High Ranked & Importers	1,3	0,8	0,5

Source: JICA Study Team

How to read this table: Venezuela, for example, is a country with domestic natural resources and typical low ranked country in institutional quality where significant amount of subsidies are provided for energy. On the other hand, Costa Rica, Chile, and Uruguay are energy importing countries with high ranked institutional quality where no subsidies are provided for energy.

2.4 Implications for the Promotion of Energy Efficiency and Renewable Energy Technologies

The penetration of EE and RE technologies in each country is highly influenced by electricity supply structures and electricity tariff. In this context the JICA Study Team would like to propose, from the viewpoint of electricity market, the Table 2.11 in order to evaluate the possibility of EE and RE technologies in Latin American countries.

Table 2.10 Evaluation Criteria to make Table 2.11

	○=10 points	△=5 points	×=0 point
Market size	Big	In between of ○ and ×	Small
Electricity Tariff	High		Low
Institutional quality (socio-political risks)	No risk		High risk

Evaluation in Table 2.11 is based on the following standard;

◎: more than 25 points

○: more than 20 points and less than 24 points

△: more than 15 points and less than 19 points, provided that market size and institutional quality is not 0 point.

From Table 2.11 we can point out the following comments for your reference.

a) Brazil and Colombia are the most attractive countries for developing EE and RE projects in LAC.
b) Mexico, Costa Rica, El Salvador, Guatemala, Honduras, Dominican Republic, and Peru are also attractive for EE and RE projects.
c) On the other hand, many of the small island countries are not suitable for EE and RE projects from the viewpoint of the size of the market.
d) Countries where electricity tariff is low, it is not easy to promote EE and RE projects because the payback year will be longer.
e) Countries like Venezuela with high political risk must be paid careful attention, as well as Nicaragua, Haiti, and Cuba which also have socio-political risk. These items are defined as “Institutional Quality” which is explained previously.

Table 2.11 Possibility of Energy Efficiency and Renewable Energy Technologies from the View Point of Electricity Market in Selected Countries

Categ oly	Country Name	Market Size	Electricity Tariff	Institutional Quality	Evaluation
1	Brazil	○	○	○	◎
2	Mexico	○	×	○	○
3	Belize	×	○	△	
3	Costa Rica	△	△	○	○
3	El Salvador	△	○	△	○
3	Guatemala	△	○	△	○
3	Honduras	△	○	△	○
3	Nicaragua	△	○	×	
3	Panama	△	△	○	○
4	Barbados	×	○	○	
4	Dominican Republic	△	○	△	○
4	Guyana	×	○	△	
4	Haiti	×	○	×	
4	Jamaica	×	○	△	
4	Suriname	×	×	△	
4	Trinidad and Tobago	△	×	○	△
4	Antigua and Barbuda	×	n.a.	○	
4	Cuba	△	△	×	
4	Dominica	×	n.a.	○	
4	Grenada	×	○	△	
4	Saint Kitts and Nevis	×	n.a.	○	
4	Saint Lucia	×	n.a.	○	
4	Saint Vincent/Grenadines	×	n.a.	○	
5	Colombia	○	△	○	◎
5	Peru	○	×	○	○
5	Venezuela	△	×	×	

Source: JICA Study Team

3 Energy Saving and Renewable Energy

3.1 Energy Efficiency (EE)

The implementation of EE projects in industrial, commercial and residential sectors in Latin America has faced the following barriers: electricity tariffs do not reflect real economic costs; lack of information on potential energy savings and benefits; limited capability in providing EE services (how to structure, finance and implement energy savings initiatives by the Energy Service Companies (ESCOs); and lack of experience in financing of EE projects.

*ESCO (Energy Service Company):

ESCO business is a comprehensive energy-saving services (including provision of energy-saving solutions, installment of EE equipment, maintenance and operation of installed equipment) provided by an ESCO (a company which operates ESCO business), which engages in a performance based contract with a client firm guaranteeing certain level of energy efficiency (EE) improvements (i.e. reduction of energy consumption and/or costs) and, in return, receives remuneration out of thus achieved energy savings.

The source of payments to such ESCO services derives from the energy-savings achieved, and the total payment amount will be arranged so as not to exceed the client's current total energy bill.

There are two major types of models in ESCO business: a) the guaranteed savings model (see Figure 3.1) in which ESCOs provide clients with performance guarantees, but no financing; and b) the shared savings model (see Figure 3.2) in which ESCOs provide performance guarantees as well as financing. As for the former, clients themselves procure funds from banks based on their credibility and make repayments out of energy cost savings. And for the latter, energy cost savings will be split between the client and ESCO based on a pre-determined rate. There are also cases where ESCOs are in alliance with banks and leasing companies.

There also exists ESCO-alike businesses to which no one provides performance guarantees, but financial institutions (such as banks, leasing companies and ESCOs) agree to provide financing based on cash flow expected to be generated from their energy-saving projects. In an ESCO-alike project, a client firm may enjoy an advantage of introducing EE equipment without any additional financial burden, but at the same time, unlike an ordinary ESCO business, it will have no risk hedge against underperformance due to incidents such as electricity price falls which make it impossible to achieve expected energy cost reductions.

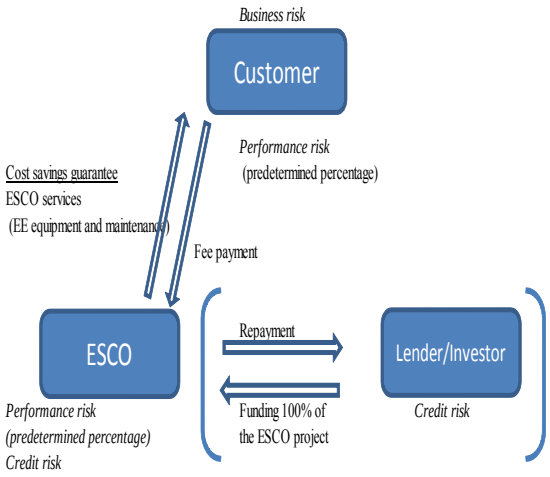


Figure 3.1 ESCO Shared Savings Scheme

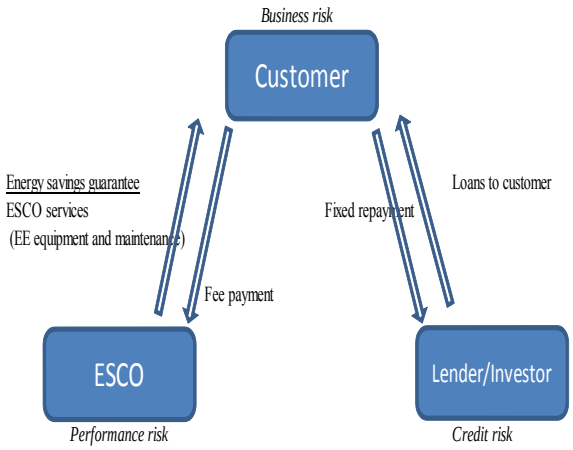


Figure 3.2 ESCO Guaranteed Savings Scheme

Source: Compiled by the JICA Study Team

Many countries in Latin America have implemented EE programs (Table 3.1) aimed to reduce these barriers which usually include the following components: adoption of policies and regulations to promote EE; dissemination of information about best practices; labeling and efficiency standards for electrical appliances and equipment; adoption of energy-efficient construction standards; creation of special funds to finance EE audits and projects; supply of high-efficiency light bulbs and led technology; creation of specialized energy saving units in power utilities; and use of solar water heaters.

The major outputs in EE project implementation through national programs in Mexico and Brazil, who have formulated so much comprehensive EE programs, are summarized below.

Mexico has achieved considerable energy savings with the implementation of several EE programs: CONAE (the National Commission for Energy Conservation) has established 18 EE norms that apply to electrical equipment in operation; FIDE (the Electricity Conservation Trust Fund) finances EE programs for large and small industrial and commercial consumers and the rehabilitation of electrical pumps used in irrigation systems; CFE-PAESE (the Electricity Conservation Program) promotes improvements in EE in the installations of public utilities; ASI (the Integral and Systematic Conservation Program) finances improvement in thermal insulation of houses, labeling of electrical appliances and information dissemination to residential consumers; and a daylight saving time program. The Secretariat of Energy claims that these programs, which cover residential, industrial, commercial and public sectors, resulted in energy savings projected of 10 GW in peak savings by 2014.

Brazil has started to formulate national EE programs since 1970s, just after the Oil Shock. The outline and effects of the most effective programs are described s follows. In 1985, the Electricity Conservation Program (PROCEL) was established and it has been up-dated and revised till now. And in 2000, the Program on Energy Efficiency (PEE) was established and under this program, the electricity utility companies are stipulated to invest a part of its

revenue in EE project. These programs resulted in the following energy savings.

a) By comprehensive electricity saving programs, around USD 2,500mil /year can be avoided.

b) As for lighting, 827TWh electricity was saved in 2013.

c) EE Labeling Program has been applied for 32 appliances and this labeling program has contributed to achieve around 95 % of the total electricity saving under PROCEL program.

d) By EE Labeling Program for Building, 51 commercial buildings and 1442 residences achieved over 20% electricity saving in 2013.

Moreover, in the National Energy Plan up-to 2030, formulated in 2007, the target of EE percentage has been defined: total energy 9%, electricity consumption 10 %, transportation12 %. And in 2011, the National EE Plan (PKEf), executing agency is Electrobras was formulated. And the breakdown of target electricity conservation by sector up-to 2030 has been published, such as 39TWh for industry, 38TWh for residence, 16TWh for commercial, 7TWh for public. (Total 103TWh/y)

Table 3.1 Energy Efficiency Programs in Latin America

Country	EE Plans/Programs - Promotors	Related EE programs	EE asociated with Renewables (Incentive to sell electricity saved) etc.	Other EE Programs developed
Brazil	National Program for Energy Conservation (PROCEL) - ELECTROBRAS/Government funds/International Donors since 1985.	Voluntary Labeling Program for Domestic Appliances and Electric Motors. Tax Incentives - Low Interest Loans - Education and Training in Public Service	---	Audit - Information - Appliances - Public Lighting
Colombia	Program for the Rational and Efficient Use of Energy (PROURE) Ministry of Mines and Energy - UPME	EE Standars and Labeling. Tax Incentives - Low Interest Loans	---	Audit - Information - Appliances -
Costa Rica	National Energy Conservation Program (PRONACE) Ministry of Environment nd Energy, Sectorial Energy Office (DSE), since 1994	Education and Information Program to improve the EE equipment, energy labeling for industrial/commercial users.- Tax Incentives	---	Audit - Information - Appliances -
Ecuador	Energy Savings Programs - PAE	EE campaings Standars and labeling	---	Information Appliances
Peru	Energy Saving Project (PAE) Ministry of Energy and Mines Ministry of Education	Emergency Energy Conservation Campaigns	---	Information Appliances
Guatemala	EC Law: Under discussion	"Energy Efficiency Alliance Alternative Platform# (PPP scheme) was established in 2014. Incentive mechanism to promote small sized projects	Up to 5 MW net metering (can be sold to grid) Import tax exemption, Income tax reduction	
Nicaragua	EC Law: Under discussion	Tax exemption for some plans. Tax Incentives	Net metering program Import tax exemption, Income tax reduction	Audit - Information - Appliances -
Jamaica	No EC law. Existing EC Guideline for public sector Building Code will be amended	Tax exemption, low interest loans	Up to 100 kW net billing (sellingpriced is regulated lower). Net wheeling program Import tax exemption for solar panel.	---
Dominican Republic	EC Law: Under discussion	Tax exemption, low interest loans	Up to 1.5 MW net metering Import tax exemption for main equipment	---
Grenada	No ED Law. Reduce the national rate of energy consumption while incre asing the economic growth (decoupling), by adopting best practices in energy efficiency and conservation	---	20% of all domestic energy usage (electricity & transportation) will originate from renewable energy sources by 2020	---
Barbados	No EC Law. Reduction in final energy consumption is 20% by 2029	---	Output from Renewable Energy in total produced electricity output is 30% by 2029	---
Antigua & Barbuda	No EC Law. Targeted efficiency and conservation measures designed to reduce the overall energy intensity of the economy by 10% below a 2010 baseline within 10 years	---	Reformed market framework and mandated targets to achieve 15% renewable energy in the electricity supply by 2030	---
Guyana	No EC Law. Strategic Loss Reduction Plan (SLRP) has been established. Target 27.9%energy consumption reduction in 2018		Hinterland Electrification Program (HEP) to accelerating power supply in the remote area.	---

Source: JICA, IDB, and other sources.

The reason why countries like Brazil and Colombia which are mostly Hydro want or need to implement EE programs is not simple but can be related to some factors. First, climate change issues, then the energy prices for the industry (mainly electro-intensive industry) need more competitive prices and mainly, equipment is obsolete or the use of fuels different from natural gas at competitive prices impact the efficiency of the overall production in a competitive market. Also, residential cost of energy in Latin America in general represent a high cost to families. Also refrigerators and other appliances have low efficiencies. Illuminations (mainly state-owned grid) are obsolete and with high

losses has an impact to the overall efficiency. For government/official buildings, EE is a target that the government is implementing in many countries.

ESCO is being formed (in a disorganized way, in general) but is a strategy that entities (from government, and some utilities and independent companies) are trying to offer to the market. Cogeneration is also one of the best projects for some industries (like sugar cane), taking into account the obvious efficiencies achieved and that in the region, cogeneration and trigeneration has a potential to produce more than 10 GW that has not been realized because of unfavorable regulations. In Brazil, there are plans for cogeneration with Bagasse (sugar cane) of more than 1 GW in 2020.

Also in the islands, it is obvious that the fuel costs for energy production and EE, in general, call urgently for efficiency improvements.

The information presented in this document does not cover the whole spectrum of EE, but in general, the suggested barriers to prevent the promotion of EE are the followings:

a) Information for the majority of the countries of interest does not constitute a well-organized and institutionally-reliable set of national statistics. This appears to be one of the weakest points in the countries' institutions in terms of energy efficiency efforts undertaken within the national policy framework. The analysis of the available information suggests that the quality of the statistics and performance indicators that make it possible to quantify results is still inadequate (except, with some limitations, in the cases of Mexico and Brazil). Due to these shortcomings in quantity and reliability of information regarding specific results, it is impossible to draw concrete, accurate conclusions (excepting, again, with regard to Mexico and Brazil). More than 1 GW installed has been saved from programs related to energy efficiency in Brazil. More than 20% of Mexico's energy consumption could be avoided through measures that would pay for themselves and programs of efficiency standards have increased potential savings.

   There are difficulties in monitoring the results of energy efficiency programs in the countries examined. The absence of key indicators of success (or failure) is a major shortcoming of national programs. It is necessary to learn how to quantify opportunities in a way that does not cost more than seizing those opportunities.

b) Regulatory frameworks have been found to be either missing or weak.

c) The concrete results from creating the portfolio of EE projects have been rather unsatisfactory. The reasons for this are not easily determined nor clarified, but the keys to the (relatively) lack of success, including a lack of continuity in policy implementation by the governmental organizations responsible for the its implementation and excessive delay in decision making due to administrative, budgetary, and/or bureaucratic reasons, associated with the number of governmental and other entities with related issues on efficient energy use.

d) It would be unrealistic to compare the results of energy efficiency programs in Latin America

with those successfully executed in countries that are more highly developed and/or those countries that have a history of energy efficiency policy dating back to the first oil shock in the 1970s. Analysis for the countries of interest, shows differences, from one country to another, among the regulatory frameworks associated with energy efficiency. Thus, it is difficult to establish "common denominators" for this parameter in the region.

e) One lesson from the region's experience is that the mere existence of energy efficiency legislation in no way guarantees that there will be positive effects on (a rational reduction of) energy demand. This will not occur unless energy efficiency activities, projects, and programs that are adapted to national realities are developed and systematically implemented. Most of the countries studied here have no (or very few) specific domestic sources of funding for energy efficiency programs. Investment decisions mean spending today what might otherwise be spent over several months or years, so financing, eg. subsidy, low interest loan and tax reduction, is necessary. As a result of the reforms of the 1990s in the region, programs for efficient energy use suffered from budget reductions and a lack of interest, since there was no political will to pursue them.

f) Economic and cultural barriers in Latin America can be the bigger barrier, while lack of human resources (due to budgetary constraints) means that monitoring and enforcement systems are inefficient. Numerous years of continuous work are required to train national experts to work with energy efficiency programs.

g) On an average, 75% of the refrigerators in use today are approximately half as efficient as the new refrigerators entering the market. This represents a great opportunity for energy saving through replacement of these older products. Cogeneration for industry and large tertiary-sector facilities has a huge potential of more than 10 GW that has remained unexploited due to lack of regulatory incentives.

h) There a need to have more strategies in providing education and for building awareness and promoting energy saving measures to the people in the government, in the education and business sectors, as well as for individual users. Lack of knowledge on the part of the users continues to create major barriers to practice efficient use of energy.

i) The market for energy services firms (ESCOs) remains underdeveloped or developed by weak entities.

j) There is little involvement on the side of utilities and fuel providers, with the exception of Brazil, where the main programs in operation are managed by energy companies (PROCEL-Electrobras and CONPET-Petrobras), although they coordinate their activities to conform to the policies of the country's Ministry of Mines and Energy. Energy regulators in the region responsible for electricity or fuels, but with the exception of Brazil's ANEEL (Brazilian Electricity regulatory Agency), which have practically no role in promoting energy efficiency.

k) Energy efficiency programs are still excessively dependent on international cooperation, although energy price signals have begun to reflect conditions of scarcity and the growing need for investment as a means of increasing supply. There is a need to have stronger national initiatives to rationally and efficiently reduce consumption.

l) Energy consumption takes place in millions of service points, but energy is being saved by a "one light bulb or LED at a time"; an effort which should be made to reach every single consumption point. Opportunities, therefore, involve an even greater number of decisions – millions of daily decisions on operation and investment. There continues to be great potential for energy saving.

m) Overall, around 20-25% of energy consumption in Latin America could be eliminated through measures that would rapidly pay for themselves.

3.2 Renewable Energy

Renewables are the most increasing economic option for new generation capacity especially for countries that depend on fuel oil for power generation, such as many in Latin America. Resource advantages in renewables (such as solar radiation, wind, geothermal and biomass) give the region the potential to match or even undercut the lowest costs achieved in other parts of the world. Low-cost financing and the scaling up of local industries are important keys to realizing that potential. Effective policies and measures can greatly improve the investment environment (public and private). Considering the longevity of current investments in the power system infrastructure, it is imperative that policymakers carry out integrated resource plans that seek to lower overall electricity system costs in the long term by taking advantage of synergies among different renewable sources, energy efficiency, and smart grid technologies. Latin America is a very diverse region, with economies of varying sizes. The two largest economies, Brazil and Mexico, drive many of the regional trends, making some of the developments in the power sector that require individual analysis. To date, ten countries in Latin America have set official targets for increased deployment of renewable energy technologies (see Table 3.2). These take several forms: in Argentina, Barbados, and Peru, renewable energy targets are based on the share of consumption; in Chile, the Dominican Republic, and Mexico, they are based on the share of generation; and in Jamaica, Nicaragua, and Uruguay, they are based on the share of capacity installed. The ambitiousness of these goals varies widely, reflecting national disparities in resource availability, the current status of renewable technologies and investment, and political willingness.

Brazil also has an experience in the execution of EE programs. In 1994, the government created PBE (Brazilian Labeling Program), coordinated by the National Institute of Metrology. Historically, after the first oil shock in 1973, Brazil had intended to deduce the percentage of oil usage by utilizing these measures, such as enforcements of the regulation to use biofuels (several revisions), a program for Alternative Electric Generation Sources (*Programa de Incentivo às Fontes Alternativas de Energia Elétrica:* PROINFA - promoting wind , mini-hydro and biomass power, setting quota) in 2002, Rural

Electrification Program (Luz para Todos) in 2003, transformation of electricity sector (public bidding for wind power starting in 2009, introduction of FIT program), and low interest loan to promote RE project financed by BNDES (Brazilian Development Bank) etc. As a result, the annual investment for RE projects stands around a billion US dollars recently.

Table 3.2 Renewable Energy Targets in Latin America

Country	Renewable Energy Targets
Argentina	8% of consumption by 2016
Barbados	29% of consumption by 2017
Chile	20% of generation by 2020
Colombia	3.5% of capacity by 2015; 6.5% by 2020
Dominican Republic	10% of generation by 2015; 20% by 2025
Jamaica	20% of capacity by 2030
Mexico	35% of generation by 2024 (15 % Eolic)
Nicaragua	9% of capacity by 2020
Peru	33% of capacity by 2021
Uruguay	20% of capacity by 2030

Source: Compiled by the JICA Study Team, based on PWC and other sources

Table 3.3 shows the different sources of the countries of interest in Renewables. The following characteristics can be observed:

a) Countries, which are deeply rely on hydro are Brazil, Mexico, Costa Rica, Panama, Colombia and Venezuela

b) Non-hydro renewables have been developed widely only in Brazil and Mexico

c) Geo-thermal and solar generation have been developed widely only in Mexico

d) Wind and biomass generation have been widely developed only in Brazil and Mexico

The other countries deeply rely on their power generation sources on fossil energy, and there exists a large potential to introduce renewables.

Table 3.3 Renewables in Latin America (MW)

Country	Total MW	Total RE	Hydro	Non hydro RE	Geothermal	Solar, tadal, wave	Wind	Biomass, waste	Fossil fuel
Brazil	108,964	97,015	84,294	12,721	0	17	2,508	10,196	24,670
Mexico	50,805	43,870	30,930	12,940	5,820	690	3,640	2,790	19,875
Belize	144	103	53	50	0	0	0	50	91
Costa Rica	2,634	2,105	1,700	405	197	0	148	60	934
El Salvador	1,273	706	472	234	204	0	0	30	801
Guatemala	2,764	1,340	991	349	49	0	0	300	1,773
Honduras	1,681	734	538	196	0	0	102	94	1,143
Nicaragua	976	537	106	431	165	0	146	120	870
Pamana	2,396	1,468	1,468	0	0	0	0	0	928
Barbados	239	0	0	0	0	0	0	0	239
Dominican Republic	3,123	586	543	43	0	0	33	10	2,580
Guyana	363	15	1	14	0	0	14	0	362
Haiti	268	61	61	0	0	0	0	0	207
Jamaica	864	77	23	54	0	0	48	6	841
Suriname	412	189	189	0	0	0	0	0	223
Trinidad Tabago	2,099	5	0	5	0	0	0	5	2,099
Antigua and Barbuda	118	0	0	0	0	0	0	0	118
Cuba	6,229	76	64	12	0	0	12	0	6,165
Dominica	26	13	6	7	0	0	7	0	20
Grenada	48	1	0	1	0	0	1	0	48
Saint Kitts and Nevis	44	2	0	2	0	0	2	0	44
Saint Lucia	89	0	0	0	0	0	0	0	89
Saint Vincent and Grenadines	47	7	7	0	0	0	0	0	40
Colombia	14,502	9,927	9,818	109	0	0	20	90	4,684
Peru	9,614	3,575	3,484	91	0	15	1	75	6,130
Venezuela	26,279	14,652	14,622	30	0	0	30	0	11,657

Source: Compiled by the JICA Study Team based on IDB and other sources

(1) Renewable Energy Auctions

Renewable energy auctions are procurement mechanisms by which public actors solicit bids to supply a given amount of renewable energy capacity. In 2013, 9 of the 26 countries in the region implemented auctions for renewable energy technologies.

Brazil integrated auctions into its regulatory framework in 2004 and has used them since, offering a long-term, 20-year contracts ahead of delivery for the regulated market. The original motivation behind the introduction of auctions was price disclosure and efficiency in the procurement process. The Brazilian auctions take two forms: regular, annual auctions exclusive to new energy; and "reserve energy" auctions. The former is technology neutral, offering standardized long-term energy contracts, organized in a central procurement by the government to achieve economies of scale and paid for by regulated consumers. Reserve energy auctions contract supplementary energy to increase supply security. The government defines the volumes to contract and can select the technologies that will participate. All consumers pay for the energy. Since 2005 to 2013 - 25 auctions, 9 of which were exclusive to renewable energy and have resulted in 62 GW of new capacity being contracted for future delivery of which, 60% was renewable (40% conventional hydro and 20% other renewables). In December 2012, auctions resulted in contracts for 574 MW, nearly half of which was allocated toward wind projects at a record low average tariff of USD 42/MWh. In 2014, Brazil has awarded power contracts to 31 PV projects (890 MW) in its first federal auction specifically for solar. However, the low average clearing bid price of USD 87/MWh leaves questions about how many of these

projects will be built and when. Now, the plan of the Brazilian government is to contract about 500 MW of solar annually through national auctions. In 2014, Brazil contracted 2.2 GW of wind power, including the 551 MW contracted at the A-3 auction in June 2014 and the 769 MW in October's reserve auction – both with a start-up date in 2017. This brings Brazil's projected wind power installed capacity to over 16 GW by 2019, including some 700 MW guaranteed through the non-regulated market.

Peru held technology-specific auctions for small hydro, solar, wind, biomass, and geothermal in 2009, 2010, 2011, and 2013. These auctions offered a 20-year power purchase agreements (PPA), with an expectation to yield an annual 12% rate of return based on a ceiling price determined by the regulator. In Peru, auctions have been largely successful because those were the only auctions in the region to successfully auction solar contracts and they brought down the prices of other renewable technologies between 2010 and 2011 decreasing prices for small hydro by 11%, wind by 14%, and solar PV by 46%. In the third auction in 2013, the bids were slightly short of their target (by less than 25 GWh per year) but still managed to award 19 small hydro projects.

In México, a new market rules – still in draft form – are intended to open up power generation to all participants and guarantee nondiscriminatory access to the electric grid. They also aim to promote energy efficiency and renewable energy through new market incentives, auctions, and a clearly defined annual roadmap to reach 35% clean energy by 2024.

Other countries implementing auctions include Argentina, Costa Rica, Guatemala, Honduras, Panama, and Uruguay. In Jamaica, the first clean energy auction was held in 2013. The tender contracted 58 MW of wind power and 20 MW of PV to supply the island's private vertically-integrated utility.

(2) Regulatory Policies

1) Feed-in Tariffs

Feed-in tariffs (FiT) set a fixed price at which renewable power can be sold and fed into the grid guaranteed over a certain period. Although their design varies according to the context in which they are implemented, FiT policies aim to incentivize renewable generators by providing market certainty and stability. The use of FiT mechanisms in Latin America has been less widespread than in other regions, partly because most governments already subsidized electricity for low-income consumers and face other development issues. The costs of implementing FiT would therefore further burden national budgets. The recent challenges surrounding FiT in Europe have also meant that countries in LAC are careful to avoid the mistakes of early adopters in Europe who had to revise tariffs to account for the changes in the market. When designing a FiT, it is important to account for the reduction in costs over time of renewable energy technologies by using a specific policy. Nevertheless, several countries in the region have moved forward with the FiT model. Argentina and the Dominican Republic approved a legislation for FiT in 2006 and 2007, respectively; however, these have yet to be implemented. Honduras and Panama offer a

10% and 5% price premium, respectively, for renewable electricity generators that sell to the main utility. Uruguay has offered contracts with private investors for electricity from biomass. Nicaragua implemented a FiT for all renewable energy sources of US¢5.5–6.5/kWh. Brazil's Program of Incentives for Alternative Energy Sources (PROINFA), which ended in 2011 and Ecuador's FiT program (ended in 2012) guaranteed above-average market prices to 3.3 GW and 645 MW of projects, respectively. The model implemented by PROINFA in Brazil differed somewhat from traditional FiT policies seen in Europe. The mechanism set the target of contracting 3.3 GW of renewable generation capacity by 2009, equally from wind, biomass, and small hydro. Although new projects could no longer qualify for PROINFA after December 2006, implementation was postponed until 2012. Installed capacity reached 2.888 MW with 132 projects (60 projects and 1.157 MW of small-hydro; 51 projects and 1.182 MW of wind; and 21 projects and 550 MW of biomass). The costs of the scheme are levied from customers on electricity bills. The program set competitive tariff rates in 2010, with wind at USD 150/MWh, small hydro at USD 96/MWh, and biomass at USD 70/MWh.

2） Quota Obligations (RPS: Renewable Portfolio Standard)

Quota obligations require certain actors to meet a minimum target for renewable energy. Chile is the only country in the region that uses a utility quota obligation. The law mandates that electric utilities with more than 200 MW of operational capacity, have to generate 20% of electricity from renewable sources by 2025. This was implemented after reforming Law No. 20-257 of March 2008 which mandated utilities to generate at least 10% of their electricity from renewable sources by 2024. The new target of 20% by 2025 will be valid for contracts established from July 2013 onward. Other quota obligations in the region concern biodiesel and ethanol blending mandates for conventional diesel and gasoline respectively which are not discussed here since they relate to transportation and not electricity.

(3) Fiscal Incentives

Fiscal incentives represent the most commonly applied mechanism to support renewable energy deployment in Latin America; they are currently being used by 14 out of 26 countries in this study. (See Table 2.3-3) The most prevalent fiscal incentives are tax relief for renewable energy generators and import duty exemptions for renewable energy equipment. Argentina and Mexico implemented accelerated depreciation[4], while the Dominican Republic, El Salvador, Guatemala, Honduras, and Nicaragua implemented income tax reductions for renewable energy generation projects.

[4] Accelerated depreciation scheme allows factories and buildings to depreciate their machinery assets faster than normal depreciation years based on its useful years. By applying this scheme, factories and buildings can reduce their income tax.

Table 3.4 Fiscal Incentives in Latin America

Country	Accelerated Depreciation	Tax Relief	Income Tax	Import Duty	Tax Rebate
Argentina	Yes	No	No	No	Yes
Bahamas	No	No	No	No	No
Barbados	No	No	No	No	No
Belize	No	No	No	No	No
Bolivia	No	No	No	No	No
Brazil	No	Yes	No	Yes	Yes
Chile	No	No	No	No	No
Colombia	No	Yes	No	No	No
Costa Rica	No	Yes	No	No	No
Dominican Republic	No	Yes	Yes	Yes	No
Ecuador	No	Yes	No	No	No
El Salvador	No	No	Yes	Yes	No
Guatemala	No	Yes	Yes	Yes	No
Guyana	No	No	No	No	No
Haiti	No	No	No	No	No
Honduras	No	Yes	Yes	Yes	No
Jamaica	No	No	No	No	No
Mexico	Yes	No	No	No	No
Nicaragua	No	No	Yes	Yes	No
Panama	No	Yes	No	Yes	No
Paraguay	No	No	No	No	No
Peru	No	No	No	No	No
Suriname	No	No	No	No	No
Trinidad & Tobago	No	No	No	No	No
Uruguay	No	Yes	No	No	No
Venezuela	No	No	No	No	No

Source: Compiled by the JICA Study Team based on IDB, PWC, and other sources

(4) Investment in Renewables

1) Mexico

CFE (the Federal Electricity Commission) expects to build about 2.3 GW of wind energy spread over eight projects by 2019. However, the industry is on the lookout for the potential implications of the recent reform in the renewable energy sector, which give more autonomy to the system operator, CENACE (the National Load Control Center). Having an impartial operator could theoretically enhance the market competitiveness of generation, although this will take some time. Also, public service power generation was passed on to CRE (the Energy Regulatory Commission), which has the responsibility for regulating and issuing permits. This will allow greater flexibility in bilateral power purchase contracts which were limited to self-supply model. Additionally, it also provides for the creation of a Mexican Petroleum Fund (which may invest in renewable energy) and the creation of a law to regulate the exploration and exploitation of

geothermal energy. Mexico has attracted over USD 8 billion in renewable energy investment since 2006, receiving USD 2.9 billion in 2012 alone. Although almost 80% of this investment was in wind power, all other renewables have received funding as well, and trends indicate that solar will continue to attract growing investment.

2） Brazil

The largest economy in Latin America's continues to be a fertile ground for renewable energy auctions for wind energy, biomass, and hydroelectric which was announced in the first half of 2015. ANEEL, who is responsible for conducting auctions at the federal level, and is expected over the next few years to become operational for at least 10 GW of wind power, 20.4 GW of hydropower (large and small scale), and almost 2 GW of biomass power derived from the auctions already made. Solar power in 2014 created great expectations for federal auctions where photovoltaic and concentrated power (CSP) projects were eligible to bid. However, these technologies still do not take off in the country as there were no projects that were implemented by the same auction. Either way, the solar potential is vast in Brazil (especially in the northeast) and is starting to promote statewide. Brazil has attracted more investment in renewable energy than any other country or sub-region in Latin America, with over USD 40 billion in cumulative investment between 2006 and 2012. As the largest regional economy and supported by a comprehensive policy framework, it is easily the most attractive market for renewable energy development. Wind has attracted over half of Brazil's renewable energy investment since 2006 primarily through asset finance. Small hydro and biomass have been funded steadily over this period as well.

3） Chile

Renewable energy installed in Chile exceeded 2 GW in 2013. To date, they have under construction more than 1.2 GW of which almost 900 MW are in solar projects. Besides promoting renewable energy projects on a large scale, the government is pushing the agenda of energy distributed through the adoption, in 2014, of the regulations necessary for the installation of bidirectional meters (net-billing) and the promotion of solar cities. 2015 will be a year of consolidation of large-scale projects that are in the stage of permits, financial closure, and construction. A downward trend in electricity prices in the Chilean market, as observed, suggests that renewables are helping to stabilize prices in these systems. There are many solar photovoltaic and wind projects under construction and permitting stage as these projects are expected to continue gaining ground in other technologies such as biomass and small-hydroelectric plants.

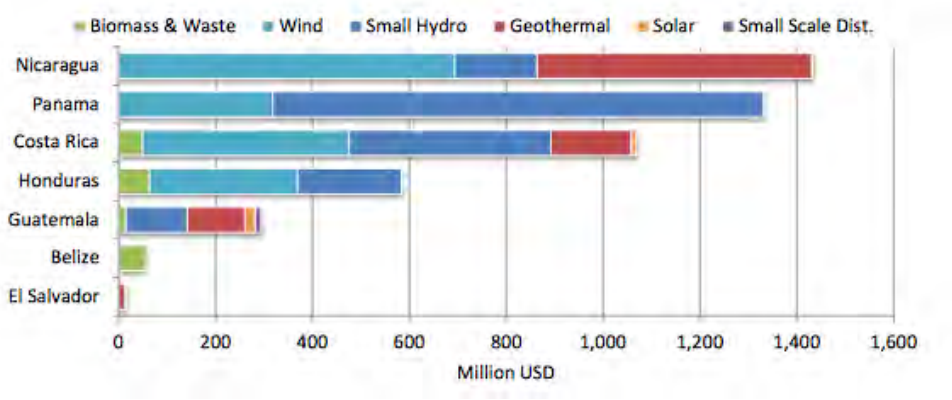
4） Peru

As a result of the expansion of its mining sector, eg. new development of copper mining and modernization of the refinery, Peru economy has been growing rapidly in recent years. Despite having large reserves of fossil fuels and low electricity prices, the country has taken the initiative

to conduct several auctions of renewable energy in recent years. Peru offers incentives such as accelerated depreciation for investments in renewable and priority dispatch of its energy sources like solar and wind. Regarding auction, Peru recently awarded more than 500,000 photovoltaic systems for rural electrification as a solution for their most marginalized areas. In 2015, plans to hold a fourth auction of renewable energy resources for about 500 MW (130 MW hydropower and the rest to be determined) to supply power to the grid and isolated systems.

5) Central America

In recent years, Guatemala, together with El Salvador, Nicaragua and Panama, has been promoting auctions to try to stabilize electricity prices with its energy matrix highly dependent on fossil resources. As the most populous country in Central America, it is expected that the electricity consumption of Guatemala will increase to 3% a year from 2015-2020. The country aims to install around 1.770 MW of new power generation mainly obtained from renewable sources from 2014 to 2028. As a result, the distribution companies, in coordination with NEC (National Energy Commission) and MEM (the Ministry of Energy and Mines), held a tender in 2014, in which almost 190 MW were awarded mainly in hydropower and biomass based. This tender was also open to other renewable technologies such as solar and wind. Additionally, the sector authorities plan to launch another tender (PEC-4) in 2015 possibly to hire up to 250 MW of geothermal power, and is scheduled to launch the PEC-5 in the near future. Guatemala also has tax incentives for renewable such as exemption from VAT and import taxes for machinery and equipment and income taxes for a period of ten years. On a GDP basis, Central America, Nicaragua and Panama in particular, has seen some of the largest renewable energy investment in the region (See Figure 3.3) Nicaragua has attracted over USD 1.4 billion since 2006, which represented 5.4% of its GDP in 2013. The country has been able to overcome its poor overall investment climate through ambitious targets, transparent policies, and micro-financing to develop its abundant wind and geothermal resources. Panama, with a significantly higher GDP than Nicaragua, has attracted over USD 1.3 billion since 2006, or 2.3% of its GDP in 2013. All of these investments have gone to small hydro and wind, although the expected combined capacity of over 300 MW of wind has yet to come on line. Costa Rica has attracted over USD 1 billion in investment, distributed unevenly among the past seven years. This funding has led primarily to geothermal, wind, and small hydro development, as well as to a utility-scale solar PV plant that received USD 10 million in support in 2012.



Source:IDB and BNEF

Figure 3.3 Largest Renewable Energy Investment in the Region

6) The Caribbean

The Caribbean has attracted very little investment for renewable energy. Cumulatively, it has received USD 0.8 billion since 2006, the majority of which was directed to the Dominican Republic. While the Dominican Republic has a relatively low share of renewables in its electricity mix, its policies and incentives are attracting greater amounts of financing, as evidenced by the USD 248 million committed to a 52 MW expansion of a wind farm and a new 30 MW solar PV plant in 2012. Outside of the Dominican Republic, there has been no significant and recent investment in renewable energy in the sub-region. In 2010, Jamaica received some investment for wind and small hydro, and Guyana for biomass.

7) The Andean Zone

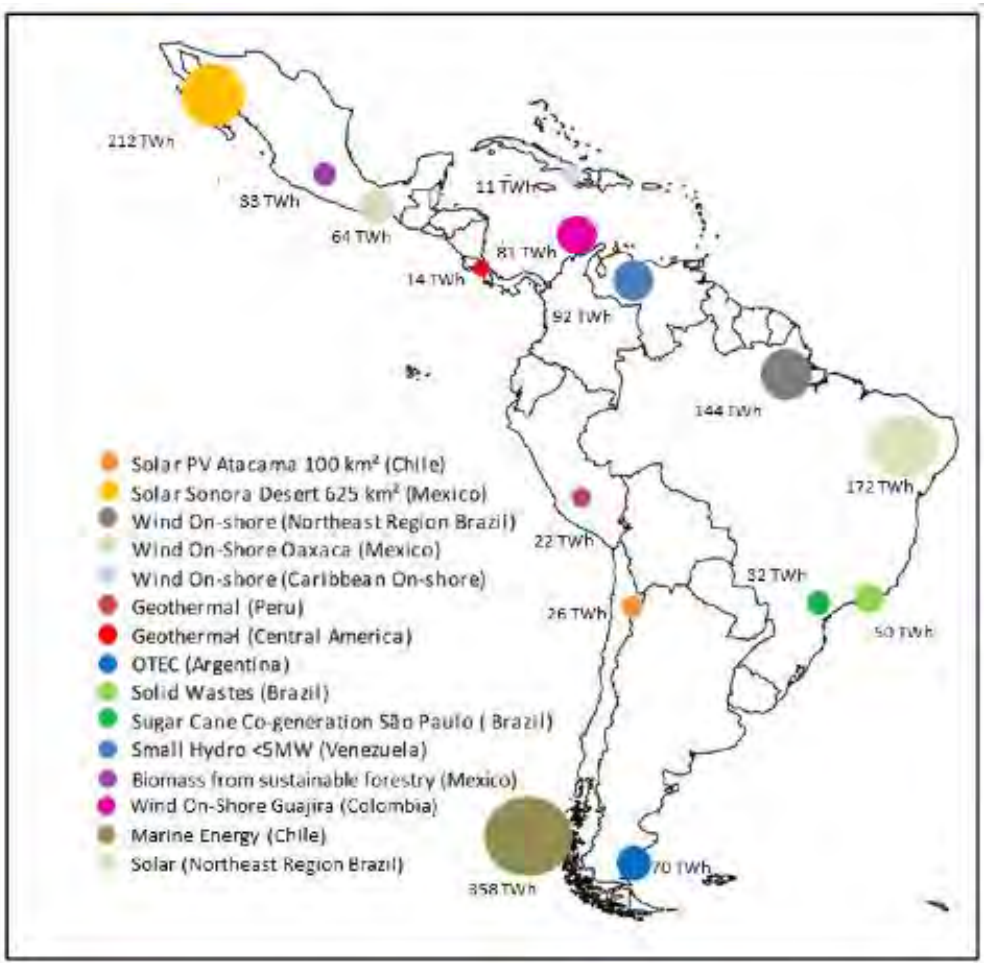
The Andean Zone attracted USD 3.2 billion in investment for renewable energy, over half of which was received by Peru, the country that has attracted the majority of the investment for solar in all of LAC. Peru's renewable energy investment has grown very fast, especially in 2012, when it attracted over USD 1 billion, for wind (USD 667 million), solar (USD 468 million), and small hydro (USD 94 million). After Peru, Colombia has the highest cumulative investment in the sub-region, but as the fifth largest economy in LAC, this level of investment falls short, especially considering that Colombia attracted none in 2012. Most of Colombia's cumulative investment has been directed to small hydro (USD 457 million) as well as some biomass (USD 131 million) and solar (USD 52 million). Nevertheless, Eolic interest in Guajira is growing. Ecuador, a much smaller economy, has attracted over USD 400 million since 2006, largely for small hydro.

8) The Southern Cone[5]

The Southern Cone has one clear outlier which is the USD 7.5 billion in cumulative investments in the sub-region, by which, more than USD 6 billion went to Chile. Chile's renewable energy

[5] Chile, Argentina and Urguay

investments have been growing consistently since 2006; in 2012 alone, over USD 2 billion was invested in wind energy. Besides wind, small hydro has received constant funding (USD 1.6 billion) and solar finally attracted investment in 2012 (USD 203 million). As the third largest economy in the region, Argentina has not attracted significant renewable energy investment; however, the investment it has received, has grown constantly since 2006, and has supported wind, biomass, and solar development. Despite its size, Uruguay has been able to attract USD 393 million by becoming a dynamic wind market, and received more than half of that investment. In Figure 3.4 are presented specific renewable rich sites for electricity generation.



Source: IDB

Figure 3.4 Examples of Specific Renewable Rich Sites for Electricity Generation

The use of renewable energy sources can significantly reduce both greenhouse gas emissions from electricity generation and national dependency on imported fuels. Several countries in the region, especially in South America, have launched programs to promote the use of unconventional renewable energy in the production of electricity. The majority of these programs are still in the implementation phase, but it is already possible to identify some areas for improvement, such as access to credit and the transparency and clarity of the processes. These programs have in common: the participation of the state in the role of regulator, promoter, and in

some cases, guarantor and financial backer, while the private sector plays the basic role of executing and operating the project. The PPP model appears to be having positive results in terms of promoting the use of unconventional renewable energy. The use of unconventional sources has increased significantly following the implementation of these programs at the beginning of the last decade. Some specialized analyzes have been carried out by entities as IDB, studying breaking barriers (regulatory and impositive measures mainly) to promote renewables.

Latin America's electricity consumption is forecasted to double by 2030 and to triple by 2050. The longevity of energy infrastructure means that investments made today will have long-term systemic impacts. Latin America diversity in renewable resource potential provides significant opportunities for regional integration. The region has some of the largest potentials in the world for emerging renewable energy technologies.

