Fiscal Year 2015

JCM Project Formulation Study for Realizing Low Carbon Cities in Asia
(Project for Developing Low-carbon Tourism Cities through the Joint Crediting Mechanism in Siem Reap)

Final Report

March 2016

Japan Development Institute Ltd.
Overseas Environmental Cooperation Center, Japan
Asian Gateway Corporation

Table of Contents

List of Tables and Figures

List of Tables

List of Figures

Abbreviation

C2CC	City-to-City Collaboration
CDM	Clean Development Mechanism
ISPP	International School of Phnom Penh
JCM	Joint Crediting Mechanism
WTE	Waste to Energy

Summary

This project is a study project for supporting the development of a low carbon tourism city through the Joint Crediting Mechanism in Siem Reap Province.

The purpose of this study project is to establish the "Upper Tier City-to-City Collaboration (C2CC)" between the Siem Reap provincial government and Kanagawa prefectural government and to aim for the realization of a low carbon society "as a whole city" through comprehensive and continuous efforts for project formulation in Siem Reap city, which will result in the emission reduction of CO2 of energetic origin. This will directly contribute to conservation of a world heritage through environmental conservation as a co-benefit of developing a clean tourism city.

The main object of this study is to study the possibility and profitability of installing photovoltaic (PV) modules on rooftops of 5-star hotels operating in Siem Reap city and to formulate projects for applying for "the Financing Programme for Joint Crediting Mechanism (JCM) Model Projects in FY2015".

Besides, this study studied needs of JCM potential projects for (1) developing a mixed combustion biomass power plant with urban wastes and rice husks, and (2) disseminating high efficiency amorphous transformers for reducing transmission loss. It also examined the possibility of collaboration with the "Eco-mobility (electric remork-motos (tuktuks)) project" implemented in FY2014, where the possibility of running electric tuktuks on electricity generated by rooftop PVs was studied.

The results of this study project are shown below.

1) The preparation works have been done for applying the JCM subsidy projects with three 5-star hotels in Siem Reap city (A-Hotel, B-Hotel etc.). There projects are ready to apply for "the Financing Programme for Joint Crediting Mechanism (JCM) Model Projects in FY2016". The outlines of the projects are shown in the table below.

Title	Introduction of rooftop PV systems at three 5-star hotels
Content of JCM projects	The EPC and O&M for the rooftop PV systems of 2.2 MW in total

	at the three hotels are commissioned to a local partner company.
Intended technology	Rooftop PV systems
Approximate project cost	Approximately JPY 450 million ※JPY 40 million /200kW (not including VAT) is assumed.
MRV methodology	A Draft Methodology for PV systems (see Appendix 1)
GHG emission reduction effect	Approximately 2,101 tCO2e/year
Co-benefit	Saving of electricity cost by replacing diesel power generation and soundproof measure

2) The proposed projects of the mixed combustion biomass power plant and the high efficiency amorphous transformers are to be studied further in the FY2015 JCM Project Formulation Study for Realizing Low Carbon Cities in Asia.

3) As a spin-off project of this study project, International School of Phnom Penh (ISPP) applied for "the Financing Programme for Joint Crediting Mechanism (JCM) Model Projects in FY2015" and received an unofficial announcement from Global Environment Centre Foundation (GEC). The outline of the project is shown in the table below.

Title	Introduction of rooftop PV system at International School of Phnom Penh (ISPP)
Content of JCM projects	The EPC and O&M for the rooftop PV systems of 200 kW at ISPP are commissioned to a local partner company.
Intended technology	A rooftop PV system
Approximate project cost	JPY 40 million /200kW (not including VAT)
MRV methodology	A Draft Methodology for PV systems (see Appendix 1)
GHG emission reduction effect	Approximately 191 tCO2e/year
Co-benefit	Saving of electricity cost by replacing grid power and diesel power generation and soundproof measure

4) Siem Reap provincial government and Kanagawa prefectural government concluded the City-to-

City Collaboration (C2CC) in November 2015 and decided to promote the realization of a low carbon society as a whole city. The Siem Reap provincial government and the Siem Reap city government officially requested the government of Japan and the Kanagawa prefectural government for their support of capacity building, the preparation of a low carbon city master plan and the implementation of pilot projects. It is important to bring substantial outcomes through offering expertise, administrative know-hows and economic cooperation for at least 3 years.

5) Under this C2CC, “local production and local consumption of energy” is promoted. “local production and local consumption of energy” consists of energy-saving and energy-generation and control system for them. Rooftop PV systems at hotels and governmental facilities and biomass are to be promoted as energy-generation while use of energy-saving architectural double-glazed glasses and replacing with high efficiency air conditioners and lightings are to be promoted as energy-saving. Besides, independent energy supply is to be promoted by introducing a smart grid system (such as Automated Distribution System (ADS)) with connection between redox flow batteries and the grid. Low-carbonization is to be promoted for the mobility of international tourists by introducing electric vehicles (EV) while the EV tourism project is to be promoted by consuming renewable energy. Furthermore, “Visualization of energy-generation/saving as a whole city” and energy-saving effects at hotels are to be monitored by introducing energy-saving equipment to large scale hotels and Community Energy Management System (CEMS) in cooperation with the city government. By implementing these projects, whole city low-carbonization is to be promoted and as a result the conservation of Angkor monument and tourist development are promoted boosting the local economy.

In the years to come, it would be possible to solve problems of Siem Reap city and to promote low-carbonization as a whole city by utilizing fund schemes including JCM of the government of Japan under C2CC and introducing technical cooperation by the Japanese municipality and technology transfer by Japanese companies.

Main Report

1. Overview of Cambodia

1.1. General Situation

1.1.1. Political Situation

Politically, Cambodia has maintained a stable regime since 1998 by the Cambodian People's Party (CPP) let by Prime Minister Hun Sen. However, in the last general election held in July 2013, although the result was announced that CPP had majority of votes, there were some doubts that the opposition party, the Cambodia National Rescue Party (CNRP) may have out-numbered the CPP. Due to unsatisfactory result, CNRP hold demonstrations seeking for the re-election which caused political and social unrest. In the end, CPP incorporated some of the intention of CNRP such as increase of minimum wages and Prime Minister Hun Sen was officially re-elected for another 5-year regime. The next general election is scheduled in 2018 and political and business world is paying close attention to its prospect.

1.1.2. Economic Situation

On the economic front, Cambodia has experiencing stable growth considering long term civil war and the domestic turmoil over the past half-century. Cambodia has been successful in attracting foreign direct investments by establishing legislation to promote investments in accordance with joining ASEAN and WTO. GDP growth rate records double-digit from 2005 to 2007 and continued to sustain strong growth of 5-7% since 2010 after recovering from Lehman shock and it is expected to maintain 7% in 2016[1]. Foreign direct investment (FDI) was dropped to $500 million in 2009 but made a quick recovery and reached $1.8 billion in 2014. It can be expected that, the recent movement towards the elimination of tariff barriers by the ASEAN free trade agreement will stimulate the regional economic activities.

[1] ADB Key Indicators Cambodia 2015

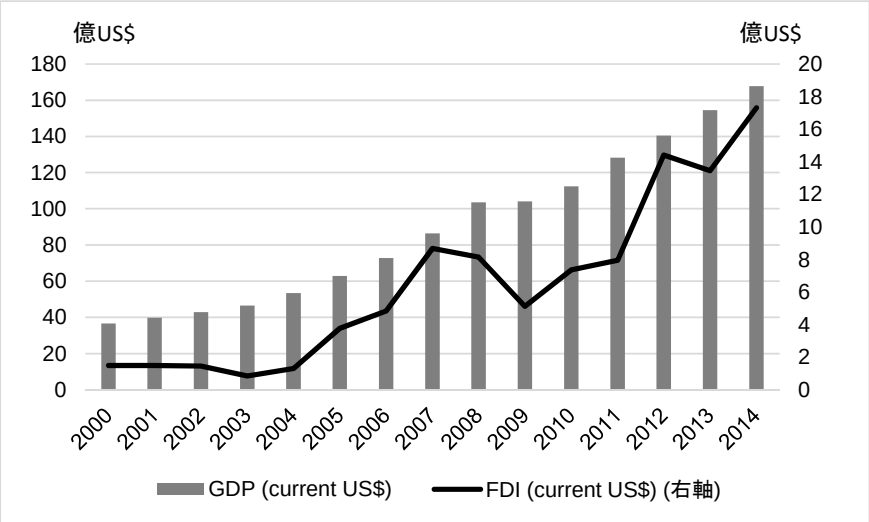


Figure 1-1：Trend of GDP growth and FDI inflow

(Source: World Development Indicators, World Bank 2015)

In terms of industrial composition of Cambodia, agriculture sector accounts for 30%, manufacturing sector 27% and 42% from service industry sector on the basis of GDP contribution. From the view point from investment, targeted sector for FDI has been diversified due to the shift of production base from neighboring countries in the area of auto parts and agricultural processing sector in addition to the conventional tourism and garment sector. However, tourism still continues to be the driving force of Cambodian economy evidenced by the fact that 24.8% of the total investment was directed to tourism and foreign visitors reached more than 450 million people in 2014[2].

1.1.3. Power situation

Due to a strong economic development and stable population growth with annual growth rate of 1.5%, power demand in Cambodia is rapidly increasing in industrial sector and for urban residential use. However, power infrastructure development in Cambodia is far from sufficient in comparison with the neighboring countries. Especially limited capacity of power supply and under developed transmission and distribution network is a serious issue in Cambodia. Since small diesel generation being the major source of power supply in non-grid connected region, the electricity tariff is the highest in the neighboring region.

[2] JETRO World Trade Investment Report 2015

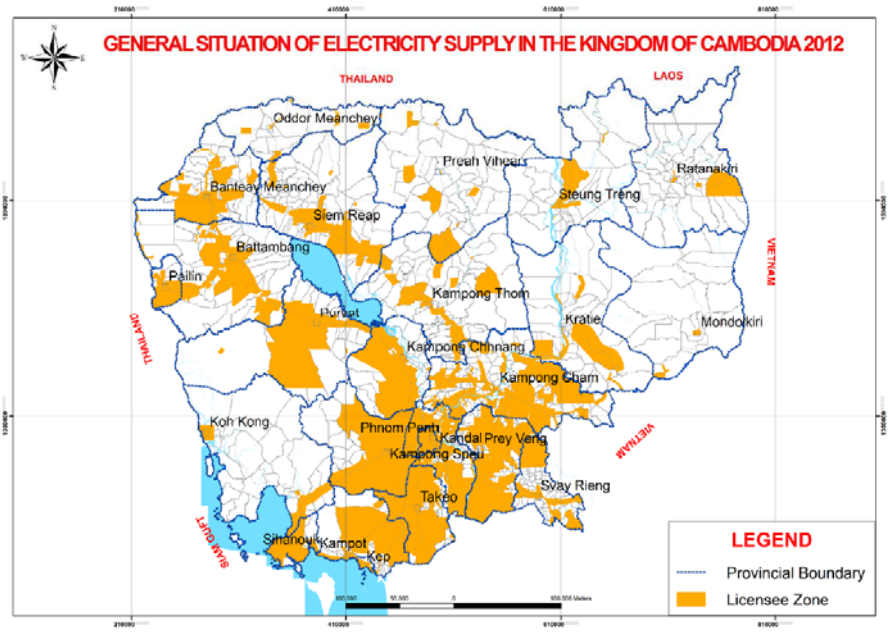


Figure 1-2：Electricity supply in Cambodia

(Source: EAC annual report 2012)

Total power installed capacity in Cambodia is about 2,000MW and total power generation capacity including the imported power is about 5000GWh. Cambodia started to import power from neighboring country since 2007 from Thailand, 2009 from Vietnam and 2010 from Lao. In 2010, imported power accounted for approximately 60% of total power generation in the Cambodia. In recent years, strong effort has been made to strengthen the domestic power generation capacity, and now the imported power has a share of 40%.

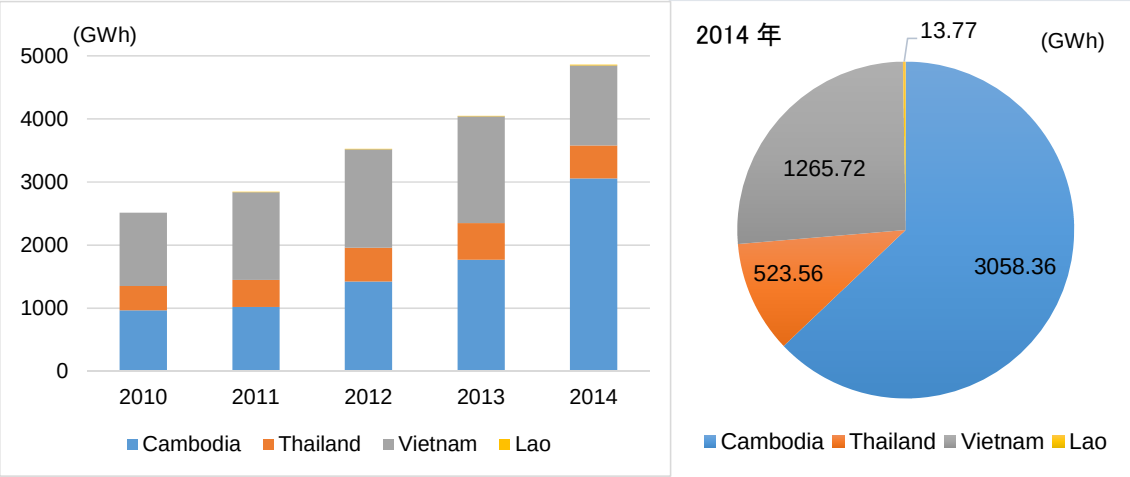


Figure 1-3： Power Supply Trend

(Source: EAC 2005-2014 Annual Report)

Before 2011, almost all the power generated in Cambodia was relied on diesel power generation. In recent years, the development of large scale hydropower and coal power plant with the capacity of 200-300 MW was promoted in order to meet the strong power demand in the country. Since those power plant started their operation, the composition of the energy sources of domestic power generation are being shifted as shown in the figure below. Hydropower accounts for 60%, coal power 30% and diesel power was reduced to 10% in 2014.

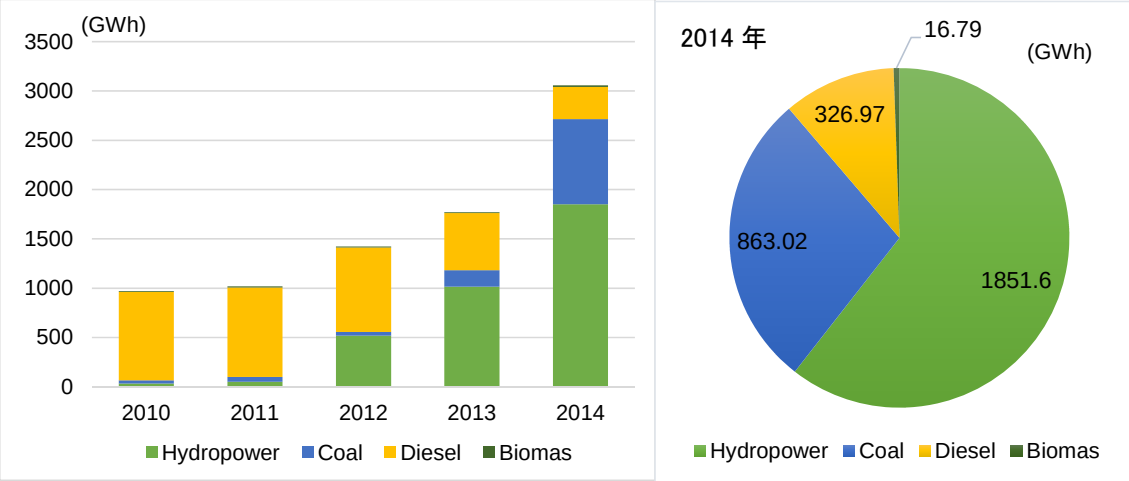


Figure 1-4： Power generated by energy sources

(Source: EAC 2005-2014 Annual Report)

Electricity in Cambodia is mainly supplied by the state owned power company called Electricite Du Cambodge (EDC); Independent Power Producers (IPP); and imported electricity. The composition of power installed capacity by the sources of supply are shown in the figure below. IPP accounts for 76% of total electricity supply and the rest are from import electricity (20%) and from EDC (4%). It is clear that IPP has an important role in the electricity supply in Cambodia.

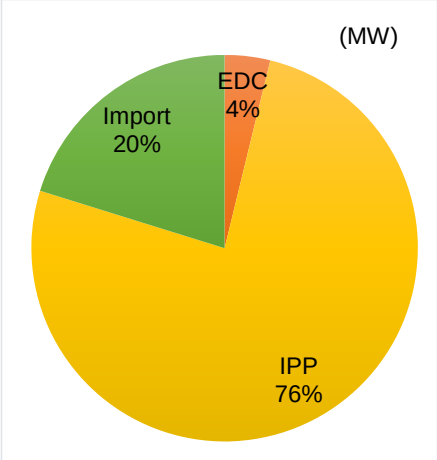


Figure 1-5：Breakdown of Installed Power

(Source: EAC 2014 Annual Report)

Power consumption is steadily increasing at the annual average of 20% after 2010. In 2014, power consumption was 4,152GWh almost doubled in the past five years. In terms of sector wise power consumption in 2014, residential, commercial, industrial sectors and power distributor accounted for 20-30% respectively. Compared with the condition in 2010, electricity consumption in the off-grid area is expanding through independent power distributors.

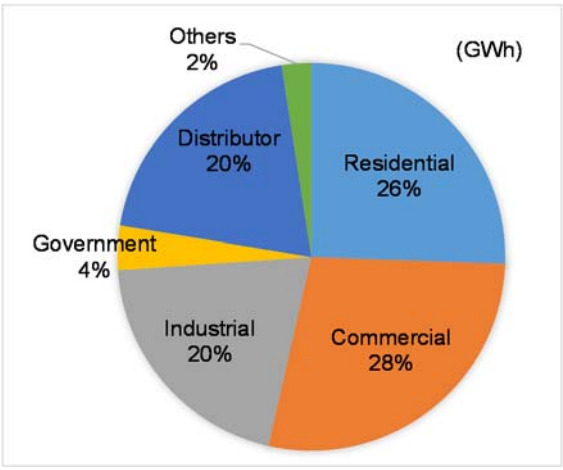
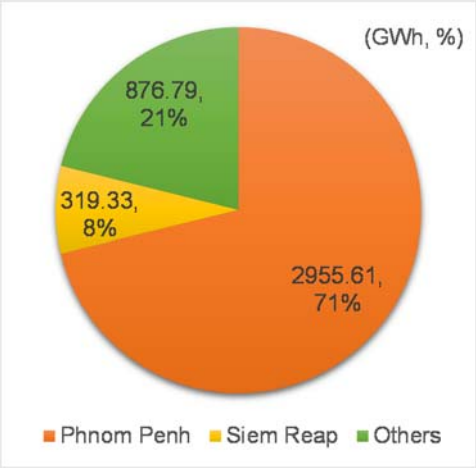


Figure 1-6：Sector wise electricity consumption

(Source: EDC 2014 Annual Report)

Electricity consumption is concentrated in major cities, especially in Phnom Penh city. Out of the electricity sold by EDC, electricity consumption in Phnom Penh city accounted for 71% which is 2,955.61GWh per year followed by Siem Reap province 8% and other states 21%.