To decrease long-term costs and improve the reliability of the electricity system, national energy plans addressing power generation variability and climate change impacts should be harmonized regionally. Technical and policy assessments can help determine the most cost-effective and socioeconomically beneficial path to regional integration. They are also an important first steps to an integrated regional power market.

Latin America, as a region, already has some clean energy value chains for biofuels, biomass, waste, and hydropower. Solar, wind, and geothermal also have near-complete value chains, except for silicon production, bearing manufacturing for wind equipment, and geothermal operation and maintenance service providers. Argentina, Brazil, Chile, and Mexico have the most complete clean energy value chains in the region. For smaller economies, it is practical to focus on the creation of regional markets. For example, Barbados' enormous experience with solar water heating could spread through the region if the Caribbean Community and Common Market (CARICOM), possibly supported by the IDB, promotes its success model and helps it expand to markets in neighboring islands. This could also serve as a first step toward a Caribbean solar manufacturing industry.

Latin America has already experienced decreases in hydropower due to extreme droughts, such as in Costa Rica and Brazil. In addition, glacial melt could cost Peru's electricity sector between USD 212 million and USD 1.5 billion. It is rather recommended to prioritize integrated watershed and hydrologic resource management to face expected climate change risks. The region continues to lack in-depth assessments of the impacts of climate change on non-hydro energy sources, vulnerability studies at the national level, and the development of adaptation strategies.

Latin America has the opportunity to become a test bed for innovation for current and future renewable power generation technologies, as well as for smart grid and storage technologies. Continuing the development and deployment of renewables in the region would lead to the creation of thousands of jobs. Governments and entities of all kinds should continue to support pilot projects as well as the regional implementation and scale-up of proven technologies. They

should help establish financing programs to support the growth of local supply chains for renewable energy technologies through business incubators. Finally, it can be instrumental in building technical capacity by fostering cooperation among technical leaders from both within and outside the region.

(5) Forecast – Technologies/Energetics

Table 3-5 shows the forecast for renewables in Latin America associated to technologies/energetics. The major points to be observed are as follows:

a) Small hydro: It is expected that the number of projects will increase. Issues to be cleared are countermeasures against water shortage and how to avoid excessive competition.

b) Wind: Cost reduction will be realized, and the number of projects will increase.

c) Biomass: The number of biomass power generation projects will increase.

d) Geo-thermal: The largest barrier to prevent its implementation is the initial financial burden for site research and exploration.

e) Solar power generation: Cost reduction will be realized, and the number of projects will increase.

f) Tidal: Success of Chilean pilot project, now under investigation, will lead the future status.

Table 3.5 Latin America's Forecast for Renewables

Energy Source	2014-2015	2015-2020 Feasibility Forecast	2020-2030 Feasibility Forecast	2030-2050 Feasibility Forecast
Small Hydro	Small-scale hydroin the region 's installed capacity amounts to about 1.6 GW.	In LAC there is a lot off oportunities for Small Hydro Projects. The problem is that hydrology compromise the viability of many projects with a very altered or dry riverbed; Strong competition for the use and purchase of project promoters is another barrier Despite some projects (less than 2 - 3 MW mainly) projects generally have good indicators.	Feasible. Subject to environmental and hydrological restrictions.	Feasible. Subject to environmental and hydrological restrictions.
Wind Energy	The costs of wind energy have also been reduced at an accelerated ritme , which have contributed to the entry of more efficient designs and larger towers with more capabilities. Among the renewables, wind energy is the fastest growing in the region. The cumulative installed capacity in Latin America reached more than15 GW .	Wind Energy is expected to gain more MW and double the 2010-2015 period.	Technologies for medium-velocity-winds will be developed with decent efficiencies.	Technologies for medium-velocity-winds will be developed with high efficiencies, achieving the top of the renewables. For some Islands this can be a big solution, also with off-shore technologies. In Brazil, Colombia, Honduras and other countries could be developed large-scale projects. Also off-shore projects can be developed, if environmental restrictions permit it.
Biomass	Biomass, including energy generated from waste is the main source of electricity from residues. Most come from sugar cane waste or wood in Brazil (7,800 MW), followed by Mexico (496 MW) , Guatemala (300 MW) , Argentina (300 MW) and Chile (526 MW . The region continues to show interest in developing electricity from biomass and waste.	Remain interest in developments in the sugar sector (cogeneration) with Brazil heading. Palm Oil still targets to small developments as well as other uses such as forest residues and municipal solid waste (MSW), among others.	Feasible developments in sugar mills projects primarily associated with fuel alcohol, if market conditions and policies (land restitution, waste, etc) allow it.	Viable. Subject to environmental restrictions. Using forest residues in Mexico to give an example could lead a large-scale project.
Geothermal	Mexico is the fifth largest producer of geothermal electricity with about 1 GW of installed capacity. Central America has nearly 500 MW of installed capacity in Costa Rica , El Salvador , Guatemala , Honduras and Nicaragua . Lately the Caribbean (St. Kitts and Nevis, Granada , Dominica , Montserrat and St. Lucia) have developed plans to exploit its geothermal resources. To date there have been no geothermal projects in South America, although Argentina is planning a 100 MW plant in Neuquén , while Colombia , Ecuador and Panama are actively exploring this resources .	There are sectoral and international cooperation signals to promote this technology. However the high cost of research and exploration are a barrier to development. By maturity generally requirements (time studies, exploration, construction and financial close), do not present a clear feasibility for development in this period, although there are some countries interested.	The costs associated with exploration if they are not leveraged by multilateral banks or by other mechanisms could lose competitiveness to this technologya. However there are signs that could point to a feasibility projectssome geographies as Costa Ricar to medium capacity.	Feasible for high reliable projects asociated with high reservoirs.
Solar Photovoltaic PV	There has been a marked increase in the activity of development projects in the field of photovoltaic solar energy in the region , driven by the significant cost reductions occurred in recent years and efficiency. Thus has begun the development of several large-scale photovoltaic systems . Industry forecasts show that by 2016 the region could have installed more than 2 GW of capacity.	It is the technological option that present the greatest reduction in installation costs and improved efficiencies projected in this period. Sites in LAC as Sonora-Mexico, Guajira in Colombia or Atacama in Chile can be places to settle large scale PV Systems. and Atlantic Coast have very good potential. The technology does not yet compete with others such as wind and hydro but a breakthrough is expected in the short term. In other countries of the region greater viability for photovoltaic developments (approximately 50 MW 25) is observed.	Possibly feasible if efficiencies are improved and installation costs down as expected on silicon or other materials technologies.	Large scale projects of High efficiency panels at low cost could be developed in sites as Sonora, Atacama or Guajira and the levelized costs could be near or even better than eolic.
Solar Concentration SC	The first SC power plant developed in Mexico is a hybrid (solar / gas) Central solar generation capacity which is 14 MW . In Chile, the government opened a tender for ESC , and now is running a 110 MW tower project.	These projects will remain at high levelized costs, compared with other technologies or PV.	These projects will remain at high levelized costs, compared with other technologies or PV.	These projects will remain at high levelized costs, compared with other technologies or PV, but technology can change everything, depending on efficiency parameters.
Marine Technologies	In LAC, there are no projects from waves, tides or ocean thermal energy in the region although there is an emerging interest in these sources as a result of the existence of a significant potential in the region . With support from the IDB , Chile is studying the possibility of tendering prototyping energy from waves and tides in the south , to avail this significant strength along its long coastline . In Colombia there are incipient studies in San Andres Island as occurs in other countries.	Chile possibly develop a pilot that can lead this kind of projects in the region.	Chile and others in the Caribbean, depending on technology advances, could develop a serius project, maybe with tide technology.	Tide Technology could be changing the way we think about energy if some improvements are carried out in specific sites.

4 Market Status

4.1 Energy Efficiency Market in Latin America

In Latin American region, energy efficiency is still not being fully implemented. The Latin American Energy Organization (*La Organizacion Lationamericana de Energia:* OLADE) points out that with greater emphasis on energy efficiency, total energy consumption could be reduced by 20-25%. According to the analysis of MGM[6], the LAC region can save nearly 200 TWh per year by adopting energy efficiency technologies for lightings, air conditioners, motors, water heaters. The total amount of the investment is expected to be USD 4.610 million. (Please see Table 4.1)

Table 4.1 Potential Energy Efficiency and Potential Energy Efficiency investment in Latin America

Country	Potential EE TWh/yr	Potential EE investment Million USD/yr
Bolivia	3.48	35.00
Colombia	15.79	321.00
Ecuador	5.13	98.00
Peru	9.93	209.00
Venezuela	9.93	257.00
Total:Andean region	**44.26**	**920.00**
Brazil	65.79	1,529.00
Total: Brazil	**65.79**	**1,529.00**
Bahamas	0.13	8.00
Barbados	0.10	5.00
Dominican Republic	3.41	63.00
Guyana	0.26	4.00
Haiti	3.38	8.00
Jamaica	0.89	4.00
Suriname	0.17	4.00
Trinidad & Tobago	0.43	17.00
Total: Caribbean	**8.77**	**113.00**
Belize	0.10	2.00
Costa Rica	1.59	37.00
El Salvador	2.09	30.00
Guatemala	5.00	50.00
Honduras	2.62	24.00
Nicaragua	1.99	17.00
Panama	1.26	36.00
Total: Central America	**14.65**	**196.00**
Mexico	40.00	1,122.00
Total: Mexico	**40.00**	**1,122.00**
Argentina	13.61	474.00
Chile	5.79	205.00
Paraguay	1.26	17.00
Uruguay	1.13	34.00
Total by technology	**195.26**	**4,610.00**

Source: MGM innova

[6] MGM Innova: MGM Innova is a multinational corporation with headquarte in Maiami, USA. Developing its business operations in Latain America and the Carribean.

Current drivers for EE in LAC can be summarized as follows:

- Increasing prices of electrical and thermal energy
- New regulations with incentives for EE
- Potential for greenhouse gas (GHG) emission reductions
- Reduced investment in new generation capacity
- Need for energy security

4.2 Renewable Energy Market in Latin America

To meet the rapidly growing electricity demand, LAC will need to double its installed power capacity by 2030. Taking this situation into account, renewable energy will play a very important role. The benefit is that the region has renewable energy sources in abundance. (Table 4.2)

Table 4.2 Potential of Renewable Energy Sources in Latin America

Country	Hydro Potential	Wind Potential	Solar Potential	Geothermal Potential	Biomass and Waste Potential
Argentina	HIGH	HIGH	HIGH	HIGH	HIGH
Bahamas	UNKNOWN	MEDIUM	HIGH	UNKNOWN	MEDIUM
Barbados	LOW	HIGH	HIGH	UNKNOWN	LOW
Belize	MEDIUM	HIGH	HIGH	UNKNOWN	UNKNOWN
Bolivia	HIGH	HIGH	HIGH	HIGH	MEDIUM
Brazil	HIGH	HIGH	HIGH	MEDIUM	HIGH
Chile	HIGH	HIGH	HIGH	HIGH	HIGH
Colombia	HIGH	HIGH	HIGH	HIGH	LOW
Costa Rica	HIGH	HIGH	HIGH	HIGH	HIGH
Dominican Republic	HIGH	MEDIUM	HIGH	UNKNOWN	LOW
Ecuador	HIGH	UNKNOWN	HIGH	HIGH	UNKNOWN
El Salvador	HIGH	HIGH	HIGH	HIGH	UNKNOWN
Guatemala	HIGH	HIGH	HIGH	HIGH	HIGH
Guyana	HIGH	MEDIUM	HIGH	UNKNOWN	LOW
Haiti	HIGH	HIGH	HIGH	UNKNOWN	LOW
Honduras	HIGH	HIGH	HIGH	HIGH	HIGH
Jamaica	LOW	MEDIUM	HIGH	HIGH	LOW
Mexico	HIGH	HIGH	HIGH	HIGH	HIGH
Nicaragua	HIGH	HIGH	HIGH	HIGH	HIGH
Panama	HIGH	HIGH	HIGH	UNKNOWN	UNKNOWN
Paraguay	HIGH	HIGH	HIGH	UNKNOWN	MEDIUM
Peru	HIGH	HIGH	HIGH	HIGH	MEDIUM
Suriname	HIGH	LOW	HIGH	UNKNOWN	LOW
Trinidad and Tobago	LOW	LOW	HIGH	UNKNOWN	LOW
Uruguay	HIGH	HIGH	HIGH	UNKNOWN	MEDIUM
Venezuela	HIGH	HIGH	HIGH	LOW	HIGH

Source: IDB

According to the analysis of MGM, the potential of the new installed capacity up to 2030 is approximately 130 GW. Wind has the biggest potential of 56 GW, followed by small hydro of 38 GW and biomass and waste of 22 GW. (Table 4.3)

The total amount of the investment is expected to be approximately USD 17 billion. (Table 4.4)

Current drivers for EE in LAC can be summarized as follows:

- Region is rich in renewable energy resources;
- New regulations provide for feed-in-tariff in many LAC countries;
- Pressure for alternative sources other than fossil fuel;
- Country commitments with sustainability and climate change; and
- Need for energy security.

Table 4.3 Renewable Energy Potential New Installed Capacity（2015-2030）

GW

	Wind	Geothermal	Solar	Small Hydro	Biomass and Waste	Total
Mexico	7.10	4.00	1.28	3.04	1.98	17.40
Brazil	14.20	0.01	0.96	15.20	8.36	38.73
Central America	0.40	1.32	0.16	4.94	3.52	10.34
Caribbean	1.50	0.12	0.32	6.08	2.62	10.64
Andes Countries	8.50	1.03	0.29	5.70	2.33	17.85
Southern Cone	24.30	0.54	0.19	3.04	3.19	31.26
Total	56.00	7.02	3.20	38.00	22.00	126.22

Source: MGM innova

Table 4.4 Annual Investment Required to Support New Installed Capacity

USD million per year

	Wind	Geothermal	Solar	Small Hydro	Biomass and Waste	Total
Mexico	686	800	154	486	363	2,489
Brazil	1,373	2	115	2,432	1,533	5,454
Central America	39	264	19	790	645	1,757
Caribbean	145	24	38	973	480	1,660
Andes	822	206	35	912	428	2,401
Southern Cone	2,349	107	23	486	585	3,550
Total	5,413	1,403	384	6,079	4,034	17,314

Source: MGM innova

4.3 Market Status in Colombia

Electricity tariff in Colombia is not so high thus providing less incentive for energy efficiency. Private companies tend to put their first emphasis on their production lines rather than energy efficiency. The public still views ESCO model with skepticism.

As for the renewable energy, there is a potential of renewable energy of 761 MW in total in the country according to the data[7] released by *La Unidad de Planeación Minero Energética* (UPME) in

[7] “Algunas Consideraciones sobre FNCE” by UPME (2011)

2011. The breakdown is as follows: small hydro of 465 GW (61% of total), biomass and waste of 268 MW (35%), wind of 20 MW (3%), and solar of 9 MW (1%).

There are credit lines for EE and RE provided by the *Banco de Comercio Exterior de Colombia* (BANCOLDEX), a state-owned bank, and BANCOLOMBIA, a private bank. (Table 4.5, 4.6)

Table 4.5 BANCOLDEX Credit Lines for Energy Efficiency and Renewable Energy Projects

Credit Line	Contents
Sustainable Development	This line finances SMEs in all economic sectors. The sources provided under this special line should be allocated in projects that prevent and mitigate the negative effects of corporate activity on the environment. Maximum amount per company is USD 2 million.
Energy Efficiency and Renewable Energy	This credit line is for SMEs in all economic sectors. The resource provided under this special line of credit is for projects that optimize electrical and thermal energy consumption in order to improve processes and increase productivity. Maximum amount per company is USD 1.5 million.

Source: Compiled by the JICA Study Team

Table 4.6 BANCOLOMBIA Credit Lines for Energy Efficiency and Renewable Energy Projects

Credit Line	Contents
State Secretariat for Economic Affairs (SECO) Environmental Credit Line	Credit line for investments in reconversion to cleaner technologies for SMEs that seek to achieve a positive environmental impact (reduce water, energy, or fuel consumption). Reduction in the environmental impact indicator must be at least 30%. This credit line has a subsidy of up to 25% of the loan value depending on the percentage of the environmental impact of the present company.
Bancolombia Green Credit Line	Credit line for eligible project below. Eligible Projects: Energy Efficiency: projects that reduce energy consumption per finished unit of production. It can be electric or thermic energy (i.e., industrial equipment, lighting, HVAC, refrigeration, boilers, heat pumps, air compression systems, among others) Renewable Energy: Any type of project such as wind, hydro, solar, geothermal, biogas, or biomass.

Source: Compiled by the JICA Study Team

4.4 Market Status in Brazil

Brazil experiences significant benefits from energy efficiency because of the high electric tariff. The government established the National Energy Efficiency Plan (*Plano Nacional de Eficiência Energética:* PNEf) in 2010 aiming at achieving energy efficiency of 10% compared with business-as-usual (BAU) scenario by 2030. Actually, private companies are aware of the potential savings with EE; however, in general, they do not want to invest their own money on it because they have more pressing investments to do in their own core business. There should be a large amount of

energy efficiency opportunities because they have not promoted energy efficiency actively so far. Many energy efficiency opportunities can be realized by introducing basic technologies without cutting edge technologies.

There are some cases that a company utilizes ESCO scheme; however, the problem is that most of ESCOs have small capital and cannot finance to execute all potential opportunities identified.

Japanese products are recognized as top quality but expensive compared with products from China and Korea and as expensive as products from Germany.

The government established the Programme of Incentives for Alternative Electricity Sources (*Programa de Incentivo às Fontes Alternativas de Energia Elétrica:* PROINFA） in 2002 in order to promote renewable energy. Thanks to the PROINFA, which is the institutional program stipulating the government to buy renewable energy of small hydro, biomass, and wind at a fixed price for 20 years. Wind power has become widespread in the country. Currently, key players do not exist in the market of PV. In the meantime, there is a risk that Chinese companies may construct a PV cell factory in Brazil in order to qualify its product to the credit line by the Brazil Development Bank (*Banco Nacional de Desenvolvimento Econômico e Social:* BNDES). On the other hand, there is a problem that the capacity of the transmission lines is not enough to make renewable power on grid.

BNDES has some credit lines for EE as shown below. (Table 4.7) *Financiamento de máquinas e equipamentos* (FINAME) is the most popular credit line with more favorable interest rate than other banks.

Table 4.7 Brazilian Development Bank (BNDES) Credit Lines for Energy Efficiency

Credit Line	Contents
BNDES Card	✓ Credit line for domestic MSMEs ✓ Credit card to purchase the products designated by BNDES ✓ Can be used for energy auditing (up to BRL 30,000) ✓ The rate of interest will be updated every month. Repayment in installments is available.
Innovative MSMEs	✓ Credit line for MSMEs aiming at promoting EE investment. ✓ Loan to the project of introducing innovative technologies.
ProESCO	✓ Credit line for EE project by ESCO. ✓ Including the project of introducing renewable energy aiming at reducing fossil fuel consumption. ✓ Applicable examples; lighting, motor, process optimization, compressed air, air conditioning and ventilation, refrigeration and cooling, production and distribution of steam, heating, automation and control, generation, transmission and distribution of energy, energy management, improve power quality (including power factor correction), reduced demand at peak hours of the electric system of consumption, etc., ✓ New machinery and equipment manufactured in the country and accredited by BNDES; imported machinery and equipment without national counterpart product and are already internalized in the domestic market. ✓ BNDES may support the working capital associated with projects of items funded in this line. ✓ The operations under the PROESCO may be held either directly by BNDES or through accredited financial institutions
FINAME	✓ Credit line for the acquisition of national machinery and equipment accredited by BNDES. ✓ In case of assembled products, 30% or more of the parts should be domestic. ✓ Financing operations are conducted indirectly only through financial institutions accredited by BNDES.
Technology Solution	✓ Credit line for the commercialization of technological solutions in the country. ✓ The solutions that may be financed by BNDES Technological solutions are offered by universities, technology companies, and other providers of technology institutions accredited by BNDES.

Source: Compiled by JICA Study Team

Another way of looking at the protected market of Brazil is the country's high tariffs for Japanese companies. The tax system in Brazil is extremely complicated, federal, state, and local taxes are respectively defined at their particular level, while each administrative agency (federal, state, and local governments) established a number of tax imposition system. Although not included as part of the tax system, there are also what they call social contributions. In case of importing products from Japan to Brazil, various taxes, as shown below, are imposed. (Table 4.8)

Table 4.8 Taxes Imposed to Imported Products

Attribute	Type (Abbreviation in Parentheses)
Federal Tax	Import Tax (II)
	Tax on Industrialized Products (IPI)
	Social Integration Program (PIS)
	Contribution to Social Security Financing (COFINS)
State Tax	Tax on Sales and Service (ICMS)

Source: Compiled by JICA Study Team

・Import Tax (II)

Equivalent to the overall import tariff imposed to the Cost Insurance and Freight (CIF) of imported goods. The tax rate varies from 0 to 35% depending on the goods. The average tax rate is about 14%.

・Tax on Industrialized Products (IPI)

Imposed in the customs clearance of imported industrialized products and the transportation of industrialized products from offices or places considered as factories. The transportation of imported industrialized products is also imposed. The tax rate varies from 0 to 60% depending on the products based on the IPI rate table. The IPI tax rate often changes from a political point-of-view as a measure to stimulate the economy and the protection of domestic industry.

・Social Integration Program (PIS)

The tax rate varies depending on the goods. In principle, the rate is at 1.65%.

・Contribution to Social Security Financing (COFINS)

The tax rate varies depending on the goods. In principle, the rate is at 3.0% or 7.6%.

・Tax on Sales and Service (ICMS)

It is a type of VAT imposed to the import/trade of goods by each state. In general, the tax rate applied on the trade within the same state is whether 17%, 18% or 19% and varies according to the states. The rate of 18% is applied in São Paulo, Minas Gerais and Paraná. The rate of 19% is applied in Rio de Janeiro. The rate of 17% is applied in other states. Moreover, each state can set a different tax rate to the specific products within the range based on the provision of the constitution. For example, the rate of 12% is set for industrial equipment in the state of São Paulo.

In addition, the trade of imported goods between states is imposed (according to the Resolution No. 13/2012 of 26.04.2012, the rate of tax on trade in goods imported between states is unified to 4% in principle from 01.01.2013). For products manufactured with imported and domestic parts, a product is treated as a whole as an imported product if it has more than 40% ratio of imported parts.

The trade of some imported products, which do not have similar ones manufactured in the country, between states is applied the standard tax rate of 12% or 7%.

As mentioned above, the sales price of an imported product will be more than double from that in the Japanese market if it is not produced in Brazil because of its distinct tax system. This must be a big

disadvantage in terms of price competitiveness for Japanese companies. The Japanese companies manufacturing products covered by this survey in Brazil are shown below.

Table 4.9 Factories of Japanese Companies in Brazil

Company	Product	State
Daikin Industries	Air conditioner	Amazonas (Manaus)
Hitachi	Air conditioner	Amazonas (Manaus)
Mayekawa	Refrigeration system	Sao Paulo

Source: JICA Study Team

4.5 Market Status in Peru

The government enacted the Law on the Promotion of Efficient Use of Energy (2000) and the Law on the Promotion of Investment in Electricity Generation through the use of Renewable Energies (2008) which aims to achieve the target goal of promoting EE and RE. The most energy consuming sector in Peru is the transport sector which accounts for 45-50% of total energy consumption, followed by the industrial sector which accounts for 14-16%. Though the energy efficiency in transportation is more of a priority in the country, the industrial sector has significant potential for development. The two main energy efficiency products that are recognized in the Peruvian market are lighting devices and motors both for residential and industrial. Regarding the lighting devices, the most popular brands are from China, Korea, and USA such as LG, OSRAM, GE, etc. Japanese products, in terms of domestic appliances, do not have much presence in the market. Korean products are predominating with brands such as LG, SAMSUNG, DAEWOO, among others.

The government target for renewable energy is to reach 5% share of the energy matrix for the period of 2020-2025. In 2015, it reached only 2%; however, according to the study conducted by SNI[8], they consider that a target of 5% is not enough. Their challenging goal is 20-30% by 2040 in order to diversify the energy matrix that is currently made up primarily with hydropower and natural gas.

Currently, the government is executing public auctions of renewable energy in which any company, including Japanese companies, could participate in the independent power producer projects. There have been four auctions so far and no Japanese companies have participated. The main barrier for Japanese companies is the price competition.

As for solar power, the best-known manufactures of solar panel in Peru are German and Spanish brands. As for wind power, they are German, Spanish, and Danish brands.

One of the most popular credit lines in Peru is the Environmental Credit Line (ACL) by Scotiabank[9]. It is the environmental credit line which finances projects up to USD 1 million. ACL has the support of the Swiss Cooperation, through the State Secretariat for Economic Affairs of Switzerland (SECO).

[8] Sociedad Nacional de Industrias (SNI) is the business association which has 120 years history and consists of more than 1,000 industrial companies. It has an Energy Commission that evaluates energy-related issues relevant to the industrial sector.
[9] Private bank which has its headquarters in Toronto, Ontario, Canada and branches in 50 countries worldwide.

ACL, which was designed to promote sustainable industrial production with cleaner technologies, has funded 23 projects (as of July 2015) nationwide. To access this loan, the company must submit the project to Scotiabank to be assessed both by the bank (financial analysis) and by the Centre for Energy Efficiency and Social Responsibility (CER[10]). Three months later after the implementation, CER visit the company to see if it met the proposed indicators. To date most of the 23 funded projects were focused on energy efficiency. The projects to be submitted must replace outdated equipment and should be subject to a law or environmental standard. Applicant companies must have a minimum of 75% of domestic capital, total assets equal to or less than USD 8.5 million, up to 500 workers, and not subsidiaries or branches of foreign companies or organizations or be public companies. The bank is expecting another 10 projects this year which would total to 33 projects.

[10] Centro de Ecoeficiencia y Responsabilidad Social (CER); an organization that will make a feasibility analysis of the project to establish a base line measurement of environmental impact for the post evaluation

5 MGM Sustainable Energy Fund (MSEF)

5.1 Outline of MSEF

The MGM Sustainable Energy Fund (MSEF) is the private fund which was established in 2013 with the aim of financing projects in the energy efficiency (EE) and renewable energy (RE) sectors in Colombia, Mexico, Central America, and the Caribbean Islands. In 2014, JICA invested USD 10 million in MSEF with a view of promoting climate change mitigation in the area by supporting efforts in EE and RE projects using cutting edge Japanese technology. In 2015, MSEF closed its first capital call with a total of USD 63.2 million contributed by international organizations/development institutions including, in addition to JICA, the Multilateral Investment Fund - MIF, InterAmerican Development Bank - IDB, the European Initiative on Clean, Renewable Energy, Energy Efficiency and Climate Change the Global Environment Facility – EIB/GEEREF, Deutsche Investitions- und Entwicklungsgesellschaft mbH - DEG, Instituto de Crédito Oficial on behalf of Government of Spain, Banco de Comercio Exterior de Colombia S.A. – Bancóldex, etc.

Table 5.1 Investment Institutions and Country to the MGM Sustainable Energy Fund

Organization	Country
MIF (IDB)	Multilateral
GEEREF (EIB)	European Union
Bancoldex	Colombia
DEG	Germany
Global Environmental Facility (GEF)	Multilateral
JICA	Japan
AECID	Spain
MGM International	United States

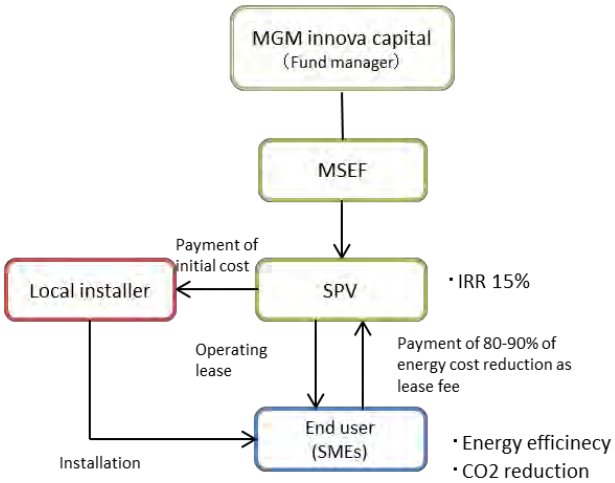
Source: JICA Study Team

5.2 Investment Strategy of MSEF

The MSEF will invest 75% of its committed capital in energy efficiency projects and 25% in renewable energy projects. The projects in which the fund invests should achieve triple bottom line results featuring: 1) due target gross IRR of 15% or more, 2) growth opportunities for small and medium sized enterprises (SMEs), 3) energy savings and reduction in greenhouse gas emissions.

In the case of EE projects, a Special Purpose Company (SPC) set up by the whole investment of MSEF signs an energy savings contract with the client. Once the EE measures have been implemented, the client will pay 80-90% of the total energy savings to the SPC over the contract period as the

operating lease fee. In this regard, the structure is same to the typical ESCO scheme even though the fee is not called the ESCO fee but the lease fee. The scheme is described as bellow



Source: JICA Study team

Figure 5.1 Scheme of MSEF

MSEF focuses on investments in the following sectors:

Energy Efficiency/Distributed Generation (75% of committed capital):

- Commercial Building Energy Efficiency Projects in hotels, hospitals, and other large commercial buildings;
- Street Lighting and Infrastructure – replacement of dated, inefficient equipment in street lighting, and other sectors such as airports.
- Industrial – cogeneration, waste heat recovery, and other efficiency projects at industrial facilities.
- Distributed Generation – primarily solar projects at various commercial and public facilities.

Utility Scale Renewable Energy (25% of committed capital):

- Small-scale renewable energy generation, including focus on hydro rehabilitation and expansion, and greenfield solar.

Investment structures will be supported by full-time technical expertise enabling the fund to offer counterparts a comprehensive financial/technical solution that optimizes equipment performance and economic savings.

Robust economic growth in the region, coupled with inadequate energy infrastructure and high fossil fuel costs, has put increasing pressure on governments to make significant investments to address power consumption, which is slated to grow at an annual rate between 3% and 5% through 2030. One of the lowest cost investment options available to meet this demand is investing in measures to

improve demand-side energy efficiency.

To date, the regional energy efficiency sector has seen limited investment from traditional equity investors and lenders. Only a handful of full service (including financing) energy efficiency firms exist and they are limited by geography, capital, and technology scope. Investment counterparts (i.e. energy end-users) in the region have limited capital available to finance the capital expenditure required for equipment upgrades and often lack the expertise to select equipment that maximizes energy savings.

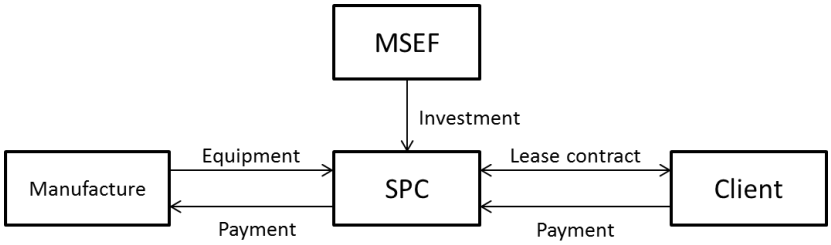
MSEF will focus on building energy savings projects which may include self/distributed generation energy systems in hotels, shopping centers, and hospitals, among others. The fund has also recently partnered with engineering technical experts to target various industrial energy efficiency projects in Colombia with a particular emphasis on the dairy, meat production, glass, and cement sectors. In the public infrastructure sector, the fund will focus on street lighting due to the scale and potential to replicate in the sector and the presence of dated technologies such as mercury and High Pressure Sodium (HPS) that are inefficient and expensive to maintain. The fund is currently analyzing mezzanine finance[11] opportunities in street lighting in Mexico where an established street lighting investment infrastructure exists, and is exploring developing a similar business model to invest in Colombia with municipalities and private concessionaires.

Investments in energy efficiency and distributed generation projects will be complemented with equity and mezzanine investments in small-scale renewable energy projects using proven technologies such as small hydro and solar. The fund will focus on hydro rehabilitation/expansion providing a low-cost investment option to address the aging regional hydro infrastructure and in solar project development in greenfield projects due to a favorable mix of equipment costs and electricity prices in some countries.

[11] Mezzanine financing is riskier and therefore more expensive than senior debts, since it will be repaid only after all senior obligations have been satisfied. Due to its flexibility in setting borrowing conditions, mezzanine financing is an important source of funding for high risk businesses (such as start up firms and SMEs).

5.3 Financial Structuring

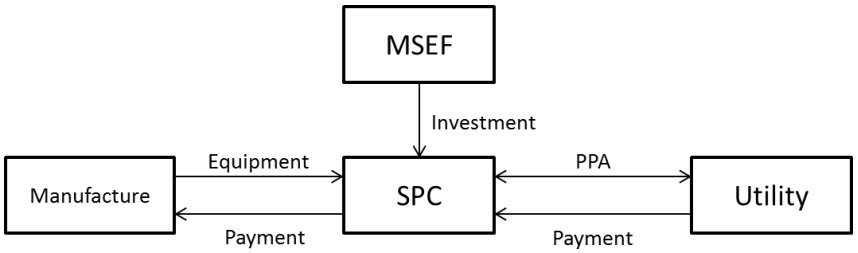
Energy efficiency investments will be made through investments in SPC set up to invest in specific bundles of projects then enter into energy savings lease contracts with customers such as commercial facilities, hotels, factories and so on. The lease contracts may take the form of either financial or operating leases depending on the local legal/tax regime. SPC receives a reward of certain rate of reduced energy cost as a lease fee. (Figure 5.2)



Source: JICA Study team

Figure 5.2 Finance structure of EE projects

On the other hand, in case of renewable energy investments, MSEF will establish an independent power producer (SPC) and install generation equipment. The benefits will be made by selling electric power to utilities.



Source: JICA Study team

Figure 5.3 Finance structure of RE projects

【BOX】Advantages of Leasing and Type of Lease

There are various advantages to leasing that is beneficial for SMEs which are financially fragile and not fit for bank loans. Leasing will provide such SMEs with an effective tool to raise funds for introducing new facilities by not purchasing (thus off-balancing) assets therewith preserve their cash reserves (through the reduction of lease expenses from the taxable income) and thereby save bank lines of credit (for other purposes).

	In Case of Purchase	In Case of Lease
Expense	Purchase Amount	Fixed Lease payment
Asset entry (ownership)	Required (on-balance sheet)	Not required in countries where book entry of leasing payments are allowed as rent expenses (off-balance sheet)
Depreciation	Required	Not required
Book entry as expenses (cash burden)	In case of declining balance depreciation, the asset is depreciated more quickly at the beginning of its useful life, therewith puts bigger cash burden at the initial stage of investment.	Leasing payment is monthly fixed. Thus, the amount of book entry of leasing expense is fixed monthly (which contributes to leveling-off of cash burden)
Bank lines of credit/own funds	Required	Not required (bank lines of credit and own funds can be saved for other purposes)
Terms and conditions	Appraisal of business performance in the past 2-3 years. (collaterals required)	Appraisal of business performance in the past six months. (collaterals not required)
Technology obsolescence of facilities/equipment	There are risks of technology obsolescence of the assets.	Compared to purchases, the risk of technology obsolescence can be eased (by setting the leasing term shorter than the useful life of the assets, thus, enabling accelerated depreciation of the assets).
Cash flow management	More difficult cash flow management ・Larger cash outflow at the purchase of the assets ・Larger cash set aside for depreciation at the earlier stage ・Interest rate on a bank loan varies according to the market. ・Higher burden on administrative duties (including fund procurement, accounting, insurance, tax and asset management)	Easier cash flow management ・Fixed annual amount of cash outflow ・The journal entry of expense is made at the fixed amount equal to each lease payment amount. ・Lease payment amount is fixed all through the lease period irrespective of inflation changes ・Less administrative duties required

There are two types of leasing arrangements: operating leases and financial leases. The former is a lease agreement in which the ownership of an asset is not transferred to the lessee but remains with the owner of the asset (i.e. the lessor), whereas the latter is a lease agreement in which the ownership of an asset is transferred from the lessor to the lessee at the end of the leasing period.
Operating lease arrangements, for example, are suitable for vehicles, which are highly versatile assets that can be traded on the secondary market and therefore their future fair market value can be estimated. In an operating lease, the leasing company (lessor) can offer the lessee a favorable price to use the leased assets during the leasing period, since the future value of the asset on the secondary market (i.e. its residual value) is not included in the total amount of lease payments.
However, leasing arrangements for high energy efficiency equipment for industrial sector customers are mostly custom-made, since normally, no secondary market for this kind of equipment exists. In these cases, financial leasing arrangements are used, in which the leasing company (lessor) will establish monthly lease payments and leasing terms in line with the client's (lessee's) requests, and require the lessee to purchase the assets on completion of the leasing term. In those cases in which it is not possible to collect total investment costs related to the leased assets during the leasing term, the residual value of the assets must either be paid in a single lump-sum by the lessee on completion of the lease contract or, alternatively, the leasing term may be extended.

	Financial lease	Operating lease
Definision	(1) Full payout (2) No cancellation	Other than listed left
Term	Shortest: 70% of the useful time designed by law (60% in case of over 10 years useful time)	Any term
Object	All property	Objects to be used in the second hand market
Lease fee	110~120% of the listing price	Below the listing price
Accounting standard	On-balance transaction	Off-balance transaction
Tax treatment	Able to write off all the money by depreciation cost	Able to write off all the money by lease fee

Souce: MUFJ lease

5.4 Competitiveness of the MSEF

The MSEF's key competitiveness resides in its ability to offer clients a one stop solution that covers both technical and financial issues. Thus, the fund not only provides clients with all the required technical studies (including energy audits), but also implements the project and guarantees energy savings. In this regard, the MSEF does not compete with bank financing, insofar as banks do not provide technical solutions or guarantee energy savings.

The fund could potentially face competition from other RE/EE funds, local ESCOs, and RE developers. However, as shown in the summary below of the main players in these fields, these do not appear to pose major threats, and in some cases might even provide interesting opportunities to synergize with.

Table 5.2 Other Funds and Competitiveness

Fund	Contents	Competitiveness
E + Co Capital Central Asia Regional Economic Cooperation (CAREC)	Manages the USD 20 million CAREC fund targeting smaller renewable energy/energy efficiency opportunities in Central America and the Caribbean.	CAREC is fully invested and only focuses in Central America, thus, it is a limited competitive threat.
Emerging Energy and Environment	Established fund manager in clean-tech/renewable energy space in Latin America that has targeted smaller deals.	More focused on renewable energy where there is some limited overlap with MSEF strategy; however, it is more focused on South American countries whereas MSEF focuses on the Caribbean basin (Mexico, Colombia, Central America, Caribbean Isles).
Actis	Actis is a large fund manager targeting emerging market opportunities across the globe. Through the portfolio company Globeleq, the fund targets renewable opportunities in Latin America.	The firm is actively targeting renewable energy investments in Latin America; however, the focus has been on larger deals where MSEF will not likely to target. For example, Actis recently purchased Mesoamerica Energy which is developing a large-scale wind project in Costa Rica.
Eco-Enterprises Fund II	This fund was recently capitalized with USD 20 million in funding. The fund is focused on investing in sustainable forestry, agriculture, and environment throughout Latin America.	This fund targets different sectors than MSEF, thus, there it presents limited direct competition.
Grupo Ecos	This fund operates out of Panama and covers the entirety of Latin America. The fund focuses on sustainable forestry, biomass, and biogas projects.	This fund is not a direct competitor to MSEF as its principal focus is in a different sector.
Central American Mezzanine Infrastructure Fund (CAMIF)	This fund is focused on infrastructure and large-scale renewable energy projects in Mexico and Central America.	CAMIF has significant overlap with MSEF's target geography; however, the fund is focused on larger deals than MSEF will target.

Source: JICA Study team

There are a number of small ESCOs operating in the MSEF's target region. These firms have suffered from lack of access to capital to finance projects and have primarily focused on providing engineering consultancy services. Only a handful of these firms are actively investing in projects. These groups are discussed below.

Table 5.3 Local ESCOs and its Competitiveness

ESCO	Contents	Competitiveness
Optima Energia (Mexico)	Mexican ESCO that is very active in market and has significant access to equity capital and debt financing in the form of credit line financing.	It is a significant competitive threat to fund in the Mexican energy efficiency market; however, the management team has a good relationship with Optima, having worked with them before and there may be opportunities to co-invest.
Garper Energy Solutions (Colombia, Costa Rica)	ESCO that is primarily active in Colombian marketplace. Significant experience in lighting technologies and access to a robust pipeline.	MSEF is actively talking to Garper, who is seeking capital to co-invest in projects, thus, they represent more of an opportunity than a threat.
EcoSolutions (Central America)	Specific expertise in the hotel sector. Actively seeking capital to increase the size of investments.	Competitive threat from EcoSolutions is limited.

Source: JICA Study team

As for the Renewable Energy Developers, MSEF faces competition from a number of renewable energy developers in all of the countries in which it will invest ranging from utilities, IPPs, and large developers focusing on projects of 20 MW or greater and smaller developers that have limited access to capital.

MSEF is primarily targeting projects that are less than 20 MW, with the exception of some hydro rehabilitation/expansion opportunities that may involve projects that are over 20 MW. Smaller developers targeting projects less than 20 MW often lack the capital to complete the financing of projects.

5.5 Analysis of Implementing Projects and the Pipelines

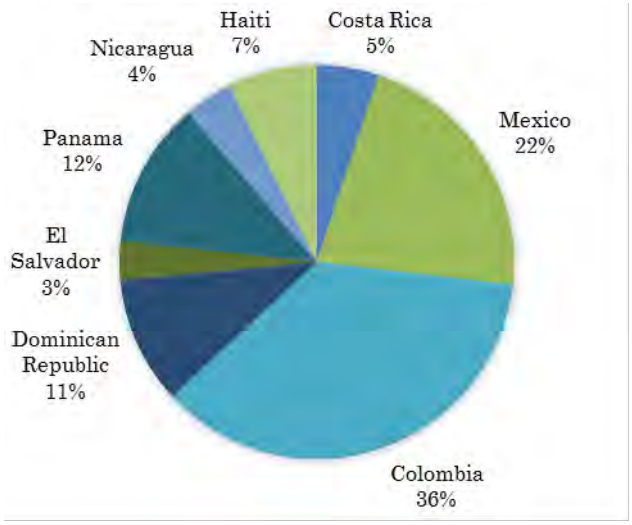
As summarized in the table below, MSEF has implemented or is in the process of implementing four projects, in Mexico, Costa Rica, Panama and Colombia. Japanese EE technology has been introduced in three of these projects.

Table 5.4 Implementing Projects of MSEF

Project	Investment (mil USD)	Country	Type	Technology	Introduced Japanese product
Sunset Hotels, Cancun Mexico	2.0	Mexico	EE	LED lighting, air conditioning, heat recovery system, solar water heater, BEMS	Air conditioners (Toshiba)
EE and Solar Distributed Generation in Costa Rica	1.6	Costa Rica	EE/RE	Air conditioning, solar power	Solar panels (Panasonic)
El Panama Hotel in Panama City	3.0	Panama	EE	LED lighting, air conditioning, solar water heater, laundry equipment, BEMS	Air conditioners (Daikin)
Colanta Biogas to Steam	0.5	Colombia	RE	Biogas generation	

Source: Study Team

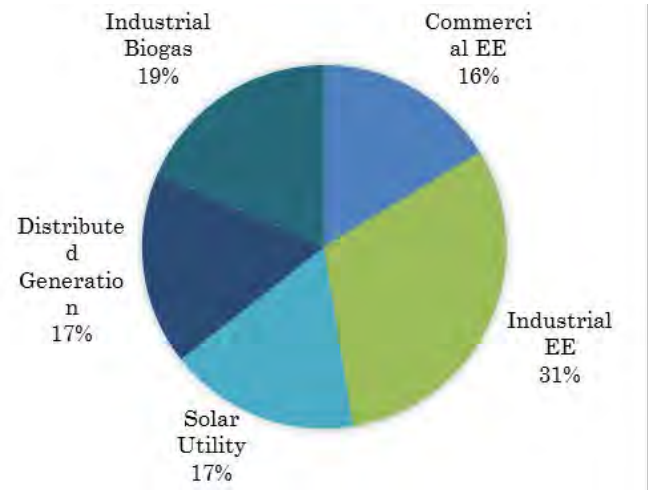
The pipelines in terms of MSEF equity investment amount are mostly located in Colombia (36%), Mexico (22%), Panama (12%), and Dominican Republic (11%). (Figure 5.1)



Source: JICA Study team

Figure 5.4 MSEF Pipelines Investment Amount by Country

By sector, Industrial EE accounts for 31% followed by Industrial biogas of 19%.



Source: JICA Study team

Figure 5.5 MSEF Pipelines Investment Amount by Sector

5.6 Barriers to Facilitate the MSEF and Countermeasures

The wider public in LAC is not yet familiar with ESCO schemes, thus, prior to signing a deal, the client must first be convinced that the SPC can in fact guarantee energy savings. To borrow a phrase from Marco Monroy, CEO of MGM Innova, the main issue to be overcome is the clients' "lack of confidence."

It goes without saying that creating a relationship with a client is of foremost importance, in this regard, the most difficult part is to achieve their confidence because they simply find it very difficult to believe in an energy savings contract. The situation in LAC differs radically from Japan due to cultural differences, thus, people in LAC are very hesitant to accept new things. They are very reluctant to trust their counterpart because of the many bad experiences they have had or have heard of, for example, of businessmen selling bad products and totally reneging on their obligations in terms of maintenance and/or guarantees once the product has been delivered.

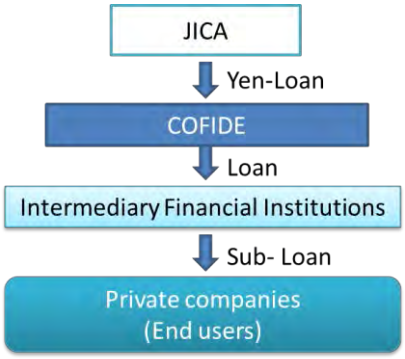
Business opportunities are normally expected to start on a "zero-zero" status, as the parties meet and get to know and trust each other. In LAC, however, this relationship does not start from "zero-zero", but from "minus-zero" since clients have too many negative prejudices. It often takes several months to bring the situation back to zero – i.e., achieve the client's confidence, the point at which productive negotiations can proceed. This is why the business cycle in LAC is so long even though the MSEF is being invested by major prestigious international institutions such as IDB, JICA, government of Spain, etc., the process of obtaining client trust and confidence is lengthy.

One of the most effective ways of attaining the said understanding and trust is by showing potential clients actual examples of successful projects. On this occasion, two orientation meetings aimed at promoting MSEF were held in Colombia and Brazil. The meetings attracted close to 80 participants each and focused primarily on furthering an understanding of the MSEF scheme and promoting the

advantages of Japanese EE products. Based on the participants' answers to the questionnaires the JICA Study Team circulated, the introduction of EE projects, using quantitative data, made the presentation more persuasive. This kind of promotional activities should help to raise people's awareness of GHG emission issues as well as of the MSEF and the role it can play.

6 State of "COFIDE AIRE Program" and issues

COFIDE AIRE program is the agreement of the two-step loan based on the Yen-loan contract reached between JICA and the Peruvian government on October 2012. The program is aiming to support the action of Peruvian effort against climate change on issues in energy sector in the country by promoting the investment of energy efficiency and renewable energy by private sector through COFIDE. COFIDE loans money as sub-loan to the intermediary financial institutions (IFI) and then, IFI loans money required for the implementation of the sub-project to end-users such as private companies. (Figure 6.1)



Source: JICA Study team

Figure 6.1 Loan scheme

This program consists of four components which are the *Conversión Financiada a Gas:* (COFIGAS), Renewable Energy (RE), Energy Efficiency (EE), and Low Emission Diesel. The progress of disbursement of loans as of September 2015 is shown below. (Table. 6.1) The components of both EE and Low Emission Diesel are not disbursed at all, while the most disbursed component is RE at 38%. On the other hand, the disbursement of the FAT component aiming at capacity building is approximately 30%.

Table 6.1 Allocation Amount of Each Component and Progress Situation

(as of September 2015)

Component	Allocation Amount (million JPY)	Disbursement (%)
Financial Component（95%）	8,332	22
COFIGAS (10%)	833	29
RE (50%)	4,166	38
EE (30%)	2,500	0
Low Emission Diesel (10%)	833	0
FAT Component（5%）	44	30

Source: Prepared by JICA study team

One of the reasons why the disbursement of EE component is not making progress might be due to the absence of a well-organized structure inside COFIDE to manage and evaluate projects. Although

approximately JPY 44 million has been allocated to the FAT component aiming at capacity building, it only uses 30% of the budget so is not being utilized well. The employment of consultants is permitted with the FAT component; however, COFIDE does not have any consultants and specialists who support their activities because the government has temporally stopped the use of public purse for the preparation of disasters caused by El Niño Southern Oscillation. The use of public purse is supposed to be resumed in early 2016.

In any case, it is indispensable to strengthen the training for COFIDE's own personnel for the funding of EE projects. The training should put emphasis on i) ability of examining the sub-loan application, ii) consulting ability to establish sub-loan projects, and iii) ability of loan administration.

In this survey, the JICA Study Team visited Bancoldex who operates a Two-Step-Loan in Colombia. Their activities are shown below for reference.

Bancoldex is a second tear bank under the Ministry of Trade and Commerce of Colombia. It was initially created to support SMEs but now it is aiming at promoting investment in Colombia. Regarding energy efficiency, Bancoldex is working on how to improve environmental aspects in the country. In 2009-2010, it started working on projects of eco-efficiency and training for customers on topics on energy efficiency. Bancoldex has worked on energy efficiency projects, geothermal energy projects, and electrification projects utilizing renewable energy with the technical support from IDB. IDB offers support by providing consultants and technical support that focuses on training and internal consultants who could help in structuring the projects as well as to do a monitoring review.

The team in Bancoldex is a four-person team, including two environmental engineers, and one mechanical engineer. This team is supported by external consultants from IDB plus some other experts and lawyers.

In the past, Bancoldex received four trainees from COFIDE to whom Bancoldex offered training on how to develop new lines on energy efficiency. COFIDE presented problems in finding projects due to its low capability.

Table 6.2 Organizational comparison between COFIDE and BANCOLDEX

	COFIDE	BANCOLDEX
Number of team members	2 persons	4 persons (3 engineers out of 4)
Number of external consultants	(to be appointed after 2016)	3 persons
Capacitybuilding	Planning	Supported by IDB

Source: Prepared by JICA study team

7 Air Conditioner

7.1 Overview of Air Conditioning

(1) Air Conditioning

Air conditioning can be classified into commercial/business and home/household use. In addition, for business use, there are two types, namely, central air conditioning and individual air conditioning. In the central air conditioning, centrifugal water chiller and chiller serve are the types of heat source equipment while in the individual air conditioning, it can be roughly divided into building multi air conditioning (e.g., Variable Refrigerant Flow (VRF)) and mini-split (e.g., Room Air Conditioner (RAC)).

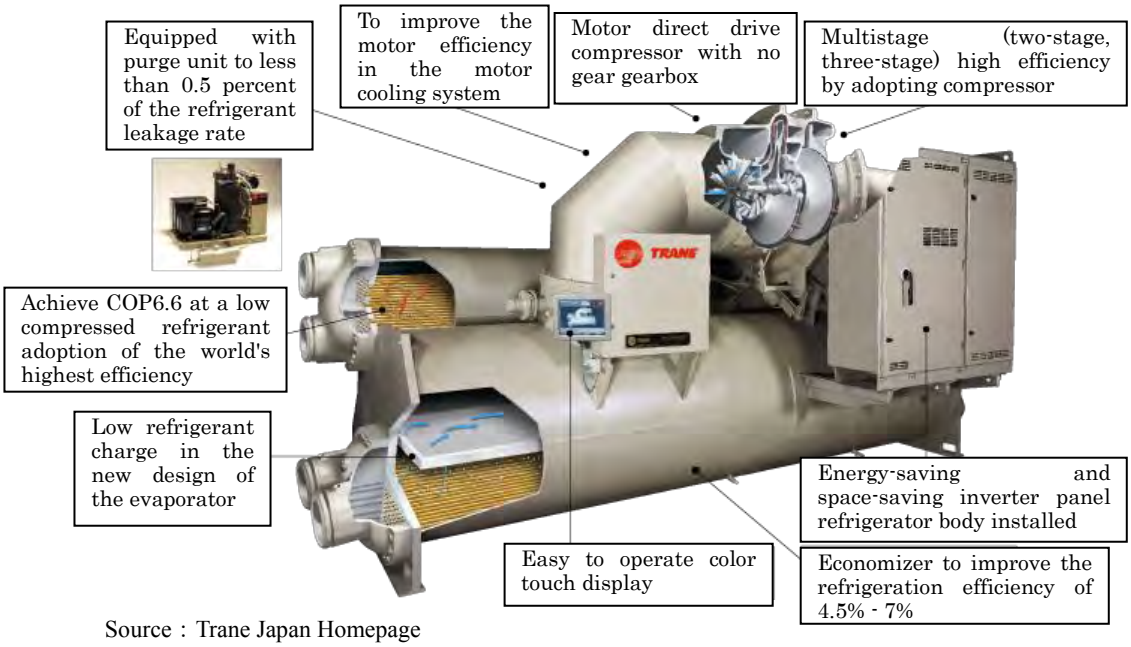
Table 7.1 Surveyed Equipment of Air Conditioning System

Usage	Type	Equipment
Commercial	Central	Centrifugal water chiller
		Chiller
	Individual	VRF
		RAC
Household	Individual	RAC

Source：Prepared by the JICA Study Team

1) Centrifugal Water Chiller

The Centrifugal Water Chiller uses centrifugal compressors and a refrigerator for compressing a refrigerant. It is a cooling-only equipment.

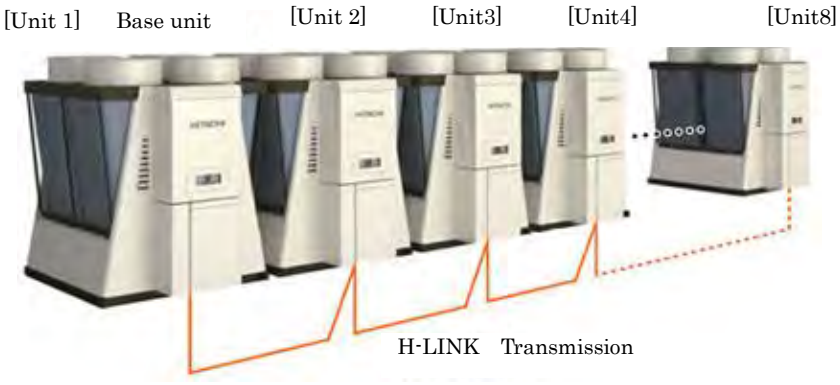


Source：Trane Japan Homepage

Figure 7.1 Centrifugal Water Chiller

2) Chiller

Chiller is a device that controls a constant temperature in order to manage the temperature of the liquid water and heating medium. It is possible to be used for cooling and heating.

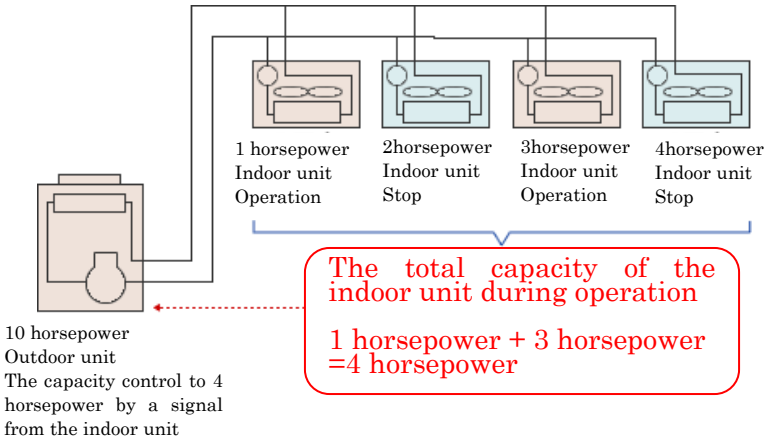


Source：Hitachi Appliances Homepage

Figure 7.2 Chiller

3) VRF

VRF is the air conditioner can be installed to the indoor unit in which a plurality of capacitance is different to one outdoor unit.



Source：Daikin Homepage

Figure 7.3 Variable Refrigerant Flow

4) RAC

RAC is an air conditioning equipment to be used in a small office, household or mainly at a place where the air conditioning load is small.

Source：Daikin Homepage

Figure 7.4　Room Air Conditioner

(2)　Analysis of the Existing Information

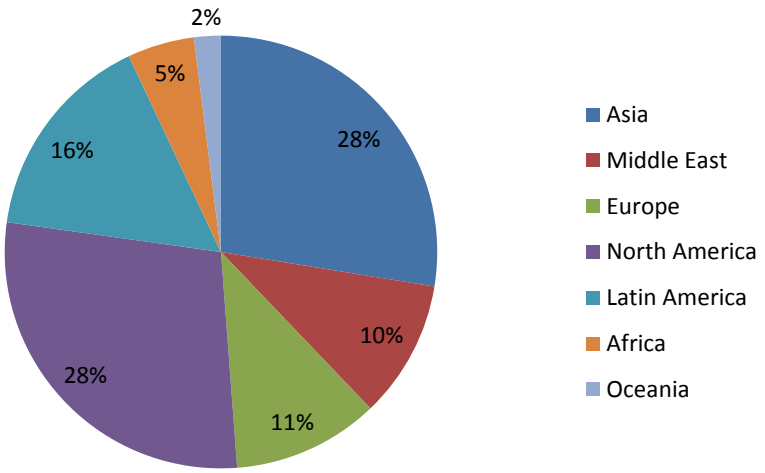
For energy saving of small air conditioner, the introduction of the inverter type becomes the main measure. Japanese consumer electronics equipment manufacturers share about 60% of the global market of this air conditioner type and they are expected to spread to the Latin American market. The Japan Air Conditioning and Refrigeration Industry Association estimates the demand of air conditioner around the world" as shown in Table 7.2.

Table 7.2 Estimates of World Demand for Air Conditioners

(unit : one thusand)

		2009	2010	2011	2012	2013	2014
The total of the world		72,229	85,002	96,791	90,514	96,691	96,231
JAPAN		7,384	8,931	9,057	9,271	9,817	9,336
The total of overseas		64,845	76,071	87,734	81,243	86,874	86,895
	China	26,804	32,719	40,729	32,764	35,632	34,938
	The total of Asia	10,297	12,005	12,217	13,065	13,672	14,314
	India	2,800	3,506	3,547	3,500	3,633	3,862
	Indonesia	1,257	1,532	1,638	2,030	2,246	2,286
	Korea	1,155	1,177	1,227	1,190	1,236	1,236
	Thailand	760	1,034	933	1,112	1,163	1,210
	Taiwan	829	878	922	987	952	1,014
	Malaysia	775	829	816	871	902	893
	Pakistan	708	677	724	623	613	678
	Vietnam	512	702	659	917	998	1,110
	The Philippines	503	502	561	611	664	687
	Hong Kong	540	575	551	538	539	538
	Singapore	159	158	162	163	163	161
	Bangladesh	121	131	147	164	156	170
	Myanmar		61	70	80	123	180
	Sri Lanka	55	55	68	79	80	81
	Cambodia		65	69	77	81	85
	others	123	123	123	123	123	123
	The total of the Middle Ea	3,996	4,054	4,246	4,279	5,300	5,355
	Saudi Arabia	1,462	1,417	1,581	1,666	2,226	2,238
	Israel	304	317	524	516	495	478
	UAE	687	577	497	493	713	728
	Iran	470	497	462	447	452	470
	Iraq	136	276	274	296	315	306
	Oman	261	246	248	217	297	305
	Qatar	199	177	189	179	275	284
	Kuwait	125	125	144	147	214	217
	Bahrain	77	77	77	82	82	80
	Lebanon	62	76	69	68	69	77
	others	213	269	181	168	162	172
	The total of Europe	4,994	6,400	7,760	6,961	6,739	5,689
	Russia	918	1,442	2,625	2,000	1,891	1,442
	Turkey	572	717	977	1,107	1,027	849
	Italy	953	1,037	1,035	919	958	774
	Spain	541	731	643	516	510	479
	France	344	419	400	355	362	348
	Ukraine	119	380	415	366	339	233
	Greece	376	279	240	278	229	188
	The U.K.	130	150	161	154	153	160
	Germany	110	113	126	127	129	128
	Bulgaria	68	86	104	113	95	88
	Romania	89	81	92	106	101	86
	Portugal	96	132	110	69	66	65
	Poland	55	74	73	70	69	70
	Norway	51	73	72	66	61	56
	Sweden	69	65	66	55	53	57
	The Netherlands	42	53	53	48	49	51
	others	461	568	568	612	647	615
	The total of North Americ	11,543	11,989	12,525	13,505	14,060	14,754
	America	11,220	11,608	12,126	13,097	13,662	14,354
	Canada	323	381	399	408	398	400
	The total of Latin America	4,642	6,203	7,157	7,333	7,943	8,208
	Brazil	2,296	3,448	3,492	3,514	4,212	4,451
	Argentina	850	1,092	1,331	1,352	1,302	1,305
	Mexico	709	662	889	1,021	1,034	1,073
	Venezuela	137	163	401	413	371	330
	Colombia	115	114	167	176	187	210
	Panama			159	169	170	161
	Puerto Rico	154	177	150	129	133	134
	Peru			128	111	117	115
	Chile		178	121	128	86	71
	Ecuador	95	96	113	100	102	103
	Cuba		93	89	98	106	116
	others	286	180	117	122	123	139
	The total of Africa	1,654	1,757	2,130	2,417	2,555	2,595
	Egypt	472	541	747	803	765	781
	Nigeria	330	349	412	488	566	603
	South Africa	200	220	203	215	221	232
	Libya	165	149	180	174	189	159
	Algeria	131	144	172	176	206	205
	Morocco			122	131	132	135
	Ghana				95	97	97
	others	356	354	294	335	379	383
	The total of Oceania	915	944	970	919	973	1,042
	Australia	813	835	861	817	869	937
	New Zealand	95	102	102	95	97	98
	others	7	7	7	7	7	7

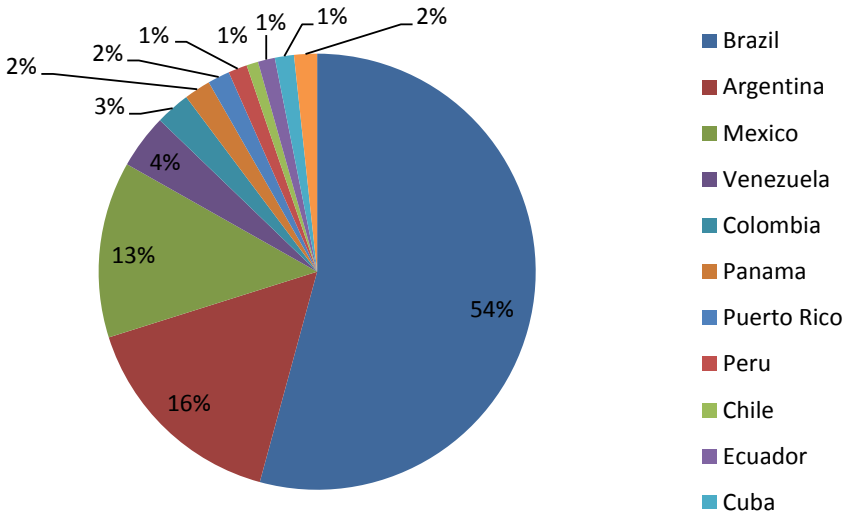
Source : The Japan Refrigeration and Air Conditioning Industry Association [World Air Conditioning Demand Estimates]



Source: Compiled by the JICA Study Team based on the published data of The Japan Refrigeration and Air Conditioning Industry Association "World Air Conditioning Demand Estimates"

Figure 7.5 Estimated Demand for Air Conditioners in 2014

Estimate of China's demand in 2014 is excluded from the graph because it is about three times of the Asian demand. Asia and Latin America can be seen to have the greatest demand followed by North America. The demand for Latin America only is as follows:

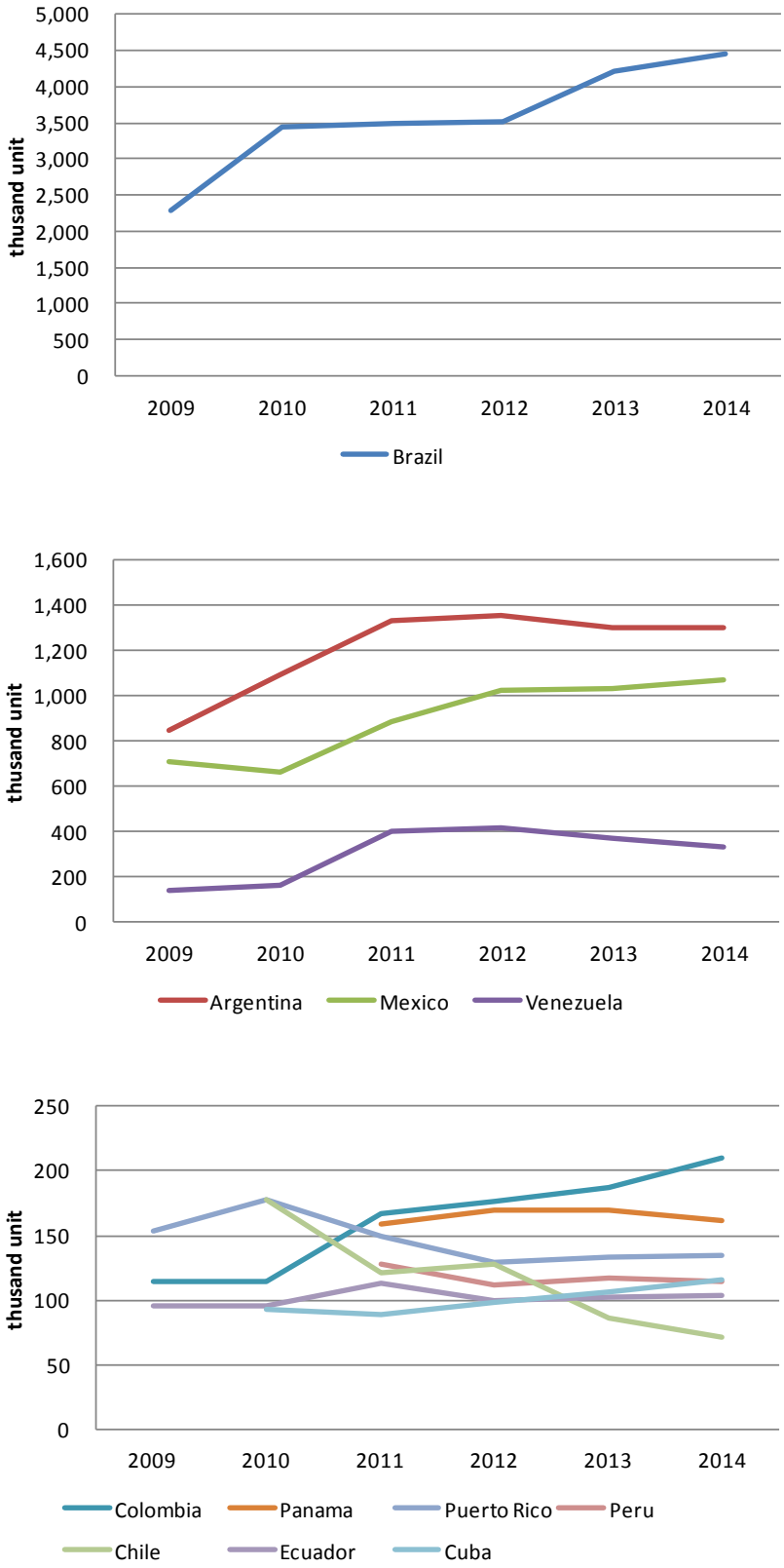


Source: Compiled by the JICA Study Team based on the published data of The Japan Refrigeration and Air Conditioning Industry Association "World Air Conditioning Demand Estimates"

Figure 7.6 Estimated Demand for Air Conditioners in 2014 (Latin America)

Brazil's demand is overwhelmingly huge at 54%, followed by Argentina, Mexico, Venezuela, and Colombia. In the surveyed countries, except Brazil and Mexico, the market is very small.

In the background, the thing in the urban areas is a climate which does not disturb the life even if there is no air conditioning and economic reasons Aguellal to have a low priority of the air conditioning equipment introduced from.



Source: Compiled by the JICA Study Team based on the published data of The Japan Refrigeration and Air Conditioning Industry Association "World Air Conditioning Demand Estimates"

Figure 7.7 Change in Air Conditioner Demand from 2009 to 2014

Air conditioning demand of Brazil, Argentina, Mexico, Venezuela, Colombia, and Cuba has increasing trend especially Brazil, Venezuela, and Colombia whose air conditioning demands in 2009 became nearly twice in 2014. Meanwhile, the air conditioning demands of Panama, Puerto Rico, Peru, Chile, and Ecuador are almost constant.

7.2 Activities of Japanese Companies

In this field, the domestic share of the top companies seems to be promising. These companies achieve an overseas advantage. The JICA Study Team confirmed the activities of the four top companies in the target countries.

Table 7.3 Survey Results of Japanese Manufacturers' Interest in the Target Countries

Products	Air Conditioning													
manufacturer/Products	A				B		C				D			
	Centrifugal water chiller	Chiller	VRF	RAC	VRF	RAC	Centrifugal water chiller	Chiller	VRF	RAC	Centrifugal water chiller	Chiller	VRF	RAC
Colombia	◎	◎	◎	◎	◎	◎	×	×	△	×	×	×	△	△
Mexico	◎	◎	◎	◎	◎	◎	×	×	◎	×	×	×	△	△
Costa Rica	◎	◎	◎	◎	◎	◎	×	×	△	×	×	×	×	×
Dominican Republic	◎	◎	◎	◎	×	◎	×	×	△	×	×	×	×	×
Panama	◎	◎	◎	◎	◎	◎	×	×	○	×	×	×	×	×
Honduras	○	◎	○	◎	×	◎	×	×	×	×	×	×	×	×
Guatemala	△	◎	○	◎	◎	◎	×	×	×	×	×	×	×	×
El Salvador	◎	◎	◎	◎	◎	◎	×	×	×	×	×	×	×	×
Nicaragua	○	◎	○	○	×	◎	×	×	×	×	×	×	×	×
Belize	○	○	○	○	×	×	×	×	×	×	×	×	×	×
Cuba	△	△	△	△	○	◎	×	◎	◎	×	×	×	△	△
Jamaica	○	◎	◎	◎	◎	◎	×	×	×	×	×	×	×	×
Dominica	○	○	○	○	×	×	×	×	×	×	×	×	×	×
Grenada	○	○	○	○	×	×	×	×	×	×	×	×	×	×
St. Lucia	○	◎	◎	◎	×	×	×	×	×	×	×	×	×	×
Barbados	○	◎	◎	◎	×	×	×	×	×	×	×	×	×	×
St. Vincent and the Grenadines	○	◎	◎	◎	×	×	×	×	×	×	×	×	×	×
Antigua and Barbuda	○	○	○	○	×	×	×	×	×	×	×	×	×	×
St. Christopher and Nevis	○	○	○	○	×	×	×	×	×	×	×	×	×	×
Haiti	○	○	○	○	×	×	×	×	×	×	×	×	×	×
Trinidad and Tobago	◎	◎	◎	◎	×	×	×	×	×	×	×	×	×	×
Venezuela	◎	◎	◎	◎	○	◎	×	×	×	×	×	×	×	×
Guyana	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Suriname	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Brazil	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	×	×	○	◎
Peru	◎	◎	◎	◎	×	×	×	×	△	×	×	×	×	×

Explanatory notes
- ◎ : Already active. There are the results
- ○ : Try to think about this positively
- △ : Try to think about this
- × : Totally unconcerned

Source: Prepared by the JICA Study Team

(1) Company A

Company A is not interested in Guyana and Suriname and is examining Cuba. It is trying to think to be positively active or active in other target countries. It focuses its efforts on centrifugal water chiller and VRF.

(2) Company B

Company B does not sell turbo refrigerator and chiller in the target countries. It sells only VRF and RAC. Because its competitors are Korean and Chinese companies whose apparatuses are cheaper, its strength lies on its brand power and design.

(3) Company C

Company C sells all apparatuses in Brazil but only sells VRF in Mexico. Actually, this company has no active business in Colombia, Costa Rica, Dominican Republic, and Peru. It lays its emphasis on sale in Brazil.

(4) Company D

Company D lays emphasis on RAC sale in Brazil. In addition, it sells more than two indoor units and a connectable multi-air conditioner with one outdoor unit which is cheaper than VRF.

Each company has a business strategy that takes advantage of their strengths, respectively, the point to be focused is clear.

7.3 Market Analysis

In the first field work, the JICA Study Team carried out the following visits:

Table 7.4 Research Company and Investigation Schedule

Country	Day of Visit	Company Name	Company Overview
Brazil	2015/9/4	Company A	Japanese company
	2015/9/4	Company B	Japanese company
	2015/8/27	Company C	Japanese company
	2015/8/31	Company D	Japanese company
	2015/9/4	Company E	Sub-user construction
Peru	2015/9/10	Company A	Japanese company
	2015/9/10	Company F	Sub-user construction
	2015/9/10	Company G	Sub-user construction
Colombia	2015/9/17	Company A	Japanese company
	2015/9/17	Company H	Sub-user construction
	2015/9/17	Company I	Sub-user design

Source: Prepared by the JICA Study Team

(1) Brazil

1) Hearing with the Local Base of the Japanese Company

The JICA Study Team described the results of the hearing with the four companies below.

① Company B

The sale of air conditioner in Brazil of Company B is GHP (Gas Heat Pump Air-conditioner)mainly.

Company B sells it through a tie-up business with the gas company. Sales reached from JPY 100 million to JPY 200 million per year. Company B sells RAC too. Sale of VRF is significant too. Approximately 80% of the electricity in Brazil comes from hydraulic power generation, and the introduction of GHP increases the greenhouse gas (GHG) and does not contribute to reduction. Therefore, it is difficult to establish as projects of MSEF.

② Company A, Company C, and Company D

The JICA Study Team described the results of the hearing with the three companies in Table 7.5 below.

Table 7.5 Results of the Hearing with the Local Base of the Japanese Companies (Brazil)

No.	Item	Company A	Company C	Company D
1	Market development strategy	The air conditioning method by the refrigerant unfolds around VRF made in the company, and there is the central air conditioning method mainly on the centrifugal water chiller of the high efficiency which adopted a magnetic bearing, an	It sells chiller, VRF, RAC mainly in Brazil.	The sale of the air conditioner in Brazil is RAC mainly.
2	The organization system (local subsidiary corporation / local agency)	There are ten Japanese in the maker sale subsidiary.	It is unclear about the future.	It is sold in a store specializing in air-conditioners constructing.
3	The number of the Japaneses staff, the number of local employees	-	-	-
4	Having factory or not	Existence	Existence	Nothing
5	Production method (import / local production)	Factory is located in Manaus.The staff is approximately 200 people including three Japaneses. While the product in Manaus factory there are tax incentives, because transport costs are high, and rather than manufacturing of large equipment, it is making an annual 120,000 RAC. Centrifugal chiller, chiller have been imported from the United States, China factories. VRF has been imported from China, Thailand and Japan factories.	There is Sao Paulo factory producing chiller, VRF. There is Manaus factory producing RAC and centrifugal water chiller that was made from two years ago.	Import
6	Business administration: The production system	〃	It is unclear about the future.	-
7	Business administration: The Sales system	-	It is unclear about the future.	It is sold in a store specializing in air-conditioners constructing.
8	Business administration: The maintenance system	It carries out the maintenance itself. Many customers enter into a maintenance contract. In addition, it cooperates when an installer enters into a maintenance contract with a customer.	It is unclear about the future.	It doesn't maintain itself, but there is a company carrying out a maintenance contract in the construction shop which is nearly 500.
9	Delivery example	It targets an office building about the introduction of VRF mainly, and it targets a hospital, a factory, a shopping center about the introduction of the centrifugal water chiller.	-	-
10	Successful example	-	-	-
11	Historical process this country	-	-	-
12	Problems in the sales activities	-	-	-
13	Problems of the legal system	The Brazilian taxation system is very complicated so that there is a story changed more every day, and a tax occurs every stage.	-	-
14	Special local problems	It is a national trait not to be able to keep a promise.	-	There was no culture of introducing the air conditioning to Brazil, the mounting method is simplistic compared to Japan.
15	Market share in the target field	Because ABRAVA and related organizations do not disclose a share, it does not exactly.	-	Around 20% of the total of which has introduced the RAC is an inverter machine.
16	Evaluation of the competitiveness of your products in efficiency	There is confidence about the performance of their products. LG and Samsung's performance is also good.	-	LG, Samsung, midea, Carrier
17	Evaluation of the competitiveness of your products in price	Although the equipment is high, it is doing a proposal to recover in the running cost. For this, it has proposed to installers and end users.	-	LG, Samsung, midea, Carrier
18	Competitor	LG, Samsung	-	LG, Samsung, midea, Carrier
19	Expected measures for your products to be more competitor	Lead certification system in the United States is also in Brazil, but there is a merit such as can increase the rent when receiving the authentication, because there is no institution to verify the performance, there is a need for performance verification agency. There is a need for specific measures of energy conservation.	-	It is the introduction of the APF (year-round energy consumption efficiency).

Source: Prepared by the JICA Study Team

As to the analysis in Section 7.2, the share of Brazil on the air conditioning market in Latin America is large; it accounts for more than half of the market. Japanese companies have advanced technology whose focus is on high-efficiency equipment and this is the companies'

strength. On the other hand, air conditioning equipment, recognition of luxury goods, and inexpensive products of Chinese and Korean companies become competitors. In such a situation, to expand the sales of products of Japanese companies, there should be proper performance evaluation, and there is a need for evaluation of not only the initial cost but also the running cost.

2) Hearing with a Sub-user

The hearing results with Company E which is an air conditioning construction company are as follows:

Table 7.6 Results of the Hearing with Sub-user (Brazil)

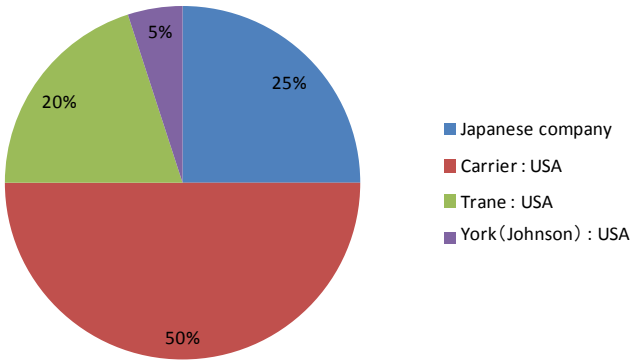
No.	Item	Company E
1	End user needs	End-user needs, 70% focus on price, because 30% is both a quality and price, quality is important.
2	On the occasion of a design, it is pointed the apparatus choice	There are around 100 design companies. They decide specifications in consideration of facilities use. They do not decide a maker then.
3	Policy, system to note about the apparatus choice	None
4	Image for the Japanese product in the comparison with the other countries product	It is high quality and is high-priced. The quality made in Korea improves.
5	Request for the Japanese product	Price reduction

Source: Prepared by the JICA Study Team

For the end users, it is recognized that the price of Japanese products is high. It is believed that the competitiveness of Japanese companies' products can be increased through price reduction. On the other hand, the expansion of the share of Japanese products can be expected because quality is also important if some measures can be taken with regard to the price.

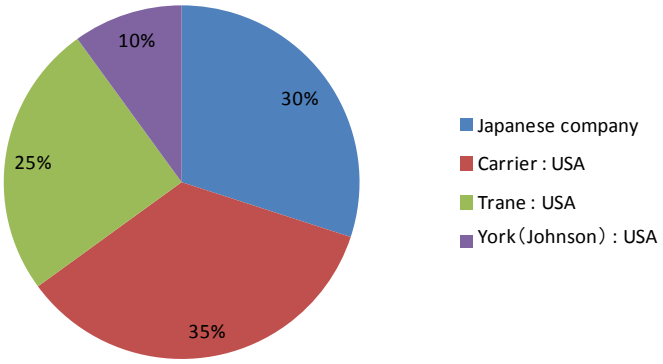
3) Share Analysis

The JICA Study Team analyzed the share of each apparatus through hearing with the Japanese companies and sub-user.



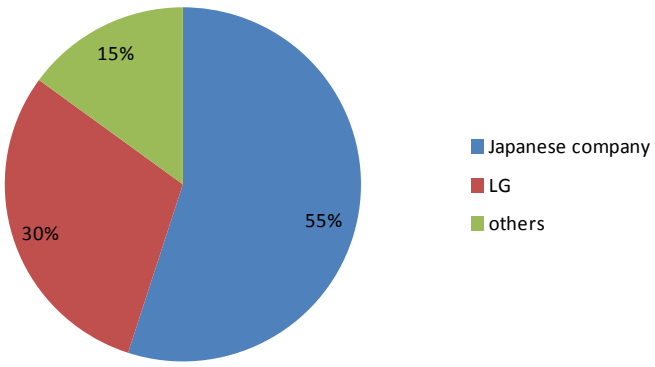
Source: Prepared by the JICA Study Team

Figure 7.8 Estimated Share of Centrifugal Water Chiller in Brazil



Source: Prepared by the JICA Study Team

Figure 7.9 Estimated Share of Chiller in Brazil



Source: Prepared by the JICA Study Team

Figure 7.10 Estimated Share of VRF in Brazil

It can be seen that the products of the American companies such as large turbo chiller and chiller

equipment have accounted for more than 70% in Brazil. On the other hand, for the VRF, Japanese companies accounted for 65%. Thus, VRF is seen as the most competitive product of Japanese companies. Although RAC's share is unknown, in the hearing, RAC penetration rate on the household is about 13%; this is regarded as a luxury. Furthermore, about 20% of inverter type machines are bought by wealthy people. Japanese companies, LG, Samsung, Midea, and Carrier are selling inverter machines.

(2) Peru

1) Hearing with the Local Base of Japanese Company

The JICA Study Team described the results of the hearing with Company A in Table 7.7 below.

Table 7.7 Results of the Hearing with the Local Base of Japanese Company (Peru)

No.	Item	Company A
1	Market development strategy	Because the company of the financial combine begins the construction such as shopping malls, It develops VRF, chiller there. It targets a hotel, a casino, a building, datacenter, a library.
2	The organization system (local subsidiary corporation / local agency)	Currently, there are 12 people, the Japanese do not. Mexican company has eight Japanese, there are doing the support of each dealer.
3	The number of the Japanese staff, the number of local employees	〃
4	Having factory or not	Noting
5	Production method (import / local production)	import
6	Business administration: The production system	〃
7	Business administration: The Sales system	-
8	Business administration: The maintenance system	-
9	Delivery example	-
10	Successful example	-
11	Historical process this country	Because a lot of companies of the financial combine go into Chile, Peru, Colombia, there are many projects.
12	Problems in the sales activities	The problem is the high price. In addition, the company is doing the after-sales service, there is a problem with the service provider because there are no Japanese.
13	Problems of the legal system	None
14	Special local problems	Humidity is high in Peru. However, it is a degree in the winter to use a small heater, the demand for air conditioning is low.
15	Market share in the target field	For chiller, Carrier 26%, Trane 24%, York (Johnson) 36%, company A 14%
16	Evaluation of the competitiveness of your products in efficiency performance	-
17	Evaluation of the competitiveness of your products in price	-
18	Competitor	For chiller, Carrier, York, Trane
19	Expected measures for your products to be more competitor	-

Source: Prepared by the JICA Study Team

For Peru, the construction of large facilities has progressed. It is believed that the demand for air conditioning will increase with the future economic growth. On the other hand, as mentioned in the analysis in Section 7.2, air conditioning demand is less; therefore, the advancement of Japanese companies is not active.

2) Hearing with Sub-users

Results of the hearing with Company F and Company G, which are air conditioning construction companies, are as follows:

Table 7.8 Results of the Hearing with Sub-users (Peru)

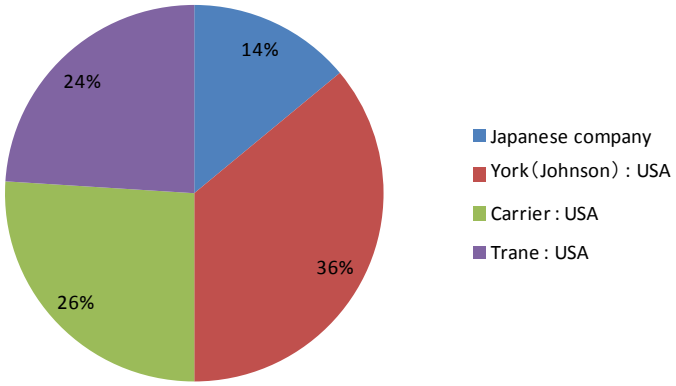
No.	Item	Company F	Company G
1	End user needs	Because the electricity bill of Peru is relatively low, the end user needs is a price.	End-user needs is the price.
2	On the occasion of a design, it is pointed the apparatus choice	The share of VRF is Daikin, LG, Samsung, York. Each company of the VRF are similar.	Specs engineers to determine.
3	Policy, system to note about the apparatus choice	Peru does not have an energy label system.	None
4	Image for the Japanese product in the comparison with the other countries product	It is high quality and is high-priced.	It is high-priced.
5	Request for the Japanese product	Because it is a high price, we want to make a proposal of the life cycle cost. Support of Daikin is necessary.	Because it is high-priced, it should be proposed in the life cycle cost.

Source: Prepared by the JICA Study Team

Because electricity bill is relatively low and there is low consciousness on cost cutting measures through energy saving, the end users' main consideration is the price. The image for Japanese product is high quality and high price, and the reliability of the product is high. Thus, promotion using the life cycle cost is important for increasing the demand for Japanese products.

3) Share Analysis

The JICA Study Team analyzed the share of each apparatus by conducting a hearing with the Japanese companies and the sub-user.



Source: Prepared by the JICA Study Team

Figure 7.11 Estimated Share of Chiller in Peru

In Peru, the JICA Study Team was able to interview only for the share of the chiller. Similar to Brazil, the American products accounted for more than 80% while the Japanese companies' share is seen to be too low.

This is because the introduction of the central air-conditioning system from the American geographical reasons.

Large equipment it is believed that the American-made is overwhelmingly accounted for market share.

(3) Colombia

1) Hearing with the Local Base of the Japanese Company

The JICA Study Team described the results of the hearing with two companies in Table 7.9 below.