	Province	Electricity sales (GWh)
1	Phnom Penh	2,955.61
2	Siem Reap	319.33
3	Battambang	161.16
4	Sihanoukville	141.27
5	Svay Rieng	129.07
6	Kampong Speu	84.50
7	Banteay Meanchey	71.32
8	Takeo	54.43
9	Kampot	44.34
10	Kampong Cham	43.35

Figure 1-7：Electricity Consumption

(Source: EDC 2014 Annual Report)

In the case of Siem Reap area, power capacity is 90.50MW, peak demand is 59.39MW and power supply amount is 346.46GWh. The sources of electricity are: from the grid, from Thailand and diesel power generation. Electricity suppling capacity in the area has improved since current operation of large scale hydropower in Koh Kong province along the Thai border. However, in areas where there are no connection to the grid network, expensive electricity price continues to be an issue supplied via independent power distributor often uses small diesel generator for its power generation.

1.2. Energy Policy

1.2.1. Energy Policy

Power Sector Strategy 1999-2016 is the relevant energy policy in Cambodia is. Policy goals are listed as follows.

(1) Carry out the power supply at a reasonable price throughout Cambodia
(2) Realize a stable and low-cost power supply to attract investments and to promote economic development
(3) Promote the development of environmental and socially accepted energy resources
(4) Promote efficient power use with minimal impact on the environment

In addition, rural electrification is positioned as an important component in the energy policy and Policy on rural electrification policy by renewable energy was formulated in 2007. The goal of rural

electrification is to realize: all villages will have access to electricity of different forms by 2020; and 70% all rural household will have access grid quality electricity by 2030.

In the power development plan, power supply development plan and the power transmission and distribution network development master plan until 2020 are being updated every year. Currently, power sector master plan was revised by the MME and revised edition has been submitted to the Cabinet. Since the growth of the current demand is larger than the assumption, it was unofficially mentioned that in the revised master plan, the high demand case scenario is considered as the base case for the demand forecast until to 2030. Officially published base case scenario of the power demand forecast (before revision) is as follows.

Table 1-1：Power demand forecast in Cambodia

Base Case	2014	2020	2025
Peak demand in the country (MW)	887	1,681	2,678
Power demand in the country (GWh)	4,954	9,406	14,951

Note: The figure of 2014 is the actual figure.

(Source: EDC 2014 Annual Report)

1.2.2. Energy Mix

Cambodia has set a policy to achieve a 100% power self-sufficiency in 2020 by reducing the import power to a minimum level. The current plan of energy mix shows its intention to actively increase the capacity of hydroelectric power and also develop coal-fired power to supplement unstable power supply in the dry season. It is also considered that if the natural gas were to be available from 2024, natural gas will replace coal-fired power.

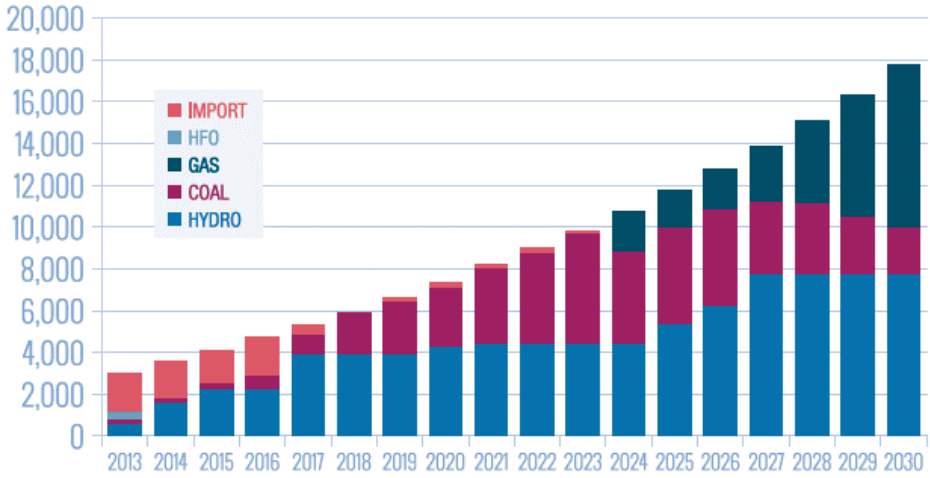


Figure 1-8：Outlook of electricity supply and the energy mix by 2030 (GWh)

(Source: MME September, 2015)

Renewable energy is heavily relying on hydropower generation in Cambodia. The importance of solar and biomass power generation is positioned in the rural electrification policy. In order to secure the stable power supply in dry season, large scale renewable energy development other than hydropower has been discussed between the Cambodian government and international donors. In those discussions, the government mentioned that solar power in particular, should not be more than 10% of the peak demand which is around 100MW at this stage.

1.2.3. Pricing Policy

Cambodia is making an effort to reduce electricity tariff to attract FDI and to promote economic and industrial development. The government has announced the gradual decrease of electricity tariff as shown in the table below by taking consideration of the upcoming hydropower developments. Furthermore, the government visions to reduce the price gap between urban and rural areas by 2020. The target for the end user price is set at 750 riel/kWh.

Table 1-2：Plan for Reduction of Prices and Price Gap for Large Commercial and Industrial Usage

(Unit: US$/kWh)

	2015	2016	2017	2018	2019	2020
From Sub-station	0.129			0.126		
From Phnom Penh main line	0.177	0.172	0.167	0.165	0.163	0.162
From Provincial main lines	0.1725	0.1675	0.165	0.164		

(Source: CDC Presentation January 2016)

1.3. Policy on Climate Change

1.3.1. Related policy and plan

Cambodia has been developing domestic laws and policy towards a low-carbon development. Rectangular strategy III and National Strategic Development Plan 2014 - 2018 are the foundation of the national development strategy. National Strategic Plan on Green Development 2013 - 2023 and the Cambodia Climate Change Strategic Plan 2013 - 2023 are the focal policies for the climate change. Incidentally, JCM and CDM are positioned as the specific schemes for the implementation of the projects.

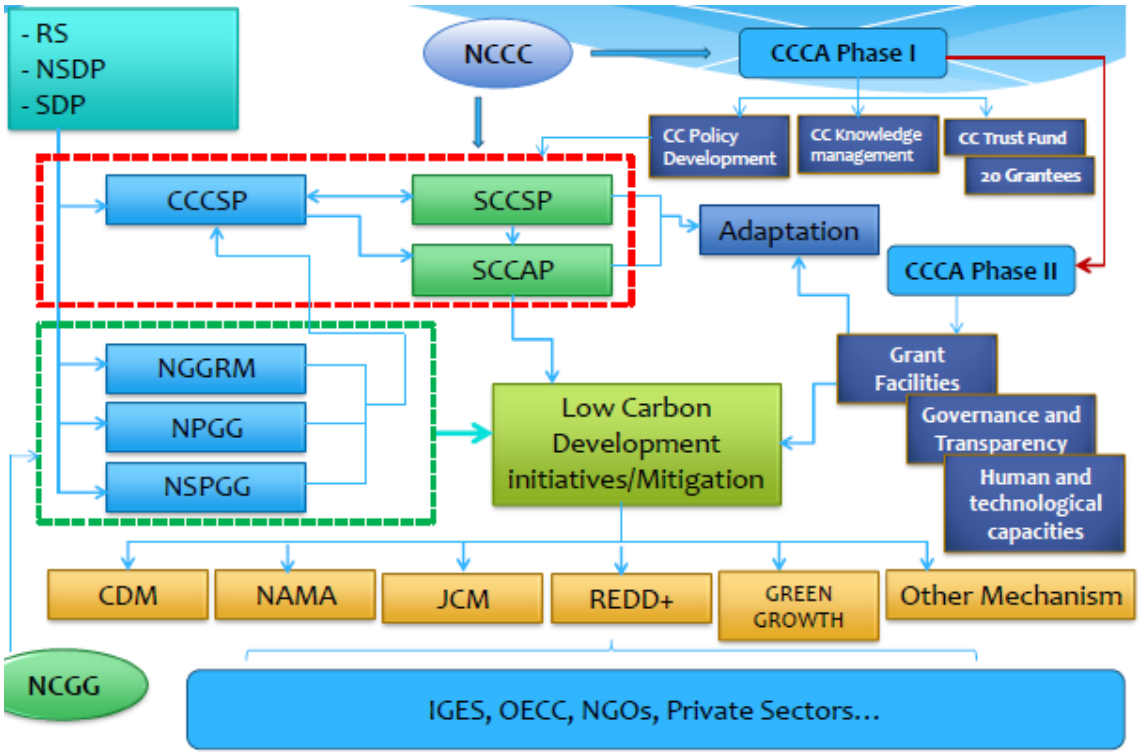


Figure 1-9：Strategy for Low Carbon Strategy in Cambodia

(Source: Towards Low Carbon Strategy in Cambodia, Seminar document of LoCARNet, 2014)

"National Policy on Green Growth and National Strategic Plan on Green Growth (NGGSP) 2013-2030" was formulated in March 2013. NGGSP put emphasis on the balance development between economic development initiative and environmental protection, cultural preservation, social stability and consumption of natural resources. NGGSP also includes the promotion of green investment by utilizing green technology.

In addition, “Cambodia Climate Change Strategic Plan (CCCSP) 2014-2023” was formulated and was positioned in the national policy for the climate change adaptation in October 2013. The objective of the plan is to contribute to low-carbon development by reducing GHG in cooperation with the international society by considering the impact on national development and climate change. Following table shows the summary of CCCSP. The action plan of each ministries for the implementation of CCCSP is under preparation and concrete plan has not been announced yet.

Table 1-3：Summary of CCCSP

Strategic Objective	Implementation Phase
1. Promote climate resilience through improving food, water and energy security 2. Reduce sectoral, regional, gender vulnerability and health risks to climate change impacts 3. Ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands, etc.), biodiversity, protected areas and cultural heritage sites; 4. Promote low-carbon planning and technologies to support sustainable development; 5. Improve capacities, knowledge and awareness for climate change responses; 6. Promote adaptive social protection and participatory approaches in reducing loss and damage due to climate change; 7. Strengthen institutions and coordination frameworks for national climate change responses; and 8. Strengthen collaboration and active participation in regional and global climate change processes.	Immediate term (2013-2014) • putting in place institutional and financial arrangements for the implementation of the CCCSP • development of national monitoring and evaluation (M&E) frameworks and indicators • development of climate change action plans (2014-2018) by line ministries Medium term (2014-2108) • accreditation of the Adaptation Fund and Green Climate Fund • research and knowledge sharing and capacity development • launching some high priority projects/programmes in key sectors Long term (2019-2023) • research and learning to scale up success cases • mainstreaming climate change into national and sub-national programmes

(Source: CCCSP 2014-2023)

As a recent development, Cambodian government submitted mitigation plan for climate change to COP 21 under the framework of UNFCCC. The following table shows the priority actions and CO2 reduction target identified in each industrial sectors by the government.

Table 1-4：Mitigation actions in key sectors – aggregate reductions by 2030

Sector	Priority actions	GgCO2eq Reduction
Energy Industries	• National grid connected renewable energy generation (solar energy, hydropower, biomass and biogas) and connecting decentralized renewable generation to the grid. • Off-grid electricity such as solar home systems, hydro (pico, mini and micro). • Promoting energy efficiency by end users.	1,800 (16%)
Manufacturing Industries	• Promoting use of renewable energy and adopting energy efficiency for garment factory, rice mills, and brick kilns.	727 (7%)
Transport	• Promoting mass public transport. • Improving operation and maintenance of vehicles through motor vehicle inspection and eco-driving, and the increased use of hybrid cars, electric vehicles and bicycles.	390 (3%)
Other	• Promoting energy efficiency for buildings and more efficient cookstoves. • Reducing emissions from waste through use of biodigesters and water filters. • Use of renewable energy for irrigation and solar lamps.	155 (1%)
Total Savings		3,100 (27%)

(Source: Intended Nationally Determined Contribution to the UNFCCC submitted to COP21, 2015)

1.3.2. Related organizational structure

As an implementation agency of above policy and strategy, National Council of Green Growth (NCGC) and National Council of Sustainable Development (NCSD) was established at initial stage. However, due to the task duplication, the responsible agency for planning and implementation of Climate Change related policy and programme is now integrated to NCSD. NCSD is a cross cutting agency of several ministries and other related agencies such as MOE, MME, EDC, EAC and MOEF, chaired by Prime Minister Hun Sen and Minister of the Environment.

1.3.3. Policy for renewable energy business promotion

As an incentive to promote the renewable energy business, import tariff of solar power generation equipment has been reduced from 30% to 7% in 2009. However, further policy support is required for the deployment of renewable energy business in Cambodia. At this moment, exemption of the import tariff for the renewable energy-related equipment has been discussed in Cambodian government

initiated by donor agencies. In addition, the introduction of the feed-in-tariff (FIT) system is also being raised as a discussion topic. In this regard, Cambodian government is taking a stance that the national benefits of introducing FIT system needs to be carefully examined.

2. Survey outline

2.1. Survey background and objective

2.1.1. Survey background

Angkor Wat is a temple complex located at the suburb of Siem Reap city in the northwest part of the Kingdom of Cambodia. The population of the city is about 256,018 in 2015. Buildings and arts from the Khmer dynasty (during 9th to 14th century) are remained in Angkor Wat which was registered as a World Cultural Heritage of the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1992. Angkor Wat is a major tourist destination of Cambodia where annual tourist reached about 5.02 million in 2014, out of which 2.35 million tourists were from overseas. It has a great presence in the tourism sector which is a leading industry in Cambodia which accounts for over 10% of GDP.

However, due to rapid increase of the population and tourists, Siem Reap city and surrounding area of Angkor Wat are facing challenges of developing adequate infrastructures and environmental facilities such as: water supply, electricity and roads, waste disposal and wastewater treatment. In addition, air pollution is becoming a serious issue which is caused by the exhaust from vehicles without sufficient emission control measures, large diesel generators used in the hotel and open burning of the accumulated wastes. In order for Siem Reap city to achieve sustainable development as an attractive tourist city, the city is required to take actions to establish a low-carbon society.

The governor of Siem Reap province and the mayor of Siem Reap city have formulated a city master plan focusing on the improvement of "environment", "transportation", and "issue of squatters" to be the model "low-carbon tourism city" in Asia. Based on this masterplan, an individual action plans are being implemented. For its execution, experiences and know-how from Japan's local governments and Japanese private companies is strongly expected.

On the other hand, Japanese government is establishing a bilateral credit system called Joint Crediting Mechanism (hereinafter called JCM) to complement the scheme of "Clean Development Mechanism (hereinafter called CDM) in order to actively promote the deployment of Japanese low-carbon technologies and products to developing countries to contribute to the mitigation of global warming in a global scale. A bilateral document on the JCM scheme was already signed between Japanese Government and 16 countries in Asia and Africa. Cambodian government is also starting to

implement specific projects under JCM scheme and there is a great expectation in the deployment of Japanese carbon technologies in Cambodia.

During this project, the United Nations Framework Convention on Climate Change 21th Conference of the Parties (COP21) was held in Paris France from 30 November to 12 December 2015. The Japanese government delegation led by Maruyama Minister of the Environment praised the fact that COP decision including "Paris agreement", the legal framework, was adopted, and that it will be a fair and effective framework agreed by the participants from all countries.

Following decisions are included in the "Paris agreement".

- Aim to limit the increase in global average temperature to 1.5°C which is below the long-term goal to keep the increase below 2°C.
- Come together every 5 years to set more ambitious targets as required by science; report to each other and the public on how well they are doing to implement their targets; and track progress towards the long-term goal through a robust transparency and accountability system.
- Market mechanism including JCM was positioned as a useful tool
- Recognizes the importance of conservation and strengthen of carbon sink such as forests and mechanism to minimize emissions from deforestation and forest degradation in developing countries
- Setting long-term goals of the adaptation, formulation and implementation of adaptation planning process and actions of each countries
- Provide continued and enhanced international support for adaptation to developing countries and developing countries are also encouraged to provide voluntary support
- Set long term goal for adaptation and implement adaptation planning and action of each countries
- Recognizes the importance of innovation
- Include number of countries and amount of emissions in the requirements for the execution of the agreement
- A reference to "Sendai disaster prevention framework" (COP decision)

2.1.2. Survey Objective

Based on the above mentioned background, following survey objective were set for the “Survey on low-carbon tourism urban development assistance project with utilization of JCM scheme in Siem Reap: Survey on the possible formulation of large-scale JCM project for the realization of low-carbon society in Asia in FY2015 (thereafter called “the Project”).

- Realize “whole city approach” towards low-carbon society through faceted deployment and continuous project formulation for the reduction of energy-origin CO2 in Siem Reap City
- Grasp the needs of the Cambodian government and conduct a survey to identify the potential JCM projects toward establishing "low-carbon tourism city" in Cambodia
- Prepare the commercialization of rooftop solar power generation project for 5-star hotels in Siem Reap City to obtain JCM credit
- Prepare for the second application opportunities in FY2015 for the Subsidies on CO2 emissions mitigation project (an equipment subsidy project using a JCM scheme among funding support projects for the realization of leapfrog type development (hereafter called “JCM equipment subsidy project”)).
- Conduct survey on "rice husk biomass power generation project (renewable energy field)" and "high-efficiency power transmission and distribution equipment project (amorphous transformer) (energy saving field)" to investigate the needs for potential JCM project and "tourist city transport development project" to investigate the needs and feasibility of JCM project formulation.

2.2. Survey item and methodology

2.2.1. Survey item

In order to move toward to the "low-carbon tourist city (low carbon tourist city formation that utilize JCM)" of Siem Reap City, the agreement for inter-regional local government cooperation between was made between Siem Reap Province and Kanagawa Prefecture. Under the guidance of Kanagawa Prefecture, a grant application to the JCM equipment introduction project was attempted by targeting two sectors "distributed and independent renewable energy project (hereinafter called “renewable energy facilities introduction project”)" and “tourist city transport development project". In particular, renewable energy equipment introduction project targeted the "solar power generation facilities introduction project".

The Project carried out a review of the revised plan and future plans of energy sector and transport sector of the Siem Reap City Master Plan and proposed a strategy for low-carbon city development. However, for the implementation of the Project, it was inevitable to examine entire region targeting not only neighboring provinces but the whole country. As a result, the Project also conducted JCM project formation feasibility study in Phnom Penh and Battambang province.

Asia Gateway Corporation (hereafter called “AG”), the subsidiary of Japan Development Institute Ltd. (hereafter called “JDI”), made grant application for “Solar power generation equipment introduction project” to JCM equipment introduction project by Global Environment Centre Foundation (GEC) on 18 December 2015, which was one of the objective of the Project. AG also carried out the preparation for the establishment of Cambodia subsidiary of AG in order to implement Solar power installation business in Siem Reap Province as well as within Cambodia.

Based on the above survey policy, the survey content of the Project is summarized as follows.

(1) Survey on Solar power generation facilities introduction feasibility project (hereafter called “rooftop solar power generation feasibility study”)

- Based on the survey conducted last year on potential solar power producers, survey targeted 5-star and 4-star hotels in Siem Reap City and public facilities including schools
- The business was divided into rooftop solar power installation & maintenance and Independent Power Producer (IPP) and prepared for the commercialization of project (business plan, financial plan, funds procurement, local subsidiary establishment, etc.)
- Conducted needs survey of target customers, site visit, performance comparison of equipment, selection of contractor for procurement and installation, calculation for return on investment of equipment installation project, organized financing and payment conditions, proposed introduction and planned installation schedule, etc.
- Selected EPC (Engineering, Procurement and Construction) and O & MM (Operation & Maintenance, Monitoring) from Cambodian solar power companies and established a partnership with them to implement JCM equipment introduction project
- Formulated the business plan, numerical plan and financing for the establishment of the Cambodian subsidiary of AG on the premise of collaborating with local EPC / O & MM companies. Currently, AG subsidiary is in the process registration. It will be a joint venture

between Japanese companies and Cambodia local companies and will mainly engage in the rooftop solar power generation business.

- Carried out needs assessment of rooftop solar power in Cambodia and investigated current renewable energy promotion activities of the Cambodian government. It also investigated prospects of rooftop solar power projects in Phnom Penn.