Table 7.9 Results of the Hearing with the Local Base of Japanese Companies (Colombia)

No.	Item	Company A	Company B
1	Market development strategy	It is the sale of a mini-split and the high efficiency heat pump. The head office is in Bogota, and the store is in Balun key jar.	Because the price of VRF is higher than one of LG, It sells directly. LG is cheap because it is only cooling. It sells equipment that can be cooling and heating.
2	The organization system (local subsidiary corporation / local agency)	There are 15 people, Japanese is one.	-
3	The number of the Japanese staff, the number of local employees	〃	-
4	Having factory or not	Nothing	Nothing
5	Production method (import / local production)	Mexico factory and Manaus factory in Brazil.	-
6	Business administration: The production system	〃	-
7	Business administration: The Sales system	It has sold air-conditioning shops. In the case of chiller It has sold directly to contractors.	-
8	Business administration: The maintenance system	Maintenance of personnel is still small, but the contractor and distributor It has done the training as that can be maintenance.	-
9	Delivery example	hotels, offices, factories and hospitals.	-
10	Successful example	offices	-
11	Historical process this country	It is one of the world strategy. If the rival companies of slump, there are attractive as a market.	-
12	Problems in the sales activities	The problem is the high price. In addition, the company is doing the after-sales service, there is a problem with the service provider because there are no Japanese.	-
13	Problems of the legal system	None	-
14	Special local problems	Cooling and heating demand is low.	-
15	Market share in the target field	LG has a share of about 10% in all models.	-
16	Evaluation of the competitiveness of your products in efficiency	There is a competitive edge. It supplies a reliable and high efficiency product .	-
17	Evaluation of the competitiveness of your products in price	China and Korea products are almost half of it.	-
18	Competitor	VRF and RAC competitors are LG, Samsung, centrifugal water chiller and chiller of competitors are Trane, JCI.	-
19	Expected measures for your products to be more competitor	Because there is it enough, the high reliability for Japan is similar about the Japanese product. On the other hand, a measure to lead to recognition up is necessary because there is little recognition for the Japanese product.	-

Source: Prepared by the JICA Study Team

In Colombia, Company A has already established a system. Company B is not too aggressive. This includes that the air conditioning demand is low, and influence to be a competition on price of RAC competing products are made in China and Korea.
It is common in all countries which the JICA Study Team visited that air conditioner in the household is regarded as a luxury, therefore, only the rich people purchase it.
Low-price air conditioning equipment made in Korea is also being sold.
Large facilities have air conditioning demand; therefore American products compete with Korean products.

2) Hearing with Sub-users

The results of the hearing with Company H, an air conditioning construction company, and Company I, a design company, are as follows:

Table 7.10 Results of the Hearing with Sub-users (Colombia)

No.	Item	Company H	Company I
1	End user needs	The end user needs of VRF are installation and operability. The end user needs of RAC are maintenance and price.	Quality is important.
2	On the occasion of a design, it is pointed the apparatus choice	Point of equipment selection in the case of the centrifugal water chiller which is an evaluation of the operation and efficiency.	It selects the equipment by the project scale.
3	Policy, system to note about the apparatus choice	Considerations of equipment selection is reliability, test results and service support system.	In the case of large-scale facilities, it considers the introduction of the centrifugal water chiller.
4	Image for the Japanese product in the comparison with the other countries product	Image of Japanese products is a high quality and high reliability, It has to understand that the high cost of manufacture Japanese products.	Japan product is a little more expensive than other countries products, it is understood that the high reliability with high quality.
5	Request for the Japanese product	If Japanese products is a fair price, to demand a cheap maintenance costs, including long-term durability and operability.	-

Source: Prepared by the JICA Study Team

They understood that Japanese product is of high quality and high price. In addition, the JICA Study Team had an impression that Japanese products are high in terms of reliability.

3) Share Analysis

The share of each instrument is unknown based on the hearing with the manufacturers and sub-users.

7.4 Identification and Analysis of Bottle Necks

The JICA Study Team considered the following bottlenecks:

(1) High Quality, High Price

In the field survey, three countries recognized the products of Japanese companies as of high quality and high price. These are energy-saving products equipped with inverter, and correspondingly are expensive. On the other hand, China and Korea rival products are being sold without an inverter and thus are inexpensive devices. In some cases, these products have been sold at nearly half of the price of the products of Japanese companies.

(2) Energy Saving Performance

Products of Japanese companies, in pursuit of energy-saving performance, tend to really become high in terms of price.

Evaluating the energy-saving performance (COP) is the performance value at a certain point in time. Because the products of Japanese companies are not able to evaluate the energy saving due to annual operation that specializes, it is not be measured is differentiating itself from competitors.

(3) Specific Problems of the Region

The JICA Study Team expects that the Latin American air conditioning market will become bigger due to future economic development. Brazil is a big market; however, there is a problem due to the complex tax system wherein the state tax rate is different from the production rate in the country.

In Peru and Colombia, there is a regional problem of little demand for air conditioner. Support measures should be examined.

7.5 Consideration of Support Measures

Based on the organization and analysis of the bottlenecks, support measures need to be considered.

(1) Introduction of the Performance Evaluation Criteria

COP is an instantaneous value. It could not evaluate the energy saving because the annual operation of the product of Japanese companies is good. It cannot be used as a measure to differentiate Japanese product from its competitors. Thus, there is a need to create a mechanism to verify the introduced APF to evaluate the year-round energy consumption efficiency. Thus, incentive should be given to the introduction of high-quality and high-price equipment.

(2) Holding of Regular Seminar

Because the orientation seminar in the three countries had a greater-than-expected number of participants, the need for energy saving was better promoted and the recognition of the product of Japanese companies was improved. Regularly holding seminars will continue advancing the understanding of the importance of evaluation of the running costs as well as the evaluation of the initial cost.

(3) Support to MSEF and COFIDE

In the orientation meeting, participants were interested in MSEF and COFIDE.
Especially for COFIDE there was also talk of specific projects in the orientation meeting, because the energy conservation-related business so far has not been implemented, business schemes and, I think that it is necessary to support in energy-saving technology. In the orientation meetings, not only one-to-one relationship presentation companies and attendance companies, for example, by introducing together a LED lighting and air conditioning, even synergistic effect achieved energy saving of the entire facility by reducing the air conditioning load since it can be expected, collaboration and the local companies between companies that sell multiple energy saving equipment, it is possible to form a new project can be information originating in the same seminars and the like, the reduction of carbon dioxide emissions, Japan It can contribute to the introduction of the company's energy-saving equipment.

8 Industrial Refrigeration System

8.1 Overview of Industrial Refrigeration System

Industrial refrigeration system can be classified many kind of types because the system is utilized food and beverage making, cooling process, logistics and cold storage warehouse. Company A has best sales in the Japanese market as below. Some of the energy efficient equipments in Company A are listed below.

1) High Efficiency Refrigeration Compressor (M-series, J-series)

Refrigeration compressor is the core of the refrigeration system and a part which significantly affects energy efficiency. Large energy reduction can be achieved by improving the efficiency. There are two types of high efficiency compressors, namely, reciprocating type called the M-series and screw type called the J-series. See Figure 8.1 for reference. Low friction piston is utilized in M-series and new profile rotor and automatic variable mechanism are utilized in J-series. Both types of high efficiency compressors are approximately from 10% to 15% more efficient than the conventional ones. In Brazil's factory, the compressors are assembled as refrigeration system. Company A not only manufactures the compressor but also undertakes the design, construction, and maintenance with high technology and efficiency. Company A has a deep trust with their customers.

Source: Company A

Figure 8.1 High Efficiency Refrigeration Compressor

2) Super Cooled Ice Making System (Container Cargo Type)

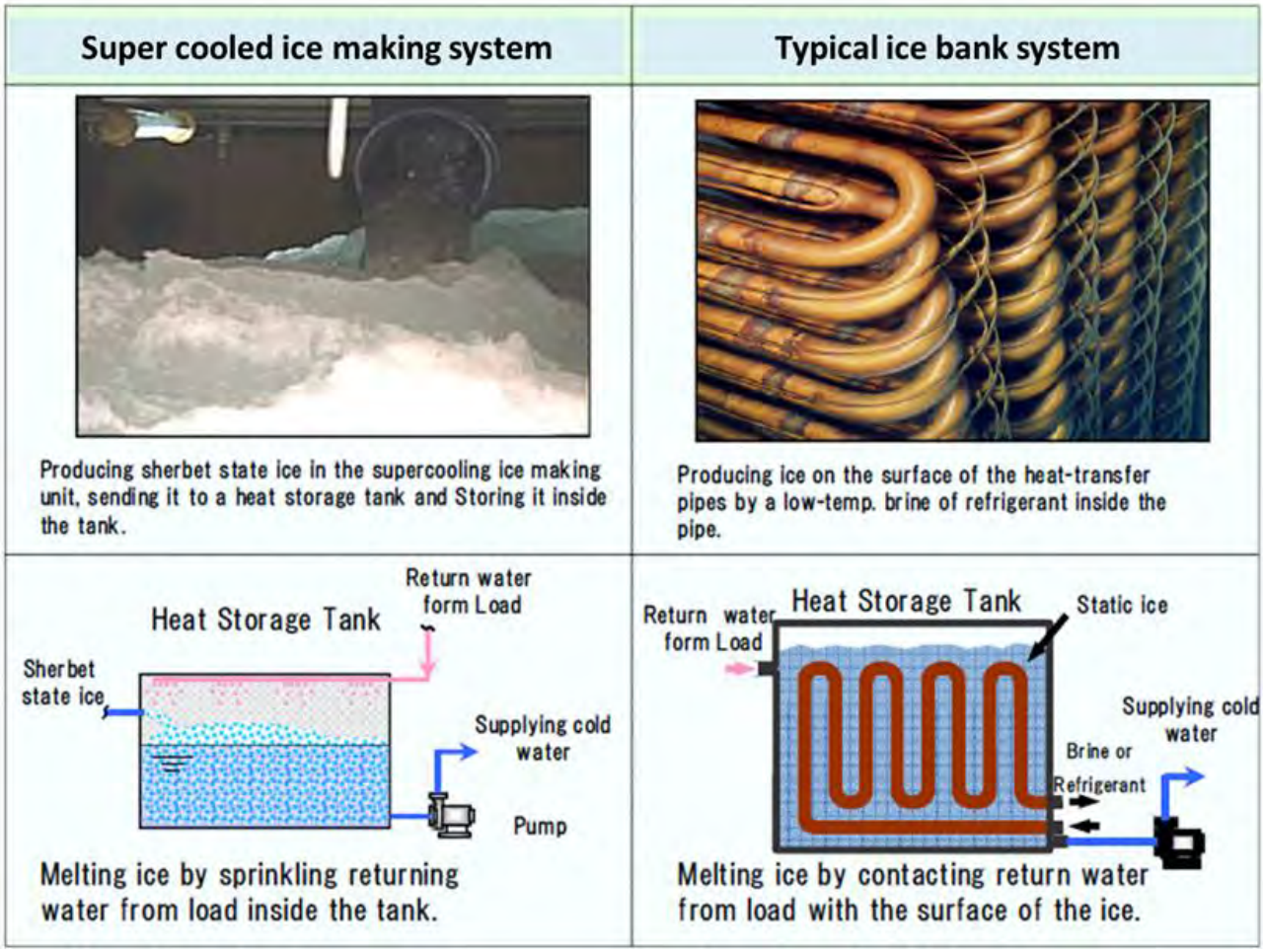
In food sector, especially dairy sector, a large amount of chilled water (approximately zero degree) is necessary for steri-cooling and cooling preservation. There are two types of chilled water supply system, namely, ice bank system and super cooled ice making system. Ice bank system makes solid ice around cooling coil in thermal storage tank. On the other hand, supercooled ice making system makes sherbet ice in the thermal storage tank. (Figure 8.2)

Solid ice such as typical ice bank system has a huge thermal resistance against ice at the time of ice making and thermal storage. On the other hand, sherbet type ice as super cooled ice making

system does not have that thermal resistance. The super cooled ice making system can reduce the energy by approximately 20%. Also the load following capability is very high because the surface of ice is large. It is very appropriate for the dairy sector, which has large load fluctuation, to install such system.

The super cooled ice making system is introduced as a plant system and not a package system because it takes long time and cost to start the operation so that refrigerant control of temperature and pressure is very difficult. Company A only develops that system in Central and South America regions.

In the near future, Company A will sell super cooled ice making packaged system in container cargo. There are many strong points to its packaging such as reduction of shipping cost, engineering time, and refrigerant. The system has added value and competitiveness (Figure 8.3).



Source: Company A

Figure 8.2 Difference between super cooled ice making system and typical ice bank system

Source: Company A

Figure 8.3 Super Cooled Ice Making System (Container Cargo Type)

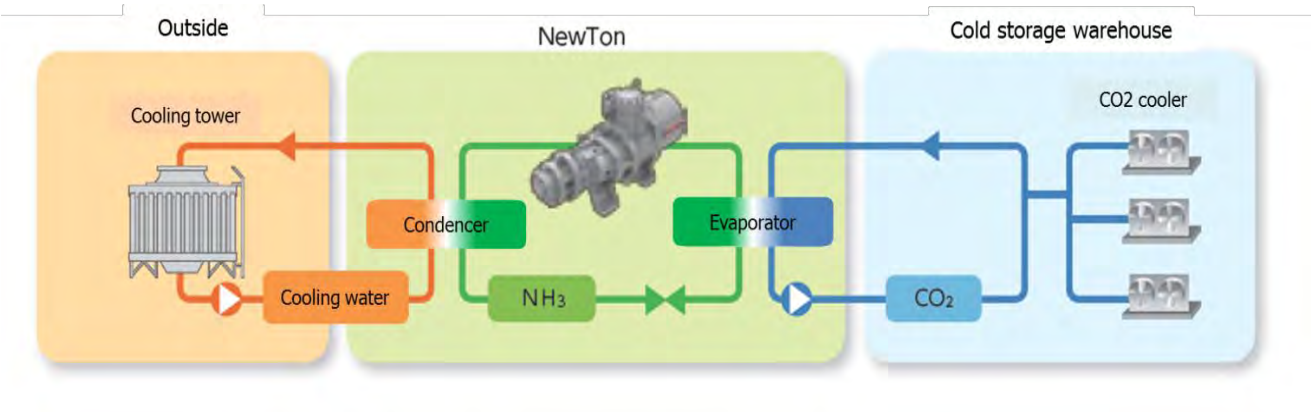
3) Refrigeration System for Cold Storage Warehouse (NewTon 3000)

Cooling preservation is necessary for food and beverage sector and distribution cold storage warehouse. The energy of cooling occupies approximately 50% of total energy, which has a huge energy saving potential.

Company A lines up a refrigeration system for cold storage warehouse, so-called "NewTon 3000". (Figure 8.4) NewTon is focusing on "F-class refrigerator", which cools objects under -20 degree. This has the highest demand among all refrigerator class. The system is shown in Figure 8.5.

Source：Company A

Figure 8.4 Appearance of NewTon 3000



Source: Company A

Figure 8.5 System Flow of NewTon

The conventional ammonia-liquid pump type cools refrigerator directly by circulating ammonia into the cold storage warehouse, but NewTon circulates carbon dioxide which exchanges heat with ammonia into the cold storage warehouse directly.

Energy saving of approximately 20% can be achieved so that NewTon has not only high efficiency and easy-maintenance IPM motor (interior permanent magnet motor) and inverter but also a new shaped screw , which reduces internal refrigerant leak. Besides, ammonia filling is reduced by more than 70% compared with ammonia-liquid pump type because carbon dioxide is utilized as brine. There are similar systems all over the world, but no packaging system like NewTon.

There are many strong points on packaging such as reduction of shipping cost, engineering time, and refrigerant.

Coefficient of greenhouse gas of ammonia is low, but it is still harmful for human or cooling object. If the ammonia pipe is broken in the cold storage warehouse, it will heavily affect the human or cooling object. NewTon introduces the system that confines the ammonia in the machine room; the system has thus led to the improvement of safety. NewTon is not only a high efficiency system but also a safe system.

8.2 Activities of Japanese Companies

(1) Present Situation of Japanese Manufacturers

There are many industrial refrigeration manufacturers such as Hasegawa (which is referred to as "Company A") and Kobelco. Between the two, Company A has better sales in the Japanese market.

Company A manufactures many kinds of compressors, which use ammonia, hydrocarbon, carbon dioxide, water, and air. Additionally, it has an extensive line up from freezer to food processing machine, which is associated with industrial refrigeration equipment. Also, it carries out plant engineering, which first focuses on energy efficiency and heat balance. It has a strong point on energy

efficiency technology, which is adapted to each sector such as food processing, beverage, or dairy.

It also has an enhanced maintenance system. It has three factories and 57 offices in Japan and six factories and 92 offices in 34 other countries. Speedy and highly technical response to trouble can increase its sales. See Figure 8.6 for reference.

In Central and South America regions, it has two factories, one in Mexico and the other in Brazil, that focus on business. In Mexico, the huge compressor factory was established in 1964. It exports compressors all over Central and South America. In Brazil, the assembly factory, which assembles the condenser and oil cooler with compressor, was established in 1968. Company A is the only Japanese manufacturer that covers the area.

Food industries (e.g., poultry, meat, dairy, beverage, and fisheries) are thriving sectors in Central and South America. They are targeting the retrofitting and new construction of refrigeration system. It will cost approximately thousands to millions of dollars, which depends on the size to be constructed.

Table 8.1 shows the result of the survey about the interest of target countries on Company A. The result shows that countries from the Central and South America regions except Belize, Guyana, and Barbados are interested.

Source: Company A

Figure 8.6 Global Network of Company A

Table 8.1 Survey Result of the Interest of Target Countries on Company A

Countries	Industrial refigeration system
Colombia	◎
Mexico	◎
Costalica	◎
Dominica Republic	◎
Panama	◎
Honduras	◎
Guatemala	◎
El Salvador	◎
Nicaragua	◎
Belize	△
Cuba	◎
Jamaica	◎
Dominica	◎
Grenada	◎
Saint Lucia	◎
Barbados	△
Saint Vincent and the Grenadines	◎
Antigua and Barbuda	◎
Saint Kitts and Nevis	◎
Haiti	◎
Trinidad and Tobago	◎
Venezuela	◎
Guyana	△
Suriname	◎
Brazil	◎
Peru	◎

Caption
◎ : Successfully introduced
○ : Positively considering
△ : Interest
× : No interest

(2) Branch Office Information of Company A (Brazil, Peru, and Colombia)

Market strategy, organization system, and production system of three countries (Brazil, Peru, and Colombia) are shown in Table 8.2 below.

Table 8.2 Brazil Office

Item	Contents
Market strategy	Dairy, meat, and beverage companies are targeted to be developed.
Organization system	Local company
Number of employees	Japanese expatriates = 4; Local employees = 250
Factory	Aruja factory Assembly factory, which assembles condenser and oil cooler with imported compressor from Mexico.
Production system (import /local production)	Import and produce in Brazil
Management structure: Production system	Local production system in cooperation with headquarter's factories in Japan.
Management structure: Sales system	There are factories in Sao Paulo where they perform maintenance service with 16 branch offices. They sell equipment to end users and sub-users directly. Maintenance service is performed for both users.
Management structure: Maintenance system	Maintenance service is performed with 16 branch offices in Brazil.
Installation example	M-series and J-series compressors were installed to freeze foods or steri-cooling for dairy, food processing, fruit juice beverage, carbonated beverage, beer, ship, chemical plant, and ice making sector.

Table 8.3 Peru Office

Item	Contents
Market strategy	Fisheries and beverage sector is targeted to be developed.
Organization system	Local company
Number of employees	Japanese expatriates = 2; Local employees = 21 (Maintenance staff / Lima = 6; Piura = 3)
Factory	No factory
Production system (import /local production)	Import or assemble in Peru
Management structure: Production system	Import or assemble in Peru
Management structure: Sales system	Sales strategy is in cooperation with the contractor or sub-users. Offices are located in Lima and Piura. Sales rate of sub-users is 70% and the remaining 30% is end users. Sales rate of end users will be shifted to 50% in the near future because dependence for sub-users is larger than end users. Maintenance service is performed for both users.
Management structure: Maintenance system	Maintenance service is performed to end users directly.
Installation example	M-series and J-series compressors were installed for freezing, steri-cooling, and carbonation for dairy and beverage company.

Table 8.4 Colombia Office

Item	Contents
Market strategy	Dairy, meat and beverage company is targeted to be developed.
Organization system	Local company
Number of employees	Japanese expatriates = 1; Local employees = 50
Factory	No factory
Production system (import /local production)	Import or assembly in Colombia
Management structure: Production system	Import or assembly in Colombia
Management structure: Sales system	Sales activity is conducted by local sales staff. Offices are located in Bogota and Medellin. Basic sales style is sale to end users.
Management structure: Maintenance system	Basic sales style is sale to end users.
Installation example	M-series and J-series compressors and super cooled ice making system were installed for freezing, steri-cooling, and carbonation for dairy, beer and beverage company.

(3) Market Competitiveness of Company A's Product

There are three major industrial refrigeration system companies in the world, namely: Johnson Controls Inc. (JCI) from United States, GEA from Germany, and Company A from Japan. VLTER of Emerson group is the second major company group. In addition, some of the Chinese and Indian products are sold all over the world. The former SABROE, FRICK and YORK had merged to JCI.

Below are the market competitiveness of Company A's product in Brazil, Peru, and Colombia.

1) Brazil

The market share of industrial refrigeration installation based on input power (kW) in Brazil is shown in Figure 8.7. Company A accounts for 75%, JCI accounts for 20%, and GEA accounts for 5% of the market share in Brazil.

There are no Chinese or Korean products. Company A, which has a factory and office in Brazil, monopolizes the market because it can avoid tariff and domestic production ratio (DPR).

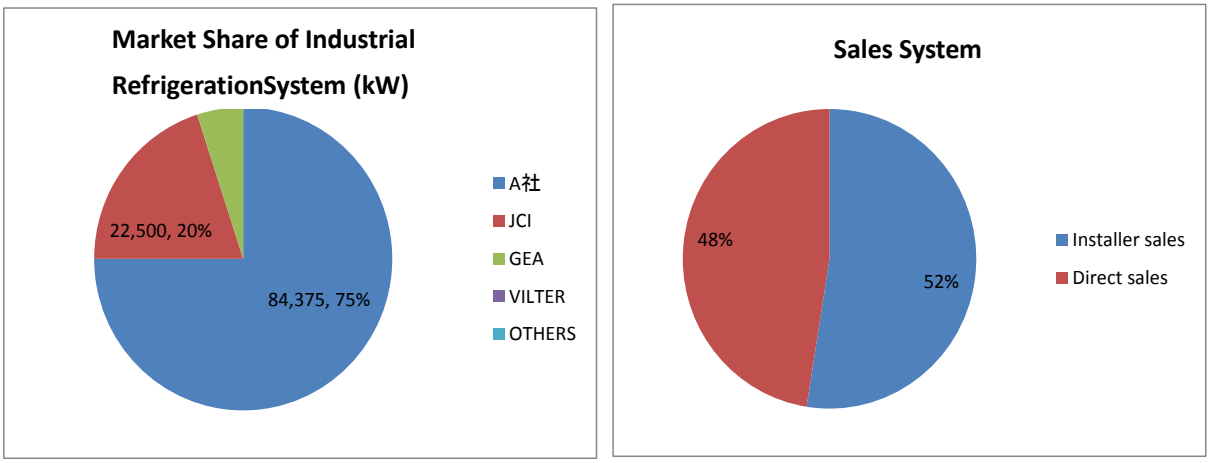
When Company A started its own business, SABROE, the current JCI group, accounted almost all the market share in Brazil. The market share shifted from SABROE to Company A after it launched the manufacturing of its compressor in 1975.

Company A can successfully increase its customers by launching its office. It can always carry out construction, provide maintenance system, and supply the spare parts necessary for an industrial

instrument.

As for the sales system, it sells 50% of its systems each to end users and sub-users. Regarding direct sales to end users, it conducts not only sales but also engineering services for worldwide food processing and beverage companies. On the other hand, it is necessary to sell its systems because it manufactures refrigeration units in its factory. It succeeded to expand its own business through sales to sub-users.

The sales system of JCI is the same as that of Company A, but it reduced its market share gradually because JCI has merged with FRICK and YORK. For old familiar sub-users and contractors, it has to manage many kinds of equipment suddenly; thus, it is very hard to manage the business. It is thought that the market share is reduced.



Source: Compiled by JICA Study Team based on Company A document

Figure 8.7 Market Share and Sales System in Brazil

2) Peru

The market share of industrial refrigeration installation based on input power (kW) in Peru is shown in Figure 8.8.

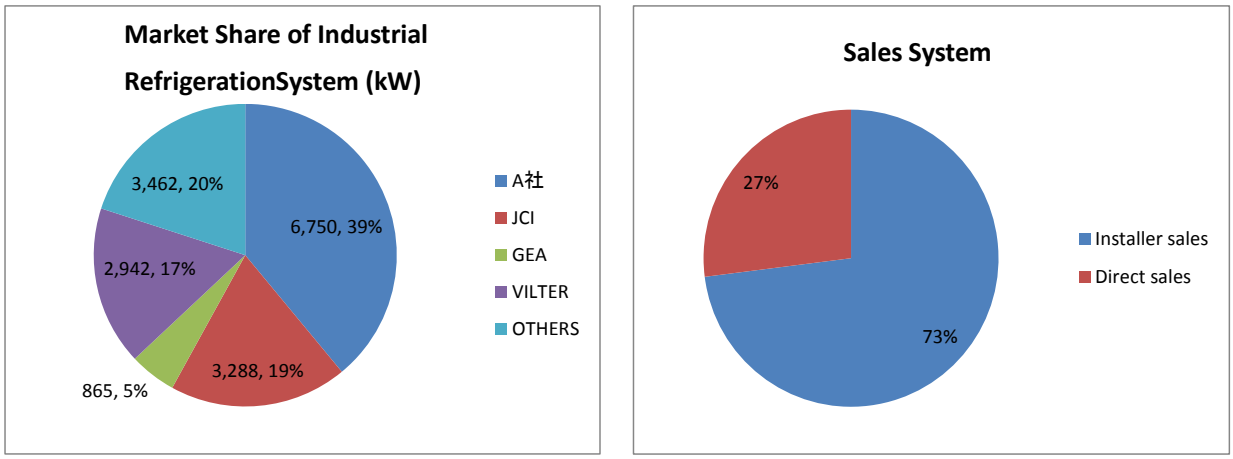
Company A accounts for 39%, JCI accounts for 19%, VILTER accounts for 17%, GEA accounts for 5%, and others account for 20% of the market share in Peru. VILTER, which is the second largest industrial refrigeration company group, accounts for 80%. There are no tariff systems like in Brazil, so that it is easy to expand business without having factory and office. Therefore, cheap Chinese products and used products are distributed more than in other countries because the price is half of the original price.

Chinese and used products are often installed because of the price, but industrial products can be utilized for long term. Chinese and used products, which do not have maintenance systems and spare parts stocks, cannot increase their market share.

As for the sales system, direct sale to end users accounts for 73% and sale to sub-users accounts

for 27%. Fisheries and agricultural sector as primary industries are prosperous and small enterprises are studied in Peru. The enterprise uses employees of local contractor for the installation of the system and purchasing products as subcontractor. Therefore, it is tough to do business with end user directly. Company A expands its sales share and good relationship by focusing on doing business with subcontractor and distributor as sub users. On the other hand, for the major dairy and beverage companies, they conduct comprehensive sales style including engineering services.

JCI basically conducts direct sales to end users. It is one of the factors why it cannot expand business because of lots of conflict.



Source: Compiled by the JICA Study Team based on Company A document

Figure 8.8 Market Share and Sales System in Peru

3) Colombia

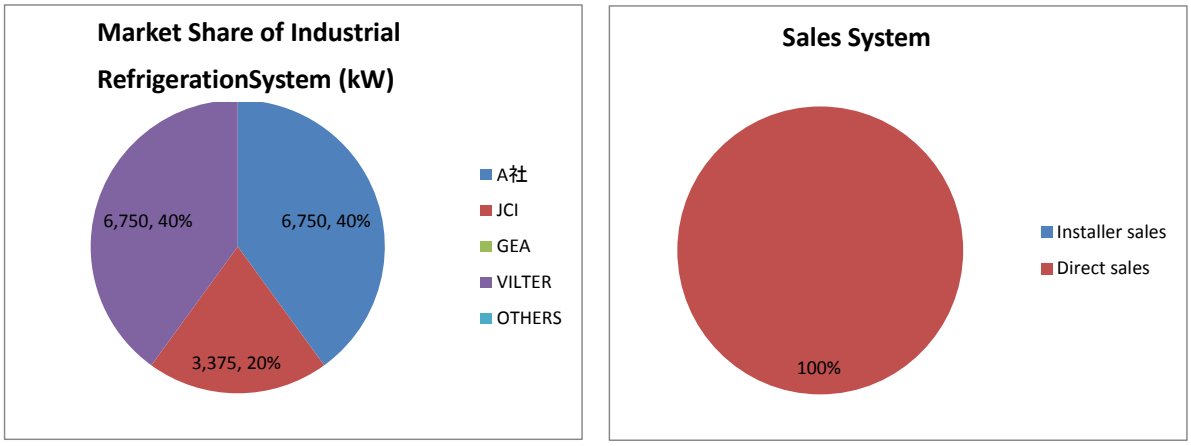
The market share of industrial refrigeration installation based on input power (kW) in Colombia is shown in Figure 8.9. Company A accounts for 40% , VILTER accounts for 40%, and JCI accounts for the remaining 20% of the market share in Peru. GEA does not conduct business in the Colombian market.

VILTER used to have the top share in Colombia. The market share shifted to Company A from VILTER after Company A launched its business in Bogota and Medellin in 1984.

Company A can successfully increase its customers by launching its office. It can always undertake construction, provide maintenance systems, and supply spare parts necessary for an industrial instrument.

As for the sales system, direct sales to end users directly accounts for 100%. It expands the business through original sales strategy unlike in other countries. From the start of the business, it did not sell to sub users but expanded the business to focus on engineering services. As a result, the company has quick response to various demands of major worldwide company, which has a

sharp sense of energy efficiency and conservation. It responded quickly not only on energy efficiency countermeasure, but also on system control by directly undertaking its own engineering services without contractor. Therefore, it expanded its market share by securing high technical skills and customer satisfaction.



Source: Compiled by the JICA Study Team based on Company A document

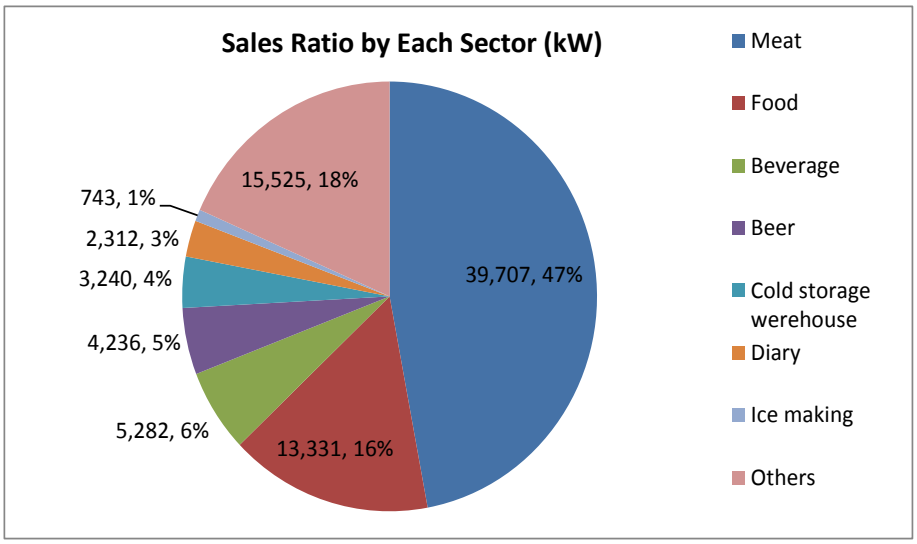
Figure 8.9 Market Share and Sales System in Colombia

8.3 Market Analysis

(1) Brazil

The sales ratio of each sector of industrial refrigeration installation based on input power (kW) in Brazil is shown in Figure 8.10. Food sector accounts for 47% or half of the total. In second place, food processing sector such as meat processing accounts for 16%, followed by the beverage sector and beer sector of large energy consumer. Others like special sector accounts for 18% such as offshore oil platform.

Company A has major worldwide meat sector customers of Brazil foods and JBS; thus, meat sector has a strong demand. Food-related business accounts for 82% of the total. The demand for industrial refrigeration system is concentrated on food-related business in Brazil.

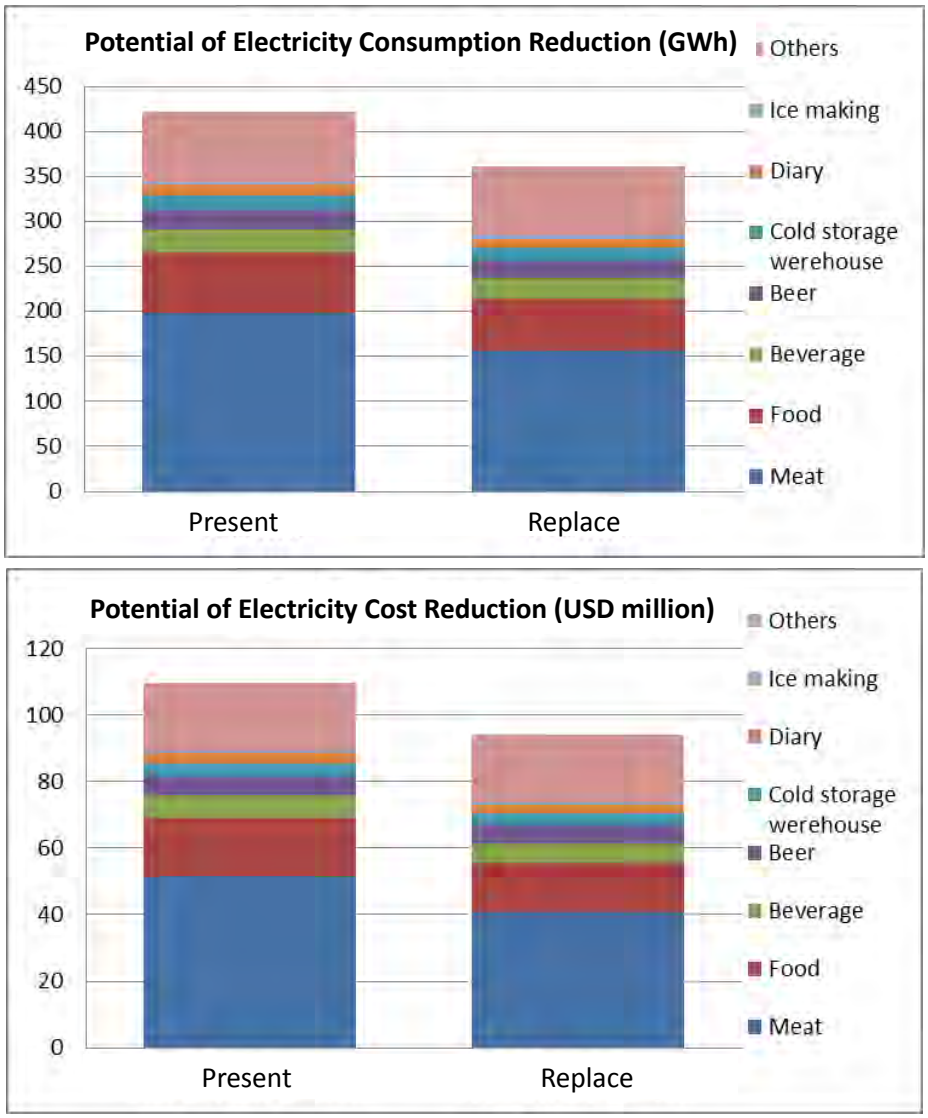


Source: Compiled by the JICA Study Team based on Company A document

Figure 8.10 Installation Ratio of Each Sector in Brazil

As for meat and food processing sector, it is very effective for energy saving to replace NewTon because there are huge needs of the refrigeration system. Then, it is also effective to replace the super cooled ice making system and high efficiency compressor for dairy sector and ice making sector. The effect of electricity consumption reduction and electricity cost reduction when M- and J-series compressors, NewTon, and super cooled ice making system are installed based on the product installation amount of the company is shown in Figure 8.11 below.

The electricity consumption reduction is 60.1 GWh/year and the electricity cost reduction is USD 15.6 million. Reduction ratio is approximately 14%. Replacement cost is approximately USD 29.4 million, and simple payback period is approximately 1.9 years. Electricity tariff in Brazil is higher than in Peru and Colombia, so that the payback period is the shortest among the three countries. The amount of energy reduction is the highest in the three countries because there is a large market size in Brazil.



Source：Compiled by JICA study team based on Company A document

Figure 8.11　Energy Reduction Potential in Brazil [12]

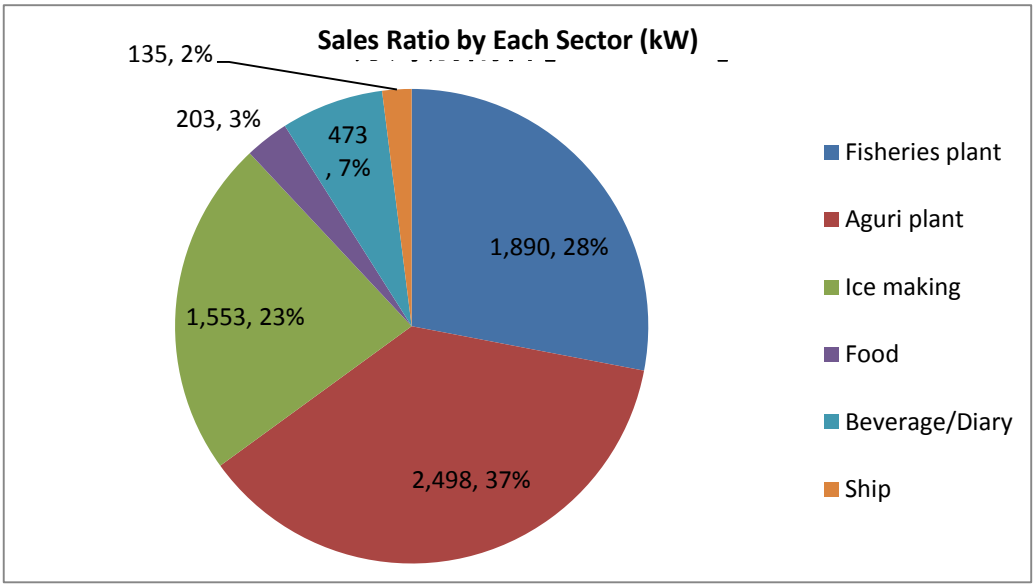
(2)　Peru

The sales ratio of each sector of industrial refrigeration installation based on input power (kW) in Peru is shown in Figure 8.12. The agriculture plant sector accounts for 37%. Second, the fisheries plant sector accounts for 28%.Third, the ice making for fishery sector accounts for 23%.

As for the agriculture plant sector, there is a need to cool the asparagus and grapes before packing them in Piura where Company A's office is located. For the fisheries plant sector, there is a need to freeze Sheila and squid in Paita that is located in the northwestern part. There is a need to freeze the fish by ice in the ice making sector for fishing boat. Fisheries plant sector and ice making sector

[12] Annual operating time: 5,000 hour/year, Electricity unit price: USD 0.26/kWh, Existing equipment COP:2, Newton EE&C: 30%, M&J-type EE&C: 20%, Supercooled ice making system EE&C: 20%, EE&C system adaptive ratio（Meat: 80%, Food: 70%, Beverage: 70%, Beer: 30%, Cold storage warehouse: 50%, Diary: 90%, Icemaking: 50%）

account for 51% in total. The need for industrial refrigeration system is concentrated on fisheries-related business in Peru.



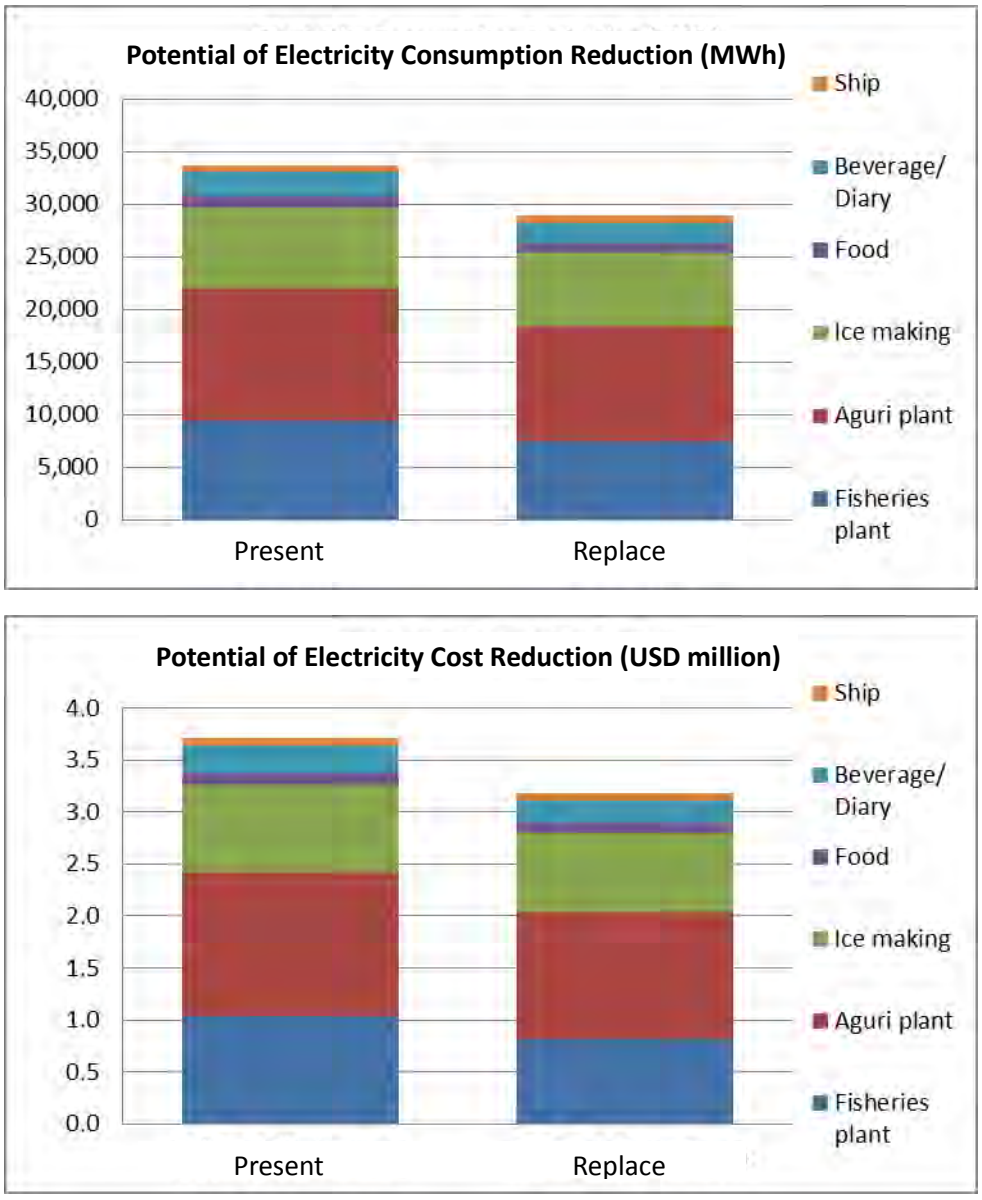
Source: Compiled by the JICA Study Team based on Company A document

Figure 8.12 Installation Ratio of Each Sector in Peru

There are few requirements to replace NewTon, so that there is few demand for the agri-plant sector. Besides, the dairy sector has few installation ratios, so that there are few needs to replace super cooled ice making system. On the other hand, as for agri-plant and fisheries plant sectors, it is very effective for energy saving to replace M- and J-series compressors from the existing system because there are huge needs of refrigeration system.

The effect of electricity consumption reduction and electricity cost reduction when M- and J-series compressors, NewTon, and super cooled ice making system are installed based on the product installation amount of the company as shown in Figure 8.13.