(2) Survey on the needs of potential JCM project

- To investigate the potential of the "rice husk biomass power generation project", the survey was carried out in large-scale rice production areas such as Battambang and Banteay Meanchey, the neighboring provinces of Siem Reap province, and in Thailand close to the Cambodian border.
- To investigate the potential of "municipal waste and rice husk co-combustion biomass power generation project", the survey team visited the municipal waste dump site in Siem Reap City and examine the possibility of the re-use and amount of rice husk aggregation potential in Siem Reap province.
- To investigate the potential of "high-efficiency power transmission and distribution equipment business (amorphous transformer)", the survey assessed the needs of the Power Company and sales route of the existing transformers. As a result, it was decided to seek opportunities for the local amorphous transformer assembly in Cambodia.
- For the "Tourist city transport development project", the survey was conducted last year to introduce of electric vehicle (electric Rumomoto (Cambodia para-transit vehicle)) to improve the mobility of foreign tourists. This year, the survey team attempted to procure finances and prepared to establish operating company for the commercialization of "Angkor Mobility Service". As a complementary policy of "Tourist city transport development project", following potential investigation was carried out.
    - Feasibility study for the promotion of electric bikes
    - Feasibility study for the improvement of urban transportation in Siam Reap city

(3) Realization of inter-regional municipality cooperation

- Cooperation was achieved between Siem Reap province and Kanagawa Prefecture who has the know-how of establishing a low-carbon society.
- To promote the recognition of the meaning and purpose of this cooperation, kick-off meeting and seminars were conducted and action policy was organized.

- With the support from Kanagawa Prefecture and its municipalities, the survey team explored the possibility of utilizing technology for low-carbon tourism urban development and introducing Japanese relevant legal system.

2.2.2. Survey method and Survey outline

For the implementation of this survey, appropriate experts from Japanese companies were assigned and a part of the task were subcontracted to specialized experts. Survey procedures and outline of the survey content are summarized as follows.

(1) Survey on the rooftop solar power generation business

Survey on the rooftop solar power generation business was conducted with the aim of AG and Cambodian subsidiary of AG to become the project owner. A summary of the survey is as follows.

(i) Reviewed existing project and future plan of energy supply in Siem Reap city and within Cambodia, condition of connecting solar power to the grid, sales price and other related laws and regulations through interviewing EDC, MME and EAC etc.

(ii) Examined installation possibility of solar power generation equipment on the site and roof of the hotels in Siem Reap city and carried out power generation simulation. Investigated current situation of the target site, mounting method and withstand load of building structures. Verified potential issues in case of grid connection, identified the specification of appropriate solar power generation facilities and estimated power generation amount.

(iii) JDI, AG and Overseas Environmental Cooperation Center (hereafter called “OECC”) assisted “Regional cooperation between municipal governments” between Siem Reap Province and Kanagawa Prefecture and MOU was signed on 5th November, 2015.

(iv) Under this cooperation, Kanagawa Prefecture introduced their policy initiative and experiences of solar power installation project to Siem Reap city. As a result, Siem Reap city confirmed that they would also like to promote the installation of solar power generation equipment on the ground and on the roof in the city.

(v) Formulated international consortium as an agency to effectively promote and implement JCM equipment subsidy project.

(vi) Selected Solar Partners Asia (Cambodia) (hereafter called “SPAC”) as EPC partner after visiting several local EPC companies. Prepared establishment of Cambodian subsidiary of AG and carried out fund procurement.

(vii) Prepared JCM equipment subsidy project by promoting business alliance with subsidiary company of AG in Cambodia and SPAC to consider business plan and fund raising plan for the rooftop solar power project.

(viii) As the representative of international consortium, AG built track record, skills and implementation system and made an effort to gain the technical ability in order to adequately carry out the subsidy project.

(ix) Prepared draft business plan of solar power generation business for subsidiary company of AG in Cambodia. Examined feasibility of drafted business plan, business risk and measures, formulated draft financial plan and draft funding plan by interviewing Japanese and local related companies. For the consideration of above mentioned plans, following different business models were examined; design, installation and maintenance business model (hereafter called installation business), electricity sales business including operation and maintenance for rooftop factory owner as an Independent Power Provider (hereafter called IPP direct power sales business); and business extended to including power supply to electric vehicle (hereafter called integrated business).

(x) AG conducted fund raising activities for the implementation of JCM equipment subsidy project.

(xi) Considered possible utilization of available funding scheme of Ministry of Environment (JCM equipment subsidy project, cooperation with JICA project, ADB's Japan Fund JCM (JFJCM) for the implementation of the Installation business, IPP direct power sales business and integrated business.

(xii) Drafted MRV methodology for JCM and Project Design Document mainly by OECC. Calculated the cost effectiveness of the amount of subsidy to the project and the reduced amount of carbon dioxide emissions based on the draft MRV. Prepared English version of draft MRV methodology to be able to submit to JCM Joint Committee in timely manner if there is an instructed from the Ministry of the Environment at the end of the Survey. Draft PDD was also prepared in English for the third-party organization assigned by JCM Joint Committee to confirm its validity at the end of the Survey

(2) Survey on needs for the potential JCM business

As described above, the Project aimed to realize "whole city approach" towards low-carbon society through faceted deployment and continuous project development anticipating the reduction of energy- origin carbon emission in Siem Reap city. The objective of the "Needs assessment for JCM

potential business" is to explore the potentials of renewable energy and energy conservation businesses other than the rooftop solar power generation to apply for the JCM project formation feasibility study and JCM equipment subsidy project in the next fiscal year

In order to achieve the objective, the Survey Team reviewed existing projects and future plans of energy, environment and transport sector in Siem Reap city and carried out the needs survey of the following areas.

(i) Rice husk biomass power generation facility introduction project
(ii) Municipal waste and rice husk co-combustion biomass power generation facility introduction project
(iii) High efficiency power transmission and distribution equipment (amorphous transformer) introduction project
(iv) Tourist city transport development project

Method of needs survey for individual potential projects are summarized as below.

(a) Survey on JCM project formulation for Rice husk biomass power generation facility introduction project

There are several rice husk biomass power plant already in operation in Cambodia. However, due to the shortage and fluctuation of the rice husk collection throughout the year, profitability of the rice husk biomass power generation business is low, thus currently there are little new business entry in this field. Therefore, the survey was carried out with the hypothesis to aggregate rice husk from neighboring rice mills and develop power plant in the center to secure the raw material. With this in mind, the rice husk biomass power plant was considered to be established in the western border of Siem Reap province by collecting rice husk from the rice mills of Siem Reap province and its neighboring provinces (Battambang, Banteay Meanchey) and supply power to the Siem Reap city. The survey also investigated the superiority of Japanese technology (rice husk biomass power generation facilities, etc.) and considered possible introduction.

Based on the above survey, possible development of the rice husk biomass power generation equipment project was considered. Recognizing the difficulty of fund procurement for the project, joint venture with local company was considered as an option for the commercialization of the project.

The survey result was reported to Siem Reap Province and the neighboring state governments and confirmed their willingness to improve current power situation and their possible support towards the commercialization of the project.

(b) Survey on JCM project formulation for municipal waste and rice husk co-combustion biomass power generation facility introduction project

Interviewed the mayor of Siem Reap city on the progress and future plans of the city master plan development. Confirmed that municipal waste generation in Siem Reap city is 250 tons per day and the volume is rapidly increasing every year. The main issues are found in garbage separation, collection, storage and disposal in Siem Reap city. By discussing with waste collection and transportation contractors, current challenges and necessary actions were organized and introduction of co-combustion biomass (with rice husk) power generation facilities was proposed. The survey team also investigated the feasibility of potential introduction of Japanese-made system.

(c) Survey on JCM project formulation for high-efficiency power transmission and distribution equipment introduction project

Currently, multiple manufacturers including ABB, Thai Patanakit and THIBIDI are supplying normal transformers to Power Corporation in Cambodia. Based on the field survey, introduction possibility of Japanese technology (core component of high efficiency transformer, etc.) in the power transmission and distribution equipment in Cambodia was considered.

(d) Survey on JCM project formulation for tourist city transport development project

Prepared business plan of introducing electric remork-motos and improve fleet management and mobility service by lending them to drivers. The survey focused on financial procurement to purchase electric remork-moto and selected excellent drivers with drivers association and discussed the content of mobility service.

(e) Preparation of draft JCM business plan, JCM MRV methodology and Project design document

Formulated draft business plan of JCM potential project by utilizing the collected information. Considered possible utilization of available funding scheme of Ministry of Environment (JCM equipment subsidy project, cooperation with JICA project, ADB’s Japan Fund JCM (JFJCM) by interviewing Japanese companies, local companies, companies in neighboring countries such as Thailand, aid agencies (JICA, ADB etc.).

(f) Identification of business operator for high-efficiency power transmission and distribution equipment introduction project

Based on the above findings, the survey team formulated the installation schedule of high-efficiency power transmission and distribution equipment. The survey also investigated the possibility of commercialization of the project in the following year with the company willing to participate in the business.

In order to conduct activities mentioned in (2), total of 8 field visits (Siem Reap and Phnom Penh) were scheduled. The survey location also include Thailand (Bangkok), Philippines (Manila) and Vietnam (Hanoi) as necessary.

2.2.3. Survey Implementation Arrangement

(i) Implementation agency

Cambodia:	Siem Reap provincial government, Siem Reap city council
Japan:	Japan Development Institute Ltd., Asian Gateway Corporation (AG), Overseas Environmental Cooperation Center (OECC)

(ii) Relevant government agencies

Cambodia:	Electricite Du Cambodge (EDC), Siem Reap rice millers association

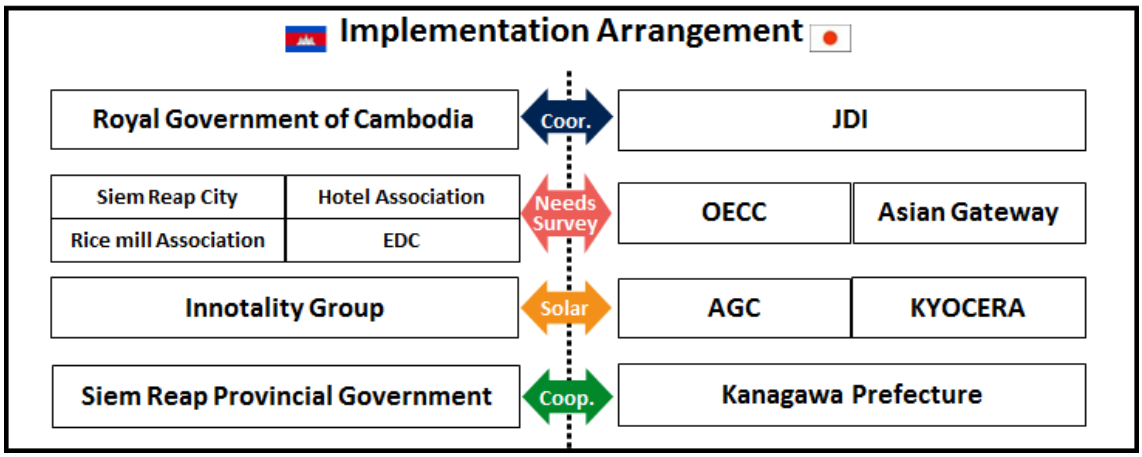
(iii) Municipality

Energy Department, Industry and Labor Bureau, Kanagawa Prefecture

(iv) Relevant donors

Japan International Cooperation Agency (JICA), United Nations Educational, Scientific and Cultural Organization (UNESCO)

Implementation arrangement is as shown below.



2.2.4. Survey Schedule

Day	JCM Formulation survey	Seminar on policies and regulations, Training in Japan	Presentation in the seminar specified by Ministry of Environment
May (1st field visit)	・ Share a strategy for the formation of low carbon tourism city using JCM scheme ・ Agree on survey plan by having meetings with relevant institutions ・ Review current status of revised master plan and future plan of Siem Reap city ・ Review existing projects, demand forecast and future plan on electricity supply in Siem Reap City ・ Confirm conditions for solar power generation business including grid connection, electricity tariff, other laws and regulations		
June	・ Summarize survey result	・ Kick off meeting ・ Preparation of seminar and Training in Japan	—
July (2nd field survey)	・ Survey on the feasibility of solar project for Hotels (land and roof) in Siem Reap City ・ Power generation simulation	・ Kick off meeting ・ Seminar	—
August	・ Summarize survey result	・ Training in Japan	—
September	・ Prepare draft business plan of solar project ・ Prepare MRV methodology, PDD	・ Summary of seminar, training visit to japan	—
Dec	・ Interview with companies in Japan	・ Invitation to Asia Smart City Week	・ Presentation in Asia Smart City Week

Nov (3rd field survey)	・ Interview with local companies ・ Discuss business risk and measures ・ Prepare draft business plan and draft financial plan	・ Preparation of final local seminar	—
Dec	・ Summary of survey result	・ Preparation of final seminar	
Jan, 2016 (4th field survey)	・ Discuss business development with local stakeholders	・ Final seminar	—
Feb	・ Final report		

3. Study of Business Implementation for Rooftop PV business

Solar power generation has been seen as a prospective solution for CO2 emission reduction. Power generation by PV modules does not emit any CO2 while all generated power can be utilized by connecting to the power grid and reversing power flow. Besides, solar power has less geographical differences in generation potential compared to other renewable energies, enabling generation almost all around the country. Therefore, there is a large potential for PV installation.

In the new Growth Strategy of the Government of Japan, “export of infrastructure and system”, which is not limited to export of individual equipment but aims to undertake all the system from engineering, construction, maintenance to management, is a focused policy measure fully backed up by the Government.

JDI promotes oversea expansion of infrastructure and system through a subsidiary, AG, by private public partnership. Introduction of PV systems is one of the JDI’s initiatives. PV business is an important business not only for realization of low-carbon society and environmental contribution of emerging countries of Asia, Africa, South America etc. and the whole world, but also for the industrial strategy of Japan.

AG starts its PV installation business from Cambodia. PV installation utilizes three types of spaces: land, rooftop and water surface. AG targets to install PV on rooftop of commercial facilities, hotels, schools, hospitals, public facilities in urban areas where the land price is quite high. Factories rooftops in special economic zones and industrial parks have also a large potential. AG aims to apply for the JCM equipment subsidy program as the leader of international consortiums while AG decided to establish a subsidiary company in Cambodia. The result of the study of AG’s and its subsidiary’s business implementation for PV installation business is explained below.

3.1. A market survey of rooftop PV business

The targets for PV installation are generally categorized as three types: utility scale type (solar farms of power companies for selling purpose); commercial type (hotels, factories, building for self-consumption and/or selling); residential type (ordinary households for self-consumption and/or selling). This study focuses on 5–star and 4-star hotels and factories rooftops in collaboration with management companies of special economic zones and industrial parks.

3.1.1. The market of rooftop PV for industry use

Rooftop PV can promote self-production and self-consumption of energy in areas where there is electricity demand without constructing a large power plant or transmission lines.

3.1.2. A- Hotel

A-Hotel is located 20 minutes away from the center of Siem Reap city and 10minutes away from the Angkor temple and the Siem Reap International Airport. The hotel has 188 rooms with the land area of 5,600m^2.

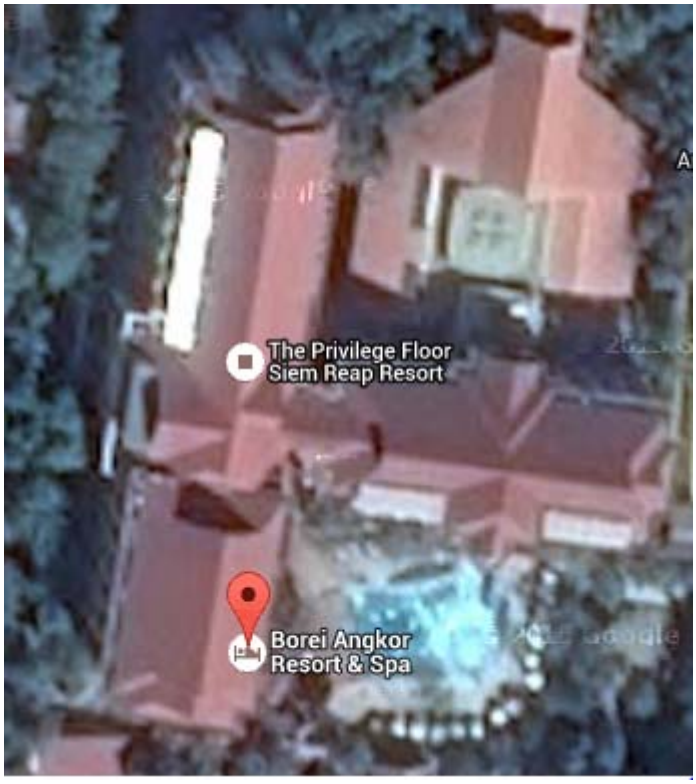


Figure 3-1：Aerial photography of A-Hotel

(Source: Google map)

https://www.google.co.jp/maps/place/Borei+Angkor+Resort+%26+Spa,+%230369+NR6,+Krong+Siem+Reap,+%E3%82%AB%E3%83%B3%E3%83%9C%E3%82%B8%E3%82%A2/@13.3596786,103.8671143,19z/data=!3m1!1e3!4m2!3m1!1s0x311017760bafa6f9:0x1612fb73509bff6f

Electricity is received as 11kV from the EDC grid and stepped down in voltage with two 550kVA transformers and one 320 kVA transformer at the hotel. A power generator is equipped for backup purpose.

The annual electricity consumption is about 3,700,000kWh, equivalent to about 662,147USD.

Figure 3-2：The external appearance of A-Hotel

Figure 3-3：The Loft of A-Hotel

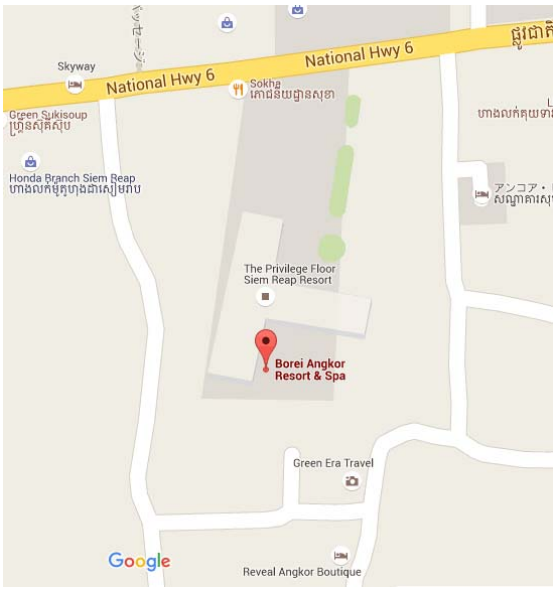


Figure 3-4：The Location of A-Hotel(Source: Google map)

https://www.google.co.jp/maps/place/Borei+Angkor+Resort+%26+Spa,+%230369+NR6,+Krong+Siem+Reap/@13.3596786,103.8671143,18z/data=!4m2!3m1!1s0x311017760bafa6f9:0x1612fb73509bff6f

3.1.3. B-Hotel

B-Hotel is a high class resort hotel located along Charles de Gaulle Street at the entrance of Angkor Wat sightseeing route. The hotel is owned by Thai Beverage Plc. and managed by Starwood Hotels & Resorts Worldwide, inc.

The main building has the deck roof with a courtyard inside. The electric power system such as distribution equipment, a diesel power generator and the air conditioning equipment such as a boiler, chiller are installed in a separate annex building.

Figure 3-5：Aerial photography of B-Hotel

(Source: Yahoo Map（ http://map.yahoo.co.jp/）)

Figure 3-6：The roof of the main building

Figure 3-7：The annex building

Electricity is received as 22kV from the EDC grid and stepped down to three-phase four-line 400/230V at the hotel. The hotel also has two 1000kVA diesel power generators for automatic switching from the EDC grid in case of power cuts.

Figure 3-8：A diesel power generator

Figure 3-9：Grid/generator switch board

The annual electricity consumption was about 3,243,200kWh, equivalent to about 567,000USD while the consumption of diesel was 33,891L (fuel cost: about 35,600USD) in 2014.

The following graph shows the result of the main power measured between 9th and 12th September 2015. As only the electric current (three-phase) was measured, it was apparent power assuming that there was no change in voltage. During the above period, the hotel rooms were fully occupied.

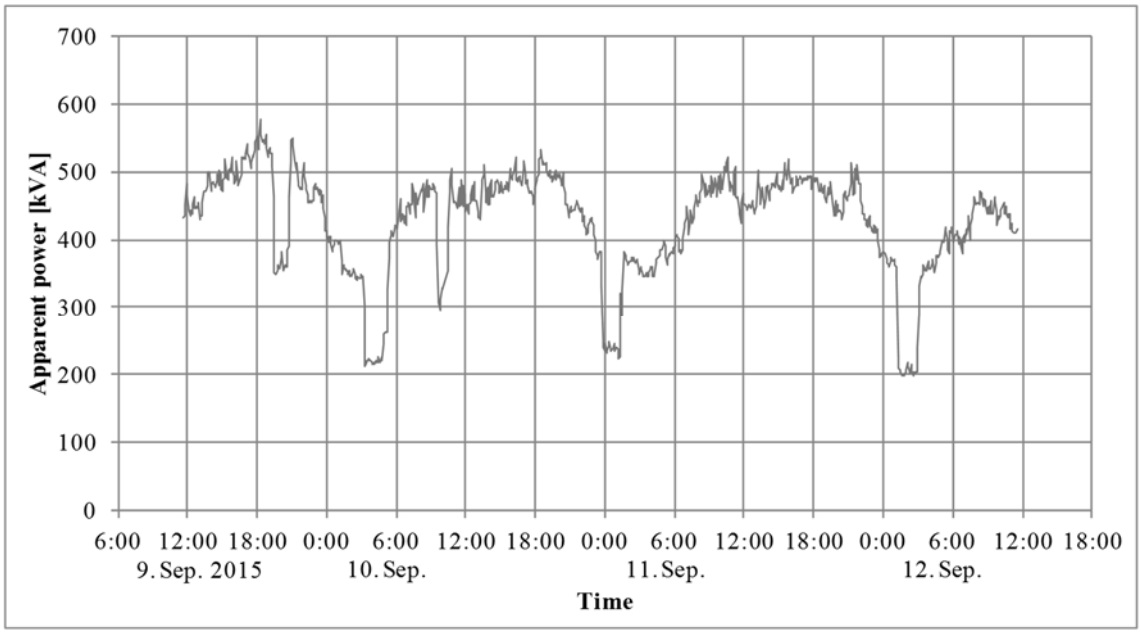


Figure 3-10：The measurement result of the main power

According to the result, the demand in early morning was the smallest while the demand peaked around 18:00-20:00. The reason for a couple of drops in demand in a day was the stop of the chiller by hand for the purpose of saving electricity.

Based on the measurement and interviews to hotel engineers, it was confirmed that the daily maximum demand was about 600kVA and the minimum demand was 200kVA.

With this study result, the study team came to the conclusion that it is possible to introduce a PC/diesel hybrid system by installing a PV system on the rooftop of the main building and a fuel reduction controller on the annex building.

3.2. Technical characteristics and advantages of rooftop PVs

The basic equipment configuration of rooftop PV systems is shown below.

3.2.1. Characteristics of AGC's ultra-lightweight solar panel

LightjouleTM is an ultra-lightweight solar panel. Using LeoflexTM, a thin and strong chemically strengthened specialty glass, as the cover glass, AGC successfully reduced the panel weight of Lightjoule by nearly 50% compared to conventional solar panels. Lightjoule^{TM} received the 2014 New Energy Award given by the New Energy Foundation.

There are three advantages of Lightjoue.

- Approximately 50% lighter than conventional solar panels

(Convertible solar panel: 17.0kg/sheet => Lightjoule: 9.5kg/sheet)

- Can be installed on rooftops with loading weight restrictions without implementing reinforcement work
- Easy to carry and greater installation efficiency

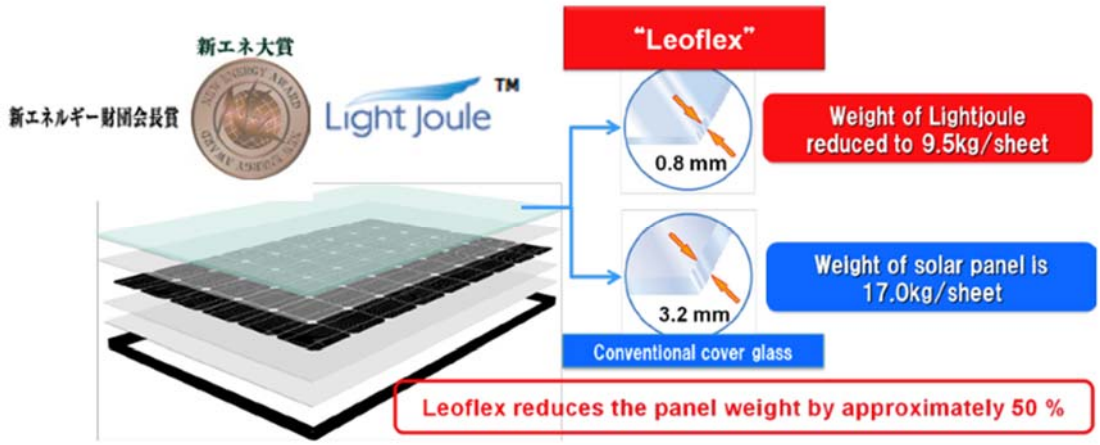


Figure 3-11：Differences between LightjouleTM ultra-lightweight photovoltaic module and concentional modules

The LightjouleTM ultra-lightweight photovoltaic module expands the possibilities for use on structures where it has formerly been difficult to install photovoltaic modules due to the load bearing capacity of the structure, such as on metal sheet roofing of factories, warehouses, stores, and carports, as well as on secondary structures (parking areas, bus stops).

Modules use LeoflexTM, a chemically strengthened glass by AGC. This achieves a significant reduction in weight while passing snow accumulation and wind pressure tests of up to 2400Pa. The latest technologies in glass and photovoltaic module manufacturing have combined in top world-class quality.

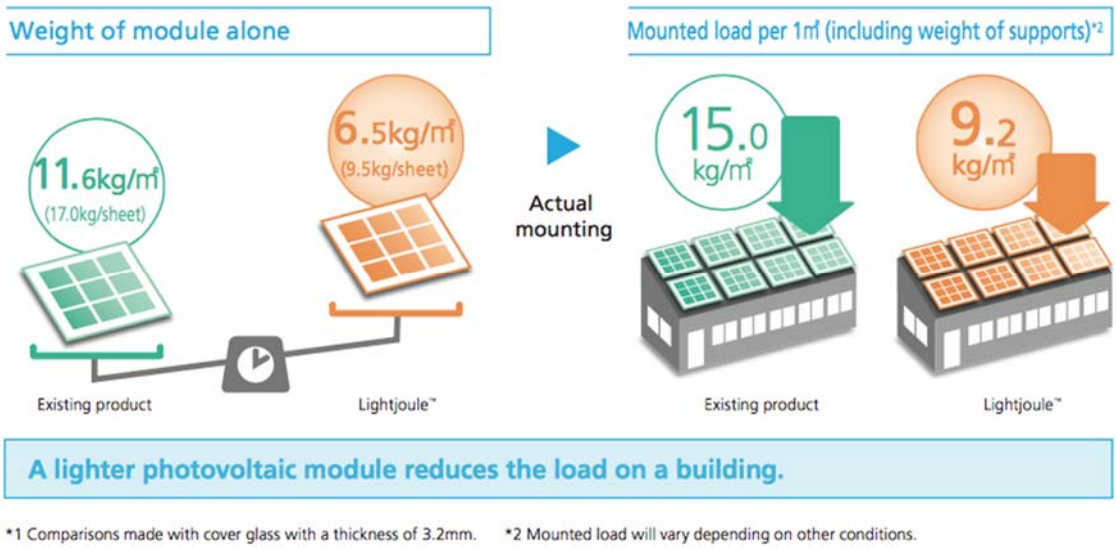


Figure 3-12：Weight of module alone and mounted load per 1m² (including weight of supports)

LightjouleTM has also passed assessment based on quality standards (IEC standards) set forth by the IEC (International Electrotechnical Commission). LightjouleTM received TUV Certification under the IEC standards in recognition of total quality, including safety during stringent durability tests. For a loing time use, the quality and durability are necessary. Therefore, a 20 year power output guarantee is offerred.

The ultra-lightweight photovoltaic module, LightjouleTM, uses **Leoflex**TM, a chemically strengthened glass manufactured and sold by AGC. LeoflexTM attains a higher strength than conventional tempered soda-lime glass, such that it can be fabricated with a smaller thickness and still resist breakage, thereby allowing lighter-weight glass. The increased strength of the chemically tempered specialty glass LeoflexTM is gained by the Na+ ions contained around the surface of the glass being exchanged by K+ ions with a larger diameter contained in a solution. This has helped to achieve thinness and strength that was previously unachievable in physically tempered glass.

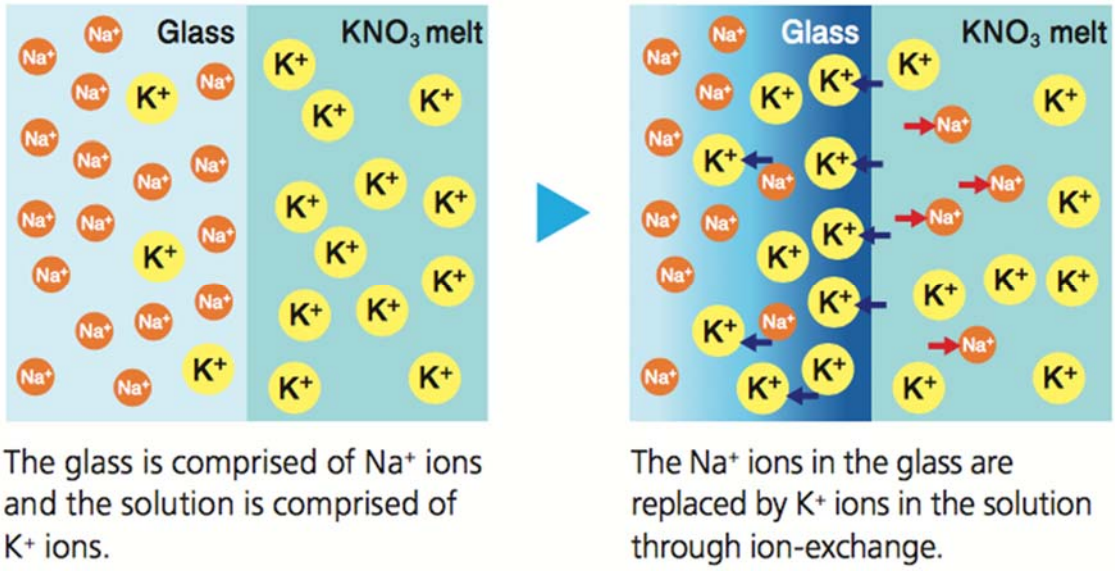


Figure 3-13：Image of manufacturing chemically tempered specialty glass

PID (Potential Induced Degradation) refers to the loss of power output in photovoltaic modules as a result of high temperatures, high humidity and high system voltages. There are several reasons why this occurs, one of them believed to be the diffusion of Na+ ions found on the surface of the glass. The amount of Na+ ions on the surface of LeoflexTM is less than conventional glass so that when it is used in photovoltaic modules the diffusion of Na+ ions is reduced, lessening the effect of PID. AGC is currently conducting PID resistance tests based on standards set forth by Fraunhofer (Europe's largest research institution). AGC has conducted further testing (Note 1) under more stringent standards, demonstrating that there is little or no loss of power output.

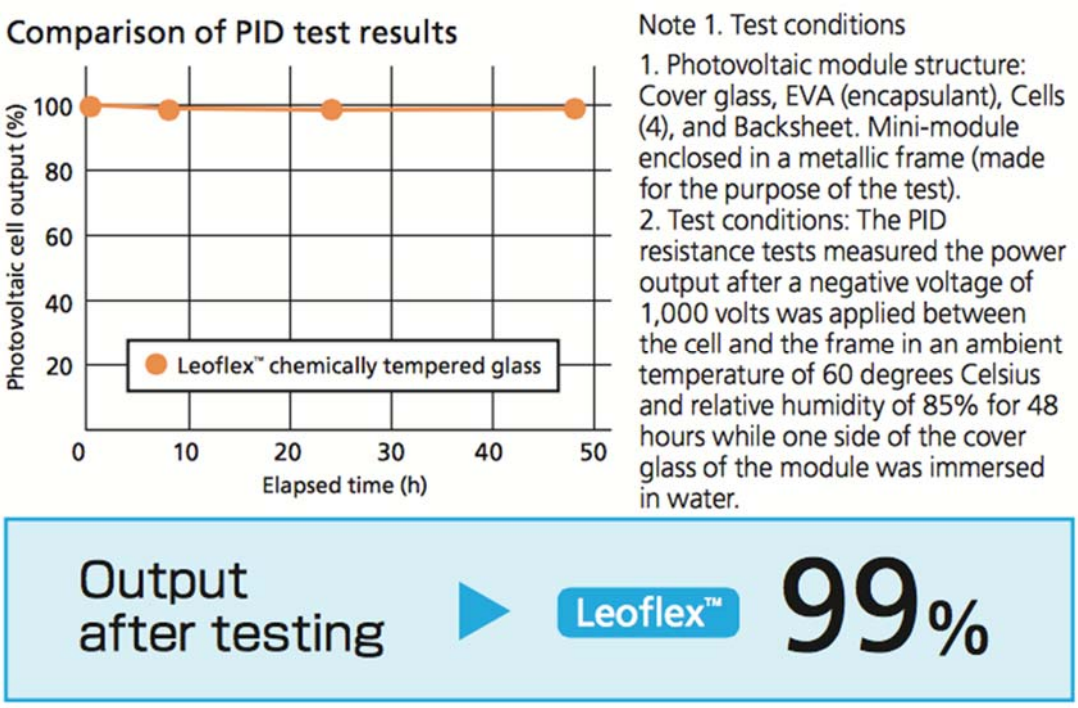


Figure 3-14：Measurement result of PID (Potential Induced Degradation)

3.2.2. Characteristics of Kyocera hybrid system

(1) Concept

Many of the resort hotels in Siem Reap city have diesel power generators for emergency power source as for the grid power is unstable. The hotel studied also had a similar system and the fuel cost for the diesel power generator is one of the management issues as well as the electricity cost.

On the other hand, the governor of Siem Reap province and the mayor of Siem Reap city have a policy of developing themselves as “low carbon tourism city” with GHGs reduction being an urgent issue. For addressing the issue, this FS project proposes a hybrid system, where a PV and a fuel reduction controller are combined and connected to the existing diesel power generator.

This proposed system can increase the PV ratio upto 60% against diesel power without using a battery. To be more precise, it monitors the balance between the generated power and power demand and reduces the fuel use by managing efficiently the diesel power generator through controlling the output of the PV. As the controlled object is a PV only, the proposed system has a characteristic that there is no need to modify or upgrade the existing electric power equipment.

When the grid power is normal, self-consumption is promoted by operating the system as a normal grid-connected PV system, reducing the power purchase from the grid.

Figure 3-15 and Figure 3-16 show the concept of the proposed system.

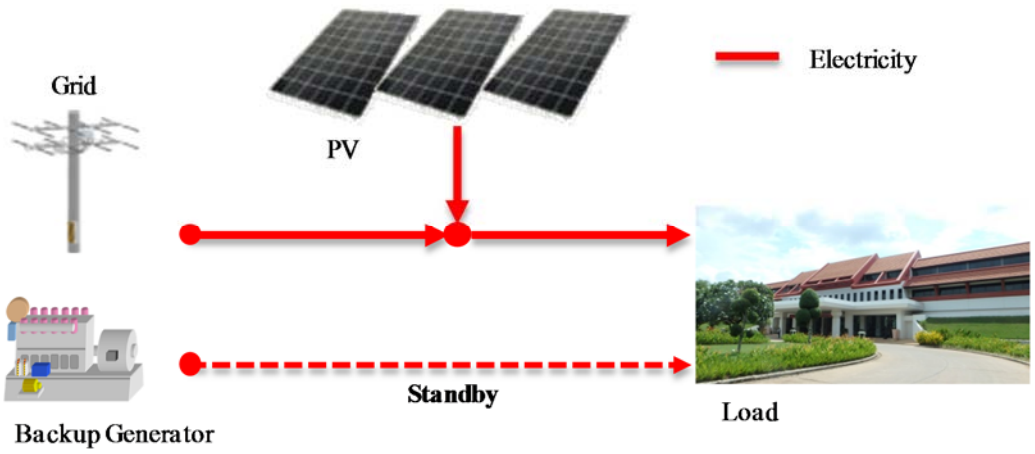


Figure 3-15：Concept (1) of PV/diesel hybrid system (for normal operation with grid connection)

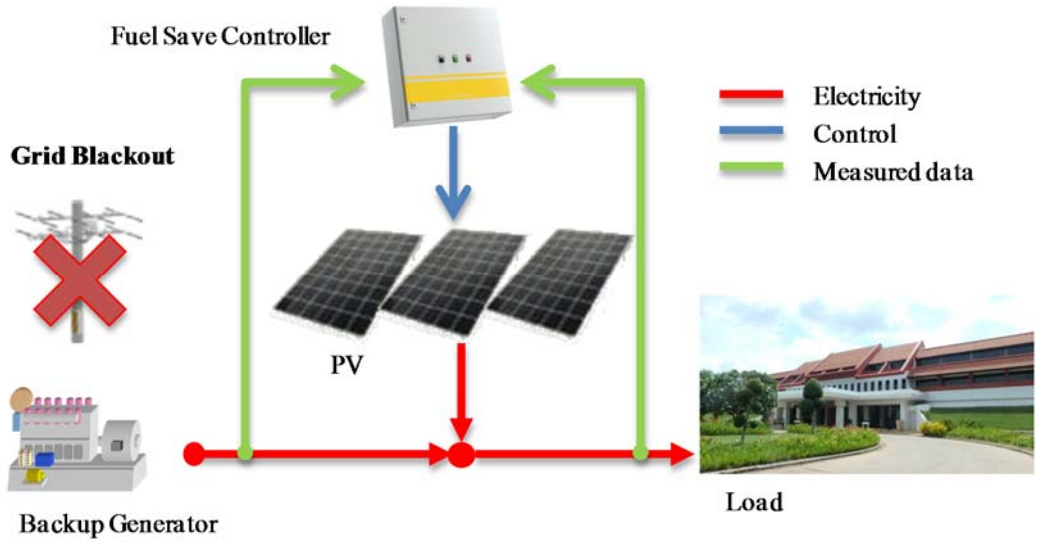


Figure 3-16：Concept (2) of PV/diesel hybrid system (for grid power cut)

(2) System configuration

PV modules are assumed to install on rooftop of the hotel. Considering possible effects of the existing pipes, exhaust outlets, ducts, solar water heater, the maximum capacity of installable modules is 149.46kW (564 modules of the rating capacity 265 Wp).

A proposed layout of the PV modules is shown in the figure below (see appendix for details).