Electricity consumption reduction is 4,867 MWh/year while electricity cost reduction is USD 0.5 million. Reduction ratio is approximately 14%. Replacement cost is approximately USD 2.5 million and simple payback period is approximately 4.6 years. Electricity tariff in Peru is cheaper than in Brazil and Colombia, so that the payback period tends to be short. Amount of energy reduction is the smallest among the three countries because there is a small market size in Peru.



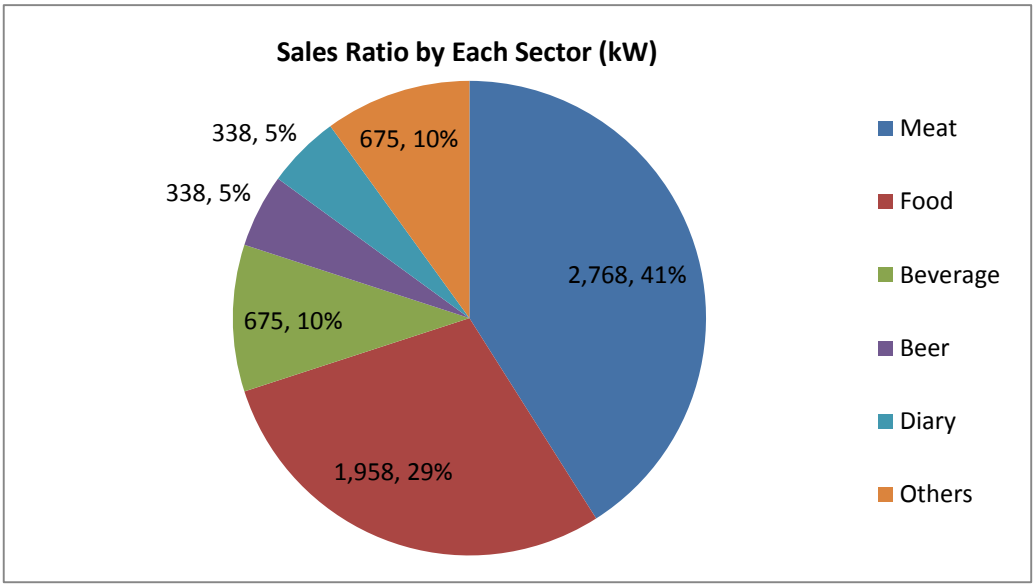
Source: Compiled by the JICA Study Team based on Company A document

Figure 8.13 Energy Reduction Potential in Peru

(3) Colombia

The sales ratio of each sector of industrial refrigeration installation based on input power (kW) in Colombia is shown in Figure 8.14 below. Meat sector accounts for 41% followed by the food processing sector which accounts for 29%, then followed by the dairy sector and beer sector.

The meat sector has a huge demand same as in Brazil. Food-related business accounts for 90% of the total. The demand for industrial refrigeration system is concentrated on food-related business in Colombia as well.



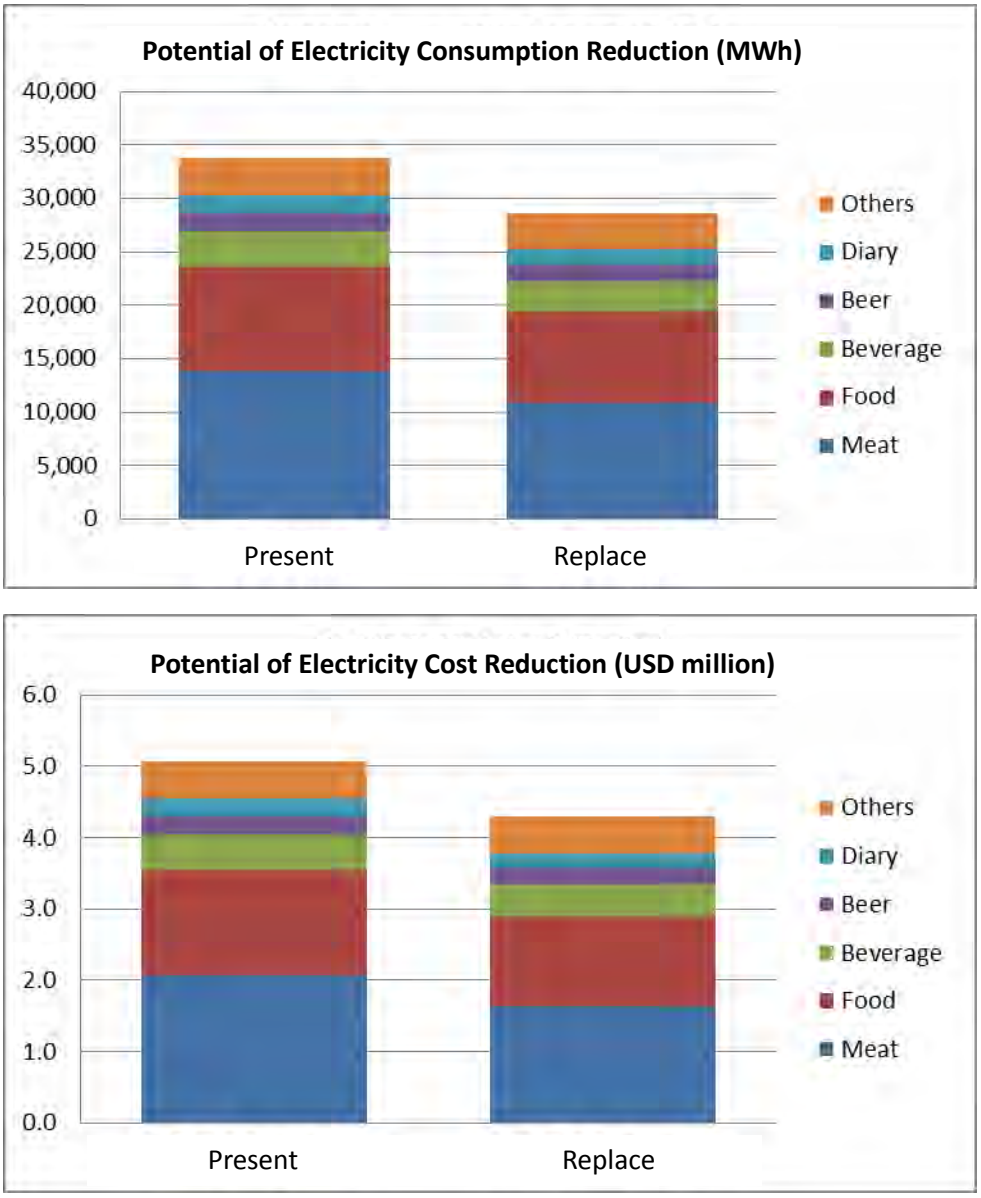
Source: Compiled by the JICA Study Team based on Company A document

Figure 8.14 Installation Ratio of Each Sector in Colombia

As for the meat and food processing sector, it is very effective for energy saving to replace NewTon from the existing system because there is a huge demand for refrigeration system. Then, it is also effective to replace super cooled ice making system and high efficiency compressor for the dairy sector and ice making sector.

The effect of electricity consumption reduction and electricity cost reduction when M- and J-series compressors, NewTon, and super cooled ice making system are installed based on the product installation amount of the company is shown in Figure 8.15.

Electricity consumption reduction is 5,154 MWh/year while electricity cost reduction is USD 0.8 million. Total reduction ratio is approximately 15%. Replacement cost is approximately USD 2.6 million, and simple payback period is approximately 3.3 years. Electricity tariff in Colombia is cheaper than in Brazil and higher than in Peru, so that the payback period is average among the three countries.



Source: Compiled by the JICA Study Team based on Company A document

Figure 8.15 Energy Reduction Potential in Colombia[13]

[13]Annual operating time: 5,000 hour/year, Electricity unit price: USD 0.15/kWh, Existing equipment COP: 2, Newton EE&C: 30%, M&J-type EE&C: 20%, Super cooled ice making system EE&C: 20%, EE&C system adaptive ratio（Meat: 80%, Food: 70%, Beverage: 70%, Beer: 30%, Diary: 70%）

8.4 Identification and Analysis of Bottle Necks

(1) Low-cost Time Plan Electricity Rate Contract

In Colombia and Peru, there is no low-cost time plan electricity rate contract, thus, it is difficult to have benefits on the running cost. This is one of the bottlenecks to spread the installation of high efficiency thermal storage systems. In Brazil, even though there is high-cost time plan from 3:00 p.m. to 8:00 p.m., there is no concept of aggressive introduction of thermal storage system, but only a concept of stopping the system during the high-cost time. LAC region people are not familiar with aggressive installing high efficiency thermal storage systems.

(2) Lack of awareness of highly efficient equipment using natural refrigerant

There are no subsidized projects for promoting natural refrigerant systems in Central and South America including Brazil, Peru, and Colombia.
High efficiency natural refrigerant system has not been recognized yet. It is one of the bottlenecks to spread the system.

8.5 Consideration of Support Measures

(1) Enactment of Low-cost Time Plan Electricity Rate Contract

Peak shift, which is from day use to night use, is enhanced to be promoted in Japan as one of the electric load leveling measures. Enactment of low-cost time plan electricity rate contract is one of the countermeasures for peak shift.

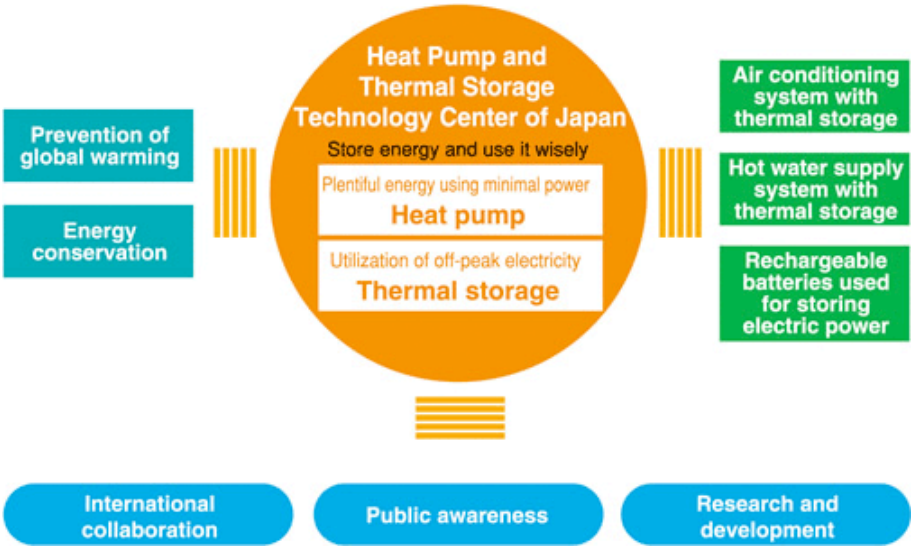
High efficiency thermal storage systems are developed to utilize the rate contract prevalent in the industrial and commercial sector.

Especially, Company A has an extensive line up of ice bank system, large eco cute for industrial sector, cascade cooling system for thermal stratification tank, and super cooled ice making system.

Energy conservation and energy efficiency can be achieved during operation through this thermal storage system. By installing thermal storage tank, operation can have constant speed in spite of load fluctuation. In particular, the refrigeration system can be operated efficiently at low temperature at night time.

In Japan, there is a Heat Pump and Thermal Storage Technology Center, which aims at the promotion and technical improvement of the heat pump and heat storage system.

Not only the introduction of low-cost time plan electricity rate contract, but also the establishment of a group to promote utilization such as the Heat Pump and Thermal Storage Technology Center of Japan can help in the promotion of the installation of high efficiency thermal storage systems of Company A.



Source: Heat Pump and Thermal Storage Technology Center of Japan

Figure 8.16 Activity Outline of Heat Pump and Thermal Storage Technology Center of Japan

(2) Enactment of Subsidized Project

The ozone depletion potential (ODP) of a natural refrigerant is zero. The alternative global warming potential (GWP) is very low compared with Freon. Natural refrigerant is friendly to the global environment. All Freon systems, such as those of new construction and renovations of retail stores and large cold storage warehouse, will be converted to natural refrigerant systems within the next ten years in Japan. Therefore, the Japanese government establishes the subsidized project to spread the use of natural refrigerant systems and reduce the natural refrigerant system's price compared to that of the Freon system.

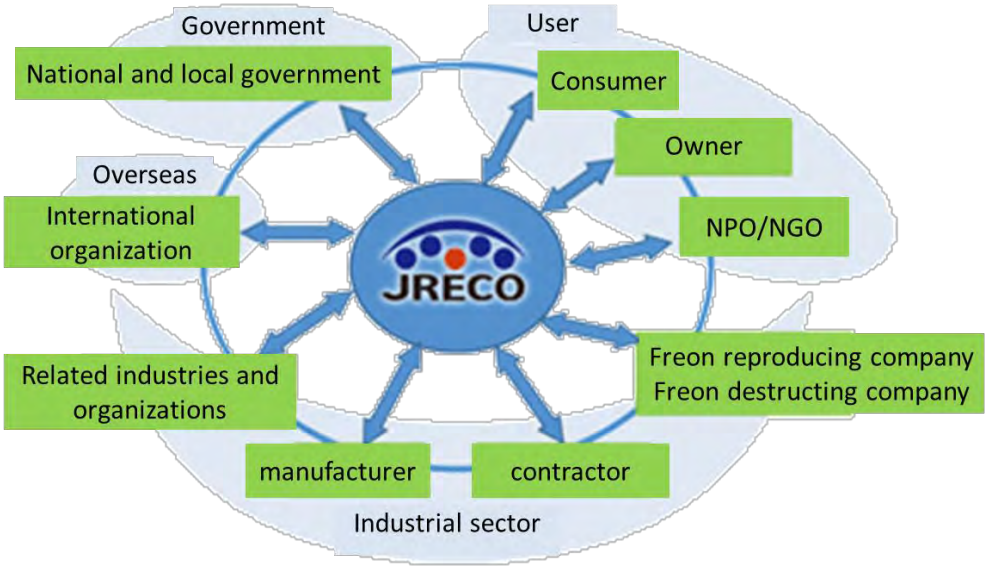
On the basis of the Freon Emissions Law of the Ministry of Economy, Trade and Industry (METI), with respect to the products which make it possible to exceed the target, the JICA Study Team has implemented a technology demonstration project that provides 1/2 or 1/3 support of the cost of the system..

The Ministry of the Environment has a project to provide 1/2 or 1/3 support for the capital cost of natural refrigerant equipment with the equivalent efficiency of a Freon equipment.

Company A, which undertakes activities for research and development of natural refrigerants such as ammonia, hydrocarbon, carbon dioxide, water, and air, named the "Natural Five", has a lineup of energy efficiency systems that cover a temperature range of -100 degrees up to 120 degrees.

In Japan, there is a general foundation, i.e., the Japan Refrigerants and Environment Conservation Organization (JRECO) that will implement and support the promotion of Freon countermeasures including the management of subsidized project.

It is considered that the establishment of an organization responsible for the enactment and promotion of subsidized project will help promote the introduction of highly efficient equipment using natural refrigerant.



Source: Japan Refrigerants and Environment Conservation Organization (JRECO)

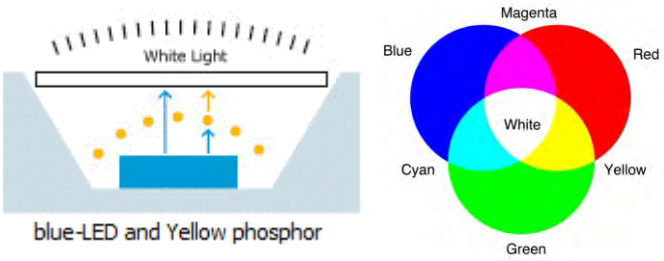
Figure 8.17 Activity Outline of Japan Refrigerants and Environment Conservation Organization

9 LED Lighting

9.1 Overview of LED Lighting

The most essential part of LED (Light Emitting Diode) lighting is a kind of semiconductor called a Blue-LED, which produces a highly energy-efficient white light source with very high brightness. (Three Japanese people were jointly-awarded the Nobel Prize in Physics in 2014 for this invention.)

In practice, however, LED lighting does not directly adopt blue-LEDs, but adopts white-LEDs instead. The current typical method of manufacturing blue-LEDs is to seal/encapsulate blue-LED with/inside yellow fluorescent resin. The yellow light emitted from the fluorescent substance excited by the blue-LED light, and the blue light itself, form complementary colors on the plane of three primary colors of light (red, green, and blue). As a result, white light is pseudoly produced by the additive color mixing of yellow and blue.



Source：TOSHIBA LIGHTING & TECHNOLOGY CORPORATION

Figure 9.1 Principle of Realizing the White-LED by using Blue-LED

The two primary features of LED lighting are its "very high conversion efficiency of electricity to light" and "very long operating life expectancy". Table 9.1 shows a comparison between LED lighting, fluorescent lighting, and incandescent lamps.

Table 9.1 Luminous Efficiency & Life Expectancy of various Light Sources

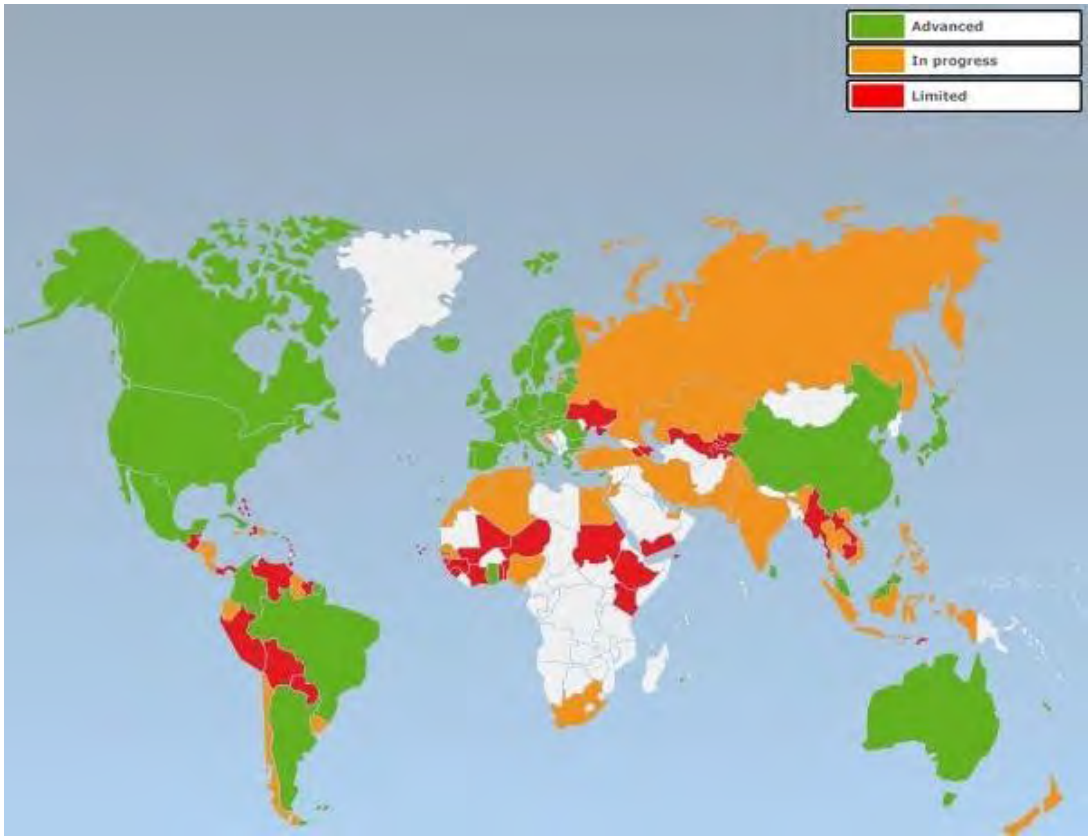
Light Sources	Luminous Efficiency [lm/W]	Operating Life Expectancy [hour]
LED Lighting	As Equipment: around 100 （LED alone: about 160）	40,000 （Light-Flux Endurance Factor: 70%）
Inverter-type Fluorescent Lamps	Straight tube: around 100 Bulb type: around 60	6,000 ～ 12,000
Incandescent Light Bulbs	Around 15	1,000 ～ 2,000

Source：NPO LED Lighting Promotion Council

As evidenced by Table 9.1 above, by replacing incandescent bulbs with LED lighting, the luminous efficiency (conversion ratio of output light-flux in lumen [lm] to input electric power in Watts [W]) can be increased by 6.7 times (by a simple calculation : 100 ÷ 15 = 6.7). In other words, the electric power required to obtain the same brightness (light flux) is 1 ÷ 6.7 = 0.15. In other words, only 15% of the power is required to match the brightness, achieving 85% in energy-saving effect. Similarly, if you replace fluorescent light bulbs, 1 ÷ (100÷60) = 0.6, only 60% of the electric power is required to obtain the same brightness, therefore 40% in energy-saving effect can be achieved.

The electric power injected into lighting systems is divided into two parts: one part is converted into light as intended, and the other part cannot be converted into light due to inherent inefficiency. The power not converted into light is consumed as heat. Therefore, LED lighting produce much less heat dissipation than incandescent lightings, because LED lighting have a much better luminous efficiency. This reduced heat dissipation is a good contribution in decreasing the heat load on to a refrigerated air conditioner. Switching to LED lighting from traditional lighting can indirectly contribute power-saving of refrigerated air conditioners.

The excellent energy-saving effects of LED lighting position them as suitable alternative lightings in the trend of “phase out of incandescent lamps” seen throughout in the world, including Japan, in order to prevent global warming (to reduce CO2 emissions).

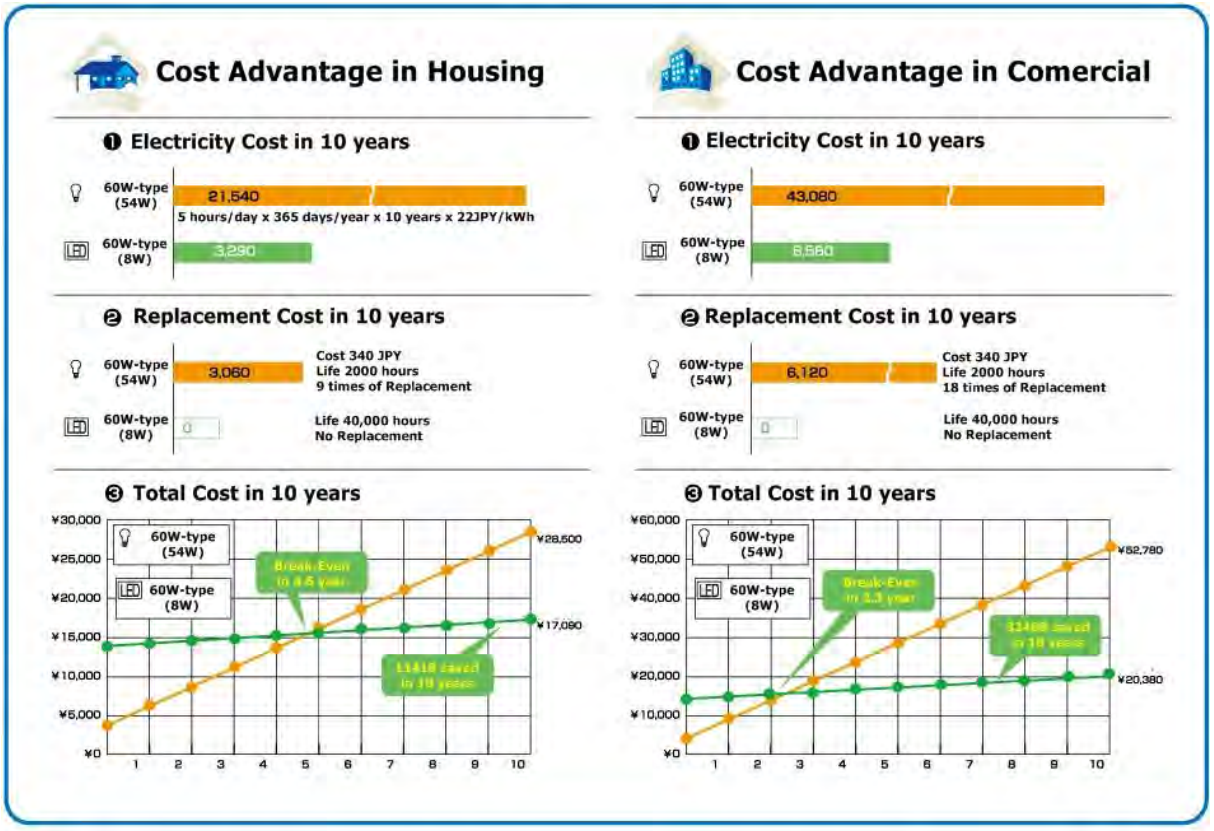


Source：UNEP　en.lighten initiative

Figure 9.2　World Trends of Phase Out of Incandescent Lamps

Practically, the speed of replacement from inexpensive incandescent light bulbs to relatively-expensive LED lighting is naturally affected by replacement costs as well.

As an example, Figure 9.2 shows the estimations of running costs of incandescent bulb and LED light bulbs in Japan. Although these figures greatly depend on the price of electricity rates and LED light bulbs themselves, generally speaking, in around two or so years the expensive initial cost of LED bulbs can be paid off for instances where the lighting-time per day is long, for example, in facility lighting implementations. (Around five years is required to be paid-off for instances where the lighting-time per day is short, for example, in residential lightings.)



Source：NPO LED lighting Promotion Council

Figure 9.3　Comparison of Running Costs of Incandescent Bulbs and LED Lighting

9.2　Activities of Japanese Companies

In Japan, starting from around 2009, consumer electronics giants such as Toshiba, Sharp, Panasonic, etc. started full-scale marketing of LED light bulbs, and therefore the awareness of LED lighting has rapidly increased. In recent days, not only light-bulbs are available, but additionally a very wide range of products, such as ones for replacing straight fluorescent tubes, ones for directly replacing ceiling light, street lightings, etc. In addition, in the early days of their release, the strongest barrier to adoption of LED lighting was that there were technical obstacles in popularization in the market, such as insufficiency of

luminance (brightness), of color rendering properties, of swath/spread of light, etc. However, these problems have now been successfully resolved. Therefore, LED lighting is now a standard choice in Japan to create brand new lighting plans for new facilities.

On the contrary, the overseas markets are very difficult markets to penetrate for LED lighting manufactured in Japan, because the main technical requirements differ country by country, and from Japan itself (such as voltage of utility power line, screw size of base of light bulbs, national safety standards to comply by the products themselves and on the production lines, etc.). Therefore, Japanese manufacturers cannot export the same products sold in Japan to the overseas market, and must modify/adjust each product to each destination country. Even if LED lighting are produced on a mass-production line and mass-inventory system, it is still necessary to prepare separate multiple specifications, designs, tools and dies for production, etc., for each destination, requiring extensive devotion of time and effort (or in other words, sufficient financial strength of the manufacturer).

The results of a series of interviews are shown in the table on the next page. The listed several interviewees are carefully chosen from different types of business categories, but they are all famous manufacturers of LED lighting in Japan. As shown in the table, the results are fairly diversified, but it is easily seen that the Latin American market is not their main target.

The main reasons for their reluctance are as follows:

Firstly, LED ventures usually do not have the financial strength enough to expand to any overseas market, let alone the Latin American market.

Secondly, manufacturers specialized in lightings usually go through the steps such as (i) developing products for the Japanese market, (ii) solidifying their position in the near-Asian market (easily managed from Japan), and (iii) aiming at the large North American market. The Latin American market is the most distant from Japan, with highest language barrier, and therefore it is the “last frontier”, and progress toward this market is generally postponed.

Thirdly, leading consumer electronics manufacturers are also in similar situations. Besides, even if the already-established sales offices dealing with other products in Latin America try to promote LED lighting products, the manufacturing teams in Japan, who already have enough profit in the Japanese market, have a tendency to not provide/develop products for Latin America, providing the excuse that they cannot extend sufficient support to the region during/after sales.

Table 9.2 Efforts in the Latin American Market of Leading LED Lighting Manufacturers in Japan

Types		Major consumer electronics manufacturer		Specialized for lighting		Electronics manufacture	LED venture	
Manufacturers		A	B	C	D	E	F	G
Target countries	Colombia	◎	×	□	×		×	×
	Mexico	○	×	□	×	◎	×	×
	Costa Rica	◎	×	◎	×		×	×
	Dominican Republic	◎	×	□	×		×	×
	Panama	◎	×	□	×		×	×
	Honduras	◎	×	□	×		×	×
	Guatemala	◎	×	□	×		×	×
	El Salvador	◎	×	□	×		×	×
	Nicaragua	◎	×	□	×		×	×
	Belize	×	×	×	×		×	×
	Cuba	○	×	×	×		×	×
	Jamaica	◎	×	×	×		×	×
	Dominica	×	×	×	×		×	×
	Grenada	×	×	×	×		×	×
	St. Lucia	×	×	×	×		×	×
	Barbados	×	×	×	×		×	×
	St. and the Grenadines	×	×	×	×		×	×
	Antigua and Barbuda	×	×	×	×		×	×
	St. Cristphor Navis	×	×	×	×		×	×
	Haiti	×	×	×	×		×	×
	Trinidad and Tobago	×	×	□	×		×	×
	Venezuela	○	×	◎	×		×	×
	Guyana	×	×	×	×		×	×
	Suriname	×	×	×	×		×	×
	Brazil	△	×	□	×	○	×	×
	Peru	○	×	□	×	○	×	×
	Japan	◎	◎	◎	◎	◎	◎	◎
	Asia	◎	◎	◎	◎			
	North America	◎	◎	◎	◎			

Explanatory notes
◎ :Already active. There are the results
○ :Try to think about this positively
△ :Try to think about this
× :Totally unconcerned

Source: JICA Study Team

9.3 Market Analysis

For the field survey of the target countries (Brazil, Peru, Colombia), lighting equipment wholesale stores were visited and the availability of LED light bulb products are shown in the following table:

Table 9.3 Popular Brands of LED Light Bulbs in South America

Area	Country	Power Line Voltage	Base Size	Popular Brand of LED Bulbs	Remarks
South America	Brazil	110V 220V mixture	E27	Philips (Netherlands) OSRAM (Germany) several Chinese Brands	―――
	Peru	110V 220V mixture	E27	Philips (Netherlands) OSRAM (Germany) GE (USA) several Chinese Brands	Company A in Japan already has sales channels for fluorescent light bulbs, which is to be used for promoting their LED Light Bulbs
	Colombia	115V	E27	Philips (Netherlands) Westinghouse (USA) Sylvania (USA) several Chinese Brands	Straight tube type LED light bulbs are also popularly available
reference	Europe	220V	E27	―――	―――
	USA	120V	E27	―――	―――
	Japan	100V	E26	―――	―――

Source：JICA Study Team

At a glance, it is noted that the common trend in these three countries is that the two European top brands, Philips (Netherlands) and Osram (Germany), are outstanding in the South America market.

The primary reason of this observation seems to be residing in the fact the two basic requirements, the power line voltage and the base size for the LED light bulbs are the same both in South America and Europe. European manufacturers can sell the same products developed for the European market in the South American market without any design changes. This intuition is backed up by another observation that the two US brands, Westinghouse and Sylvania, are sold in Colombia, where the power line voltage is the same as in the US.

In addition to the shared technical specifications, both Philips and Osram develop/provide one single product can be commonly used in these three countries instead of different products individually customized to each destination – more specifically, products with universal line voltage coverage 100 ~

240V instead of separately developed low and high voltage types. This commonalization of products/parts is very effective for the cost reduction in mass production. (As a note, both of these European brands are manufactured in China.)

The individual situations in these three countries are as follows:

1) Brazil

The power line voltages in Brazil are not unified, and 220V and 110V are very sporadically mixed and mosaiced everywhere throughout the country, and even within a single city. Therefore, universal voltage designs covering 100 ~ 240V are welcomed by consumers, not only for lighting, but also other electric/electronic products.

According to a local LED lighting manufacturer, a national safety standard only for LED light bulbs is specified, but the one for LED lighting equipment is not issued, and therefore cheaply-made, poor-quality, China-produced LED lighting equipment flood the market.

2) Peru

Power line voltage is mainly 220V, although there are some areas adopting 110V. Therefore, LED light bulbs that the Japanese manufacturer A is planning to promote in Peru by utilizing the existing sales channel of fluorescent light bulbs are compatible with 220 ~ 240V operation.

3) Colombia

Already a phasing-out of incandescent light bulbs has been declared by law, requiring LED replacements of street lights, store and facility lighting, etc.. With this, Colombia is considered the most-advanced of the three countries in this initiative. In fact, straight-tube type LED light bulbs are popular and easily available at storefronts, whereas they are not as easily-available at storefronts in Brazil or Peru.

9.4 Identification and Analysis of Bottle Necks

Through the interviews with Japanese manufacturers of LED lighting conducted in Japan and in South America, the following issues were identified as the primary obstacles toward penetrating into Latin American market.

(1) Lack of eagerness on the Japanese part for sales promotion in Latin America

In case for a manufacturer who has its own local sales offices in Latin America, many inquiries for LED lighting also come to those local offices based on established customer loyalties to Japanese products, and local representatives naturally try to promote LED lighting as new product lines. Besides, local representatives usually try to increase profit margins by selling system products, (combined/integrated products) rather than selling simple products.

However, on the Japan side, manufacturers, especially the departments responsible for design and/or production, are fully occupied in taking care of the products for the Japanese market, or simply satisfied with the profit made in the Japanese market. Therefore, they try to avoid accepting additional tasks necessary for cultivating the Latin American market; they prefer and allow to sell less-expensive, low-profit, simple products requiring minimal after-sales support rather than expensive, high-profit, integrated system products, requiring intensive after-sales support, because Latin America is most distant from Japan and the costs to dispatch maintenance crews is the highest. Therefore, the variety of products of Japanese LED manufacturers are limited as compared to European, US, or Chinese manufacturers, and incoming inquiries cannot reach closure of contract. This tendency is notable especially in large companies.

(2) Excessive Quality ("Galapagos" Effect)

In cases in which Japanese manufacturers develop electronic devices such as LED lighting, generally, they develop a product for the Japanese market first, and then try to export the same product in the overseas market. A popular problem in this situation is the particularity/singularity of the preferences of Japanese consumers. In general, Japanese consumers prefer "multi-function, high-functionality, and high-performance" even if the price is more expensive, whereas the consumers in other countries prefer "decent-functionality, moderate-performance, and affordable-price." This preference of Japanese consumers is a minority in the world and a headache for manufacturers. Products developed for Japanese market have over-specification and are too-expensive for overseas markets, while products developed for overseas market cannot satisfy Japanese consumers. The reason why Korean consumer electronics manufacturers succeeded in domination of the world market was because they gave up on producing products to satisfy the unique preferences of Japanese consumers, and instead they focused their product development efforts on the majority of the world market. On the other hand, Japanese manufacturers were not allowed not to develop product for Japanese market, did not prioritize product development for overseas markets, and then lost the world market share.

Through the interviews during our survey, Japanese manufacturers of LED lighting seem to be making the same mistake again. A leading manufacturer has a selection process of white LED chips in order to reduce the manufacturing variations of the LED lighting such as non-uniformity of color and/or brightness, and they selected only the best/top group of LED chips and scrapped all the rest. Since most of the cost of an LED lighting unit is the cost of a white LED chip, the cost of the manufactured LED lighting of the manufacturer must absorb the discarded pieces of LED chips, and as the result the price of the LED lighting of the Japanese manufacturer are several times higher than the Chinese ones, and lose their price competitiveness in the world market.

(3) Geographic Barriers; Difficult to Provide Support from Japan

In general, when companies try to expand their business overseas, not only Japanese manufacturers but also other foreign manufacturers, they first open "sales offices", then open “service/maintenance offices” if sales volume reaches a sufficient threshold, and then open “assembly/manufacturing facilities” if the volume of business reaches a very successful level.

Through these steps, it is best if continuous sufficient technical support from the home country is available until the overseas office becomes self-sustainable. It is ideal if the technical staff of the home country is constantly- and continuously-stationed in the overseas office. If not, as a workaround, the home office should be able to respond the inquiries from the overseas office, and to fly to location immediately if necessary.

In other words, in case the distance and/or time zone difference between the home office and overseas office is large, the support from the home country is minimized. The geographic relationship between Latin America and Japan is exactly this way: too far to travel, and too much of a time difference for phone support.

9.5 Consideration of Support Measures

Based on the observations noted in the previous section, the possible promotion alternatives for Japan-made LED lighting in the Latin American market are listed below.

(1) Find and distinguish motivated manufacturers

Even if the demand in the Latin American market is promising, and even though there are abundant energy conservation promotion funds available, these realities are irrelevant if LED manufactures in Japan do not have the intent, motivation, financial strength, and readiness to expand their businesses into Latin America.

It might be too early for start-up ventures to expand overseas at this point, and thus it is the first step should be to find motivated companies, by explaining and advertising the situations of the Latin American market to as many companies as possible, whether famous or not-yet famous, so long as the scale of the company is large enough. In this sense, business-matching events for Japanese manufacturers held in Japan planned by JICA are extremely effective.

(2) Improve price-competitiveness by devising manufacturing process and design

Although this aspect is highly-dependent on manufacturers’ own efforts, products for overseas markets should target minimum cost without unnecessary added value, by narrowing features and performance down to only what is necessary for the consumers.

Similar to the strategies adopted by European manufacturers such as Philips and OSRAM, it is highly recommended to develop a single product commonly usable in all the Latin American countries by

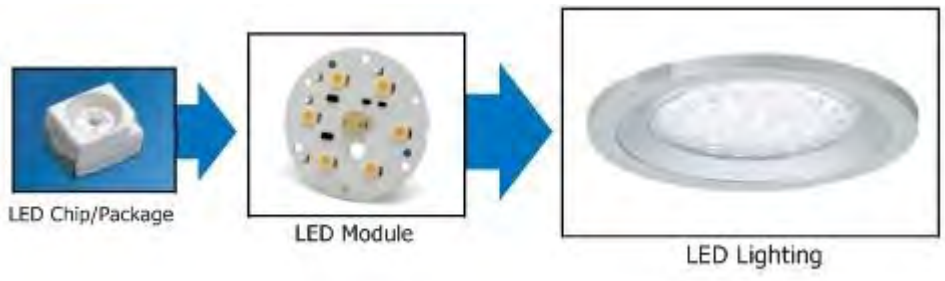
adopting a universal power line voltage design which can work in the wide range of 100 ~ 240V in order to realize cost-saving effects for economies of scale for production.

(3) Collaboration with local manufacturers (local Japanese immigrant-owned companies)

At the orientation meeting held in Brazil as part of this survey, among other Japanese manufacturers, a local Japanese immigrant-owned company named "Omega Light" was also invited. Although this company is not precisely a Japanese company, they manufacture and sell LED lighting adopting Japan-made LED modules. Omega Light is a successful medium-sized company that is fully-capable in illumination planning, design, manufacture, installation, and maintenance of lighting equipment as a one-stop solution provider.

Even if the technical support from Japan is not yet available in Latin America, collaboration/alliances, such as sales of finished products and/or supply of LED modules, with a local company such as Omega Light can eliminate most of the technical concerns. Besides, there are many Japanese immigrants in Latin America and some of them are in the manufacturing business. Even if the second- or third-generation immigrants might not be able to speak Japanese, they still share a common cultural background with us and therefore the communication barrier might be lower than with other local people.

If energy conservation promotion funds such as MSEF and/or COFIDE are pursued, it is not inevitable to tie Japanese products to some extent. The largest portion of cost of LED lighting is the cost of the LED modules themselves (refer to the figure below). Therefore, LED lighting adopting Japan-made LED modules and assembled by local companies can still qualify for the funds. This business practice to supply only parts/components to overseas manufacturers from Japan does not require intensive technical support, and lowers the hurdle to penetrate into the Latin American market.



Source：NPO LED Lighting Promotion Council

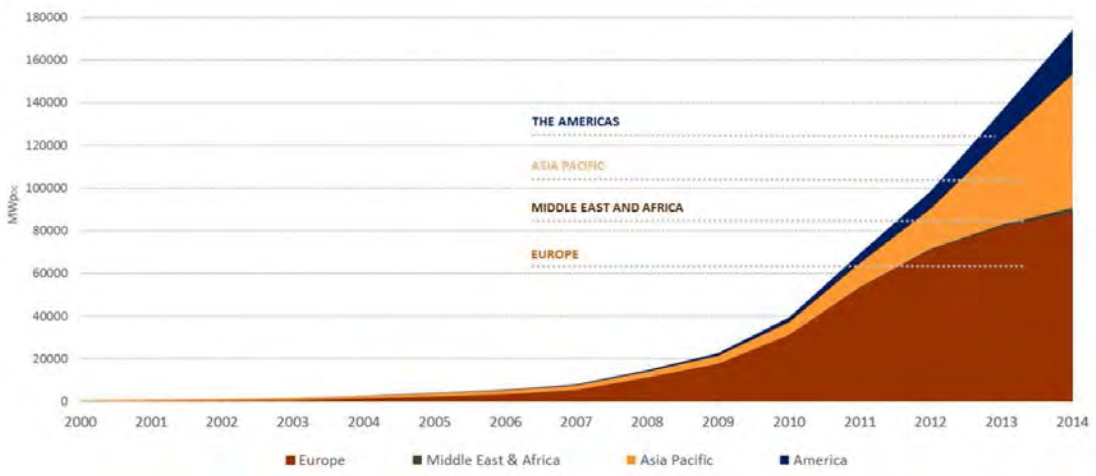
Figure 9.4 Hierarchical Structure of LED Lighting

10 Photovoltaic Generation

10.1 Overview of Photovoltaic Generation

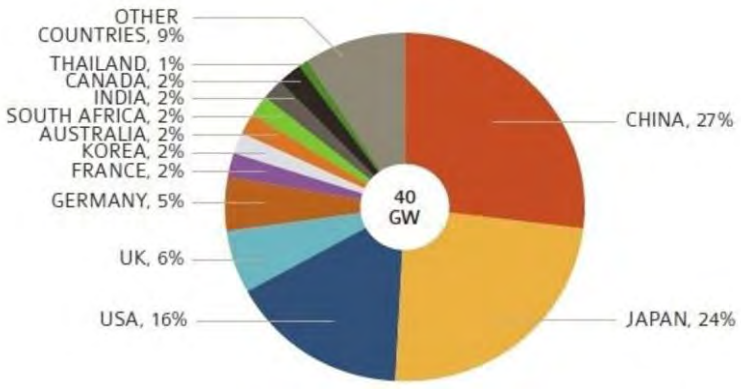
(1) Current Situation of Photovoltaic Generation in Latin America

According to the International Energy Agency (IEA), the cumulative amount of photovoltaic generation in the world was 177 GW at the end of 2014. As shown in Figure 10.1, most of this amount is introduced in Europe, but in recent years the introduction amount in the Asia Pacific Region has increased. As shown in Figure 10.2, in 2014 alone, 40 GW has been introduced, 27% of this is in China, and then 24% is in Japan.