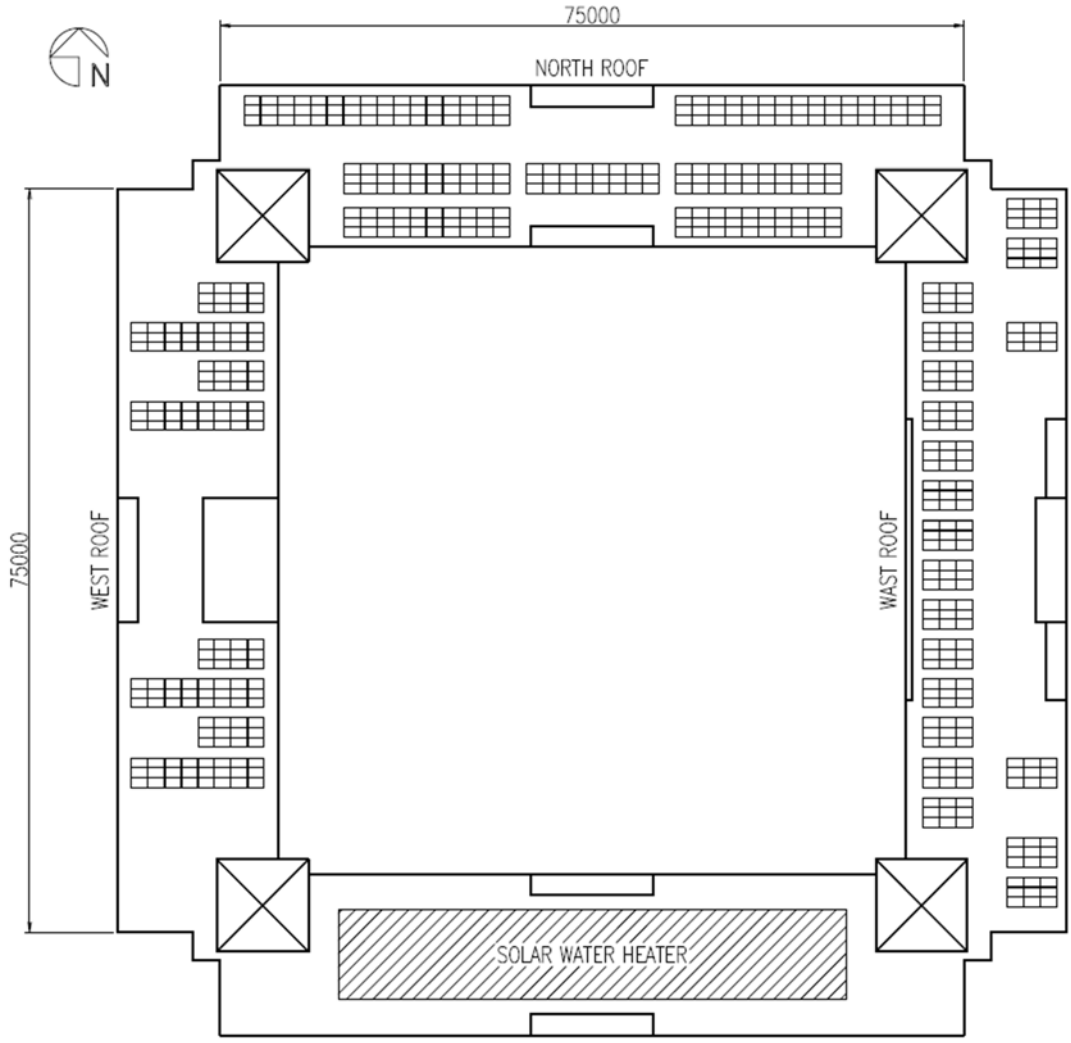


Figure 3-17：Panel layout of PV modules

The system includes five power conditioners of rating capacity 20kW and two of rating capacity 25kW. All the power conditioners are to install on the rooftop of the main building while the AC output is connected to the existing switchboard by laying electric cables to the electric room.

A fuel reduction controller is to install in the electric room, recording data and controlling output of the power conditioners.

Besides, a pyranometer, a thermometer and a weather signal converter box are to install on the rooftop of the main building for measuring and collecting weather data.

The system configuration diagram is shown in the figure below (see a single line diagram in appendix for details).

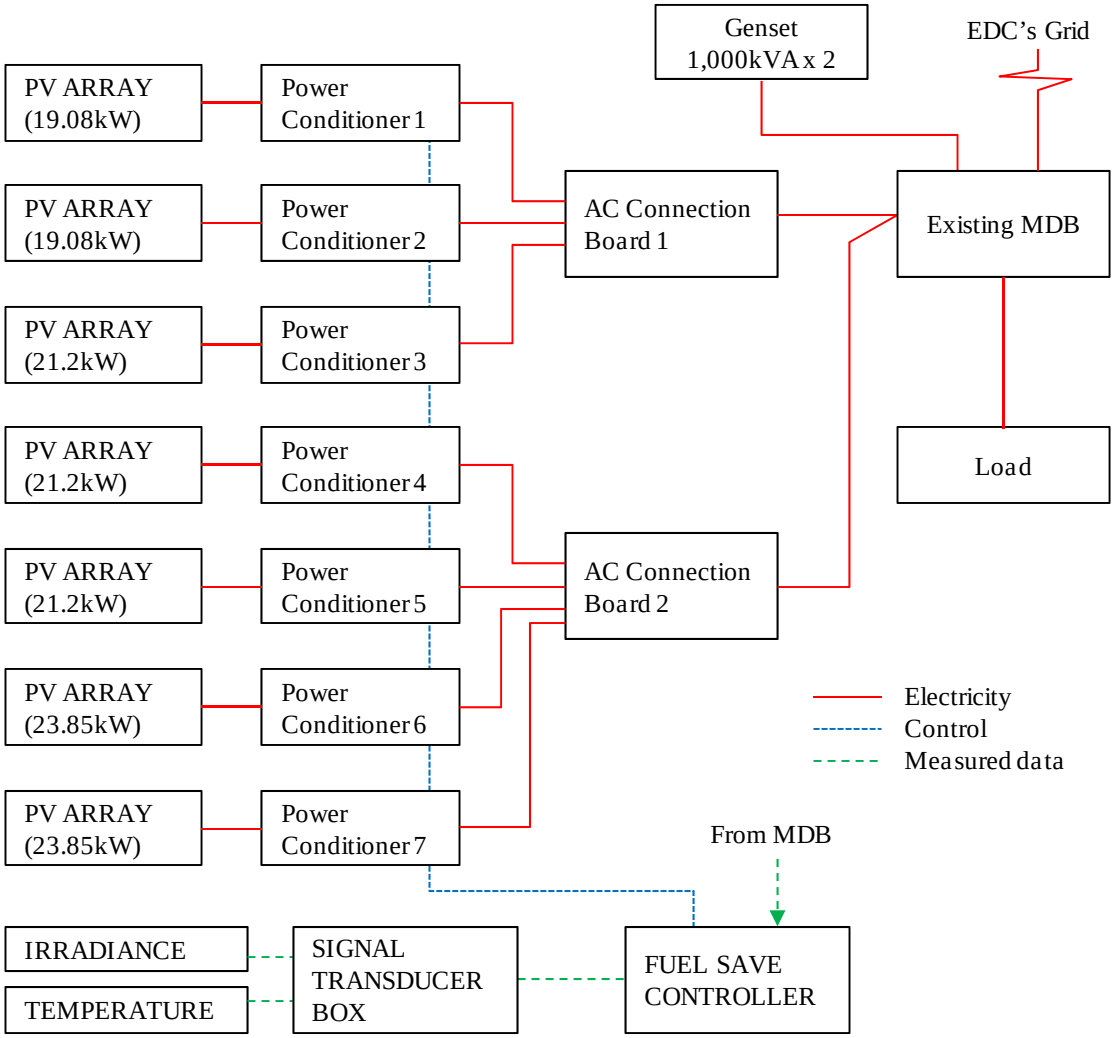


Figure 3-18：System configuration diagram

(3) Energy management system under consideration

We here consider visualization and automatic load controlling by introducing an energy management system (EMS) for further reduction in electricity consumption.

By visualizing electricity it can expect an effect of enhancing awareness of the owner and employees to save electricity.

The object of automatic load controlling is a chiller, which is currently switched on and off manually while other loads are not objects of automating load controlling as many of them could have direct

effects on hotel guests.

During the power measured period of 72 hours from 12:00 September 9th to 12:00 September 12th, the chiller was stopped five times as shown in Table 3-1.

Table 3-1 : Chiller stop period

No.	Period	Time [h:m]
①	09. Sep 19:25 – 20:50	1:25
②	10. Sep 03:15 – 05:15	2:00
③	10. Sep 09:30 – 10:30	1:00
④	10. Sep 23:45 – 01:30	1:45
⑤	11. Sep 01:10 – 03:05	1:55
Total	-	8:05

The daily stop period is about 2 hours and 40 minutes on average. However it fluctuates widely due to manual operation. In this situation, introducing an EMS and smoothing by automatic controlling can expect reduction in electricity consumption. Compared to the present manual controlling, it can expect annually reduction of electricity of about 18,250kWh.

3.3. Preparation of subsidiary in Cambodia

3.3.1. Business Plan

Asian Energy Solutions Inc (AGE), a subsidiary of AG, is a company pursuing decentralized power development which designs, constructs and operate rooftop PVs in Southeast and South Asia. AGC's business model concept is shown below.

(i) The target segment is rooftops of hotels, schools and factories

(ii) Standardization of installation techniques for rooftops (light-weight and easy-to-install racks and jigs) and education of local installers for higher quality

(iii) Package sales of Japanese PV equipment and systems (PV modules, power conditioners, inverters, hybrid systems, batteries, monitoring etc.) and one-stop maintenance services

(iv) Targeting off-grid self-consumption (without grid connection) as main customers

(v) In case of IPP direct selling businesses with factories rooftops, special purpose companies (SPCs) are to set up in order to own the whole PV system and sell to the grid

(vi) Services of stabilizing grid connection for decentralized powers (ancillary services)

(vii) Direct selling to a rooftop factory owner based on a Power Purchase Agreement (PPA)

(viii) Providing energy management services and selling power saving equipment

3.3.2. Business risks and analysis

The following business risks are assumed and their countermeasures are considered.

(i) Possibility of stable business foundation in terms of local laws and policies, economy, technology, customs etc.

(ii) Possibility of coexistence of PVs, utilities and other renewable energy

(iii) Possibility of win-win relationship among rooftops owners of hotels, commercial facilities, schools, factories and industrial parks developers

(iv) Possibility of differentiation, competition against later comers with the same business model

3.4. Building a MRV Methodology for rooftop PVs

In this study project, a draft of a MRV methodology (the Methodology) is prepared for applying to PVs installation at hotels in Siem Reap city. The draft is attached to this report as Appendix 1. Besides, the scope of application, eligibility criteria, calculation method for GHGs emission reduction and monitoring plan and implementation structure are shown below.

3.4.1. Scope of application

The proposed methodology is to apply to projects which reduce electricity from the grid/diesel power generators by introducing ultra light-weight PVs systems in Cambodia and reduces GDGS emissions reduction.

3.4.2. Eligibility criteria

The proposed methodology proposes the following eligibility criteria.

Criterion ① The project installs solar PV system(s).

Criterion ② The solar PV system is connected to the internal power grid of the project site and/or to the grid for displacing grid electricity and/or captive electricity at the project site.

Criterion ③ The PV modules have obtained a certification of design qualifications (IEC 61215, IEC 61646 or IEC 62108) and safety qualification (IEC 61730-1 and IEC 61730-2).

Criterion ④ The PV modules have more than 15% of module conversion efficiency and less than 6.5 kg/m2 of weight.

Criterion ⑤ The equipment to monitor output power of the solar PV system and irradiance is installed at the project site.

3.4.3. Reference emissions

The reference emissions of this methodology is GHGs emissions which would occur if the power generated by the PV system is supplied by the existing system (the power grid and/or diesel power generators).

3.4.4. Project emissions

The project emissions for this methodology is assumed to be the GHG emissions of PV systems（0 tCO2/year.

3.4.5. Calculation method for GHGs emissions reduction

Equations for calculating GHG emission reduction are shown below.

(A) Reference emissions

$$RE_y = \sum_i EG_{i,y} \times EF_{RE}$$

(B) Project emissions

$$PE_y = 0$$

(C) Emission reduction

$$ER_y = RE_y - PE_y = RE_y$$

Table 3-2: Default value for calculating reference emissions

Parameter	Content	Value	Source
EF_{RE}	The emission factor of the grid and captive electricity	0.6257 tCO2/MWh	Ministry of Environment, Cambodia 2011, Grid Emission Factor of the Phnom Penh Electricity Grid. (operating margin)

3.4.6. Monitoring method

The hotel, being the owner of the equipment, is assumed to monthly check and record the power (kWh) generated by the PV system through monitoring equipment while AG, being the project

manager, is assumed to check the records and prepare a monitoring report and report to the Joint Committee.

Table 3-3: Values to be monitored and monitoring method

Parameter	Content	Unit	Method
$EG_{i,y}$	Quantity of the electricity generated during the period y	MWh/year	The owner of the equipment is to monthly check and record the power (kWh) generated by the PV system through monitoring equipment.

3.5. Economic effects

3.5.1. Effects of Introducing Rooftop PVs

Power generation simulations were conducted for A-Hotel under the following assumptions

- Based on the drawings obrained from Borei Ankor, an installable layout is developed complying with Japanese standards.
- As the structural strength is unknown, the layout assumes that the panels are within the carrying capacity of the roof.
- Power generation simulations are based on the Japanese calculation method (JIS C8907 2005 estimation method for PV power generation)
- Radiation data and average temperature data are from “NASA Surface meteorology and Solar Energy –Available Tables”.

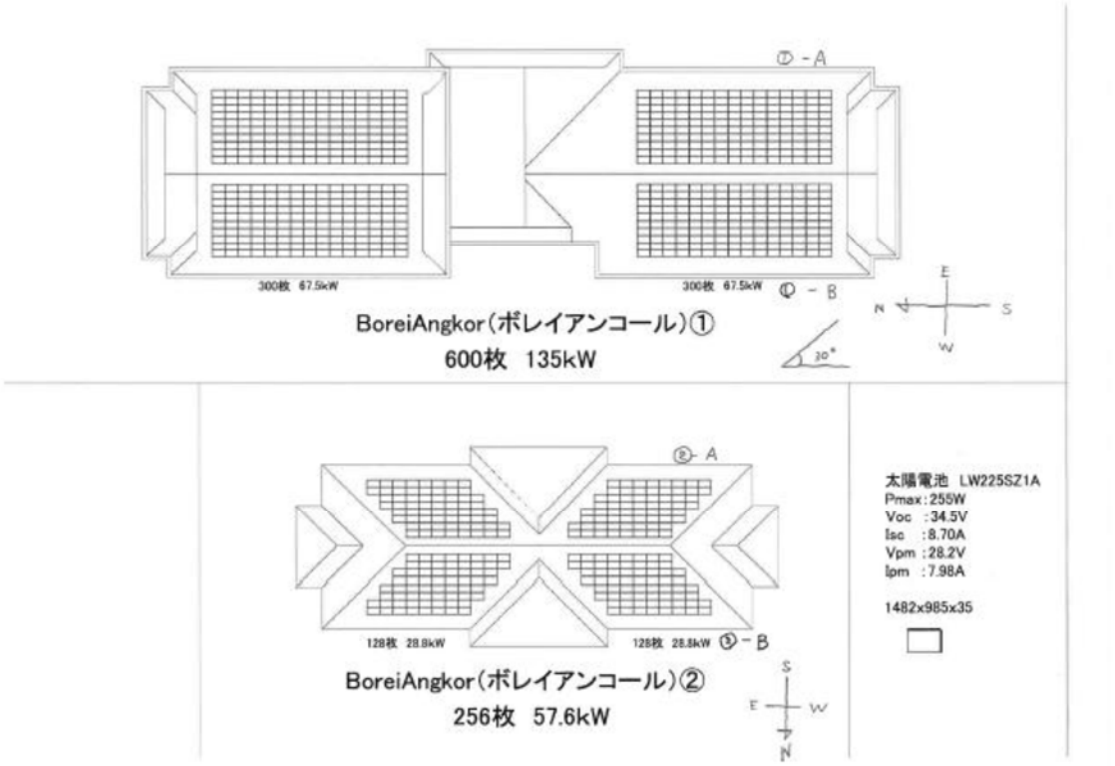
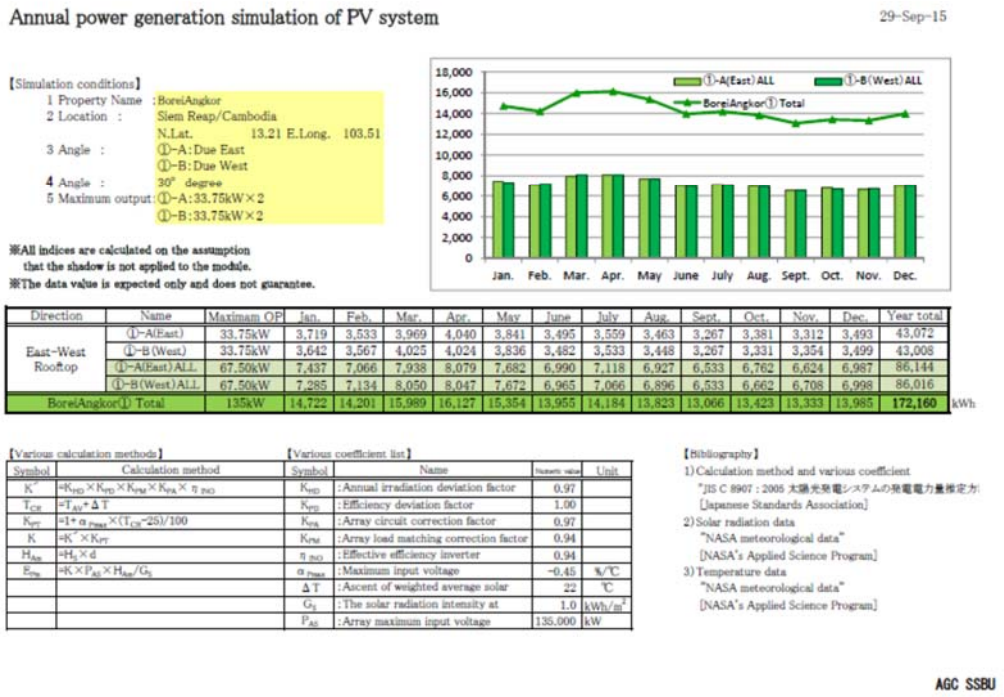


Figure 3-19：Panel layout for A-Hotel

The results of power generation simulations are shown below separately for individual rooftops.



Annual power generation simulation of PV system

29-Sep-15

【Simulation conditions】

1 Property Name : BoreiAngkor
2 Location : Siem Reap/Cambodia
N.Lat. 13.21 E.Long. 103.51
3 Angle : ①-A:Due East
①-B:Due West
4 Angle : 30° degree
5 Maximum output: ①-A:33.75kW×2
①-B:33.75kW×2

※All indices are calculated on the assumption that the shadow is not applied to the module.
※The data value is expected only and does not guarantee.

Direction	Name	Maximam OP	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year total
East-West Rooftop	①-A(East)	33.75kW	3,719	3,533	3,969	4,040	3,841	3,495	3,559	3,463	3,267	3,381	3,312	3,493	43,072
	①-B(West)	33.75kW	3,642	3,567	4,025	4,024	3,836	3,482	3,533	3,448	3,267	3,331	3,354	3,499	43,008
	①-A(East) ALL	67.50kW	7,437	7,066	7,938	8,079	7,682	6,990	7,118	6,927	6,533	6,762	6,624	6,987	86,144
	①-B(West) ALL	67.50kW	7,285	7,134	8,050	8,047	7,672	6,965	7,066	6,896	6,533	6,662	6,708	6,998	86,016
BoreiAngkor① Total		135kW	14,722	14,201	15,989	16,127	15,354	13,955	14,184	13,823	13,066	13,423	13,333	13,985	**172,160** kWh

【Various calculation methods】

Symbol	Calculation method
K'	$=K_{PD}\times K_{PD}\times K_{PM}\times K_{PA}\times \eta_{INO}$
T_{CR}	$=T_{AV}+\Delta T$
K_{PT}	$=1+\alpha_{Pmax}\times(T_{CR}-25)/100$
K	$=K'\times K_{PT}$
H_{Ax}	$=H_0\times d$
E_{Pa}	$=K\times P_{AS}\times H_{Ax}/G_S$

【Various coefficient list】

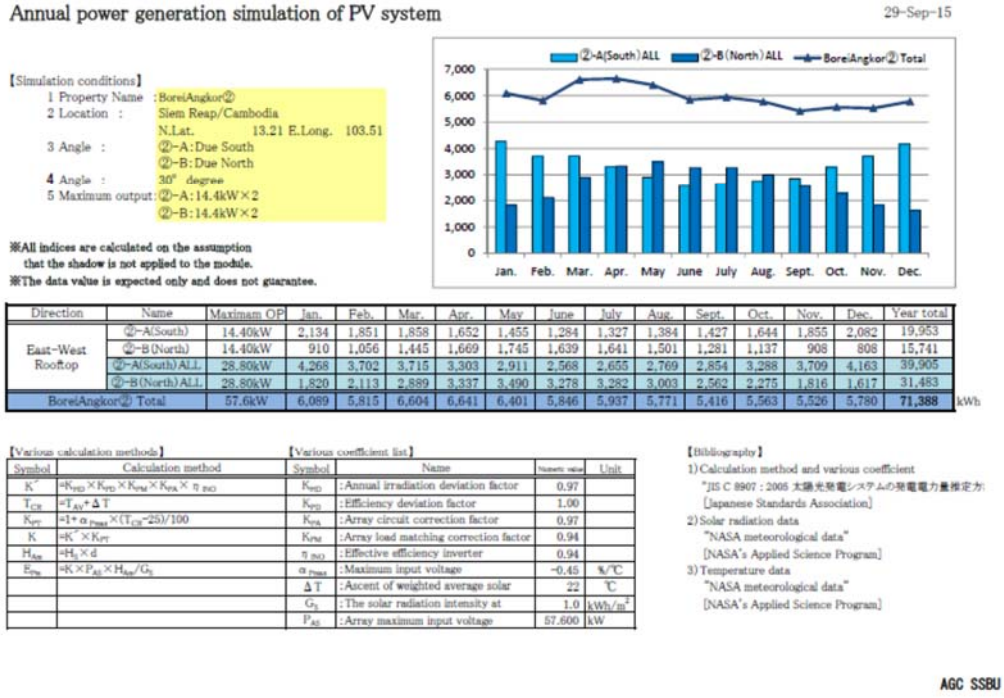
Symbol	Name	Numeric value	Unit
K_{PD}	:Annual irradiation deviation factor	0.97	
K_{PD}	:Efficiency deviation factor	1.00	
K_{PA}	:Array circuit correction factor	0.97	
K_{PM}	:Array load matching correction factor	0.94	
η_{INO}	:Effective efficiency inverter	0.94	
α_{Pmax}	:Maximum input voltage	-0.45	%/℃
ΔT	:Ascent of weighted average solar	22	℃
G_S	:The solar radiation intensity at	1.0	kWh/m²
P_{AS}	:Array maximum input voltage	135.000	kW

【Bibliography】

1) Calculation method and various coefficient
"JIS C 8907 : 2005 太陽光発電システムの発電電力量推定方
[Japanese Standards Association]
2) Solar radiation data
"NASA meteorological data"
[NASA's Applied Science Program]
3) Temperature data
"NASA meteorological data"
[NASA's Applied Science Program]

AGC SSBU

Figure 3-20：Power generation simulation of Building ① (600 PV panels)



Annual power generation simulation of PV system

29-Sep-15

【Simulation conditions】

1 Property Name : BoreiAngkor②
2 Location : Siem Reap/Cambodia
N.Lat. 13.21 E.Long. 103.51
3 Angle : ②-A:Due South
②-B:Due North
4 Angle : 30° degree
5 Maximum output: ②-A:14.4kW×2
②-B:14.4kW×2

※All indices are calculated on the assumption that the shadow is not applied to the module.
※The data value is expected only and does not guarantee.

Direction	Name	Maximam OP	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year total
East-West Rooftop	②-A(South)	14.40kW	2,134	1,851	1,858	1,652	1,455	1,284	1,327	1,384	1,427	1,644	1,855	2,082	19,953
	②-B(North)	14.40kW	910	1,056	1,445	1,669	1,745	1,639	1,641	1,501	1,281	1,137	908	808	15,741
	②-A(South) ALL	28.80kW	4,268	3,702	3,715	3,303	2,911	2,568	2,655	2,769	2,854	3,288	3,709	4,163	39,905
	②-B(North) ALL	28.80kW	1,820	2,113	2,889	3,337	3,490	3,278	3,282	3,003	2,562	2,275	1,816	1,617	31,483
BoreiAngkor② Total		57.6kW	6,089	5,815	6,604	6,641	6,401	5,846	5,937	5,771	5,416	5,563	5,526	5,780	**71,388** kWh

【Various calculation methods】

Symbol	Calculation method
K'	$=K_{PD}\times K_{PD}\times K_{PM}\times K_{PA}\times \eta_{INO}$
T_{CR}	$=T_{AV}+\Delta T$
K_{PT}	$=1+\alpha_{Pmax}\times(T_{CR}-25)/100$
K	$=K'\times K_{PT}$
H_{Ax}	$=H_0\times d$
E_{Pa}	$=K\times P_{AS}\times H_{Ax}/G_S$

【Various coefficient list】

Symbol	Name	Numeric value	Unit
K_{PD}	:Annual irradiation deviation factor	0.97	
K_{PD}	:Efficiency deviation factor	1.00	
K_{PA}	:Array circuit correction factor	0.97	
K_{PM}	:Array load matching correction factor	0.94	
η_{INO}	:Effective efficiency inverter	0.94	
α_{Pmax}	:Maximum input voltage	-0.45	%/℃
ΔT	:Ascent of weighted average solar	22	℃
G_S	:The solar radiation intensity at	1.0	kWh/m²
P_{AS}	:Array maximum input voltage	57.600	kW

【Bibliography】

1) Calculation method and various coefficient
"JIS C 8907 : 2005 太陽光発電システムの発電電力量推定方
[Japanese Standards Association]
2) Solar radiation data
"NASA meteorological data"
[NASA's Applied Science Program]
3) Temperature data
"NASA meteorological data"
[NASA's Applied Science Program]

AGC SSBU

Figure 3-21：Power generation simulation of Building ② (256 PV panels)

Based on the above generation results, the result of a balance simulations is shown below.

Table 3-4：Result of Balance simulation

	Installed PV capacity (kw)			Power generation (kwh)			Unit price for install (c)	Initial investment (kUSD) d=a*c	Unit price for electric power (USD) (d)	Saving amount (kUSD/年) e =b*d	Collection period (year) c/e
	Area 1	Area 2	total(a)	Area 1	Area 2	total (b)					
Case 1	135	57.6	192.6	172.16	71.39	243.55	2.38	458	0.18	43.8	10.5
Case 2	135	57.6	192.6	172.16	71.39	243.55	2.38	298	0.18	43.8	6.8
Case 3	135	57.6	192.6	172.16	71.39	243.55	1.53	295	0.18	43.8	6.7

- "Saving amount" is based on "all generated electric power is consumed by the hotel."
- "Unit price for install" is based on past record of "Solar Partners Asia (Cambodia)"
- In Case 1 & 2, PV module price changed "Lightjoule" from standard PV module price of "Solar Partners Asia (Cambodia)"

Case 1

The JCM scheme is not applied with the ultra light-weight PV module "Lightjoule TM"

Case 2

The JCM scheme is applied with the ultra light-weight PV module "Lightjoule TM"

Case 3

The ultra light-weight PV module "Lightjoule TM" is not used but non-Japanese standard PV modules are used.

In Case 2 with Lightjoule TM and JCM scheme application, the payback period is 6.8 years, which is feasible enough. Future issues are described below.

- Verification of possible use of 100% of power generated
- Verification of the carrying capacity of the building
- Verification of the installation method (preparation of detailed design for installation, reviewing of the panel layout)
- An installation plan (necessity of heavy machines, scaffolds, possible effects on hotel operation)

3.5.2. Other economic effects

(1) System operation result

For estimating the effect of the operation of the proposed system, the following assumptions are made.

(i) The PV output is to be controlled so that the minimum operational power output is maintained at 300kW for the diesel power generator.

(ii) The actual time period of power cuts in 2014 is used.

(iii) The average price of 1.05USD/Liter is used as the diesel price for 2014.

(iv) The 2014 average tariff of 0.175USD/kWh is used as the tariff of the grid for 2014.

Table 3-5：Result of Annual operation simulation

	Inclined irradiation [kWh/m^2]	Averaged ambient temp. [deg C]	PV Output [kWh]	Fuel reduction [Liter]	Fuel cost reduction [USD]	Electricity reduction [kWh]	Electricity cost reduction [USD]
Jan.	174.2	26.5	22,095	5	5	23,548	4,121
Feb.	150.0	28.2	18,941	15	15	20,037	3,506
Mar.	174.2	29.5	21,811	157	164	20,108	3,519
Apr.	158.4	29.7	19,939	28	30	20,847	3,648
May.	173.9	29.2	21,942	9	10	23,298	4,077
Jun.	154.5	28.4	19,789	9	9	21,105	3,693
Jul.	167.5	28.4	21,354	5	5	22,809	3,992
Aug.	151.4	28.2	19,450	28	29	20,417	3,573
Sep.	132.6	27.5	17,092	72	75	17,103	2,993
Oct.	139.0	27.8	17,952	15	16	19,188	3,358
Nov.	145.0	26.5	18,490	3	3	19,935	3,489
Dec.	161.8	26.2	20,637	6	6	22,065	3,861
Annual	1882.5	28.0	239,492	350	368	250,460	43,831

Meteorological data source: Meteonorm Ver. 7

Based on the above simulation result, an annual reduction of 44,199USD is expected for the fuel cost and electricity cost combined.

(2) System price under consideration

As the design of the proposed system is to be prepared by Kyocera, the major equipment is to be procured by Kyocera. An average construction cost for deck roofs was calculated based on estimations quoted by Solar Partners Asia (Cambodia) Ltd and Khmer Solar, who have PV installation experiences in Cambodia.

The details of the project cost are I) equipment costs, II) transportation costs, III) technical costs for commissioning and adjustment, IV) construction costs, with the total project cost shown in the table below.

Table 3-6：Total project cost (not including VAT)

No.	Item	Quantity	Price
I	Equipment	-	$338,000
1	PV Module	564 pcs.	
2	Power Conditioner	7 units	
3	AC Connection Board	2 units	
4	Fuel Save Controller	1 set	
5	Meteorological Observation Device	1 set	
6	Energy Management System	1 set	
II	Transportation	-	$21,000
III	Supervisor	-	$42,000
IV	Construction including -PV Mounting Structure -Cable and wiring materials	-	$96,000
-	Total	-	$497,000

(3) Estimation of payback period

An estimation of balance of payments is shown in the figure below. About 11 years of payback period is estimated, with an estimated surplus of 386,980USD for 20 years.

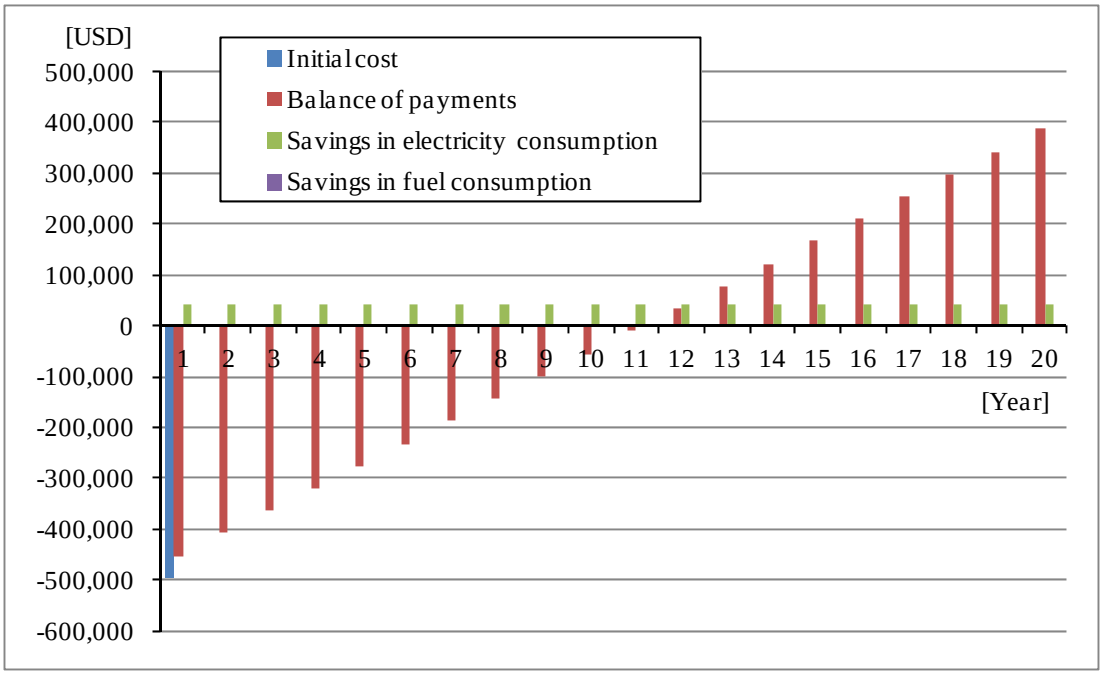


Figure 3-22：Estimation of balance of payments

4. Result of JCM Potential Project Needs Study and Future Efforts

4.1. Rice husk biomass power generation project

4.1.1. Technical advantage of biomass power generation

Cambodia is a major rice producing country with nearly 10 million ton of rice production (on paddy basis).

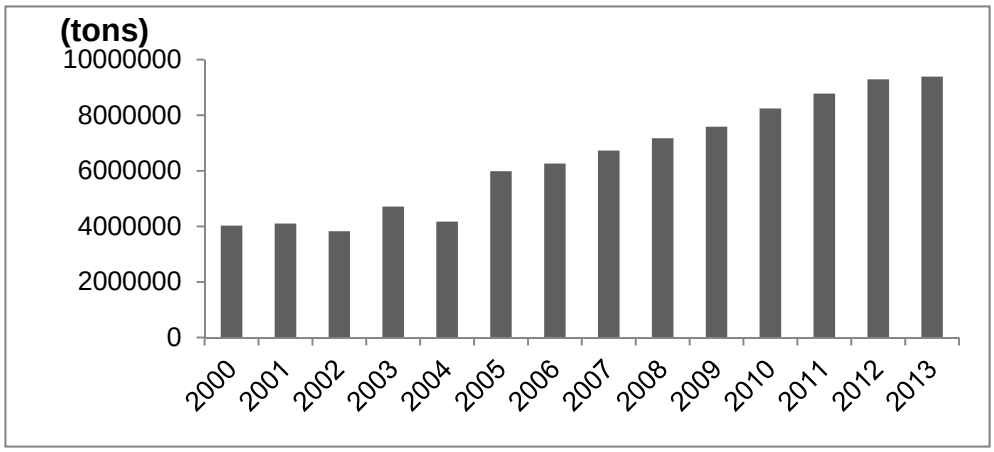


Figure 4-1：Rice production in Cambodia (on paddy basis)

Source：FAOstat

About 20-25% of the weight of the paddy will be rice husks. Therefore, there is a potential of 2 to 2.5 million tons of rice husks in the country. Assuming that a 1 MW biomass power plant needs about 10,000 ton/year of rice husks, there is a potential of 200-250MW biomass power generation.

However, about half of the paddy is at present exported to and milled in Thailand and Vietnam, resulting in a large loss of biomass resources. Besides, the rice husks produced in Cambodia also started to be exported to Thailand since 2014. The export price is relatively low as shown in the figure below as compared to the rice husk price are about 150 baht/to in Thailand (if 1baht＝0.028USD, 42USD/ton).

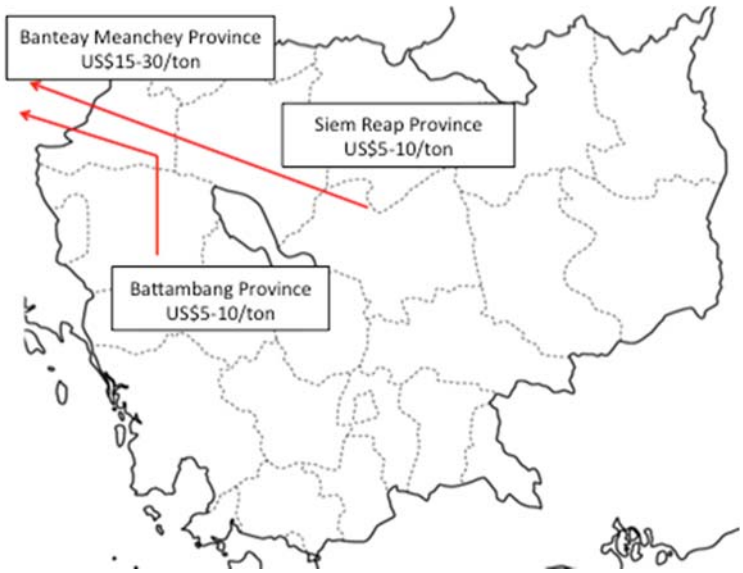


Figure 4-2：Rice husk export to Thailand and rice husk prices

On the other hand, Siem Reap depends on the imported power from Thailand at a relatively high price of about 18 cent/kWh.

Thailand already has a feed-in-tariff scheme for biomass power generation and the number of biomass power projects has been increasing. In Cambodia where there is no large-scale biomass power plant, most of rice husks are not utilized except some husks used for brick factories. The rice milling industry in Cambodia has not been well developed in terms of modernization, concentration and scale expansion as compared to Thailand. If enough rice husks can be efficiently collected within the close distance from rice mills, it can be important fuel for electricity generation in Cambodia. However, a proper business model is necessary for optimizing the husk supply, scale of generation, generation technology and husk price/transportation cost.

4.1.2. Expected GHGs emission reduction effect of investment in biomass power generation

At present it is impossible to decide the scale and specifications of the proposed biomass power plant. Considering the availability of rice husk resources in Siem Reap, we could assume to build a 2 MW power plant with an estimated power generation of about 12,264MWh per year on operating rate of 70%. With the emission factor of 0.6257kg-CO2/year (Ministry of Environment, Cambodia) for the grid, the project can reduce 7,673 ton/year CO2.

4.1.3. Need for project formation study of urban wastes and rice husk co-combustion biomass power generation project

The rice production is about 560,000 ton in Siem Reap province, being the 7th largest province in the country.

There are 10-15 middle-scale rice mills (milling capacity: 3-5 ton/hour) along the national road No.6 in Siem Reap province. However, some of them do not operate due to unfavorable market conditions. On the other hand, there is only one or two large-scale rice mill (milling capacity: more than 10 ton/hour) in the province.

In this study, the Study team visited 8 rice mills for interviewing on their rice mill management. The result is summarized in the table below. The average rice husk produced from one middle-scale rice mill is about 740 ton per year. As there is no record on rice mill operation at rice mills, it is quite hard to obtain accurate data on annual milling quantity and rice husk production.