Source: Trends_2015_Executive_Summary (IEA, 2015)

Figure 10.1 Transition of Introduction Amount of Photovoltaic Generation in the World



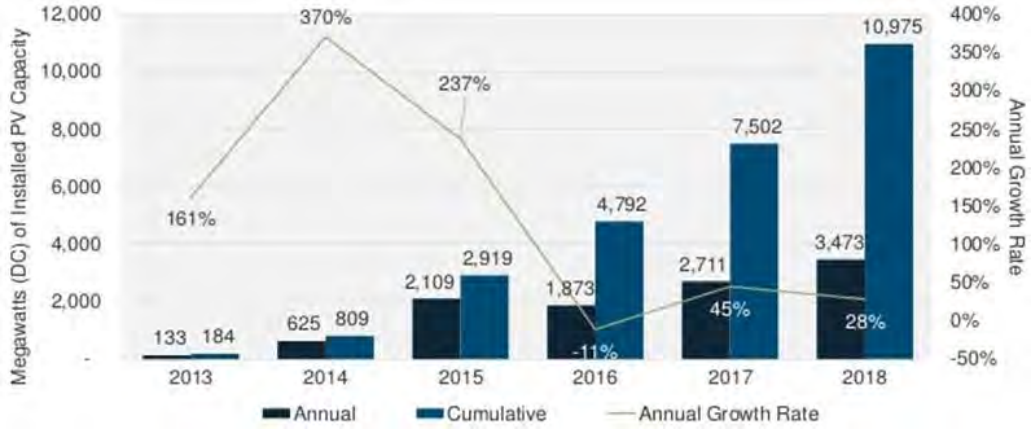
Source: Trends_2015_Executive_Summary (IEA, 2015)

Figure 10.2 Introduction Amount of Photovoltaic Generation in 2014

On the other hand, according to GTM Research Inc., the accumulated introduction amount of photovoltaic generation in Latin America was about 0.8 GW at the end of 2014 (Figure 10.3). This is

only 0.45% of the entire world introduction amount. This shows that the photovoltaic generation market in Latin America has not been developed yet so far.

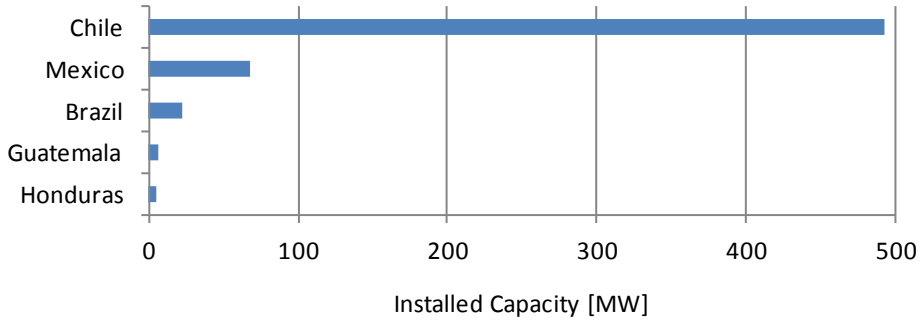
However, as shown in the prediction of photovoltaic generation introduction in Latin America by GTM Research in Figure 10.3, about 2.1 GW will be introduced in 2015 in the Latin American region and the introduction amount is expected to increase significantly in the future.



Source: The 4 Key Issues Shaping Latin America's Solar Market (GTM Research, 2015)

Figure 10.3 Forecast Introduction Amount of Photovoltaic Generation in Latin America

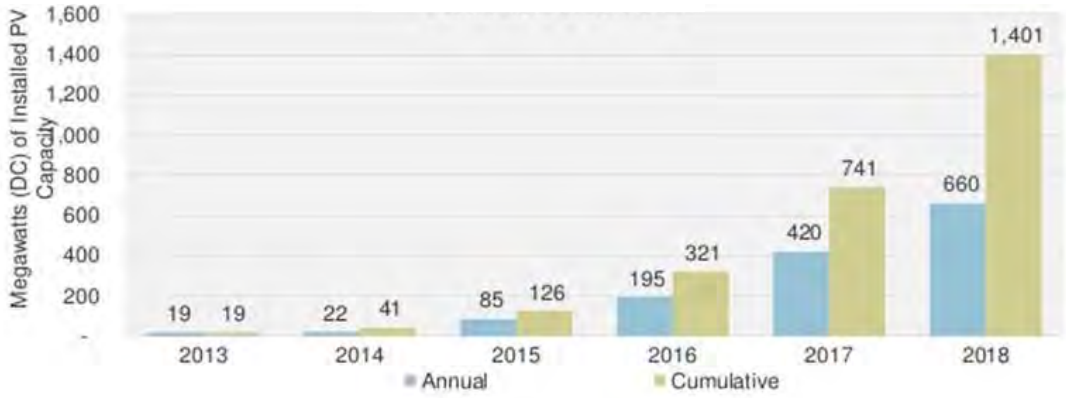
Figure 10.4 shows the top five countries for the introduction of photovoltaic generation in 2014 in LAC. It shows that the introduction amount in Chile is significant. In recent years, the introduction of large solar park is progressing in Chile. In April 2015, Marubeni decided to invest in a 146 MW photovoltaic generation power plant project in Chile with EDF Energies Nouvelles Company (EDF EN Company), a renewable energy power generation business company of the major French power company Electricite de France Inc. (EDF Inc.). In addition, the Chilean government has set a target share of renewable energy of 20% in the total power generation in 2025.



Source: JICA Study Team based on the "Forecasts Latin America to install 2.2 GW of PV in 2015. (GTM Research)

Figure 10.4 Introduction Amount of Photovoltaic Generation of Top Five Countries in Latin America (2014)

Meanwhile, the amount of introduction is presently about 40 MW in Brazil, but it is expected to increase greatly in the future (Figure 10.3). It is expected to introduce 500 MW every year from 2017 and to reach 3.5 GW in 2023. In the first federal power auction, which was held in 2014, 890 MW was contracted, and it will start generation by 2017. Additionally, in the 2015 bidding, 382 projects were registered and the total amount reached to 12.5 GW. The following figure shows the projection of the introduction amount of photovoltaic generation in Brazil in the future by GTM Research. It shows that photovoltaic power generation is expected to increase in the future.



Source: The 4 Key Issues Shaping Latin America's Solar Market (GTM Research, 2015)

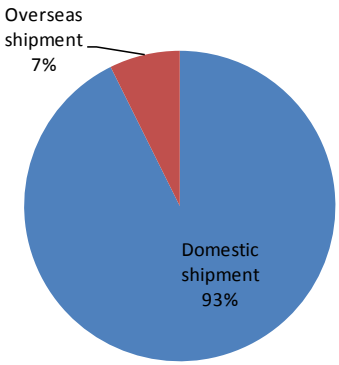
Figure 10.5 Solar Power Generation Facilities Introduction Amount Forecast in Brazil

(2) Export Volume of Japanese Companies to Overseas

The Japanese Solar Energy Association (JPEA) data on the production and shipments of Japanese solar panel manufacturers in fiscal year 2014 are shown below. According to the data, of the total shipping amount of about 6.8 GW of Japanese manufacturers, 93% was shipped to the domestic market. Moreover, even those manufactured in overseas factories, it can be seen that they are shipped almost to Japan. As mentioned above, introduction in Japan accounted for approximately one quarter of the amount of the world introduction of photovoltaic generation. This means that the domestic demand in Japan is large. Based on last year's performance, it seems that Japanese solar panel manufacturers did not focus on exports to foreign countries but focused on domestic demand. (It should be noted that shipments of each area destination have not been indicated in this statistics.)

However, due to the decrease of FIT prices in Japan, the domestic demand is expected to shrink in the future.

Domestic shipment		**6,27**
	Produced in Japan	3,4(
	Produced overseas	2,8(
Overseas shipment		**49**
	Produced in Japan	1(
	Produced overseas	3(
Total shipment		**6,76**



Source: Compiled by the JICA Study Team based on the published data of the Japanese Photovoltaic Energy Association

Figure 10.6 Shipments of Japanese Solar Panel Manufacturers in Fiscal Year 2014

(3) Imports of Solar Panels in Latin American Countries

Currently, there is no factory to manufacture solar panels in Latin America. For this reason, all panels of photovoltaic generation which have been installed in the Latin American region are imported from outside the country.

The International Centre for Trade and Sustainable Development (ICTSD) has announced the import source of solar panels in Latin America. According to this, China has delivered about 80% of the entire amount in Latin America, followed by Taiwan and America. The data in 2014 is shown in Table 10.1.

It should be noted that in Brazil, several projects have been published for local production. Brazil local company, Tecnometal Inc., is already accredited by the BNDES for the production of photovoltaic power generation module. The Chinese industry group BYD has announced that it will start the annual production of 400 MW photovoltaic modules from mid-2016. About 390 MW is supplied to large-scale project, and 10 MW will be supplied to the rooftop.

Table 10.1 Import Amount of Solar Panel to Latin America

Exporter	Amount [USD million]	proportion
China	435.5	82%
Chinese Taipei	57.3	11%
United States	30.0	6%
others	10.1	2%
Total	532.9	100%

Source: Compiled by the JICA Study Team based on the ICTSD data

10.2 Activities of Japanese Companies

(1) List of Leading Technology and Achievements of Japanese Companies

The JICA Study Team conducted interviews with four Japanese solar panel manufacturers about their achievement and interest in the Latin American market based on the market share. The results are shown below. Two companies out of the four companies have a proven track record in several countries in Latin America, and are selling aggressively. Company C has only single interest to Mexico. Company D is considering the Latin American market and does not have a track record.

Table 10.2 Survey Results of Japanese Companies' Interest in the Target Countries

Manufacturer	A	B	C	D
Colombia	◎	◎	△	x
Mexico	◎	◎	◎	x
Costa Rica	◎	◎	△	x
Dominican republic	◎	◎	△	x
Panama	◎	◎	△	x
Honduras	◎	◎	△	x
Guatemala	◎	◎	△	x
El Salvador	◎	◎	△	x
Nicaragua	◎	◎	△	x
Belize	○	×	△	x
Cuba	○	○	△	x
Jamaica	◎	◎	△	x
Dominica	○	×	△	x
Grenada	○	×	△	x
St. Lucia	○	×	△	x
Barbados	○	×	△	x
St. and the Grenadines	○	×	△	x
Antigua and Barbuda	○	×	△	x
St. Cristphor Navis	○	×	△	x
Haiti	◎	×	△	x
Trinidad and Tobago	○	×	△	x
Venezuela	○	◎	△	x
Guyana	○	×	△	x
Suriname	○	×	△	x
Brazil	◎	△	○	△
Peru	◎	×	△	X

Explanatory notes	
◎	:Already active. There are the results
○	:Under consideration positively
△	:Under consideration
×	:No interest

Source: Compiled by the JICA Study Team based on the interview

(2) Achievements and Strategy of Japanese Companies in Latin America

Based on the results of interviews with the Japanese Companies, the following strategies for the Latin American market are confirmed:

1) Sale by local base

Some companies have offices in Latin America (including its subsidiaries or sub-subsidiary), and they perform their own activities locally. In addition, these companies have delivered a photovoltaic generation system on a turnkey basis to the customer. They do not have a factory to manufacture and sell these systems in the field, but they procure their panels (there is a possibility that they use a third party's panel) and other construction equipment on site, including from the outside, and offered them in bulk to the customers.

2) Sale of panel only

Some companies have their partners which are local installers in each country. Since these partners design and install photovoltaic generation locally, so the Japanese manufacturer only sells their panels from their manufacturing plant in North America. Therefore, without any office base in each country, they succeeded in the sale of panels by themselves.

3) Having a local manufacturing base

Company A has a sales company in United States and manufacturing base in Mexico. In addition, since there are partners that become the sales target in each country in Latin America, they spread their panels to each country from Mexico. Then, these partners sell the panels to their customers in their countries.

4) Single-shot performance

However, there is only one delivery record in a particular country; they do not continue the sale activities.

5) Other confirmed policy

A certain company said that selling for residential use entails risk if it has no local office where it can build a sufficient maintenance system. In addition, they are considering a micro-grid which is the combination of photovoltaic generation and batteries in a high tariff country, such as an island.

Some important matters such as problems or challenges that these companies faced are as follows:

- The challenging problem in a new country is the low recognition of their brand.
- Price competitiveness is a major sales problem. The decreasing electricity cost in some countries is also a problem.
- Chinese manufacturer is basically the competitor. US companies are competing in Mexico

and El Salvador.

- Based on the history of entry to Latin America, there is a short payback period in terms of the amount of solar radiation and electrical charge.

(3) Quantitative Evaluation of Products of Japanese Companies

Generally, Japanese products are said to "have high quality with high price". Therefore, the life cycle cost is one method for the assessment of price considering the quality. But for the solar panel, it is important to quickly recover the initial cost through the actual amount of power generation. So, instead of using the life cycle of the product, the JICA Study Team evaluated power generation cost compared with the actual power generation amount.

It should be noted that for the price of general solar panel, because it varies depending on the scale of delivery, the manufacturer does not publish the price per one panel. Therefore, based on the interview with the end user who has installed the solar panels of Company B in Colombia, to compare the Japanese products and general products, the JICA Study Team compared the solar panel of Company B with the highest efficiency with the YINGLI SOLAR panel of a Chinese manufacturer as the representative of the other products. A comparison of the price and the amount of power generation was made. As a result, the price of Company B's product is 15% higher than that of the other products. However, it was said that the increase in the initial cost can be compensated by the increase of the power generation amount. Table 10.4 shows the comparison of the power generation amount based on the data obtained from the specifications and of the prices. This shows that the power generation per area of Company B is much higher than that of YINGLI SOLAR, resulting in Company B's products having 7% lower cost, in terms of power generation unit cost. The reason for this is the difference between "cell conversion efficiency" and "temperature characteristics". In general, the conversion efficiency of solar panel decreases if the surface temperature goes up. The degree of deterioration of the efficiency by temperature is called temperature characteristics. Company B's products do not only enhance the power generation efficiency using unique technology but also results in only a small reduction in the power generation efficiency at high temperature due to its excellent temperature characteristics. For this reason, it can be said that it has an advantage especially in Latin America which sometimes experience a high temperature. In addition, Company B has the provision of "performance guarantee" of 25 years and the monitoring system for the support of these performances after introduction, so that they can secure the trust of the customers.

Table 10.3 Price-to-Power Generation Amount Comparison

Manufacturer ※1	Campany B	YINGLI SOLAR
Models	Campany B' product	YGE 60 CELL
Price (USD/m2) ※2	500	435
Output (W)	240	260
Area (m2)	1.28	1.62
Cell conversion efficiency(%) ※3	25.6	17.7
Output per area (W / m2)	187	160
Temperature characteristics(%/℃) ※3	-0.29	-0.42
Monthly amount of power generation (kWh/month・m2) ※4	19.5	15.9
Price per kWh (USD/kWh・20 years)	0.107	0.114
Comparison price per kWh	0.93	1.00

※1 Using a generally widespread YINGLI SOLAR (made in China) for the comparison of Company B's products,.
※2 Price per unit area is based on the value from the interviews to end-user.
This price is the system cost, not a price of only panel.
(According the opinion, Company B's products were 15% higher than the other products)
※ 3 Cell conversion efficiency, temperature characteristics are published value
※ 4 Calculated by the amount of solar radiation of Bogota, Colombia in January, with the panel surface temperature is 60 ℃.

Source: Compiled by the JICA Study Team based on published data and interview

10.3 Market Analysis

The following shows the market potential of photovoltaic generation in Latin America based on the amount of solar radiation and market demand. The perception of Japanese products is also shown below.

(1) Potential Evaluation by the Amount of Solar Radiation

Survey results of the amount of solar radiation in the target countries are shown below. The countries which have higher amount of solar radiation make higher power generation and shorter payback period, so these countries are suitable for the introduction of photovoltaic generation. Annual average solar radiation in Japan is 3.7 kWh/m^2/day. On the other hand, the average in the target countries is 5.5 kWh/m^2/day, and most of these countries also has 1.3-1.6 times higher amount than Japan. It can thus be said that these countries have very excellent solar radiation and potential for photovoltaic generation. Note that the amount of solar radiation is the amount in the capital city of each country. By using GAISMA, which publishes the amount of solar radiation in the world, the amount of solar radiation in several cities of each country has been registered and can be confirmed. For example, the amount of solar radiation in the capital Bogota of Colombia is 4.6 kWh/m^2/day (1.3 times higher than Japan), but in the city of Barranquilla, which is located in the north coastal area, the amount of solar radiation is 6.3 kWh/m^2/day (1.7 times higher than Japan).

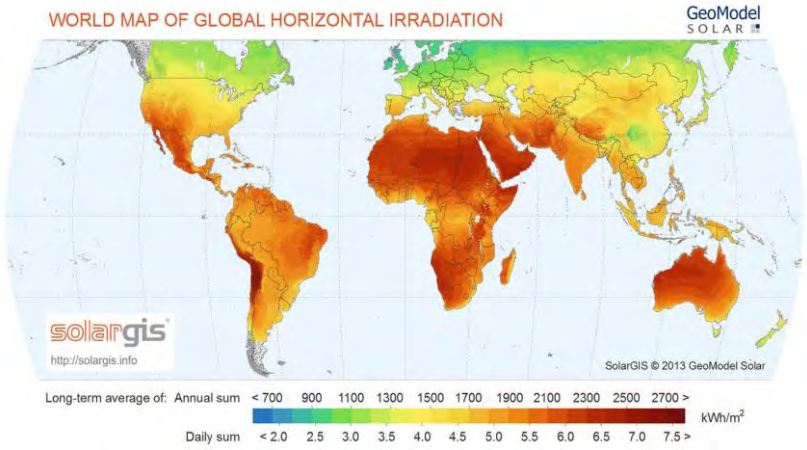
In extracting a promising country which is suitable for photovoltaic generation, the first step is to determine the target country based on the evaluation of the market such as population and electricity

cost. After that, it is necessary to consider some areas in that country in detail because the amount of solar radiation is different by domestic region.

Table 10.4 Data of Solar Radiation Amount of the Target Countries

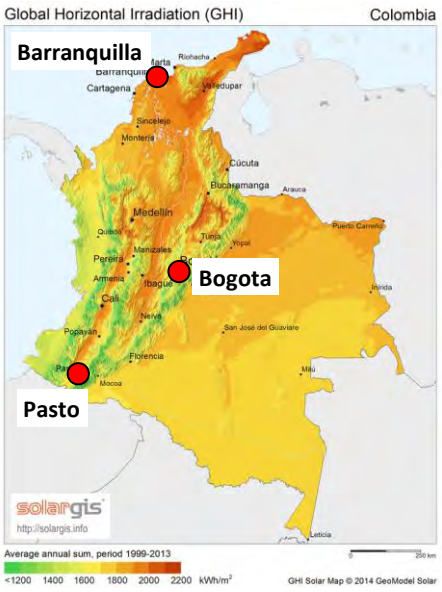
Countries	City	Average radiation (kWh/m2/day)	Comparison with Japan
Colombia	Bogotá	4.6	1.3
Mexico	Mexico City	5.1	1.4
Costa Rica	San José	4.2	1.1
Dominican republic	Santo Domingo	4.9	1.3
Panama	Panamá	4.8	1.3
Honduras	Tegucigalpa	4.9	1.3
Guatemala	Guatemala	4.9	1.3
El Salvador	San Salvador	5.2	1.4
Nicaragua	Managua	5.2	1.4
Belize	Belmopan	4.8	1.3
Cuba	Havanna	5.8	1.6
Jamaica	Kingston	5.7	1.5
Dominica	Roseau	5.9	1.6
Grenada	Saint George's	6.2	1.7
St. Lucia	Castries	6.1	1.6
Barbados	Bridgetown	6.1	1.7
St. and the Grenadines	Kingstown	6.1	1.6
Antigua and Barbuda	Saint John's	6.1	1.7
St. Cristphor Navis	Basseterre	6.2	1.7
Haiti	Port-au-Prince	5.3	1.4
Trinidad and Tobago	Port of Spain	6.2	1.7
Venezuela	Caracas	6.5	1.8
Guyana	Georgetown	5.8	1.6
Suriname	Paramaribo	6.1	1.7
Brazil	Brasília	5.2	1.4
Peru	Lima	5.1	1.4
Japan		3.7	1.0

Source: Compiled by the JICA Study Team based on the data of GAISMA



Source: Solargis

Figure 10.7 Map of Solar Radiation Amount of the World



City	Average solar radiation (kWh/m2/day)	Comparison with Japan
Bogotá	6.3	1.7
Pasto	4.6	1.3
Barranquilla	4.0	1.1

Source: Map: Solargis; Data: Compiled by the JICA Study Team based on the data of GAISMA

Figure 10.8 Solar Radiation Map and Comparison of the Amount of Solar Radiation of Three Cities in Colombia

(2) Market Demand of Photovoltaic Generation

As summarized in the preceding items of energy efficiency and renewable energy, feed-in tariff (FIT) in Latin America is not the most popular. Basic types of photovoltaic generation are as follows:

- Owned by the power company
- Transactions by PPA with the power company
- Supply to the spot electricity market
- Self-consumption type in industrial and household
- Island, independent power supply in non-electrified areas

As well as in the case of energy saving, the incentives of introduction of self-consumption type depend on the electricity tariff of the country. The evaluation of market demand of photovoltaic generation in the three countries was carried out through field survey as shown below.

1) Brazil

In Brazil, as a countermeasure to the soaring electricity cost and tax, the demand for self-consumption type of photovoltaic generation is growing. Since Brazil relies on hydroelectric power, electricity cost is soaring at about 70% from 2014 to 2015 due to the influence of the water shortage. Also, the price is scheduled to rise by 16% in the next fiscal year. Note that the electricity cost and tax are different items in Brazil, so it is necessary to pay attention.

According to Neosolar Inc., which is a design, installation and distribution company of photovoltaic generation intended for the residential sector in Brazil, since 2013, the regulation of grid connection was applied and photovoltaic generation can be connected in the electrification

region. Since the electricity contract price for residential is higher than industrial, the payback period for residential photovoltaic is shorter than for industrial. This is the reason why they targeted the residential sector in recent years.

In addition, with respect to the possibility of photovoltaic generation for the industry, there was a need for an introduction of photovoltaic generation for a large-scale food factory. Due to the large power consumption of the factory, 1 MW can be expected even if it is a self-consumption type. The panels should be installed on the rooftop of the factory.

However, ANEEL, the organization of conducting renewable energy auctions and making technical regulations, established a provision that in general, customers cannot install photovoltaic generation exceeding the self-power consumption. Thus, it is not possible to install and sell electric power to the grid like in Japan. Because of this, the solar power plant as an investment target, called mega solar in Japan, is difficult at present. On the other hand, there is a way to deliver to the electric power company, but it might be difficult according to the interview with Sao Paulo State Industries Association (FIESP). They said that the power company has many cheaper choices such as hydroelectric power, ethanol, and natural gas, so it is difficult to obtain and give attention to photovoltaic generation. For these reasons, the demand of the industrial and residential sectors will seem to increase in the future in Brazil.

2) Peru

In Peru, since the electricity cost is low, the need for photovoltaic generation for self consumption seems to be low. As mentioned above, according to the National Industries Association (SNI), the target introduction of renewable energy is 5% of the total power, and at present, it is 2%. It should be noted that although both wind and photovoltaic generation are popular in the renewable energy sector in Peru, the wind power plant is more popular than photovoltaic generation because the construction of a wind power plant is very simple than photovoltaic generation.

Currently, the government has conducted a public auction of renewable energy at 1,300 GWh/year, and foreign companies including Japanese companies can also participate in the auction. However, although four auctions were conducted so far, Japanese companies did not participate. For these auctions, electricity sales price should be set by the competition with other companies and the concession period is 20 years. SNI assumes the main barrier for Japanese companies is the price competitiveness. They mentioned that another possible method for Japanese companies to enter into this field is to build a power generation company in Peru.

They also mentioned that there is no direct financial aid for the costs of installation of renewable energy.

3) Colombia

Colombia has a lot of energy resources such as hydropower, petroleum, gas, and coal. Since the

electric cost is low as well as in Peru, it can be said that the demand for photovoltaic generation for self consumption is low. In this situation, the Mining and Energy Projects Agency (UPME) enforced laws and regulations related to energy efficiency and renewable energy. First, the Law of Energy Efficiency (Law 697 in 2001) is enforced. It enables those who introduce energy efficiency products to receive tax reduction. Following this law, Law 1715 was enforced in 2014. This law covers not only the introduction of energy efficiency products but also renewable energy products to have tax reduction. Specifically, the sales tax in the year when these products were introduced can be reduced by 16%. In fact, in the case of Company B who sold its product to a local shopping mall, this tax reduction was applied and this shopping mall received a tax reduction of about USD 60,000 during the year of installation.

For more information, in the case of this shopping mall, the installation of photovoltaic generation was a part of its CSR activities to show that it is an environmentally friendly company. However, this is not a specialized case in Colombia. In this case, the purpose of introduction is CSR. It might also be required to utilize the MSEF and introduce the system with no initial costs, because the main purpose of this company is not for monthly electricity cost reduction but for introducing photovoltaic generation. (Additionally, the company can receive tax reduction.)

From the above, it can be speculated that to make the products more appealing, tax reduction and environmental measures rather than the direct reduction of electricity cost can be used to obtain the local interest in Colombia.

In addition, there is a market for photovoltaic generation in the non-electrified region. As mentioned above, non-electrification reaches 34 million people in Latin America.

In Brazil, Company A has achieved the delivery of photovoltaic generation in 30,000 non-electrified areas. Because of this activity, their market share of small-scale power generation in this country is 75-90% every year and they are recognized well by the local people. Note that this was the project called "Light for all" which the Brazilian government has implemented and for which it invested BRL 20 billion (about JPY 660 billion).

As a result of the power supply program to the non-electrified areas, more income, employment, and regional development were promoted in these areas and the business activities in the rural areas progressed. In fact, after the "Light for all" program of Brazil, sales of electrical appliances such as TV, refrigerator, fan, CD player, and freezer increased significantly. For example, the number of purchased TV increased to 79.3%, and purchased refrigerators increased to 73.3%. For a general consumer electronics manufacturer from Japan, which handles consumer electronics products as well as solar panels, after raising the recognition through such approach to the non-electrified areas, other consumer electronics products which it handles are expected to be recognized also and can be distributed widely in the same or other domestic regions.

(3) Evaluation, Demand, and Recognition of Japanese Products

The following shows the evaluations and recognitions for Japanese products, which the JICA Study Team confirmed during the field survey:

1) Brazil

Company A has a high recognition. As mentioned above, before 2011, it was only possible to install photovoltaic generation in the non-electrified areas. At this time, Company A has introduced photovoltaic generation to 30,000 non-electrified areas and they got a recognition in Brazil. In addition, in recent years, they provided highway street lights and a variety of solutions, so they are well known in Brazil.

On the other hand, the local design and installation company of photovoltaic generation mentioned that there is a recognition that Japanese products are expensive including those of Company A. Also, import taxes are basically high in Brazil, so it is difficult for Japanese companies to be selected as the supplier.

2) Peru

Japanese Peruvian Chamber of Commerce and Industry (CCPIJ) mentioned in the interview that there is an understanding that "Japanese products are of good quality" thanks to the success of Toyota in Peru. However, most of the consumer electronics are not popular and solar panels is not an exception. Also, SNI mentioned in the interview that German and Spanish brands are the famous brands of solar panels in Peru.

DGEE (General Administration of Energy Efficiency), the organization of conducting audits of energy efficiency in Peru, mentioned that as for solar panels and wind power generation equipment, European products (Germany, Netherlands, and Denmark) have been adopted. All procurements by public institutions are approved by the Ministry of Economy and Finance (MEF) and the main criteria of the selection of manufacturer is based on price. However, there are not many Chinese products in the market in Peru at the moment.

3) Colombia

EPM (Empresas Publicas de Medellín) which is the utility company and provides infrastructure such as electric power, city gas, and water in Colombia mentioned that although they do not have photovoltaic generation currently, they know and evaluate that the Japanese solar panels and batteries have easy maintenance even if they are expensive. EPM usually evaluates not only the price but also the maintenance costs and efficiency. UPME mentioned that Japanese products were demanded in Colombia but the problem was that there was no Free Trade Agreement (FTA).

(4) Matching the Potential and Marketability of the Target Countries and Japanese Companies' Interest

In the target countries of this study, the JICA Study Team conducted matching with the following items:

1. Potential amount of solar radiation
2. Market in view of the population and electricity costs
3. System of renewable energy introduction
4. Interest of the Japanese companies

Matching is shown in Table 10.5.

First, as to the top five countries which have large population like Brazil, Mexico, Colombia, Venezuela, and Peru, some companies already have achievements. As to the next large population countries such as Guatemala, Cuba, Dominican Republic, Haiti, and Honduras, they also have achievements in most of these countries except in Cuba.

Next, for electricity cost, because the Caribbean has a high electricity cost and high amount of solar radiation, the potential of photovoltaic generation is excellent. However, most companies do not have achievements and interest in these countries.

Achievements and interest of Japanese companies are mostly linked with the "system related to renewable energy". In other words, even for high potential countries like the Caribbean, it can be seen that there is little achievement in the country which has no rules of incentives and grid connection. From this fact, the establishment of systems and rules related to renewable energy is important.

As for the countries which cannot obtain the interest of Japanese companies despite having high potential and high electricity costs (mainly in the Caribbean Islands), they are considered to be low priority for Japanese companies because of their small population. For these countries, it is considered that the implementation of pilot program led by the government can trigger the Japanese companies to get more interested.

Table 10.5 Photovoltaic Potential of the Target Countries and Matching with the interests of Japanese Companies

Countries	Radiation		Marketability		System of renewable energy introduction			Acheivements and interest of Japanese companies				Matching	Remarks
	Average radiation (kWh/m2/day)	compare to Japan	Popuration [million people]	Electlicity cost [US cent]	Target for RE	Incentive for RE	Guaranteed grid access	A	B	C	D		
Colombia	4.6	1.3	80	15	○	○	○	◎	◎	△	x	○	Large population with system of RE
Mexico	5.1	1.4	120.6	12	○	○	○	◎	◎	◎	x	○	Large population with system of RE
Costa Rica	4.2	1.1	4.9	18		○	○	◎	◎	△	x	○	Large population with system of RE
Dominican republic	4.9	1.3	10.4	20	○	○	○	◎	◎	△	x	○	Large population with system of RE
Panama	4.8	1.3	6.9	18		○		◎	◎	△	x	○	Large population with system of RE
Honduras	4.9	1.3	8.2	22		○	○	◎	◎	△	x	○	Large population with system of RE
Guatemala	4.9	1.3	15.8	23		○		◎	◎	△	x	○	Large population with system of RE
El Salvador	5.2	1.4	6.4	17		○	○	◎	◎	△	x	○	Large population with system of RE
Nicaragua	5.2	1.4	6.2	24	○	○	○	◎	◎	△	x	○	Large population with system of RE
Belize	4.8	1.3	0.3	23			×	○	×	△	x	△	Small population and high electricity cost
Cuba	5.8	1.6	11.3	12				○	○	△	x	△	Large population but low electricity cost
Jamaica	5.7	1.5	2.8	42	○		○	◎	◎	△	x	○	Large population and high electricity cost
Dominica	5.9	1.6	0.1	43				○	×	△	x	△	High radiation and electricity cost, but small population and no system
Grenada	6.2	1.7	0.1	32			×	○	×	△	x	△	High radiation and electricity cost, but small population and no system
St. Lucia	6.1	1.6	0.2	32				○	×	△	x	△	High radiation and electricity cost, but small population and no system
Barbados	6.1	1.7	0.3	29	○		×	○	×	△	x	△	High radiation and electricity cost, but small population and no system
St. and the Grenadines	6.1	1.6	0.1	36				○	×	△	x	△	High radiation and electricity cost, but small population and no system
Antigua and Barbuda	6.1	1.7	0.1	35			×	○	×	△	x	△	High radiation and electricity cost, but small population and no system
St. Cristphor Navis	6.2	1.7	0.1	30				○	×	△	x	△	High radiation and electricity cost, but small population and no system
Haiti	5.3	1.4	10.4					◎	×	△	x	○	Large population
Trinidad and Tobago	6.2	1.7	1.3	5			×	○	×	△	x		Low electlicity cost
Venezuela	6.5	1.8	30.8				×	○	◎	△	x	○	Large population and high radiation
Guyana	5.8	1.6	0.8	32			×	○	×	△	x	△	High radiation and electricity cost, but small population and no system
Suriname	6.1	1.7	0.5	7			×	○	×	△	x		Low electlicity cost
Brazil	5.2	1.4	201.5	26		○	○	◎	△	○	△	○	Large population and high electricity cost
Peru	5.1	1.4	30.6	11	○	○	○	◎	×	△	X	○	Large population

※As for amount of solar radiation, Yellow is more than 5, Red is higher than 6.
As for population, yellow is more than 100 million people, red is more than 1000 million people.
As for The electricity cost, yellow is more than 20 yen, red is more than 30 yen. As for system, each ○ is red.
As for Japanese manufacturers interest, ○ is yellow, ◎ is red.
As for matching, ○ is haigh radiation or marketability with the achievements of Japanese manufacturer's
△ is the country which can not obtain Japanese interest destite high amount of radiation or marketability.

Source: Compiled by the JICA Study Team based on the abovementioned data and interview

10.4 Identification and Analysis of Bottle Necks

The JICA Study Team extracted the assumed market bottlenecks of photovoltaic generation of Japanese companies in Latin America.

(1) Technical Issues

In the countries where the provision of grid connection is not enforced, photovoltaic generation is introduced as limited independent system. In these countries, the market is very small. Therefore, the first step for the Japanese manufacturer is to enter the country which allows the installation of photovoltaic generation in the electrification region.

As for the standards, according to Company A, the product standard of solar panels is only the IEC standard and they do not manufacture products tailored to each country.

(2) Market Issues

In the country with cheap electricity cost, the demand for photovoltaic generation for self consumption is low. Additionally, in the country with decreasing electricity cost, it seems to be difficult to estimate and guarantee the payback period.

Also, there are some cases that the Japanese companies were disadvantaged by the fake data sheet of Chinese products which seem to have good quality on the surface. It is necessary to obtain the local consumer's understanding and trust through the performance guarantee of power generation efficiency.

The Caribbean countries have very high potential of solar radiation and electricity cost. They are very attractive, but their population is too small to set up a base.

(3) System Issues

There are some countries which have no target of introduction of renewable energy and these countries are not active to introduce photovoltaic generation. Or even if they have a target introduction, some countries have no specific support system or rules which promote renewable energy. It is necessary to work on the incentives of installation for the end users like tax reduction in Colombia.

(4) Financial Issues

As confirmed in Brazil, it is difficult to secure the initial cost in some countries because of high market interest rates.

Also, specifically for Brazil, BNDES has investment rules which limit the ratio of domestic product to 60% in the entire system, but it seems that they will increase this ratio in the near future. It is difficult for foreign manufacturers to use this bank.

10.5 Consideration of Support Measures

In this section, the JICA Study Team suggested the support measures to expand the introduction of photovoltaic generation by Japanese companies in the Latin America market.

(1) Measures by Japanese Companies

First of all, the JICA Study Team organized the strategy of the Japanese companies.

As for the quality of today's solar panels, it is difficult to make a comparison with other countries' products in terms of the quality of the product itself because the quality of the products is almost at the same level. Products with remarkable high generation efficiency such as those of Company B are few. Therefore, Japanese companies are required not to sell solar panels only, but to provide a solution including procurement of peripheral devices other than the panel.

Although Company A does not have a particularly significant value in the panel itself, it has a local office and works on various businesses (for example, provision of photovoltaic generation system to the non-electrified areas and to highway lighting). By doing this, it provides the total value of the whole system.

In addition, Company A has another strategy. It does not have a base in Latin American countries other than Brazil, but has sales partners in each country. Because of this, it has a market share of about 1 to 13% depending on the countries.

Also like for Company B, if it has an overwhelmingly efficient product, it is necessary for the local end user to recognize the benefits of the product. In addition, by providing product guarantee, performance guarantee, and monitoring system, it can obtain the trust of the customers and will lead to advantage over the other companies.

This time, large-scale achievements, such as selling of "mega solar" to the power company with PPA were not observed in these companies. Basically speaking, when it comes to a large-scale power plant, price competition will be the major consideration; thus, it is difficult to win over other countries' cheap panels like those of China. This is consistent with the abovementioned point that China is the top supplier of solar panels in Latin America.

The arrangement of the company's success story is as follows:

- Providing solutions by local bases
- Having local sales partners
- Quantitatively enhancing the excellent quality by guarantee of performance and payback time to obtain the recognition and trust
- Making difference through other continuous service (such as monitoring system)
- Consideration of marketability in view of Mercosur and the Pacific Ocean Alliance is required if planning to establish the manufacturing base

Additionally, the residential market such as that covered by Brazilian Neosolar is not a developed market for Japanese manufacturer and it can be said that this can be considered particularly in high electricity cost country. In addition, the following general activities should be considered:

- Micro-grid in the island (especially the Caribbean)
- Sales to non-electrified areas

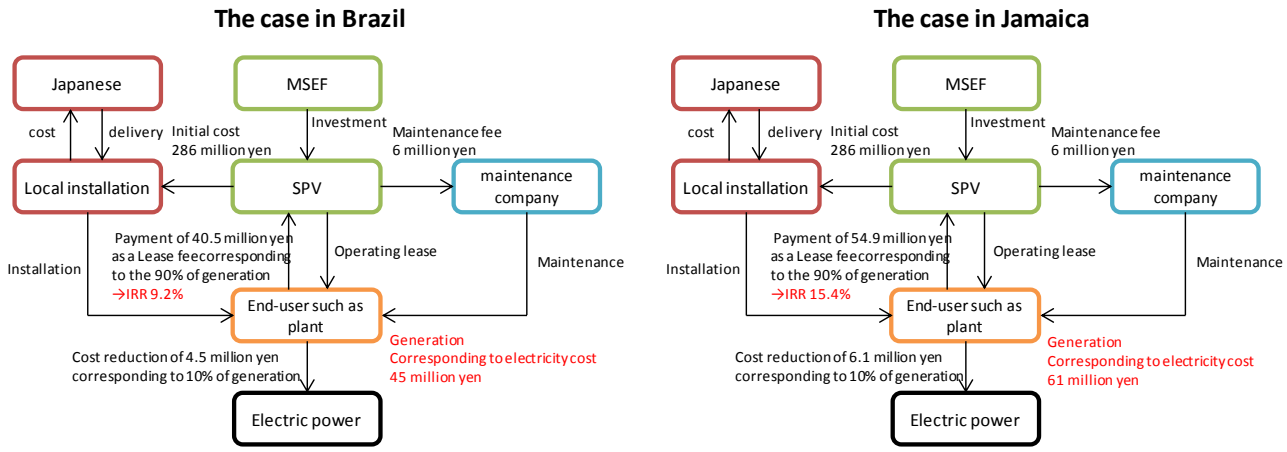
(2) Study of Finance Measures

The use of MSEF that JICA invested should be considered. By utilizing MSEF funds, the initial investment can be zero or significantly reduced. Based on the estimates, the system unit price of JPY 286,000/kW (more than 1 MW for industrial use), which the Ministry of Economy, Trade and Industry (METI) in Japan has published, is being used.

Based on this unit price, the initial investment of 1 MW for industrial use will be JPY 286 million. When calculated using Brazilian solar radiation amount and electricity cost (including the 30% tax), the reduction of electricity cost per year is JPY 45 million. The maintenance cost is also calculated by using the published data of JPY 6,000/kW of METI and it will be JPY 6 million per year. The simple payback period is 7.3 years. If utilizing MSEF funds, 90% of the power generation should be paid to MSEF. Then, the internal rate of return (IRR) of MSEF becomes 9.2%. Even if 100% of power generation was paid to MSEF, IRR for MSEF is still 11.2% and it does not reach the minimum IRR standards of MSEF. Therefore, in order to utilize MSEF for the industrial use in Brazil, a cheaper system price is required.

Making a trial with the condition in Jamaica, due to the high solar radiation and electricity cost, reduction of electricity cost is JPY 61 million per year and simple payback period is 5.2 years. By making a 90% payment to MSEF, it can get an IRR of 15.4%. Thus, in order to establish a business based on MSEF, it is necessary to examine the conditions of solar radiation and electricity cost.

(In the above calculation, total correction coefficient was set as 70%. In Japan, it is generally 75-80%. This is affected by the temperature and high temperature area which makes a significant decrease of the power generation efficiency. In this calculation, the average temperature was set as 30 degrees and total correction coefficient as 70%.)



Source: Compiled by JICA Study Team

Figure 10.9 MSEF Utilization Example (Industrial: Brazil and Jamaica Comparison)

It is considered that by introducing photovoltaic generation with zero initial cost, by utilizing the above model, to the company that has the purpose of CSR activities such as the shopping mall in Colombia, the company is able to receive benefit of both the achievement of CSR activity and tax reduction based on the rule of the country.

(3) Study of System Measures

FIT accelerates the spread of photovoltaic generation. Also, it is required to prepare the power regulation to be able to connect to the grid. Then, the target volume of renewable energy introduction of the nation is required. At the same time, subsidies or tax measures are also required to support it.

Measures to be enacted in Latin American countries, in order of priority, are as follows:

1) Enforcement of grid connection system

Since Latin America is mostly an electrified area, first priority is to arrange the conditions that can allow the installation of photovoltaic generation to the electrification region. It is necessary to increase the number of areas in which it can be introduced.

2) Setting target volume of introduction and system to support introduction

Introducing the target volume of the country is required, but in order to increase the incentives for the introduction by the private sector, it is necessary to provide the subsidies or tax systems.

3) Introduction of feed-in tariff

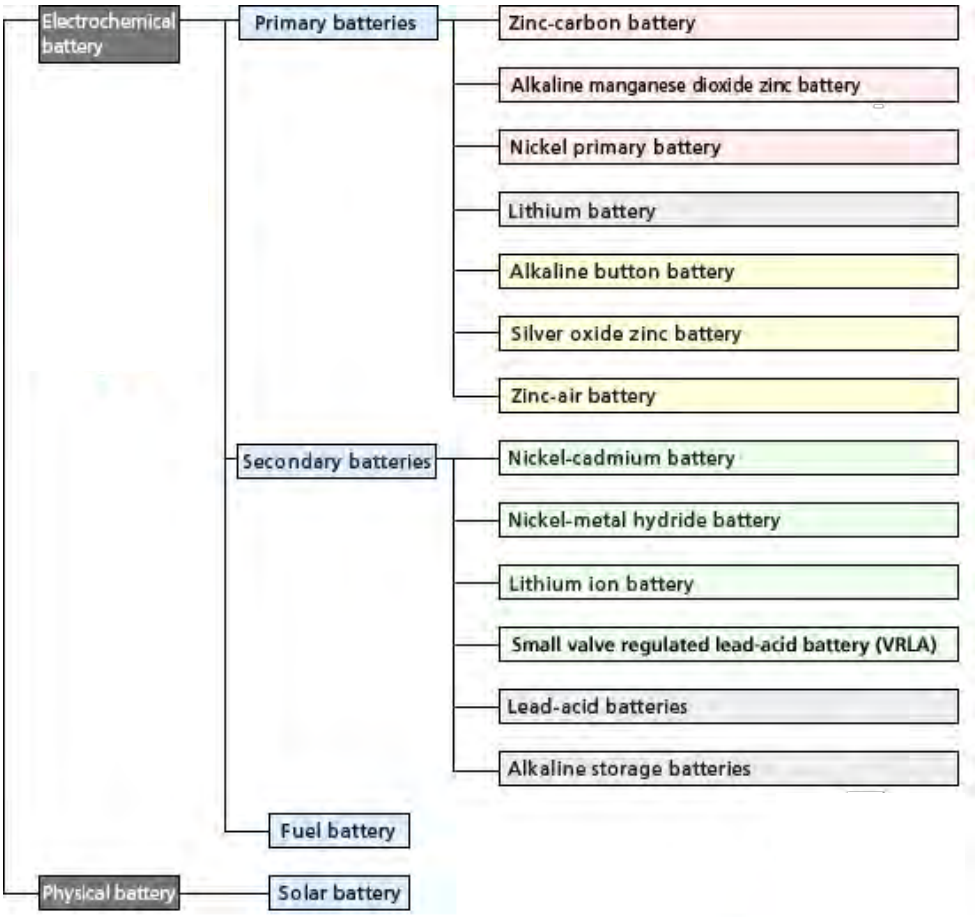
Some interviewee mentioned that FIT has a large burden on the national budget. By introducing photovoltaic generation in the countries which are politically and economically stable, it is expected that the introduction amount will dramatically increase.