Table 4-1：Rice mills in Siem Reap province

Rice mill	Location	Capacity of rice milling (ton/hour)	Annual milling quantity (ton/year)	Annual rice husk production (ton/year)	Rice husk disposal
Rice mill A	Soutr Nikom district	3	3,000	600	Selling to Thailand through a broker
Rice mill B	Soutr Nikom district	0.5	200	40	Providing nearby farmers for free
Rice mill C	Kralanh district	6	10,800 (2-3 years of operation stop)	2160	Selling domestically
Rice mill D	Bakong district	1.2	1,000	200	Selling domestically （only one time to Thailand）
Rice mill E	Soutr Nikom district	2.5	3,000	600	Selling half husk to Thailand
Rice mill F	Soutr Nikom district	3	5,000	1000	Selling domestically

Rice mill G	Soutr Nikom district	1.5	600	120	Selling domestically （only one time to Thailand）
Rice mill H	Pouk district	4	6,000	1200	Selling domestically （only one time to Thailand）

Source：prepared by the Study team based on a interview with a local rice miller

Note：The annual milling quantity and annual rice husk production are estimated based on interviews with rice millers on their milling capacity and operating days per year.

Photo：A rice mill in Siem Reap province

Photo：Rice milling machines

Photo：Rice husks exhausted from a rice mill

Photo：A truck for transporting rice husks

A typical middle-scale rice mill is connected with the grid, and their electricity demand is less than 500 kW and their monthly electricity consumption is about 30,000 kWh/month. The table below shows the monthly electricity consumption of a typical middle-scale rice mill in Siem Reap province. The average monthly electricity consumption at this mill from October 2013 to November 2014 was 29,949kWh with the maximum being 47,520kWh and the minimum being 20,339kkWh. The electricity tariff has been declining in recent years from 1200 riel/kWh ($ 0.30/kWh) in October – December 2013 down to 880 riel/kWh ($ 0.22/kWh) in November 2015.

Table 4-2：An example of electricity consumption at a rice mill in Siem Reap province

	2013											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Electricity consumption (kWh/month)	-	-	-	-	-	-	-	-	-	20,339	28,062	47,520
Electricity Trariff ($/kWh)	-	-	-	-	-	-	-	-	-	0.30	0.30	0.30
Electricity cost ($/month)	-	-	-	-	-	-	-	-	-	6,102	8,419	14,256

	2014											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Electricity consumption (kWh/month)	41,546	29,180	29,015	24,686	28,002	28,072	26,054	25,133	28,233	34,268	29,173	-
Electricity Trariff ($/kWh)	0.29	0.29	0.29	0.28	0.28	0.28	0.26	0.26	0.26	0.25	0.25	-
Electricity cost ($/month)	11,944	8,389	8,342	6,789	7,701	7,720	6,839	6,597	7,411	8,567	7,293	-

	2015											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Electricity consumption (kWh/month)	-	-	-	-	-	-	-	-	-	-	19,422	-
Electricity Trariff ($/kWh)	-	-	-	-	-	-	-	-	-	-	0.22	-
Electricity cost ($/month)	-	-	-	-	-	-	-	-	-	-	4,273	-

Source：prepared by the Study team based on a interview with a local rice miller

As described above, most of the rice mills in Siem Reap province are middle-scale, making it necessary to collect rice husk from several rice mills in order to have enough biomass fuel. Besides, a careful planning of husk collection is necessary as rice mills do not always operate their factories in a stable manner throughout a year.

On the other hand, urban waste has been rapidly increasing in recent years as the number of tourists has increased. At present the city have 270 ton of waste per day. The waste collection company, DEVENCO／GAEA, collects urban wastes in the city, transport them to a dumping site about 30 km away from the city center and dumps them without sorting. At the dumping site, waster pickers collect sellable wastes such as pet bottles manually. The present dumping site is already full and DEVENCO ／GAEA is developing the second dumping site.

Photo：The dumping site in Siem Reap province

Photo：Waste pickers in the dumping site

As there is an issue of stable supply of rice husks, there is a possibility of stabilizing the fuel supply by mixed combustion of rice husks and urban wastes (organic wastes). There is an established Japanese technology for co-combusting organic waste of relatively high moisture. As DEVENCO／GAEA are interested in this technology, a further study is expected. The following figure shows a candidate area for rice husk biomass power plant in Siem Reap province.

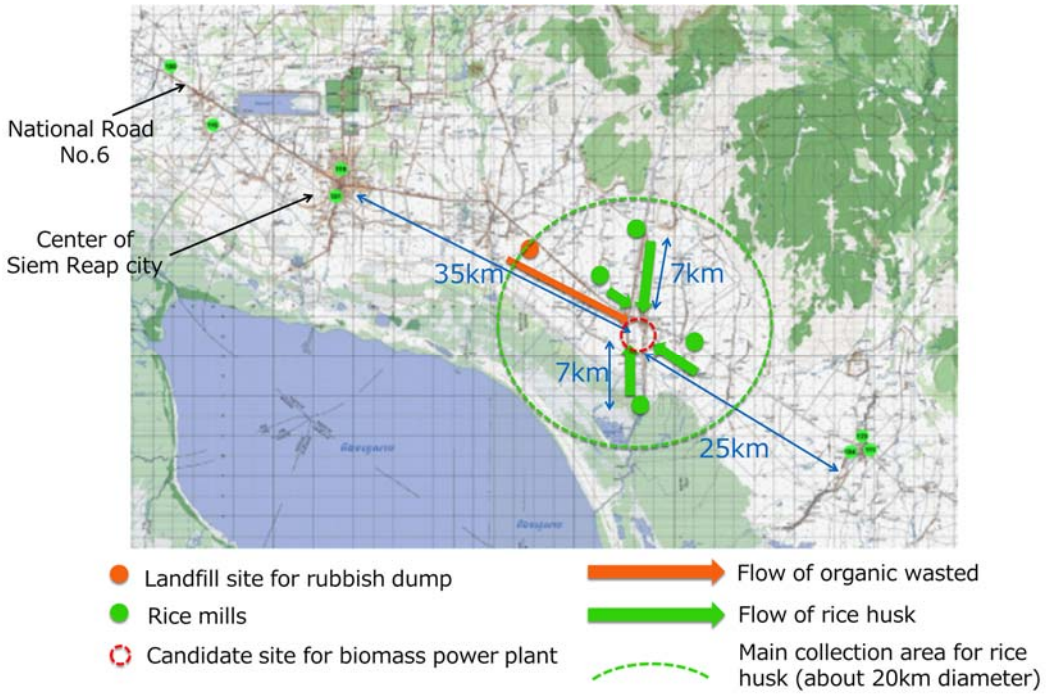


Figure 4-3：A candidate area for rice husk biomass power plant in Siem Reap province

Source: prepared by the Study team based on a map provided by ARPEC

4.1.4. Need for project formation study of rice husk biomass power generation project in Battambang Province

In this study, the initial hypothesis was that a biomass power plant should be placed in a place on the boarder of Siem Reap, Banteay Meachey and Battambang provinces in order to collect rice husk from the three provinces and supplying power to Siem Reap province. However, it was found that rice miller associations of these province had intentions to have biomass power plants but each provincial rice miller association intends to have its own power plant in each province using their own rice husks in order to supply power to rice millers in each province.

Large scale rice mills are concentrated in Battambang province with a larger and more stable supply of rice husks. To be more precise, Thmar Kol district in the province has a cluster of 10-15 large scale rice mille, each of which need about 1 MW of electricity for its milling operation. The chairman of the Battambang Rice Millers Association agrees to conduct a joint study with a Japanese consortium in the district.

Although the chairman of the Battambang Rice Millers Association wishes to have a 10 MW power plant, the study team consider that it is better to start with a smaller power plant such as 2 MW and gradually increase the capacity step by step. The following figure shows a candidate area for rice husk biomass power plant in Battambang province.

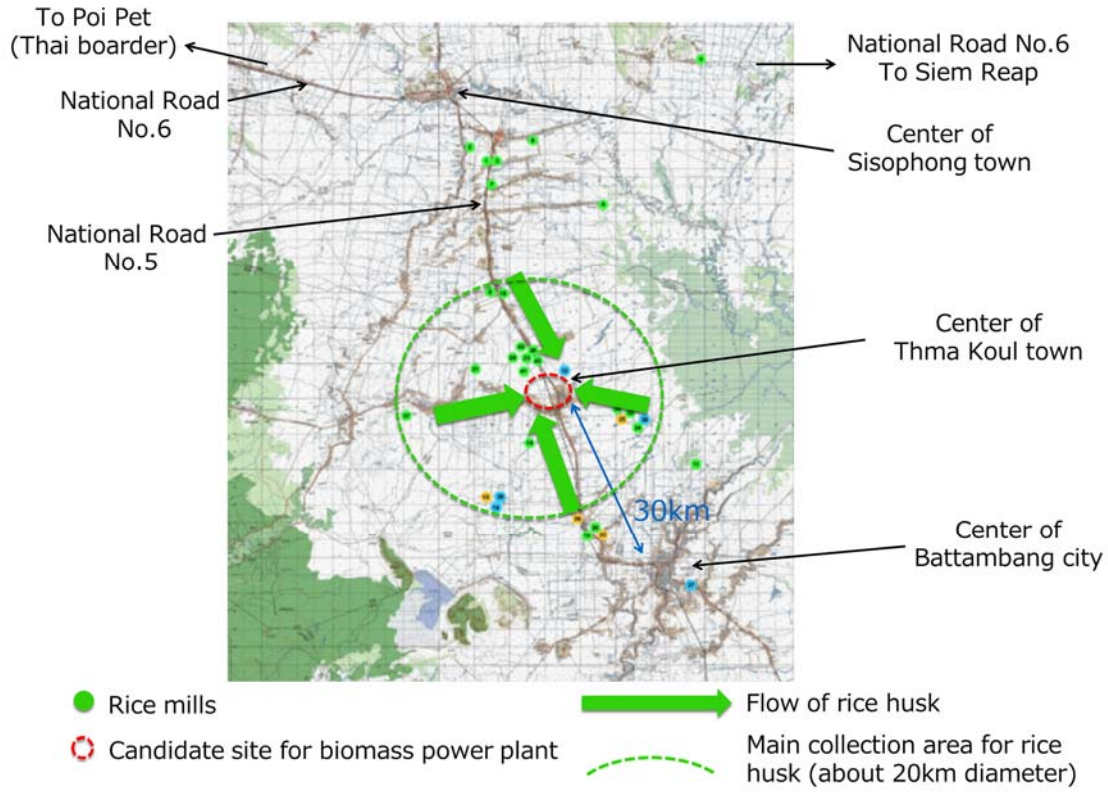


Figure 4-4：A candidate area for rice husk biomass power plant in Battambang province

Source：prepared by the Study team based on a map provided by ARPEC

It has been found that there is a potential of developing a biomass power plant of a larger scale in Battambang province than that in Siem Reap province. For realizing the potential project, a further detailed study is necessary.

4.2. Amorphous transformers dissemination project

4.2.1. Technological advantages of amorphous transformers

Amorphous transformers are transformers which do not use standard silicon steel for its core part, but use amorphous alloy. Amorphous transformers have higher performance than Japan's top runner standard, reducing non-load loss by 60% compared to general silicon-type transformers. Therefore, it can reduce power transmission loss and can contribute to increase electricity supply.

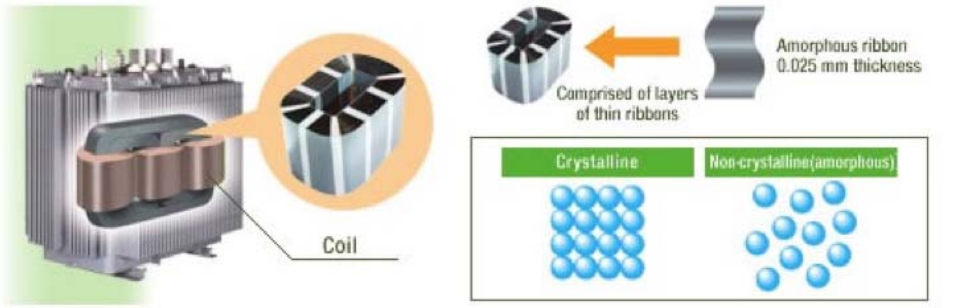


Figure 4-5：Structure of amorphous transformers

Amorphous transformers can reduce non-load loss by 60% compared to conventional transformers. According to a Schneider Electric's report, as shown in Figure 4-6, the non-load loss cost of conventional transformers during their durable years is 4,880 EUR and the load loss cost 4,600 EUR while the non-load loss cost of amorphous transformers during their durable years is 1,600 EUR and the load loss cost is 4,600 EUR. Amorphous transformers are lower in terms of non-load loss cost compared to conventional transformers.

Though amorphous transformers are superior in quality, their prices are higher. On the other hand, as shown in Figure 4-6, the return of investment is higher for amorphous transformers if the total cost is taken into consideration.

Hitachi Metal has 90% share of the world market of amorphous alloy, which is the core component of amorphous transformers. Amorphous transformers, which are superior in terms of energy saving, are a technology of which the Japanese maker has an advantage.

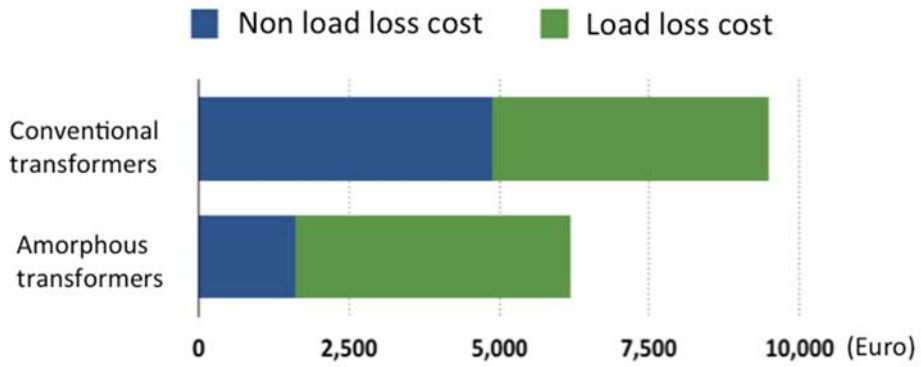


Figure 4-6：Cost comparison between amorphous and conventional transformers ①

（Source：http://bit.ly/1ovArXN）

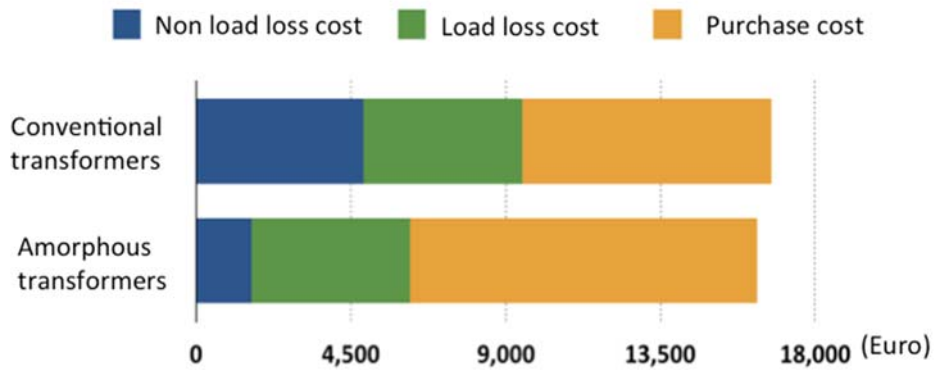


Figure 4-7：Cost comparison between amorphous and conventional transformers ②

（Source：http://bit.ly/1ovArXN）

4.2.2. Expected GHGs emission reduction effect of investment in amorphous transformers

For calculating an expected GHGs emission reduction effect of investment in amorphous transformers in Cambodia, the following data are necessary. A draft of a MRV methodology is attached in Appendix 2.

1) Non load loss of the existing transformers
2) Non load loss of high efficient transformers to be introduced
3) Annual rate of power cuts
4) The number of high efficient transformers to be introduced

Presently the non load loss and the number of high efficient transformers to be introduced are still under consideration. Therefore, it is impossible to calculate an expected GHGs emission reduction effect of investment. The GHGs emission reduction effects of investment of example cases from other countries are about 40,000JPY/CO2 ton.

5. Significance and Action Policy of City to City Cooperation Between Kanagawa Prefecture and Siem Reap Province

5.1. Purpose of City to City Cooperation

5.1.1. Purpose

To cooperate for the development of both the prefecture and province through low-carbon tourism city development while deepening mutual understanding and friendship

5.1.2. Terms of the agreement

- Siem Reap Province: Utilization of renewable energy and introduction of energy-saving equipment
- Kanagawa Prefecture: Advices on promotion of low-carbon tourism city, especially for promoting utilization of renewable energy such as PVs, improvement of efficiency in energy-consumption, and promotion of EVs.
- Assistance to economic cooperation among private companies of both countries

(Source: http://www.pref.kanagawa.jp/prs/p975449.html)

5.2. Capacity Building

5.2.1. Invitation to Japan

The study team invited 5 related persons of Siem Reap Province to Hakone city and Kanagawa Prefecture for 5 days in order for them to learn related institutions of Kanagawa Prefecture and apply them in future in Cambodia. In this training program, The 5 persons from Siem Reap exchanged views with the Industry and Energy department, the Industry and Labor Bureau of Kanagawa Prefecture and also visited a solar farm “Aikawa Solar Park Sunterasu Tobishima” operated by the prefectural government.

5.2.2. Workshop in Cambodia

Two seminars were organized for Cambodia’s related organizations (Siem Reap Provincial Government, Siem Reap City Government, APSARA authority) in order to introduce policies and institutions of Kanagawa Prefecture. The kick-off seminar and the final seminar were half-day seminars received about 50 people for each seminar.

5.2.3. Presentation at High Level Seminar on Environmentally Sustainable Cities in Hanoi, Vietnam

The study team made a presentation in order to disseminate the activities of this project at High Level Seminar on Environmentally Sustainable Cities in Hanoi, Vietnam in March 2016.

5.3. Action Policy in Future

Based on the MOU between Kanagawa prefecture and Siem Reap province, the action policy includes the following activities.

1) Application to JICA Grass-root Cooperation Project
   - A community development for a low-carbon city as a whole
   - Capacity building for implementing and managing the community
   - Kanagawa Prefecture, as a municipal government, is to advise Siem Reap provincial government, on policy development and administrative guidance for energy utilization (renewable energy and energy-saving) and transport in a tourism city.
   - Invitation of Siem Reap Provincial staff to Kanagawa prefecture and practical training on policy development and administrative guidance

2) Assistance to Formulation of the Master Plan of Siem Reap City
   - For the above two sectors, Kanagawa prefecture is to advise based on the present situation of the master plan.
   - Project finding for the formulation of the master plan.

6. Consideration on Implementation of Tourism City Transport Project

There are mainly four living areas in Siem Reap province: the urban area including the Siem Reap city, the World Heritage area controlled by APSARA authority, the surrounding rural area and the fishing area near Tonle Sap Lake. In the province there are many areas with no connection to the national grid. The land is not fertile and agricultural development is necessary. The common issues throughout the four areas are underdevelopment of 1) urban transport infrastructure, 2) environment and energy policy, 3) policies for income enhancement for the poor. This City to City Cooperation focuses on 1) and 2) and proposes “local production for local consumption of energy” as a solution to the issue.