11 Battery

11.1 Overview of Battery

(1) Battery Type

Batteries can be classified into primary batteries and secondary batteries. Primary batteries cannot be recharged while secondary batteries are rechargeable batteries. This report covers the secondary batteries. The types of batteries are shown below.



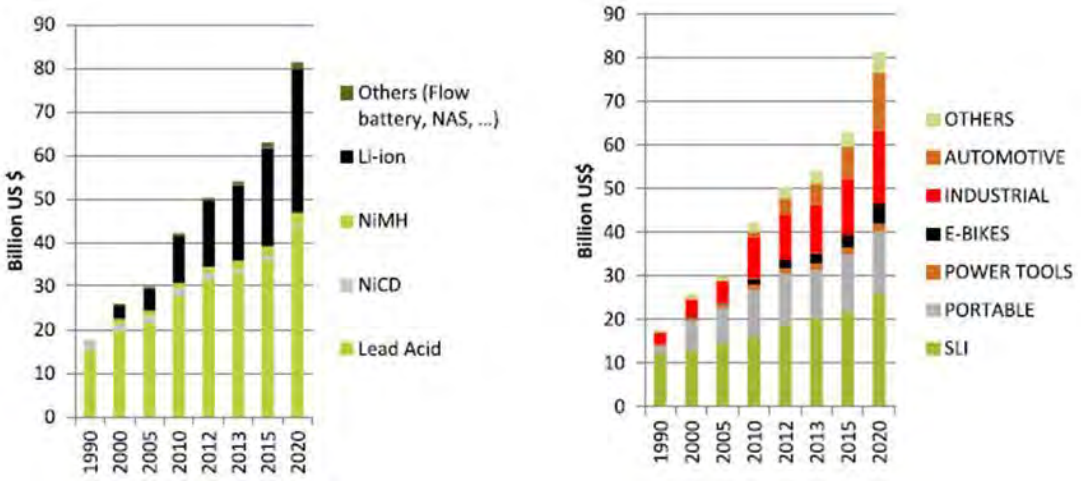
Source: Battery Association of Japan

Figure 11.1 Type of Storage Battery

(2) Analysis of the Existing Information

According to the research firm Avicenne ENERGY, the battery market around the world has been increasing as follows: Until 2000, the market was occupied almost by lead acid batteries, but in recent years, lithium ion batteries have increased and reached more than 30% of the market. According to the prediction of Avicenne ENERGY, lithium ion batteries will expand further in the future. As mentioned later, this trend is more noticeable in Japan.

As for application, the SLI (battery for the vehicle: starting, lighting, ignition) occupies most of the market currently, followed by portable and industrial batteries.



Source: Avicenne ENERGY

Figure 11.2 Future Prediction of the Battery Market (Unit: USD 1 billion)

As shown in Figure 11.2, the storage battery market is almost occupied by lead acid batteries and lithium ion batteries only in terms of money. For this reason, the JICA Study Team will discuss only lead acid batteries and lithium ion batteries in this report.

Lead acid batteries are used for the SLI in the automotive industry. In addition, these are used for uninterruptible power supply (UPS). Lead acid batteries have high durability at low cost as well as recyclable. Lead acid battery has a long history in terms of its technology, and it has been produced all over the world as a general purpose product. Three quarters of lead acid batteries are used for the vehicle (Information from Company F).

According to the market research firm Future Market Insights (FMI), the Asia Pacific Region accounted for USD 15.3 billion, which is 34.2% of the total world market in 2014, and it will reach about USD 20 billion by 2020. In the current situation, following the Asia Pacific Region, North America has 21.6%, Western Europe has 18.7%, and Latin America has 14.4%. The world lead acid batteries market is expected to reach USD 58.5 billion by 2020 with the estimated annual average growth rate of 4.6% during the forecast period. Due to the rise of the national income in China and India, the automotive sector is growing, and this has become an important factor for the growth of the lead acid batteries market.

Demand for lead acid batteries used for UPS is another factor for the growth of lead acid batteries market in the Asia Pacific Region. Many hospitals, schools, companies, and complex residential facility require a backup system to deal with intermittent power supply, and this situation results in additional demand in the lead acid batteries market.

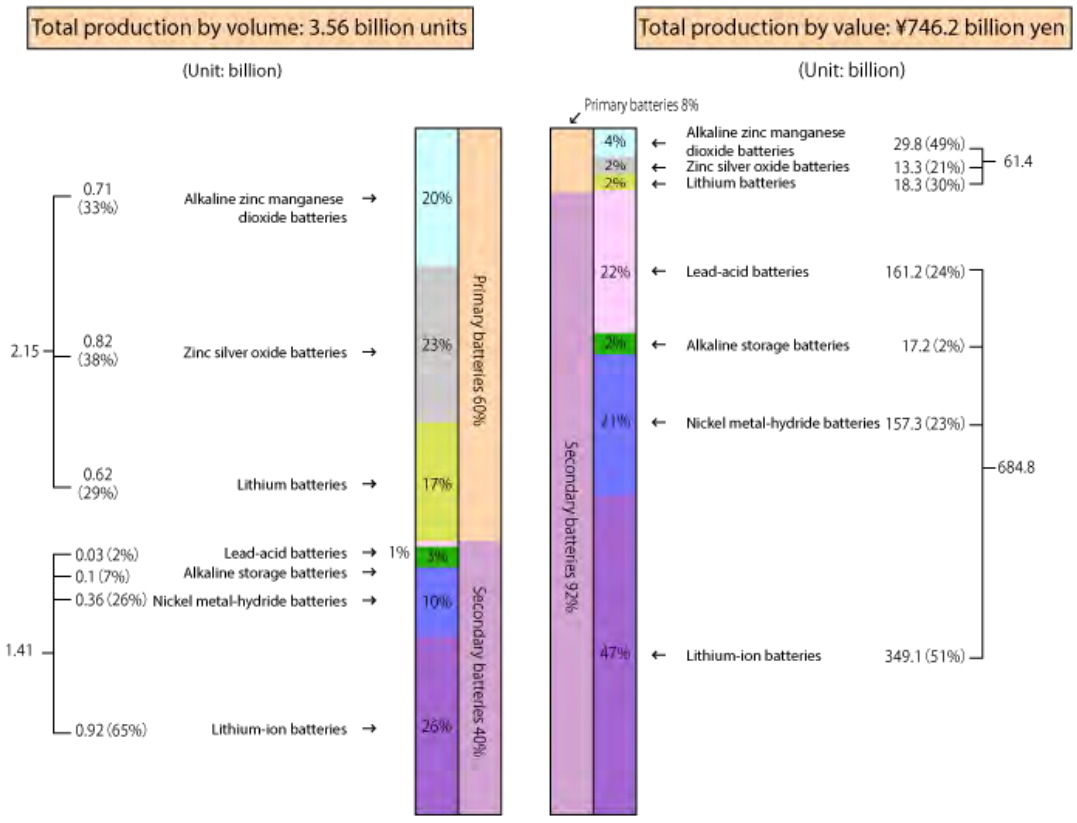
According to the report of Frost & Sullivan, lithium ion battery industry has reached USD 17.6 billion in 2013, and it is expected to increase to more than four times of this amount by 2020. Consumer batteries (e.g., notebook personal computers, mobile phones, cameras) accounted for 64% of the entire lithium ion battery market.

Automotive and industrial markets (cordless power tools, forklifts, garden equipments, and cars) are also expected to increase. In the transportation sector, it is expected to exceed more than 25% of the industry demand in 2020, and it is expected that the most rapid growth will happen over the next four years.

11.2 Activities of Japanese Companies

(1) Total Production Volume

According to the Battery Association of Japan, 90% of domestic battery production is for secondary battery, while primary battery has only 10% of the total production. In the production of secondary battery, lithium ion battery generally shares about 50% of the total production, and lead acid battery and nickel metal-hydride battery each share approximately 20% (measured by amount of money).



Source: Battery Association of Japan

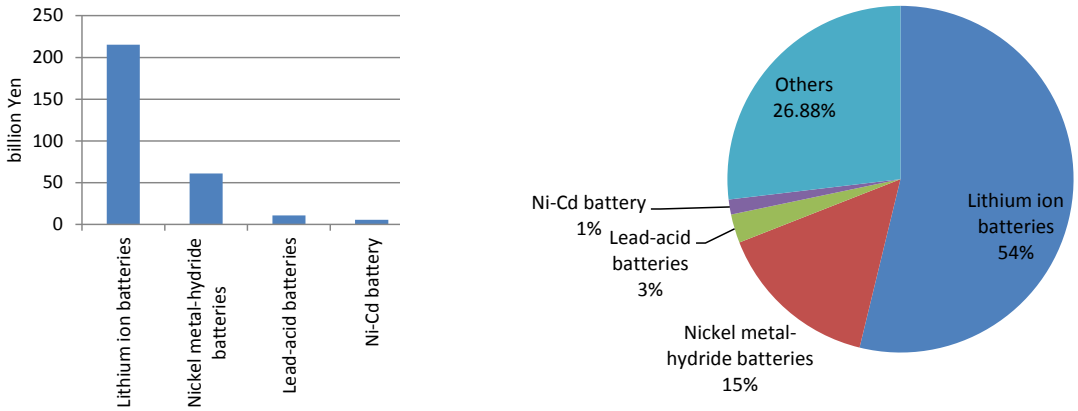
Figure 11.3 Production Volume of Each Battery Type in Japan

(2) Export Volume

In the above domestic production amount of around JPY 684.8 billion of secondary battery, about JPY 400 billion are exported. The JICA Study Team summarized the shipment statistics data from the Ministry of Finance below.

In terms of battery type, lithium ion battery accounts for more than 50% of the total export amount. Nickel metal-hydride batteries have the next biggest export amount and it accounts for about 15%. Although almost the same amount of lead acid batteries is produced as nickel metal-hydride batteries in the domestic production according to Figure 11.3, the shipment statistics shows that lead acid batteries are hardly exported. The reason for this is that the lead acid battery is old from the technical point of view and is popular which makes it a general purpose product around the world. Thus, there are many local manufacturers which can produce them and basically they tend to be procured locally (Information from Company F). In particular, three-fourths of the lead acid batteries are applied for vehicles. From the information of Company F, Japanese companies have their factories in Asia. Since Japanese vehicle manufacturers also have factories in Asia, supply and demand has been satisfied in the local setting. Therefore, they generally do not export this product but they set up a plant in the area which has a demand.

In the following figure, the "others" refers to a battery which is an accessory for many different products, and it is not possible to identify the content (Information from Battery Association in Japan). In addition, the main application of nickel metal-hydride battery is as rechargeable battery which is an alternative to dry batteries, e.g., "eneloop" of Panasonic.



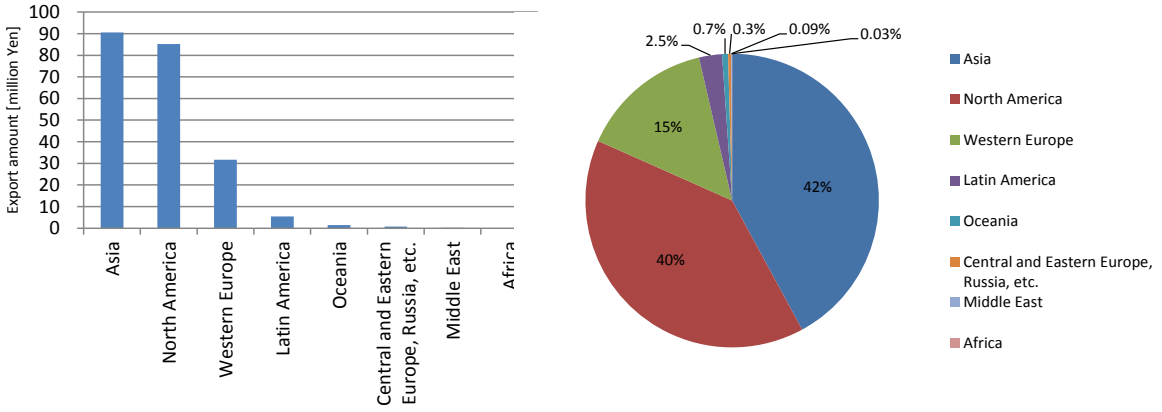
Source: Prepared by the JICA Study Team based on the data of Battery Association in Japan

Figure 11.4 Storage Battery Type Production Volume in Japan

(3) Regional Export Volume

Since the lithium ion batteries accounted for about half of the exports, the JICA Study Team focused on lithium ion batteries and investigated the regional export volume. Figure 11.5 below shows the regional battery shipments of Japanese companies. In terms of export value, Asia accounts for 42%

and North America for 40%. These two regions accounted for over 80% of the total amount. Then, Western Europe has 14% and Latin America has only 3% of the total amount. It can be seen that the shipment to Latin America is very small out of the total amount.



Source: Prepared by the JICA Study Team based on the data of Battery Association in Japan

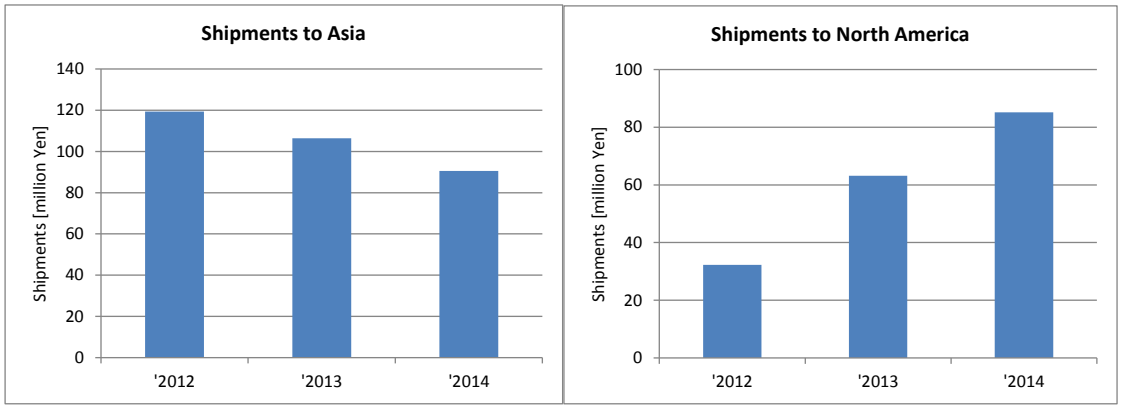
Figure 11.5 Regional Battery Shipments of Japanese Companies

Figure 11.6 below shows the most recent transition of export value to Asia and North America which are the major export destinations of lithium ion battery. In the last three years, Asia is declining and North America is in a rising trend. The difference of this transition is due to the trend of each industry.

In the breakdown of the lithium ion battery export to Asia, "small battery field" such as PC and mobile phones is the main market. In recent years, a downward trend happened because of the increase of Korean and Chinese companies.

On the other hand, in the breakdown of the lithium ion battery export to North America, although there are also consumer products as well as in Asia, the large part is in the "large battery field" such as automotive and industrial use. There is an increasing trend because of the expansion of the electric car and hybrid vehicles such as Tesla.

In Latin America, there are no features of such industry which utilizes lithium ion batteries, so the Japanese companies cannot export well at present. For this reason, it can be said that it is necessary to find a new application that can apply lithium ion battery particularly in order to export them to Central and South America from Japan.



Source: Prepared by the JICA Study Team based on the data of the Battery Association in Japan

Figure 11.6 Most Recent Shipments to Asia and North America

(4) Organization of the List of Leading Technology and Track Record of Japanese Companies

The JICA Study Team conducted interviews with the Japanese companies which have high sales share of batteries in Japan. According to the confirmation of each company, there is no company which has an achievement in Latin America. The battery type handled by each Japanese companies is shown in Table 11.2.

As for lead acid battery, it has a feature where its life does not decrease when used under deep depth discharge (mentioned below). Both Company A and Company F have this kind of batteries.

As for the lithium ion battery, Company B has been manufacturing it for vehicles and industry. Company C mainly manufactures it for small consumer use.

Table 11.1 Survey Results of Japanese Companies' Interest to Target Countries

Manufacturer	A	B	C	D	E
Colombia	○	△	×	△	×
Mexico	△	○	×	△	×
Costa Rica	△	△	×	△	×
Dominican Republic	○	△	×	△	×
Panama	○	△	×	△	×
Honduras	△	×	×	△	×
Guatemala	○	△	×	△	×
El Salvador	△	△	×	△	×
Nicaragua	△	×	×	△	×
Belize	△	×	×	△	×
Cuba	×	×	○	△	×
Jamaica	△	△	×	△	×
Dominica	△	×	×	△	△
Grenada	×	×	×	△	×
St. Lucia	×	×	×	△	×
Barbados	×	×	×	△	×
St. and the Grenadines	×	×	×	△	×
Antigua and Barbuda	×	×	×	△	×
St. Cristphor Navis	×	×	×	△	×
Haiti	△	×	×	△	×
Trinidad and Tobago	△	×	×	△	×
Venezuela	△	△	×	△	×
Guyana	×	×	×	△	×
Suriname	×	×	×	△	×
Brazil	×	○	×	△	△
Peru	○	○	×	△	×

Explanatory notes
◎ : Already active. There are the results
○ : Try to think about this positively
△ : Try to think about this
× : Totally unconcerned

Source: Prepared by the JICA Study Team based on the result of the interviews

Table 11.2 Battery Type of Each Japanese Companies

Lead acid batteries	Lithium ion battery
・Company A	・Company B
・Company F	・Company A
・Company G	・Company C
	・Company D
	・Company E
	・Company G

Source: Prepared by the JICA Study Team

(5) Quantitative Evaluation of Products of Japanese Companies

As for lead acid batteries and lithium ion batteries, the superiority of the quality of Japanese products is discussed below.

1) Lead acid batteries

Based on the information from Company F, Japanese lead acid battery is compared with common lead acid battery. Typical lead acid battery shortened its life when it repeats more than 50% of the discharge capacity. The ratio of the discharge amount per total capacity is called the depth of discharge. Lead acid batteries of Company F have the feature that the decrease of their life is small even for 80% depth of discharge by adding improvements to the electrode material of the battery. In the case of Company F, if they used 80% depth of discharge every time, they can work up to over two cycles relative to the normal lead acid battery. Also, the price is almost at the same level as the Western products. Thus, when they are used in this environment, they are very superior in terms of life cycle cost compared with the common lead acid battery.

It should be noted that the lithium ion batteries can also be used up to 100% of its capacity, but since the main benefit of lithium ion battery is the sudden discharge and fast charging, lead acid battery is more suitable than a lithium ion battery when it is used in an environment with large fluctuation range of charge and discharge such as in a solar plant, which has no steep charge and discharge but has a large range in a day. Especially in the case of overseas projects, lead acid battery is easy to install even by the local people. In the case of lithium ion batteries, peripheral equipment such as control circuit, fire extinguishing equipment, and ventilation equipment are required and this becomes complicated. These features that can withstand deep depth of discharge were observed in both two companies, namely, Company F and Company A.

As another feature of these two companies' products, there is a battery for idling stop system (ISS) cars. In recent years, the idling stop of automobile is promoted because of environmental consideration. But because the idling stop increases the frequency of discharge and recharge for battery, it shortens the battery life. Both companies also have this kind of battery for the ISS vehicles.

2) Lithium ion battery

Lithium ion batteries are used for various purposes, so it is difficult to simply compare their performance. Thus, the general features of the lithium ion battery when it is compared with lead acid battery are shown below (From the information of the catalogue of Company A).

- High energy density, small, and light as compared with the lead acid battery.
- Because of completely sealed structure, it does not release gas during use.
- Cycle characteristics are good.
- Charging efficiency is good so it is energy saving.
- Possible for rapid charging and large current discharge.

Taking advantage of these features, there is a wide variety of applications from batteries for small consumer products to large size battery for electric vehicles. In addition, the Korean manufacturers (Samsung and LG) have also actively manufactured lithium ion battery for consumer products in recent years. It causes the prices to fall. As mentioned above, the export amount to Asia has decreased. For this reason, the Japanese companies are required to make a difference, not only on quality but also on safety.

(6) Achievements and Strategy of Japanese Companies in Latin America

Activities of Japanese companies in Latin America and other overseas markets are shown below.

1) Application of lithium ion batteries to the telecommunication station

Two Japanese companies are considering the replacement of lead acid batteries with lithium ion batteries in the telecommunication stations which telecommunication companies own. As shown above, lithium ion battery is capable of rapid charging. Therefore, even if it is fully discharged in the event of power failure, it is possible to fully charge it immediately after power restoration. Where power failure happens frequently, there is no time to fully charge lead acid batteries so they are not reliable. In addition, as also mentioned above, repeatedly charging and discharging lead acid battery under deep depth of discharge will cause the battery life to shrink. For this reason, as a feature of the general Latin American telecommunication station, the reserve generator rises first in the event of a power failure (the lead acid battery serves as the backup when the fuel of the reserve generator has run out). By replacing the lead storage batteries with lithium ion batteries, it is possible for the lithium ion battery to cover only about three hours of power failure. This reduces the number of starts of the reserve generator, and to achieve a reduction in running costs. For this reason, there is a merit when it is applied in an unreliable electric power supply. For example, in Nicaragua and Dominican Republic, power failure often happens so they seem to be the target countries.

In addition, since the lithium ion battery can output a large current, it requires only small amount of installation in cases where many lead acid batteries are needed in order to output the necessary current value. For example, even if the price is 3-4 times more than that of lead acid battery, the installation capacity requires only 500 kW → 250 kW; thus, the price difference will be only 1.5 to 2 times, and because there are additional benefits of decreased running cost, it is expected that there is a merit for replacement.

Currently, the telecommunications companies in Latin America cover many countries in this region, so it is expected that the application area will spread quickly if Japanese companies can work with a particular telecommunications company in one of the countries.

Note that vehicles such as hybrid and electric vehicles can also use lithium ion battery. Tesla is an American electric car manufacturer that has procured 100% of its lithium ion batteries from

Japanese companies.

2) Lead acid batteries

Of the companies interviewed by the JICA Study Team, at least three companies have their respective factories in Asia such as in China, Taiwan, Thailand, Vietnam, and Indonesia. These are plants that mainly supply to car manufacturers, and car manufacturers also have factories in the same area.

3) Others

Other activities confirmed by the JICA Study Team are as follows:

- Some manufacturers produce a lot of lithium ion batteries for consumer products. In addition, this company has a collaboration with heavy electric manufacturers overseas, and delivers these batteries as an accessory of the power generation equipment.
- There is a storage battery used for the regenerative energy of train. But currently, there is no such project in Latin America.
- A certain company handles solar panels, and they are considering micro-grid for the island with these solar panels. It is said that it is considering the Caribbean.

11.3 Market Analysis

(1) Market Needs of the Storage Battery

The battery market demand and application are discussed below.

1) Uninterruptible Power Supply (UPS)

Uninterruptible power supply has been used where voltage drop and power failure for an instant are not allowed and where high power supply reliability is required such as for computer and communications, disaster prevention, and control equipment and broadcast equipment (central office, transmission plants and large-scale relay station). Additionally, there is a wide range of use for UPS such as for clean room, blast furnace control equipment, power plants, and air traffic control tower,.

Based on the World Bank data, Table 11.3 and Figure 11.7 respectively show the frequency of power outage and the ratio of reserve generator ownership in the target countries. If there are many power outages, UPS for backup seems to be highly required. Also, for those who own a reserve generator, the UPS is required to provide power until the start-up of the reserve generator. This means that the rate of owning reserve generator is related to the subsidiary UPS market. Among the target countries, Dominican Republic has remarkably high number of power failure at 17.7 times a month (2010 data) followed by Guyana and Nicaragua.

The same data by region of the world is also shown in Figure 11.8. It shows that the areas with higher frequency of power outage have higher ratio of owning reserve generator. However, when it

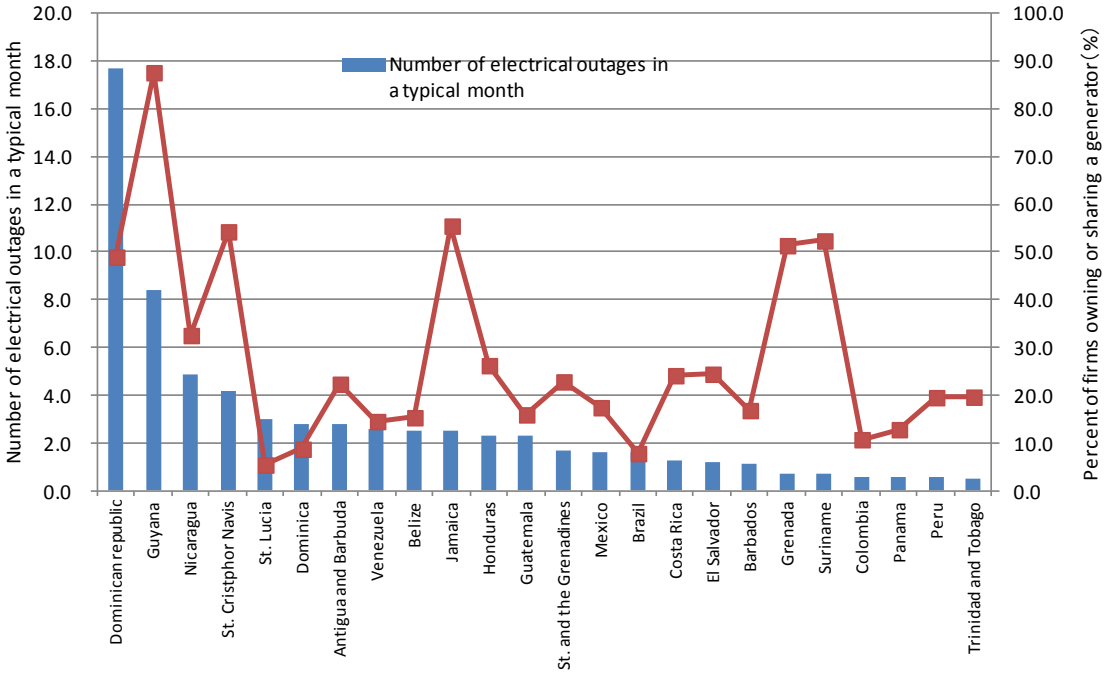
comes to the entire world, it can be said that Latin America does not encounter so high frequency level of power outage. Therefore, according to the manufacturer, it is considering actively another area such as Bangladesh.

Efforts of the two companies to replace the lead acid batteries of the telecommunication station with lithium ion batteries that are underway will make a higher merit when implemented in countries which have higher frequency of power outage.

Table 11.3 Power Failure Frequency and Rate of Reserve Generator Ownership of Firms in the Target Countries

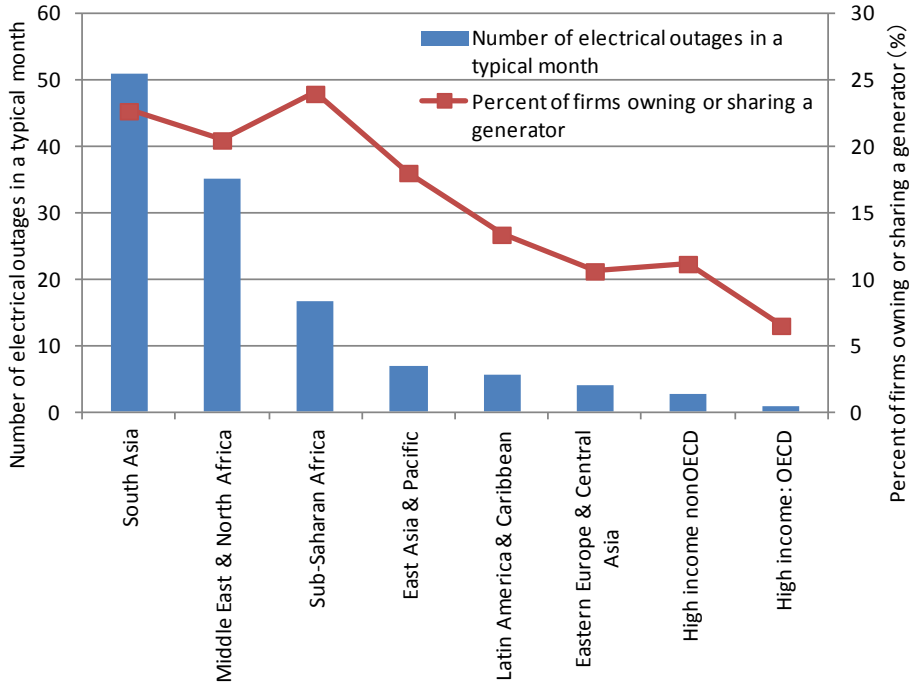
	the year of the data	Number of electrical outages in a typical month	Duration of a typical electrical outage (hours)	Percent of firms owning or sharing a generator	Remarks
Dominican republic	(2010)	17.7	3.1	49.0	
Guyana	(2010)	8.4	2.4	87.6	
Nicaragua	(2010)	4.9	3.1	32.6	
St. Cristphor Navis	(2010)	4.2	2.6	54.3	
St. Lucia	(2010)	3.0	2.1	5.5	
Dominica	(2010)	2.8	2.0	8.8	
Antigua and Barbuda	(2010)	2.8	1.9	22.4	
Venezuela	(2010)	2.6	1.1	14.6	
Belize	(2010)	2.5	1.4	15.4	
Jamaica	(2010)	2.5	1.3	55.5	
Honduras	(2010)	2.3	1.8	26.3	
Guatemala	(2010)	2.3	1.1	16.0	
St. and the Grenadines	(2010)	1.7	1.2	22.9	
Mexico	(2010)	1.6	2.6	17.5	
Brazil	(2009)	1.6	1.8	7.9	
Costa Rica	(2010)	1.3	0.8	24.2	
El Salvador	(2010)	1.2	1.2	24.5	
Barbados	(2010)	1.1	0.6	16.9	
Grenada	(2010)	0.7	1.6	51.4	
Suriname	(2010)	0.7	1.0	52.4	
Colombia	(2010)	0.6	0.8	10.8	
Panama	(2010)	0.6	0.3	12.9	
Peru	(2010)	0.6	0.7	19.6	
Trinidad and Tobago	(2010)	0.5	0.5	19.7	
Cuba					no data
Haiti					no data
Average		2.8	1.5	27.9	

Source: Prepared by the JICA Study Team based on the World Bank published data (http://data.worldbank.org/indicator/IC.ELC.OUTG)



Source: Prepared by the JICA Study Team based on the World Bank published data

Figure 11.7 Frequency of Power Outage per Month in the Target Countries



Source: Prepared by the JICA Study Team based on the World Bank published data

Figure 11.8 Regional Frequency of Power Outage and Rate of Firms Owning Reserve Generator in the World

2) Supply to Car Manufacturers

According to the lead acid battery manufacturer, three-fourths of the statistics of lead acid battery produced is said to be for vehicle application; deliveries to the automobile manufacturers are mainly lead acid batteries. The population of Latin America will increase in the future, so an increase in the number of vehicles is expected. It should be noted that the standards of battery are different between Japanese automobile manufacturers and overseas car manufacturers. It is necessary to supply the rechargeable battery that has combined standards to a particular manufacturer in the country where some overseas automotive manufacturers are dominant. At that time, the local battery factory should be established in Latin America, as described above.

3) Peak Cut by the Battery

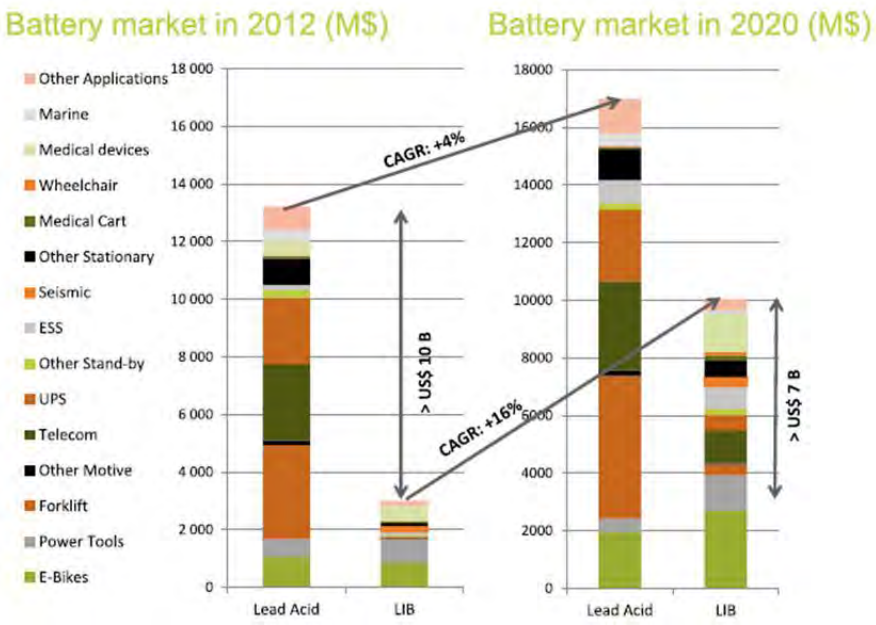
If the electricity cost is high and the system of the electric bill steps in, lowering of the basic rate of electricity bills through the peak cut of battery can be expected. However, as it has been verified in Japan, because it is difficult to return the investment only through peak cut, a set of solar power generation is expected.

4) Utilization Combined with Distributed Power to the Non-electrified Areas

Storage battery market includes a combination of renewable energy in the island and in the non-electrified areas. Non-electrified areas mentioned at the time of the power market becomes the market.

5) Other Utilization

In terms of other market potential, Avicenne ENERGY is predicting the non-vehicle application of batteries as shown in Figure 11.9 below. The descending order of market share in 2020 in the expected market is shown in Table 11.4. Based on these references, collaboration with companies which Japanese companies had no contact with seems to be worth considering.



Source:Avicenne

Figure 11.9 Forecast of Non-vehicle Battery Market

Table 11.4 Battery Marketing up to 2020 (Other than for Vehicle)

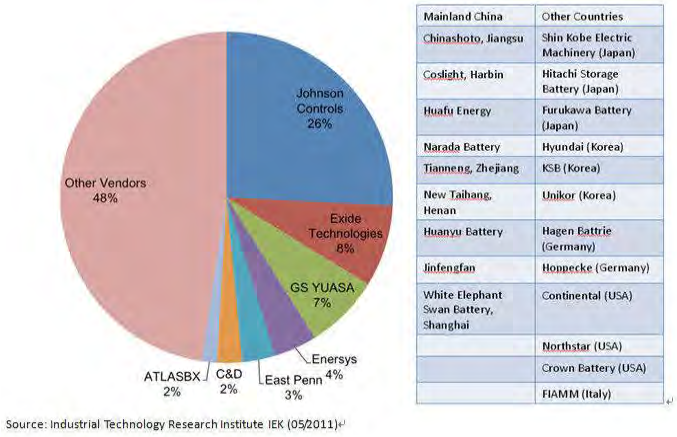
Lead Storage Battery	Lithium Ion Battery
・Forklift	・Electric bicycle
・Communication station building	・Medical equipment
・UPS	・Electric tool
・Electric bicycle	・Telecommunication station

Source: Prepared by study team on the basis of the Avicenne article

(2) Evaluation, Demand, and Awareness of Japanese Products

In the countries where the JICA Study Team conducted a field survey, the recognition of batteries was confirmed. Since only the battery itself is hard to configure, confirmation of recognition is difficult. Also, because there is almost lead acid battery market, the following mostly discusses lead acid batteries. As a result, lead acid batteries are mostly procured from local manufacturers in each country, because it is not a particular product which requires a high quality. However, recognition of Japanese companies is low.

The following Figure 11.10 shows the share of each manufacturer in the lead acid battery market in 2010. The category "Other Vendors" has the highest share of almost 50%, which indicates that there are various sales made by local manufacturers.



Mainland China	Other Countries
Chinashoto, Jiangsu	Shin Kobe Electric Machinery (Japan)
Cosligh, Harbin	Hitachi Storage Battery (Japan)
Huafu Energy	Furukawa Battery (Japan)
Narada Battery	Hyundai (Korea)
Tianneng, Zhejiang	KSB (Korea)
New Taihang, Henan	Unikor (Korea)
Huanyu Battery	Hagen Battrie (Germany)
Jinfengfan	Hoppecke (Germany)
White Elephant Swan Battery, Shanghai	Continental (USA)
	Northstar (USA)
	Crown Battery (USA)
	FIAMM (Italy)

Source: Sunlight

Figure 11.10 Share of Battery Market

1) Brazil

According the interview with the Brazilian solar power design and installation company Neosolar, they do not set battery in the system. This is because the company's target is a system of self-consumer in the electrified region. On the other hand, it is always necessary to introduce a battery to introduce photovoltaic generation to the non-electrified areas. According to the interview with Company A, which has introduced many photovoltaic generations in many non-electrified areas in Brazil, the manufacturer of battery which it usually procures is the local manufacturer Enersystem Inc., which is based in Argentina. This is the same as the information from Company F. Thus, it is consistent that general batteries tend to be purchased from local manufacturers. The reason why Company A choose this manufacturer is that their support to customers is good, their quality is also good, and there is no problem in delivery. At the time of selection, Japanese companies are included in their options. This is a very important opinion. Enersystem Inc. is a company with a track record of more than 20 years in Latin America, but it does not appear in the abovementioned figure. This means that they are belonging to the "Other Vendors" category in the whole world share. However, even such local manufacturer can fully satisfy the quality for practical use of lead acid batteries. For a Japanese manufacturer, it is difficult to beat such local manufacturer in terms of price, service, and delivery, even if its batteries have excellent quality compared to local batteries.

Also, in recent large-scale case, such as highway illumination with photovoltaic generation by Company A, they procured from Johnson Controls and Mora. Although Johnson Controls is an American company, they have offices in Brazil. Mora Company is based in Brazil, and has covered the whole Mercosur and part of European.

As an additional information, EMAC Inc., which is a maintenance company for industrial and commercial facilities, recognizes the US products (manufactured by EATON Corporation) for UPS.

2) Peru

As a result of the interview with the local office of Company B, three local manufacturers (CAPSA, RECORD, and ETNA) were mentioned. As for the foreign company, they mentioned GS Yuasa (Japan), DEKA (USA), and BOSCH (Germany) .

3) Colombia

EPM has recognized Japanese battery. They said that they are easy to maintain even if they have expensive price. In addition, the end users of Company B in Colombia have no battery because it is a self-consumption system.

(3) Matching the Marketability of the Target Countries and Japanese Companies' Interest

The JICA Study Team tried to conduct matching between the Japanese companies and the marketability based on the abovementioned power failure occurrences per month, ratio of owning reserve generator, and additional data of diesel unit price. However, because of the originally low achievement and interest of Japanese companies, it is not matched well. Dominican Republic and Nicaragua are superior in terms of frequency of power outage and marketability is consistent with the manufacturer's comments. Additionally, Honduras, Nicaragua, Jamaica, Guyana, and Venezuela seem to be good candidates to consider.

These countries are also considered as priority for the battery replacement of telecommunication station. In the case of telecommunication station, it is necessary to consider the size of land area because it seems to be proportional to the number of station.

For other cases, such as micro-grid in combination with photovoltaic generation, the Caribbean Islands have higher electricity costs and installation demands seem to be high, as mentioned before. For other applications, such as electric bicycles and medical equipment mentioned above, priority will be determined based on the population.

Table 11.5 Matching of Marketability and Interest of Japanese Companies

Countries	Marketability	Stability of grid		Pump price for diesel fuel (USD/L)	Acheivements and interest of Japanese companies					Matching	Remarks
	Popuration [million people]	Number of electrical outages in a typical month	Percent of firms owning or sharing a generator		A	B	C	D	E		
Colombia	80	0.6	10.8	1.04	○	△	×	△	×	○	
Mexico	120.6	1.6	17.5	1.02	△	○	×	△	×	○	
Costa Rica	4.9	1.3	24.2	1.21	△	△	×	△	×	△	Large population, ratio of owning generator and fuel price are high.
Dominican republic	10.4	17.7	49	1.21	○	△	×	△	×	○	Large population, the number of outage, ratio of owning generator and the fuel price are high.
Panama	6.9	0.6	12.9	0.85	○	△	×	△	×	○	
Honduras	8.2	2.3	26.3	1.03	△	×	×	△	×	△	Large population, the number of outage and the ratio of owning generator are high.
Guatemala	15.8	2.3	16	0.9	○	△	×	△	×	○	
El Salvador	6.4	1.2	24.5	1.02	△	△	×	△	×	△	Large population, ratio of owning generator is high.
Nicaragua	6.2	4.9	32.6	1.04	△	×	×	△	×	△	Large population, the number of outage and ratio of owning generator are high.
Belize	0.3	2.5	15.4	–	△	×	×	△	×		
Cuba	11.3			1.2	×	×	○	△	×	○	
Jamaica	2.8	2.5	55.5	1.06	△	△	×	△	×	△	Large population, the number of outage and the ratio of owning generator are high.
Dominica	0.1	2.8	8.8	–	△	×	×	△	△		
Grenada	0.1	0.7	51.4	–	×	×	×	△	×		
St. Lucia	0.2	3	5.5	–	×	×	×	△	×		
Barbados	0.3	1.1	16.9	1.44	×	×	×	△	×		
St. and the Grenadines	0.1	1.7	22.9	–	×	×	×	△	×		
Antigua and Barbuda	0.1	2.8	22.4	–	×	×	×	△	×		
St. Cristphor Navis	0.1	4.2	54.3	–	×	×	×	△	×	△	The number of outage and the ratio of owning generators are high.
Haiti	10.4			0.94	△	×	×	△	×		
Trinidad and Tobago	1.3	0.5	19.7	–	△	×	×	△	×		
Venezuela	30.8	2.6	14.6	0.008	△	△	×	△	×	△	Large population, the number of outage is high.
Guyana	0.8	8.4	87.6	1.11	×	×	×	△	×	△	The number of outage, ratio of owning generator and the fuel price are high.
Suriname	0.5	0.7	52.4	1.34	×	×	×	△	×	△	The ratio of owning generator and fuel price are high.
Brazil	201.5	1.6	7.9	1.02	×	○	×	△	△	○	
Peru	30.6	0.6	19.6	1.17	○	○	×	△	×	○	

※ As for population, yellow cell indicates more than 1 million people, the red cell indicates more than 10 million people.
As for "Number of electrical outages in a typical monthMonthly power outage", yellow cell indicates more than twice , red cell indicates more than four times.
As for Generator ownership rate, the yellow cell indicates more than 25 percent, the red cell indicates more than 50%.
As for Diesel prices, the yellow cell is more than 1.1USD/L , the red cell is more than 1.2US
The ○ in Matching is with red or yellow cell in any of Marketability, Stability of grid or Pump price for diesel fuel and also with interest of any manufacturers.
The △ are the countries which does not obtain the interest of manufacturers despite they are expected the potential.

Source: Prepared by the JICA Study Team on the basis of the abovementioned data and hearing result

11.4 Identification and Analysis of Bottle Necks

The bottlenecks for Japanese products' expansion in the countries are discussed below.

(1) Technical Challenges

The standards of battery for motor vehicles are different. There is no problem in Asia because it is under JIS standard. There are problems of partnership with the car company for delivery.

Also, lead acid batteries are technically mature products, so local products are distributed well. Therefore, some of the strength in terms of the charge-discharge characteristics, which are different between the local lead acid batteries and those of Company A and Company F, should be promoted in terms of the benefits and should be recognized.

(2) Market Challenges

Although commercial power supply in Latin America cannot be said to be stable as compared with developed countries, it is more stable than Asia and Africa. For this reason, battery manufacturers consider the countries to be of lower priority than other countries as UPS sales destination.

Furthermore, in terms of technical recognition in the market, there is a possibility that it is not recognized that the life cycle cost becomes high when the battery discharges 50% or more for lead acid battery. (Low life might have been generalized.) As mentioned above, Japanese products can withstand deep depth of discharge and this needs to be recognized.

Despite having their factory in Asia, Japanese battery manufacturers have not taken similar measures in Latin America. Because the growth of population and economy can be expected to increase significantly in Asia at present, they focus more in Asia.

On the other hand, if they do not have a local factory, they have no choice and they can sell batteries only by export, normally by shipment. It is difficult to beat a local company in terms of delivery time, customs, and transportation expenses.

(3) Financial Issues

When combined with storage batteries and photovoltaic generation, payout time is longer. In the case of Japan, there are many users who attach a storage battery to photovoltaic generation. In some countries in which the interest rate is high, it seems to avoid additional initial cost.

11.5 Consideration of Support Measures

The possibility of a new application of battery and other support measures are discussed below.

(1) Effort of Japanese Companies

1) Expanding the target of the telecommunication station

The two Japanese companies are trying to approach a communication company which is considering the application of lithium ion batteries to its telecommunication station. In addition to telecommunications companies, the power companies and the Waterworks Bureau have a lot of stations. In addition, dams also have a lot of stations for the alarm of

discharge. In order to alarm the whole downstream basin at the time of discharge from the gate, the dam has a number of stations with siren along the downstream of the river. In the case of the dam, it also has stations for the water level observation at the upstream. In addition, Latin America has many hydroelectric power, but the number of dams are not so many. The number of dams in the country is shown below for reference. For more information, there are about 23,000 dams in China, 9,000 dams in America and 3,000 dams in Japan.

Table 11.6 Number of Dams in the Target Countries

Countries	The number of dams
Brazil	1392
Mexico	572
Venezuela	76
Peru	67
Colombia	62
Panama	21
Dominican Republic	14
Costa Rica	11
Honduras	10
Guatemala	4

Source: Prepared by the JICA Study Team on the basis of the International Commission on Large Dams published data

2) Micro grid

As mentioned in the section on photovoltaic generation, the Caribbean has a high electricity cost, so renewable energy is required. There is a room to take advantage of the storage battery as system stability and independent power.

3) Train regenerative energy storage battery

During train stoppage, a train has a system for regenerating kinetic energy into electrical energy, so the battery is required to save energy. With the spread of the train in emerging countries, it may be possible to deliver the battery with this system.

4) Uninterruptible power system

For the sales of UPS itself, it should be recognized by local customer. As mentioned before, the Japanese company should have an office in a region where power outage frequently occurs, or find a local sales partner.

5) Establishment of new factory

It is also possible to set up a local factory if certain sales channels such as automotive and uninterruptible power supply are expected. If you want to increase sales from the factory, there is a need to consider the size of the market from the viewpoint of Mercosur and Pacific

Ocean Alliance.

6) Other applications

As for other applications such as electric bicycles, medical equipment, power tools, and forklift, partnership with new industries is important.

(2) Study of Finance Measures

In the application of the lithium ion battery to the telecommunication station, the scheme which is similar to ESCO is obtained by using the scheme of MSEF. An example is shown below. Unit price is assumed based on the manufacturer's information. It is set at JPY 1 million per station. It is assumed that the investment can be recovered in four years by energy-saving of fuel and maintenance cost reduction of reserve power generation, as well as better efficiency of the charge and discharge by changing from lead acid batteries to lithium ion battery. Thus, it is assumed to achieve a cost saving of JPY 250,000 per year for a end user. MSEF funds were leveraged for a bundle of 100 places, and the initial investment is zero through the replacement to lithium ion batteries. Then, 90% of the cost-saving margin of the year will be repaid to MSEF. Conditions of the MSEF are shown below. As a result, the internal rate of return (IRR) is 17%, and this satisfies the criteria of MSEF.

Initial investment	JPY 100 million (JPY 1 million × 100 places)
Payment to MSEF per year	JPY 22.5 million (JPY 250 000 × 100 locations × 90%)
Contract period	10 years
IRR of MSEF	17% (Without deducting related costs and expenses)
Business benefits	Saving annual cost of JPY 2.5 million (JPY 250,000 × 100 places × 10%) without initial investment and reduction of environmental load

(3) Institutional Measures

As mentioned, there is a tendency for local manufacturers to distribute lead acid batteries, but some US products are recognized in Latin America. Japanese companies mentioned that some of them have plants in Latin America, and some of them expand their market by direct FTA. The FTA expansion into Latin America countries is also required in Japan.

In addition, preferential treatment for CO2 reduction companies may be effective. When there is a system to subsidize sales of idling stop cars, Japanese lead acid batteries for the ISS vehicles might be considered. The population is large in Latin America, so the number of vehicles is also big. For this reason, there are some cities that are chronically congested. For the improvement of the recent environmental consideration, the idling stop vehicle can be sold, and it is believed that the demand of lead acid battery suitable for this kind of ISS car will increase.

If there are the same incentives to reduce CO2 emissions for each company, telecommunications companies might also become positive to replace lithium ion of telecommunication station. For example, in the case of Bangladesh, because thermal power generation is the main power source in the country, even when not using the reserve generator of the station, the charging of the lithium ion battery is carried out through thermal power generation. This means that the CO2 reduction effect is small (strictly speaking, the difference of efficiency between the reserve generator and the thermal power plant will determine the CO2 reduction). On the other hand, the main power source in Latin America is hydropower generation, so when the reserve generator is not required to work, CO2 reduction is remarkable by replacing lithium ion of telecommunication station. For this reason, if there are some benefits by reducing CO2 emissions, more telecommunication companies which are large companies with many stations might become active to be involved in this effort.

12 Others

12.1 Wind Turbine

(1) Activities of Japanese Companies

Wind turbines are an excellent Made-in-Japan solution for the renewable energy sector. The primary characteristic of a wind turbine is that it can generate electricity during the nighttime or on a rainy day so long as there is wind, compared to solar panels, which only function on sunny days.

Wind turbines are roughly categorized into three classes based on the diameter of the windmills: LARGE (diameter > 60m, output > 1MW, for grid-tie in wind parks), MIDDLE (diameter = around 20m, output = around 100kW, for grid-tie in wind parks), SMALL(diameter = around 2m, output = around 1kW, for stand-alone use). In Japan, there are manufacturers such as Manufacturer A, famous in the heavy-industry sector for the LARGE class, and ventures such as Manufacturer B for the SMALL class. (At present no manufacturers in Japan produce the MIDDLE class of turbines, but foreign wind turbines imported from overseas are used even in Japan.

The two manufacturers were interviewed and explained their current market situations as follows:

1) Manufacturer A: had been manufacturing wind turbines for ground installation in the past, however, they are now shifting to high value-added floating types for installation in the ocean, due to recent intense price competition with Chinese and/or Korean manufacturers. Therefore, they do not have any near-future plan for marketing/sales in the Central/South American market, where ground installation type is primarily required, even for off-shore sites. In any case, there is only one sales record in this market: a 450kW wind turbine for Peru in 1997.

2) Manufacturer B: is a well-known wind turbine venture with 1.7 billion Yen invested in it by the Innovation Network Corporation in Japan (INCJ, a PPP fund). Its flagship model, the "Airdorphin" series, was borne from an industry-academia-government collaboration, and its outstanding small-size, lightweight, high-output, and low-noise character is well known in the world. Manufacturer B's current main target is the domestic market in Japan, as well as the US market. This manufacturer has been awarded with the H25 Ministry of Foreign Affairs ODA Overseas Economic Cooporation (Assistance for Developing Countires by Utilizing Japanese Technology), Project Name: Preliminary Survey in Kenya for Electrification of Off-Grid Villages with Small Wind Turbine and Cellular-Phone Base Station). Although only Manufacturer B, among other wind turbine ventures, has an authorized distributor in Central/South America, the distributor in Brazil has no sales record yet since its establishment five years ago.

Source: Company B

Figure 12.1 Airdorphin Mark-Pro made by Manufacturer B

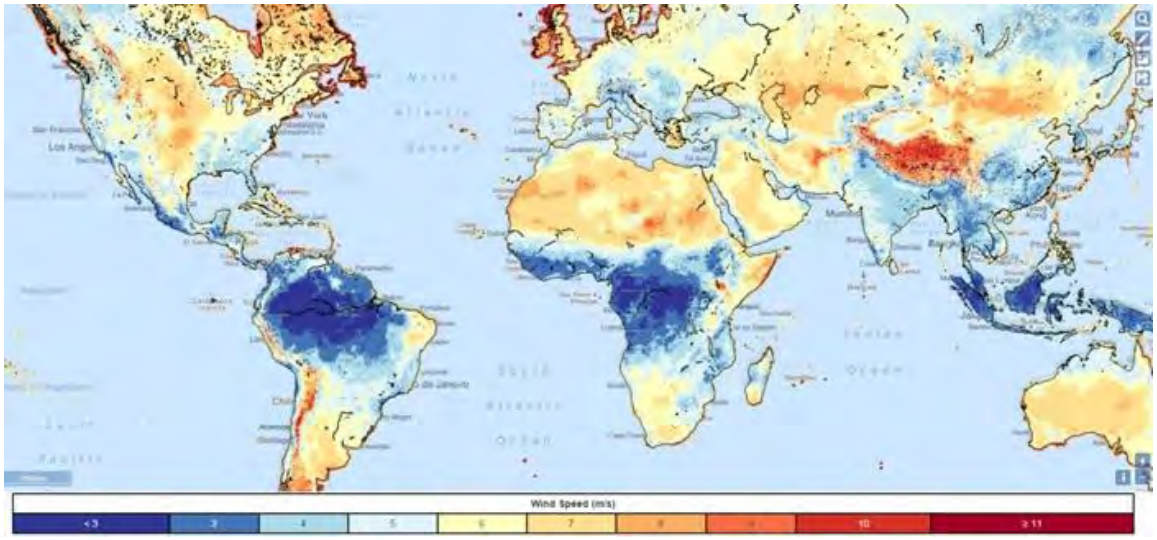
(2) Market Analysis

The wind conditions in the world, including Latin America, are indicated in the chart below.

As evidenced in the chart, the northwest corner of Brazil is suitable for wind-powered electricity generation due to its stronger wind speeds as compared to other areas in Brazil. In this area, the LARGE-class wind turbines of European manufacturers, such as Germany and Spain, as well as manufacturers from China and Korea, have captured the majority of the market share.

In Colombia, there is an area with good wind speeds along the shore facing the Caribbean Sea, and a Medellin-based electric power company, EPM : Empresas Publicas de Medellin, is trying to plan a development of wind parks.

An area with good wind conditions along the Peruvian shore is not yet well-developed for wind power generation.



Source: DTU (Denmark Technology University)

Figure 12.2 World Wind Conditions (Speeds)

(3) Identification and Analysis of Bottle Necks

The business decision made by Manufacturer A to shift their business focus from ground use wind turbines to ocean use ones (in order to exploit their strengths), should be respected. Therefore, it is not adequate to promote Japan-made wind turbines in the Latin American market of LARGE-class wind turbines with MW outputs required in windparks for renewable energy auctions.

According to our interview with an authorized distributor of Manufacturer B's wind turbines, the reason why there have been no sales for five years seems to be because of an inappropriate selection of the distributor. The original business of the distributor was the sale of medical electronics, and the marketing and sales of the wind turbine is just a side-business during their leisure time. This distributor was chosen based on the personal connection to the founder of Manufacturer B, because there is no other connection in the renewable energy sector in the Latin American market. It seems that the technical background and necessary knowledge between the wind turbine and medical electronics are too different for efficient promotion.

(4) Consideration of Support Measures

1) Combination with products in other categories

The wind turbine of Manufacturer B has been adopted as the primary component in the "Solar Wind Hybrid Street Light" developed by Lighting Manufacture C (described in the Chapter 9). Even if it is difficult for wind turbines to penetrate into the market as a standalone product, it seems efficient and effective to sell them through LED lighting channels as a combined product integrated with LED lighting and solar panels. The necessary knowledge for distributors should be more similar because the sectors are closely-related.

Marketing to cellular phone base stations in unelectrifed rural areas by combining the units with batteries (described in Chapter 11) as well as solar panels (described in Chapter 10), and through their associated sales channels, is also a viable alternative.

2) Utilization of JICA and/or MOFA scheme for Small/Medium business promotion

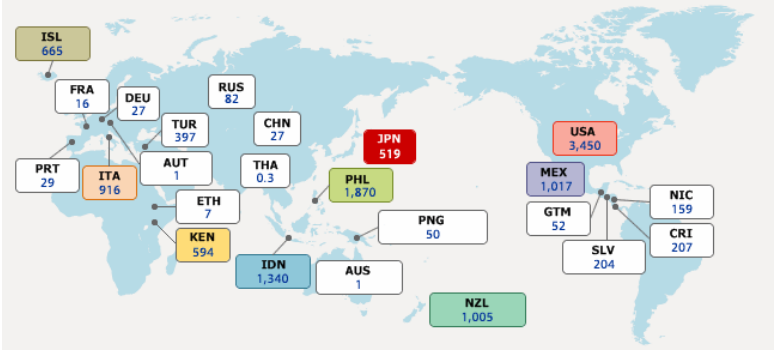
As described in the previous section, there is a similar heritage in Kenya, and it seems effective for marketing by utilizing a JICA and/or MOFA scheme for small/medium business promotion in Latin America, in order to demonstrate the product in real situations, and to improve the exposure and awareness of the brand, and then finally, to launch a project with a significant number of wind turbines by applying the renewable energy promoting fund.

Figure 12.3 Solar Wind Hyblid Street Light made by Manufacturer C

12.2 Traditional and Small Geothermal Power Generators

(1) Market Analysis

As for the current utilization of geothermal power generation in Latin America, according to the "Geothermal Power Generation in the World 2010-2014 Update Report," five countries (Mexico, Guatemala, El Salvador, Nicaragua, and Costa Rica) have already been operating geothermal power generation facilities, and seven others (Argentina, Bolivia, Chile, Commonwealth of Dominica, Ecuador, Honduras, and Peru) will start operation by 2020. JICA is assisting in several ways in Peru, Guatemala, Costa Rica, Nicaragua, and Bolivia.

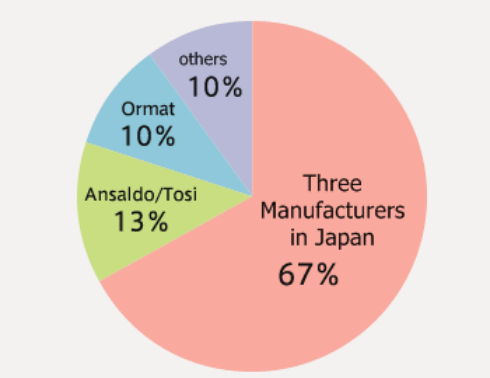


Source: Japan Geothermal Association

Figure 12.4 World Geothermal Power Output

(2) Activities of Japanese Companies

According to the older edition "Geothermal Power Generation in the World 2005-2010 Update Report," three manufactures in Japan, (Toshiba, Fuji Electric, and Mitsubishi Hitachi Power Systems), have 70% of the world market share of geothermal turbines, which are the heart of geothermal power generation plants in widely-used single-flash configurations in which "turbines directly driven by high-temperature steam [are] sprung out from the ground." Therefore, the global competitiveness of Japanese manufacturers is very high, and the three companies dominate the existing market in Mexico, Guatemala, El Salvador, Nicaragua, and Costa Rica.



Source : Japan Geothermal Association

Figure 12.5 Global Production of Geothermal Power Turbines

Small geothermal power plants/turbines, such as the 100kW class with binary configuration using lower boiling-point secondary medium adequate for lower temperature heat sources, are not the major product line of the three big companies previously mentioned. Therefore, some ventures and/or other companies, which are not in the geothermal business are domestically and globally trying to enter the market.

According to the interview with such company with relatively larger size, they are now still in R&D phase in Japan and their product is not ready for global market yet. It seems it takes a little bit more time for Japan-made Small Geothermal Power Plant/Turbine to go overseas market actively.

(3) Identification and Analysis of Bottle Necks

According to "Japan Geothermal Association," the procedure to construct Geothermal Power Plant is as follows and it takes 10 or 15 years to start operation.

The Renewable Energy Promotion Fund can invest only in equipment acquisition. Therefore, it is very difficult/unrealistic to find such a big risk-taker to develop geothermal resources among private enterprises. Establishment of a public support system for exploration of steam sources is the top priority.

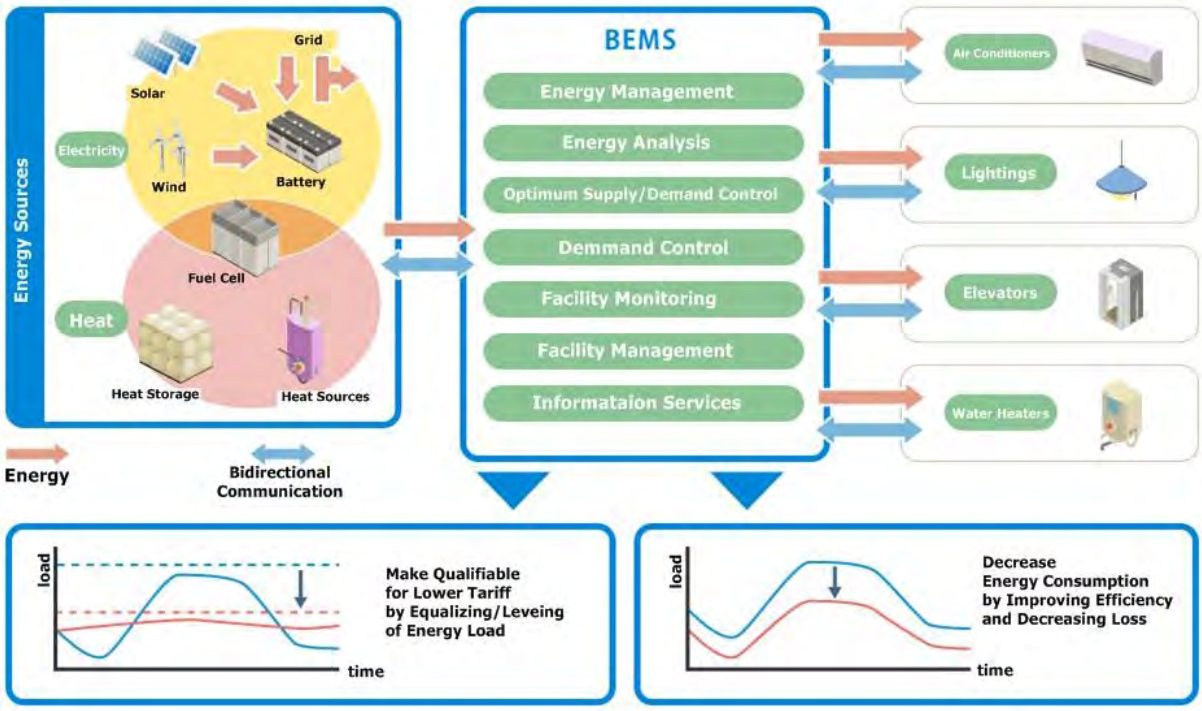
⇒ **Surface Survey (1-3 years)**
⇒ **Survey by Drilling Trial Well (2-3 years)**
⇒ **Business Feasibility Survey (0.5 years)**
⇒ **Environmental Assessment (4 years)**
⇒ **Drilling Well and Plant Construction (3-5 years)**

12.3 BEMS

(1) Overview of BEMS

BEMS （Building Energy Management System） are integrated systems composed of effectively-combined renewable energy sources, energy storage systems, energy-saving equipment, and a system to manage energy consumption of the entire building or facility.

A BEMS visualizes the real-time status of energy consumption, analyzes the accumulated data from multiple aspects, and automatically and autonomously switches and controls optimum operation modes of each piece of equipment in the facility. BEMS optimize energy consumption of the entire building/facility, improve energy efficiency, decrease energy cost and or CO2 emissions, and continuously decrease the environmental load and vitalize energy-saving activities.



Source : Fuji Electric

Figure 12.6 Concept of BEMS

Renewable energy sources such as solar panels and/or wind turbines, energy reservoirs such as batteries and/or heat storage tanks, and energy-conservation equipment such as energy-efficient lightings and/or energy-efficient air conditioners are combined and connected to a central controller of BEMS via a bi-directional communication system, in order to restrain the peak levels of power consumption by leveling/equalizing the energy load and consumption.

Especially in Japan, as the tariff for commercial-scale utility customers depends not only on the total consumption but also the peak power consumption, there are several types of BEMS available from Azbil, Hitachi, Mitsubishi Electric, Toshiba, and Fuji Electric suitable for various facility sizes.

The significance of BEMS resides in not only energy-saving effects based on the BEMS itself, but also enlarging the size of the project/investment as a system package for the Renewable Energy Promotion Fund by involving/combining various technologies/products for energy-saving and renewable energy, with the BEMS as the core.

(2) Activities of Japanese Companies

MSEF sent inquiries to one of the BEMS manufacturers in Japan. Their reply to our interview about their frameworks for marketing, sales, maintenance, sales record, and competitiveness are as follows. It seems very typical for manufactures in Japan and seems to be a practical model.

1) Fundamental Policy

- Prioritize the countries with MSEF investment records
- Prioritize English-speaking Caricom countries
- Prioritize JCM-applicable countries
- Deprioritize Spanish-speaking countries not included above
- Deprioritize oil-producing countries

2) Principal Strategy

- Collaborate with MGM-Es, which is an ESCO company in Latin America under the MGM group, in order to exploit projects.
- EMS business is planned/operated in Japan, exported to Latin America, and sold through the North American branch.
- Outsource after-purchase services of EMS equipment to MGM-FS.
- Improve brand-awareness by providing solutions instead of just products.

3) Challanges

- No sales branches in Latin America.
- High language barrier in Spanish-speaking countries.
- No experiences in system-business, such as EMS, in North American branch.

13 Implementation of the Orientation Meeting

In this study, in addition to the above study, the JICA Study Team conducted orientation meetings in the three countries, i.e., Peru, Colombia, and Brazil. The results are shown below.

13.1 Implementation Contents

Among the target countries of this study, the JICA Study Team conducted the orientation meetings in Peru, Colombia, and Brazil to introduce COFIDE and MSEF as well as Japanese technology and products. In the orientation meeting in each country, the JICA Study Team basically recruited presenters from the Japanese companies which have local offices in the countries. In the morning, company presentations were conducted and the financial schemes of COFIDE and MSEF were introduced. Then in the afternoon, Japanese companies, COFIDE, MSEF and general participants have respective business meetings to make opportunities for future projects and cooperation. In addition, a questionnaire was given to the participants of the orientation meeting.

Table 13.1 Contents of the Orientation Meeting

Date/City/Venue	Co-host	Presenters/Theme		Registration / participants	The numbers of business meetings	
October 22 , 2015 (Thursday) Lima, Peru Hotel Jose Antonio Miraflores	JICA COFIDE CCPJ	JICA COFIDE Daikin Mayekawa Panasonic	Opening remarks Financial scheme Air conditioner Industrial refrigirator LED lighting	116 people /60 people	JICA COFIDE Daikin MYCOM Panasonic **Total**	6 6 2 2 8 26
October 29, 2015 (Thursday) Medellin, Colombia Hotel San Fernando Plaza	JICA MGM Innova	JICA MGM Innova UPME Daikin MYCOM Panasonic Toshiba	Opening remarks (only voice) Financial scheme For EE and RE legislation Air conditioner Industrial refrigirator Photovoltaic generation High-efficiency motors	96 people /76 people	MGM Innova UPME Daikin MYCOM Panasonic Toshiba **Total**	3 4 4 2 3 3 19
November 10, 2015 (Tuesday) Sao Paulo, Brazil Hotel Golden Tulip Paulista Plaza	JICA MGM Innova ABESCO	JICA MGM Innova ABESCO Daikin Industries Fujitsu General Hitachi Kyocera MYCOM Miura Fuji Electric Omega Light	Opening remarks Financial scheme Energy efficiency Air conditioner (VRF) Air conditioner (RAC) Air conditioner (Chiller) Photovoltaic generation Industrial refrigerator Energy-saving boiler BEMS LED lighting	129 people /98 people	JICA MGM Innova ABESCO Daikin Industries Fujitsu General Hitachi Kyocera MYCOM Miura Fuji Electric Omega Light **Total**	1 3 10 1 2 1 5 2 1 3 4 33

Source: Compiled by the JICA Study Team

13.2 Result in Peru

(1) Overview

Date and time: October 22, 2015 (Thursday)
Host cities: Lima
Venue: Hotel Jose Antonio, Miraflores
Co-host: JICA, COFIDE, CCIPJ

(2) Result

There are 116 people listed in the registration, 60 of whom are the participants for that day. Presenters are as follows. COFIDE made a presentation to the audience about their financial scheme and three Japanese companies introduced their energy efficiency and renewable energy products.

Table 13.2 Presenters in Peru

Presenter	Theme
JICA	Opening remarks
JICA Study Team	Outline of the study
COFIDE	Financial scheme
Daikin	Air conditioner
MYCOM (Mayekawa)	Industrial refrigerator
Panasonic	LED lighting

Source: Compiled by the JICA Study Team based on the interview

In the business meetings in the afternoon, a total of 26 meetings have been conducted. Specific contents are as follows. Each companies has implemented business meetings which have the possibilities to lead their future projects. The future progresses of these projects are expected.

- The number of meetings of Daikin Industries was 2. After this day, the seminar attendees of Daikin Industries mentioned that there are some projects that will utilize COFIDE and it will proceed as a pilot project through the initiative of the JICA Peru Office.
- Mayekawa had three meetings. Meat processing plants, seafood processing plants, and seafood cold storage warehouse require M-type and J-type high-efficiency compressors. Meeting partner was a good customer of Mayekawa and it mentioned that it would like to utilize COFIDE scheme if it is applicable to its project.
- Panasonic had two meetings about LED lighting. First meeting is the application of LED to school and second is about the LED application in the rural area in combination with photovoltaic generation.

Company Presentations　　Business Meetings

Figure 13.1　Photos of the Orientation Meeting in Peru

(3)　Results of Questionnaire

Comments on COFIDE and Japanese companies are shown below. There are many praise comments to Japanese companies. On the other hand, there are many comments that point out the ambiguity of the financial scheme of COFIDE. It can be said that COFIDE needs to improve its explanation method to expand its scheme more in the future.

Table 13.3　Answers in the Questionnaire in Peru

Company name	Comments to COFIDE	Comments to Japanese campanies and products
LAPC GROUP SAC	It's necessary that banks make a commitment to grant the final user any JICA effort, as it relates to fees and time.	
Grupo TZ SAC	Interesting, this plan needs to be more spreaded.	Innovative products, specially energy efficiency matters.
Ajinomoto del Peru	It's not yet defined if which Financing Intermediary Institution will participate.	2 out of 3 supplier presentations were interesting and with possibilities.
Sudesco Energy SAC	It's necessary to involve financing institutions as soon as possible.	Excellent
RTI Reftec	Very interesting	They are good and it's necessary to get to know the technical criteria for the application.
ANEPAP	Good but it's necessary to get further information (technical assistance, rates and guarantee).	Good, specially MYCOM and Panasonic
CENERGIA	More difussion, more detailed information for the business sector.	Very good, improve difussion for public and general audience.
Inversiones MK Proyectos y Soluciones SAC	It seems very beneficial for small and medium enterprises.	Good equipment.
TERMO Sistemas	It's not clear how banks will participate with the 50% of the investment.	Technologies of Japanese manufactures is very interesting.
CCIPJ	How to define a first-tier bank?	
CANPRODEM	Lack of information on the participation of banks to assess the feasibility of the financing scheme.	Very good, information on costs was not addressed.
MYCOM PERU SAC	Informatio about the scheme is not very clear; I think that the IFIs perhaps do not offer good benefits (competetiveness)	

Source: Compiled by the JICA Study Team based on the answers to the questionnaire

13.3 Result in Colombia

(1) Overview

Date and time： October 29, 2015 (Thursday)
Host cities： Medellin
Venue： Hotel San Fernando
Co-host： JICA, MGM Innova

(2) Result

There were 96 people listed in the registration, 76 of whom are the participants for that day. Presenters are as follows. MGM Innova made a presentation to the audience about their financial scheme and 4 Japanese companies introduced their energy efficiency and renewable energy products.

Table 13.4 Presenters in Colombia

Presenter	Theme
JICA	Opening remarks (voice only)
JICA Study Team	Outline of the study
MGM Innova	Financial scheme
UPME (Mining and Energy Planning Unit)	For energy efficiency and renewable energy legislation
Daikin	Air conditioner
MYCOM (Mayekawa)	Industrial refrigerator
Panasonic	Photovoltaic generation
Toshiba	High-efficiency motors

Source: Compiled by the JICA Study Team based on the interview

In the business meetings in the afternoon, a total of 19 meetings have been conducted. Specific contents are as follows. Each companies conducted business meetings with local end-users. It is expected that these meetings will lead their future projects and to utilize the MSEF scheme.

- The person in charge of Daikin Industries mentioned that they gained contact with important companies in the energy sector which they do not have contact at present, so it was very meaningful.
- As for Mayekawa, the equipment design company asked them about the introduction of energy-saving refrigeration system to the energy-saving refrigerated warehouse to correspond with LEED that they are designing now. They are interested in the high efficiency direct

refrigeration system, NewTon, which is still not introduced in South America. They are considering to introduce it now. They are also considering the possibility of utilizing MSEF.

- Panasonic had three meetings about photovoltaic generation with the Colombian Power Corporation, a local design and installation company of photovoltaic generation, and a local spinning company.

Company Presentations

Business Meetings

Figure 13.2 Photos of the Orientation Meeting in Colombia

(3) Result of the Questionnaire

Comments on MSEF and Japanese companies are shown as follows. For the presentation of MSEF, there are many comments that the presentation was well understandable. For the Japanese companies, on the other hand, some comments said that a certain company's presentation has focused on the description of product specifications itself and they wanted to see the case study more. It can be said that it is necessary to appeal to concrete customer's benefits by installing their products, not to appeal their product itself.

Table 13.5 Answers to the Questionnaires in Colombia

Company name	Comments to MSEF	Comments to Japanese campanies and products
SUMICOL S.A.S.	Model to evaluate and study	interesting Technologies
ALPINA S.A.	It could have been deepened as it was the main topic of the event.	I wish I could have seen more cases applied
JCGAVIRIA	interesting see how a business like these is undertaken and the results obtained	it was possible to gather relevant information and know the technical specification of the equipment.
CIDET	Innovative, Ambitious	high technological development

Source: Compiled by the JICA Study Team based on the answers to the questionnaire

13.4 Result in Brazil

(1) Overview

Date and time： November 10, 2015 (Tuesday)
Host cities： Sao Paulo
Venue： Golden Tulip Hotel Paulista Plaza
Co-host： JICA, MGM Innova, ABESCO

(2) Result

There were 129 people listed in the registration, 98 of whom are the participants for that day. Presenters are as follows. MGM Innova made a presentation to the audience about their financial scheme and 8 Japanese companies introduced their energy efficiency and renewable energy products.

Table 13.6 Presenters in Brazil

Presenter	Theme
JICA	Opening remarks
JICA Study Team	Outline of the study
MGM Innova	Financial scheme
ABESCO	Energy efficiency
Daikin	Air conditioner (VRF)
Fujitsu General	Air conditioner (RAC)
Hitachi	Air conditioner (Chiller)
Kyocera	Photovoltaic generation
MYCOM (Mayekawa)	Industrial refrigerator
Miura	Energy-saving boiler
Fuji Electric	BEMS
Omega Light	LED lighting

Source: Compiled by the JICA Study Team based on the interview

In the business meetings in the afternoon, a total of 33 meetings have been conducted. Specific contents are as follows:

- Mayekawa had three business meetings. It had the experience to participate in the ESCO scheme that power companies carried out in the past, so it would like to utilize the MSEF scheme for future projects.
- Omega Light manufactures and sells lighting equipment composed of Japan LED. It had meetings about LED projects with architectural design firm and lighting factory. Omega Light

has the ability to consistently work from planning to design, manufacture, installation, adjustment and maintenance of lighting and also has achievements; therefore, it generally ensures that these inquiries will become projects. It is expected to utilize MSEF scheme in the future.

- Kyocera carried out five meetings. Specific topics of the meetings were the introduction of photovoltaic generation to the facility of Sao Paulo State Engineering Institute (IPT) and the future cooperation with Furukawa Electric and Building Technology Center. In addition, according to the answer to the questionnaire by the Kyocera presenter, some of the solar companies in Brazil have been using the mechanism to collect the amount in accordance with the electric cost reduction using a financial plan, and Kyocera is also looking for this kind of financial plan. It can be expected to cooperate with MGM in the near future.
- Daikin Industries had meeting with one company; Hitachi Appliances met with one company; and Fujitsu General met with two companies.
- Fuji Electric conducted a meeting about BEMS, and the project is concretely planned based on the questionnaire.

Company Presentations

Business Meetings

Figure 13.3 Photos of the Orientation Meeting in Brazil

(3) Result of Questionnaire

Comments on MSEF and Japanese companies are as follows. There are so many praise comments to both MSEF and Japanese companies. Because of soaring electricity costs and high interest rates in Brazil, it can be said that there are many market needs for the energy efficiency & renewable energy products and this financial scheme.

Table 13.7 Answers to the Questionnaire in Brazil

Company name	Comments to MSEF	Comments to Japanese campanies and products
Bolt Serviços e Comercialização de Energia Ltda	Close relationship with business of our company that is an ESCO	Some of them were already known, but Miura is new.
Câmara de Comercio Industria Japonesa do Brasil.	As investment amount might be high it is important that this fund can give assistance. It is important to evaluate through long term period.	It is a high level technology with high reliabilty. It is necessary to verify brazilian market demand and then evaluate Japanese technologies.
CTE – Centro de Tecnologia de Edificaç ões	It is a very nice plan, but I felt lack of end users and investors participation in event	Good products with cutting edge technologies
ECOMARCO Eficiê ncia Energética	Excellent. It is a Brazilian market need	Very good. Quality level higher than market level
Furukawa Electric Group	Good opportunity, but there is limit for total amount	Good product, but lack of appeal (advertising)
Furukawa Electric Group	Very interesting, especially if we consider projects that we are visualizing	They are first class innovative technologies
General Motors do Brasil	Excellent opportunty to implement Energy Efficiency Projects	Excellent quality
PSR Consultoria	Important mechanism for EE in Brazil	Advanced technologies with high potential for adoption
Schaeffler	Interesting	High potential for utilization
Schaeffler	Excellent opportunity for current market situation, where we have to improve efficiency and at same time we don´t have investment	Great quality
Empresa Takaoka Empreendimentos S/A	It is positive to have business partner with funding	Excellent

Source: Compiled by the JICA Study Team based on the answers to the questionnaire

13.5 Summary of the Orientation Meetings

As mentioned above, the results of the study for each product showed that local end users have the impression that Japanese products are of "high quality but expensive". Actually, initial cost might be higher compared with cheap Chinese products, but as mentioned before, the life cycle costs of these energy-efficient products and the generation cost of solar panels should be recognized by the potential local users.

In these orientation meetings, each presenter focused on providing the benefit for end-users by showing the case study of their high quality products rather than by using product specification.

According to the actual answer in the questionnaire, these energy-efficiency products are actually required in the local market, especially in Brazil where electricity cost have risen significantly in recent years. In addition, there are also certain needs for MSEF which support the introduction of these products financially.

By carrying out this kind of activity for the recognition of Japanese companies and products, it is expected that some end users who originally had the impression that Japanese products are too expensive will consider to finally purchase them now that they have recognized the benefits of the introduction of these products. It is expected to increase the end users of Japanese products in Latin America.

14 Achievements of this Study (SAPI)

14.1 Achievements for MGM Innova

(1) Expansion of Target Countries of Investment

MSEF currently does not cover Brazil on its target countries of investment. In this study, it has been confirmed that there are certain demands for energy efficiency and renewable energy and a need for financial schemes such as MSEF because of high interest rates in Brazil.

Also in the orientation meeting in Sao Paulo, Mr. Alfredo of MGM Innova mentioned that they recognized these local needs and the possibility of putting Brazil in their target countries seems to be interesting. Additionally, according to Mr. Marco, CEO of MGM, they would like to put Chile and Peru as well as Brazil in their target countries.

(2) Providing New Information

During the visit to MGM Innova in Colombia, the JICA Study Team provided some new information to the fund manager. Specifically, Kyocera and Fujitsu General were introduced as possible partners when they expand their business into Brazil in the near future. GS Yuasa was also introduced as a new Japanese company. MSEF schemes were then presented for the adoption of lithium ion battery in the telecommunication station, which they are now considering. As a result, MGM Innova made a connection with Kyocera and Fujitsu General in the orientation meeting in Brazil. Their future collaboration is expected.

(3) Support for Creation of New Projects

In the orientation meetings in Colombia and Brazil, many business meetings were conducted. There are possibilities to utilize the MSEF scheme in new projects which originated from these meetings. The JICA Study Team also invited the audience and manufacturers who do not have contacts with them and supported to establish business relationships between them.

14.2 Achievements of COFIDE

(1) Support for Creation of New Projects

In the orientation meeting in Peru, many business meetings were conducted. There is a possibility to utilize the scheme of COFIDE in new projects which originated from these meetings. Also, the JICA Study Team introduced the COFIDE scheme to manufacturers and audience. It is expected that there is a possibility to utilize COFIDE scheme in their projects in the future.

(2) Extraction of Issues

According to the answers to the questionnaires of the orientation meetings, some answers pointed out

that there are many ambiguities in the scheme and procedure of COFIDE. The improvement of their own promotional activities in the future is expected.

In addition, in Bancoldex, which corresponds to COFIDE in Colombia, they are assisted by consultants of IDB and have been successful. Additionally, USAID also supports the private organizations in Bogota through an American consulting company. They are establishing a scheme of sustainable project development.

Also, it is revealed that the technical training assistance fund, corresponding to 5% of the total budget. has not been used in COFIDE yet. It is required to use these funds well and develop a new project.

14.3 Results of the Japanese Companies

Orientation meetings in each country became a venue to do PR activities for Japanese products and technologies. Below are the projects that materialized and currently underway. It is expected that COFIDE and MSEF will be utilized by these projects and their activities in the future.

(1) Peru

- Daikin is trying to approach COFIDE through the initiative of the JICA Peru Office.
- Mayekawa is considering to utilize COFIDE for the meat processing plant, seafood processing plant, and seafood cold storage warehouse projects, which have been created at the orientation meeting.
- Panasonic is proceeding with the lighting project of a village in combination with LED and solar panels and the project of a school.

(2) Colombia

- Daikin built a relationship with important entities in the corporate energy sector. It is expected that future projects will be created.
- Mayekawa is considering to introduce the energy efficiency refrigeration system to the energy-saving refrigerated warehouse, corresponding to LEED, including utilizing MSEF.
- Panasonic is promoting three projects as a result of its meetings.

(3) Brazil

- Omega Light has began consultation with an architectural design firm for the LED lighting of a factory.
- Fuji Electric is promoting BEMS projects amounting to JPY 10 million.
- Kyocera is asking MGM Innova for the utilization of MSEF for three photovoltaic

generation projects. Also, it was able to have contact with Furukawa Electric and it is expected that there will be a collaboration between these Japanese companies in the future.

14.4 Arrangement of Support Measures

The JICA Study Team arranged the support measures mentioned in each product. They can be divided into support measures to be conducted by Japanese companies and to encourage institutions for the enforcement of these system or rules.

(1) By the Japanese Companies (Self-effort)

- Utilizing the finance schemes such as MSEF and COFIDE to lower the burden of the initial cost to the customer.
- Building a maintenance system. As a result, they can get the trust from the local end users.
- To provide the entire system in order to avoid price competition of the product itself.
- Market evaluation with the support of the Pacific Ocean Alliance and Mercosur. In particular, for example of establishing new factory, the large marketability is expected by utilizing a regional FTA, even if there are not sufficient population in one country.
- Conducting seminars to present the benefits of introducing high quality products that respond to the customers' needs.

(2) System or Rules

- Enactment of APF evaluation criteria. Since this index is to evaluate performance of such as air conditioners using the year-round energy efficiency, it is possible to quantitatively appeal the quality of Japanese products as compared to other countries products.
- Enactment of the power contract with time zone. Some Japanese industrial refrigerator has the function of reducing running cost by making ices at night using cheaper night electric cost taking advantage of its heat storage capability. There are no benefit in the country which does not have a time zone power contract. Thus, it is expected that the establishment of this electric cost system will promote the introduction of this kind of products.
- Enactment of auxiliary business to promote natural refrigerant. Some Japanese companies use a natural refrigerant which ozone-depleting coefficient is zero. Once the system which assist introduction of these products has been established, these Japanese products will attract attention and will be expected to expand the opportunity to be introduced.
- System enactment of grid connection. This will promote the spread of photovoltaic generation in the electrification region.

- Establishment of incentive plan for the introduction of energy efficiency and renewable energy. If there are such auxiliary system and tax reduction benefits, the introduction of energy efficiency and renewable energy products will expand more.
- Enactment of FIT. The result of FIT in Europe and Japan shows that this system will significantly spread the renewable energy.

15 Summary

The summary of this study is as follows:

- In the local interview, there were common opinions to the entire Japanese products as "High quality but expensive". Although in most cases the Japanese products are higher than such as Chinese and Korean products in initial cost indeed, some customers evaluate the benefits of using the Japanese products and finally decide to introduce them.
- These customers' benefit is not only due to the quality of products such as energy efficiency performance, but also due to sufficient maintenance service system. Because of these reliable relationship, some Japanese companies are evaluated in local.
- These customers' benefits are recognized by mainly manufacturer's effort. Other than this, if there are some preferential treatments shown in above paragraph which is for the promotion of energy efficiency and renewable energy products, it seems to expand the opportunity that such high quality Japanese products has attracted attention and recognized and finally selected.
- In addition, the utilization of MSEF and COFIDE scheme will lower the hurdle of the customers' initial investment. Thus, there are advantages for both Japanese companies and end users.
- As a result of the study, there are some countries which did not get the interest of Japanese companies despite their good marketability. Japanese companies mentioned that they decide the priority of the target countries by their own strategy; however, this study might give them some awareness. For these countries, it is desirable to implement a similar new project by JICA.
- In the orientation meetings conducted by the JICA Study Team during the study, the JICA Study Team invited many participants as potential customers which are significantly beyond the original expected number of participants, and these meetings increased the recognition of new financial schemes and Japanese companies which are still unknown in the local market.
- In addition, the JICA Study Team realized a very large number of business matching. As a result, MSEF, COFIDE, and the Japanese companies are introduced to the potential customers in each country and these meetings created new projects.
- Especially for Japanese products, it was a good opportunity to ask the potential customers to consider the benefits by looking at the advantage of quality. By conducting these activities periodically, potential customers who have the impression that "Japanese products are too expensive and there is no room for consideration" may be identified and convinced to change their impression.
- By conducting this study, the JICA Study Team provided MSEF the rationale for putting Brazil into their target countries, and also giving them new information about Japanese technology

and products. It is one of the support measures to conduct this kind of events when MSEF is expanding their target countries.

- There are some comments from potential customers such as "Japanese companies sometimes seem to be not enthusiastic to sell their products" and "buying Japanese products requires patience". This is the comment to the Japanese companies which promote their business based on the instructions from their headquarters in Japan. Particularly in the case of Japanese companies, the slow response is noticeable due to the interaction between local and headquarter offices. In the case of the Chinese and Korean companies, the competitors of Japanese companies, they respond immediately at the discretion of the local office and there are few case to make their customers wait.
- The JICA Study Team expects that the results and contents of this study will contribute to the future activities of Japanese companies, MSEF, and COFIDE.