Appendix 1: A Draft Methodology for PV systems

JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	The Kingdom of Cambodia
Name of the methodology proponents submitting this form	Japan Development Institute
Sectoral scope(s) to which the Proposed Methodology applies	1. Energy industries (renewable-/non-renewable sources)
Title of the proposed methodology, and version number	Displacement of Grid and Captive Genset Electricity by Ultra-lightweight Solar PV System, Ver 01.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☐Additional information
Date of completion	XX/XX/2016

History of the proposed methodology

Version	Date	Contents revised
01.0	XX/XX/2016	First Edition

A. Title of the methodology

Displacement of Grid and Captive Genset Electricity by Ultra-lightweight Solar PV System, Ver 01.0

B. Terms and definitions

Terms	Definitions
Solar photovoltaic (PV) system	An electricity generation system which converts sunlight into electricity by the use of photovoltaic (PV) modules. The system also includes ancillary equipment such as inverters required to change the electrical current from direct current (DC) to alternating current (AC).

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Displacement of grid electricity and/or captive electricity using diesel fuel as power source by installation and operation of the solar PV system(s)
Calculation of reference emissions	Reference emissions are calculated on the basis of the AC output of the solar PV system(s) multiplied by the conservative emission factor of the grid and captive electricity.
Calculation of project emissions	Project emissions are the emission from the solar PV system(s), which is assumed to be zero.
Monitoring parameters	Quantity of the electricity generated by the project solar PV system

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	The project installs solar PV system(s).
Criterion 2	The solar PV system is connected to the internal power grid of the project site and/or to the grid for displacing grid electricity and/or captive electricity at the

	project site.
Criterion 3	The PV modules have obtained a certification of design qualifications (IEC 61215, IEC 61646 or IEC 62108) and safety qualification (IEC 61730-1 and IEC 61730-2).
Criterion 4	The PV modules have more than 15% of module conversion efficiency and less than 6.5 kg/m2 of weight.
Criterion 5	The equipment to monitor output power of the solar PV system and irradiance is installed at the project site.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Consumption of grid electricity and/or captive electricity	CO_2
Project emissions	
Emission sources	GHG types
Generation of electricity from solar PV system(s)	N/A

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

In the absence of the project, the power from the gird or the captive genset will continue to be used. The reference emissions are the AC output of the solar PV system(s) multiplied by the conservative emission factor of the grid and captive electricity.

The emission factor of the grid and captive electricity is set to 0.5631 tCO_2/MWh. This is derived by multiplying the grid emission factor of the Phnom Penh electricity grid published by the Ministry of Environment, Cambodia and Institute of Global Environmental Strategies (IGES) in 2011 by 0.9. The emission factor of the grid and captive electricity is set this way to ensure the achievement of net emission reductions.

F.2. Calculation of reference emissions

$$RE_p = \sum_i EG_{i,p} \times EF_{RE}$$

RE_p : Reference emissions during the period *p* [tCO_2/p]

$EG_{i,p}$: Quantity of the electricity generated by the project solar PV system *i* during the period *p* [MWh/p]

EF_{RE} : Reference CO_2 emission factor of the grid and captive electricity [tCO_2/MWh]

G. Calculation of project emissions

$PE_p = 0$

PE_p : Project emissions during the period *p* [tCO_2/p]

H. Calculation of emissions reductions

$ER_p = RE_p - PE_p$

$= RE_p$

ER_p : Emission reductions during the period *p* [tCO_2/p]

RE_p : Reference emissions during the period *p* [tCO_2/p]

PE_p : Project emissions during the period *p* [tCO_2/p]

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
EF_{RE}	The emission factor of the grid and captive electricity is derived by multiplying the grid emission factor of the Phnom Penh electricity grid by 0.9	Ministry of Environment, Cambodia and IGES, March 2011, Grid Emission Factor of the Phnom Penh Electricity Grid.

Appendix 2：A Draft Methodology for Amorphous Transformers

JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	The Kingdom of Cambodia
Name of the methodology proponents submitting this form	Japan Development Institute
Sectoral scope(s) to which the Proposed Methodology applies	2. Energy distribution
Title of the proposed methodology, and version number	Installation of energy efficient transformers in a power distribution grid, Version 1.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☐Additional information
Date of completion	XX/XX/2016

History of the proposed methodology

Version	Date	Contents revised
01.0	XX/XX/2016	First Edition

J. Title of the methodology

Installation of energy efficient transformers in a power distribution grid, Version 1.0

K. Terms and definitions

Terms	Definitions
Power distribution grid	The portion of the electric system that is dedicated to delivering electricity to the end-users.
No-load losses	Losses of electricity due to transformer core magnetizing or energizing. These losses occur whenever a transformer is energized and remain constant regardless of the amount of electricity flowing through it.
Load losses	Losses of electricity due to resistance in the electrical winding of the transformer. These losses include eddy current losses in the primary and secondary conductors of the transformer. These losses occur when the electricity flows through the transformer.

L. Summary of the methodology

Items	Summary
GHG emission reduction measures	Installation of energy efficient transformers (transformers with amorphous metal core) in a power distribution grid reduces no-load losses by transformers, which leads to reduction of losses for grid electricity, thus reduction of GHG emissions.
Calculation of reference emissions	Reference emissions are calculated by no-load losses of the reference transformer, blackout rate and CO_2 emission factor of the grid.
Calculation of project emissions	Project emissions are calculated by no-load losses of the project transformer, maximum allowable uncertainty for the no-load losses of the project transformer, blackout rate and CO_2

	emission factor of the grid.
Monitoring parameters	Energizing time of the project transformer

M. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	Single-phase and/or three-phase oil-immersed transformer with amorphous metal core is installed in the distribution grid.
Criterion 2	Load losses of the project transformer determined in line with IEC 60076-1 or national/industrial standards complying with IEC 60076-1 is equal or smaller than the standard values or specification values of load loss, required by the power company of the grid where the project transformer is installed, corresponding to its capacity and number of phases.

N. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
No-load losses of grid electricity by reference transformers	CO_2
Project emissions	
Emission sources	GHG types
No-load losses of grid electricity by project transformers	CO_2

O. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Transformer with silicon steel core is commonly installed in Cambodia. On the one hand transformer with amorphous metal core has been installed to a very limited extent. Also, power companies in Cambodia have the standard or set tender specifications for no-load losses when procuring transformers, and such no-load losses is set on the premise of transformer with silicon steel core.

Therefore, transformer with silicon steel core is assumed to be reference transformer in this methodology.

Reference emissions are mainly determined by no-load loss of the reference transformer, however, blackout rate also affects the calculation of reference emissions. Blackout rate varies among the regions, and it is improving year by year. To achieve net emission reductions, default value of blackout rate in Cambodia is set in a conservative manner.

Blackout rate is set in line with the general principle of conservative calculation methodology for GHG emission reduction. A rate closer to 0% reflects shorter blackout hours, since the more electricity is distributed, the greater the energy saving. Therefore, it is required to avoid an underestimated blackout rate in order to achieve conservative reduction estimates. However, Cambodia's blackout rate is not publicly available at the moment. Tentatively, a blackout rate in Vietnam is set in this methodology, as Vietnam is one of the transporter power suppliers for Cambodia (Data obtained from JCM Approved methodology JCM_VN_AM005_ver01.0 (originally from the power companies in Vietnam)).

The emission factor of the grid is set to 0.5631 tCO2/MWh. This is derived from the grid emission factor of the Phnom Penh electricity grid published by the Ministry of Environment, Cambodia and Institute of Global Environmental Strategies (IGS) in 2011, which is multiplied by 0.9 in this methodology, in order to achieve GHG emission reduction calculation in a conservative manner.

F.2. Calculation of reference emissions

The reference emissions, RE_p, during the period *p* are given by:

$$RE_p = \sum_i \left(NLL_{RE,i,j,k} \times H_{i,p}\right) \times \left(1 - Br_p\right) \times EF_{grid} \times 10^{-6}$$

Where:

RE_p	: Reference emissions during the period p [tCO_2/p]
i	: Identification number of the reference transformer
j	: Identification number of the power company where the transformer i is installed
k	: Index which represents type of the reference transformer defined by its

	capacity and number of phases
$NLL_{RE,i,j,k}$	: No-load losses of the reference transformer i of capacity category k for the power company j [W]
$H_{i,p}$	: Energizing time of the project transformer i during the period p [hour/p]
Br_p	: Blackout rate during the period p [fraction]
EF_{grid}	: CO_2 emission factor of the grid [tCO_2/MWh]

P. Calculation of project emissions

The project emissions, PE_p, during the period *p* are given by:

$$PE_p = \sum_i \left[NLL_{PJ,i,j,k} \times (1 + UNC_i) \times H_{i,p}\right] \times \left(1 - Br_p\right) \times EF_{grid} \times 10^{-6}$$

Where:

PE_p	: Project emissions during the period p [tCO_2/p]
i	: Identification number of the project transformer
j	: Identification number of the power company where the transformer i is installed
k	: Index which represents type of the project transformer defined by its capacity and number of phases
$NLL_{PJ,i,j,k}$	: No-load losses of the project transformer i of capacity category k for the power company j [W]
UNC_i	: Maximum allowable uncertainty for the no-load losses of the project transformer i [fraction]
$H_{i,p}$	: Energizing time of the project transformer i during the period p [hour/p]
Br_p	: Blackout rate during the period p [fraction]
EF_{grid}	: CO_2 emission factor of the grid [tCO_2/MWh]

Q. Calculation of emissions reductions

The emission reductions, ER_p, during the period *p* are given by:

$$ER_p = RE_p - PE_p$$

Where:

ER_p	: Emission reductions during the period p [tCO_2/p]
RE_p	: Reference emissions during the period p [tCO_2/p]
PE_p	: Project emissions during the period p [tCO_2/p]

R. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
$NLL_{RE,i,j,k}$	No-load losses of the reference transformer *i* of capacity category *k* for the power company *j*. The no-load losses of the reference transformer *i* are determined *ex ante* by applying the lower value of the latest standard for no-load losses or the specification value of no-load losses where applicable, required by the power companies where the project transformer is installed, corresponding to the capacity and number of phases of the project transformer *i*.	The latest standard for no-load loss required by the power companies, or the specification value of no-load losses set by the power companies
$NLL_{PJ,i,j,k}$	No-load losses of the project transformer *i* of capacity category *k* for the power company *j*.	Manufacturer's performance test report measured at the time of pre-delivery inspection
Br_p	Blackout rate during the period *p*. Default value: 1.87% (tentative)	Data obtained from JCM Approved methodology JCM_VN_AM005_ver01.0 (originally from the power companies in Vietnam)
UNC_i	Maximum allowable uncertainty for the no-load losses of the project transformer *i*.	Manufacturer's performance test report measured at the time of pre-delivery inspection

EF_{grid}	The emission factor of the grid and captive electricity is derived by multiplying the grid emission factor of the Phnom Penh electricity grid by 0.9	Ministry of Environment, Cambodia and IGES, March 2011, Grid Emission Factor of the Phnom Penh Electricity Grid.

Appendix 3

City-to-City Cooperation (C2CC)

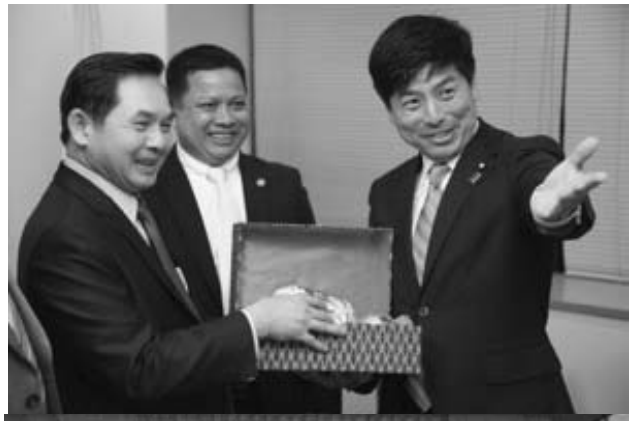
Japan Development Institute Ltd.,
January 25, 2016

JDI Japan Development Institute

Siem Reap in Cambodia and Kanagawa in Japan

Sep. 30, 2013

Nov. 19, 2014

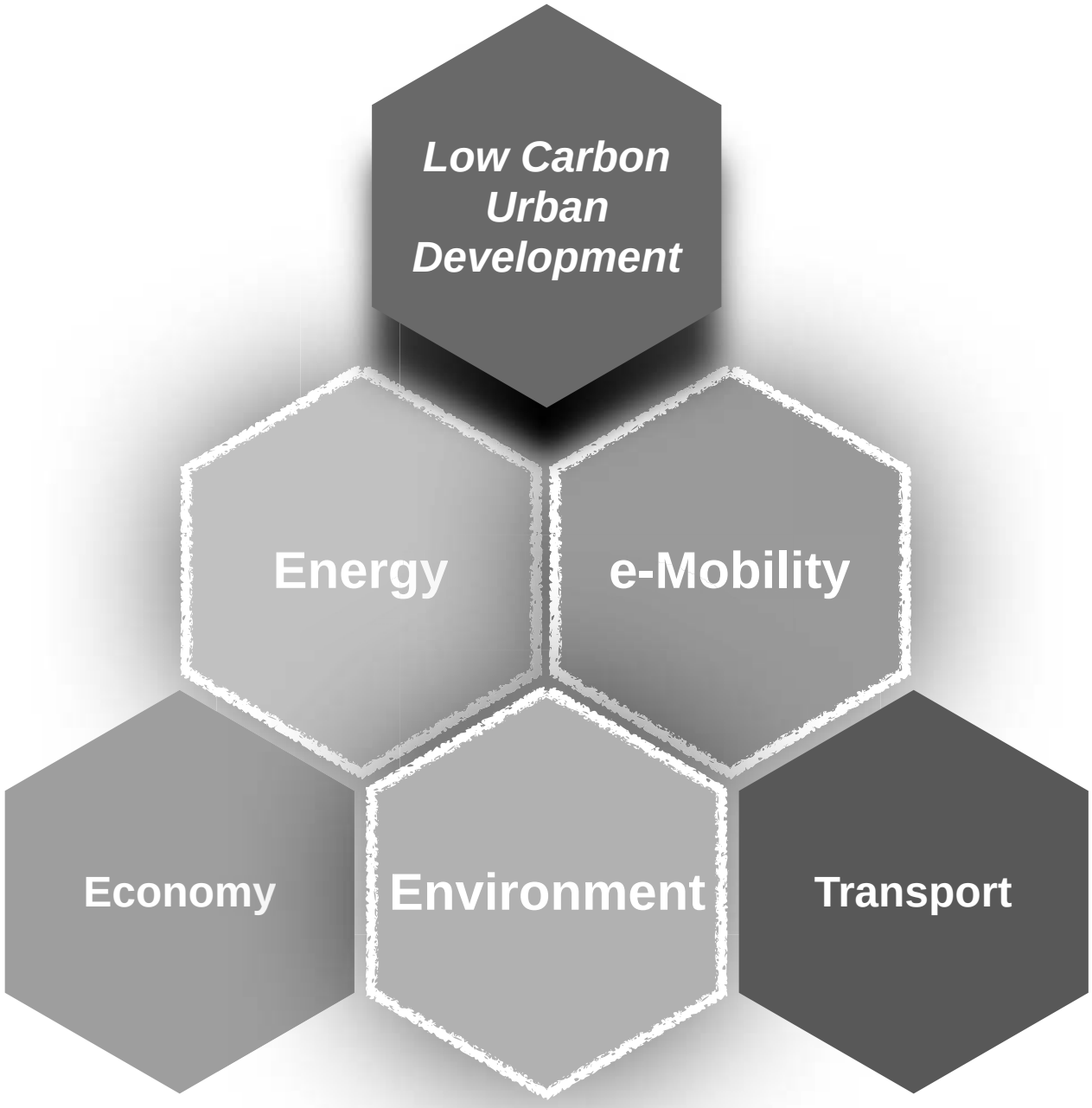


Nov. 5, 2015

C2C Cooperation

Objectives

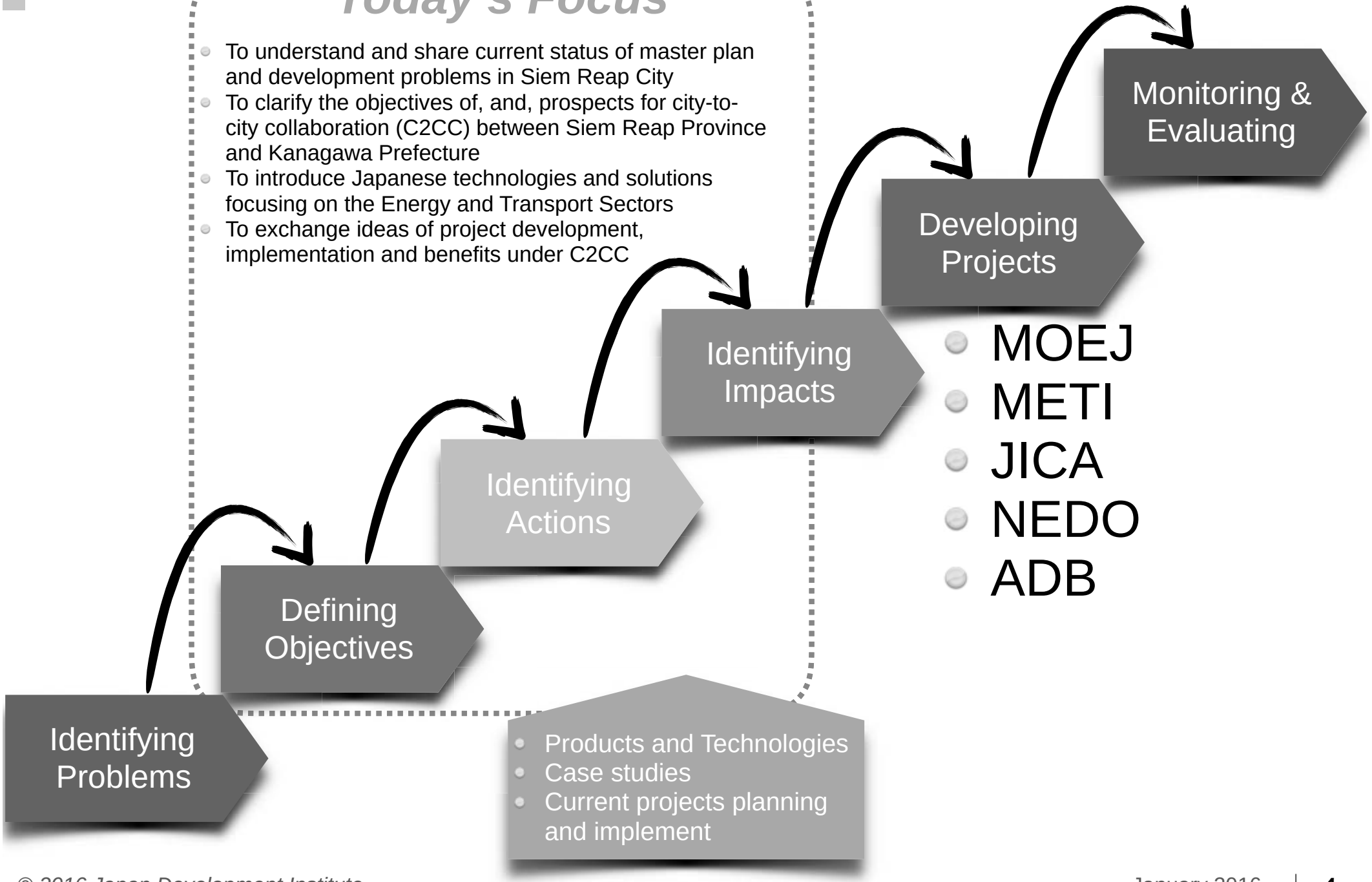
- Creating low-carbon tourism city development in Siem Reap Province;
- Benefitting from the results of Feasibility Studies on Joint Crediting Mechanism Projects;
- Aiming to promote mutual understanding and friendship; and,
- Undertaking development of the two regions in collaboration



Strategical Steps for C2C Cooperation

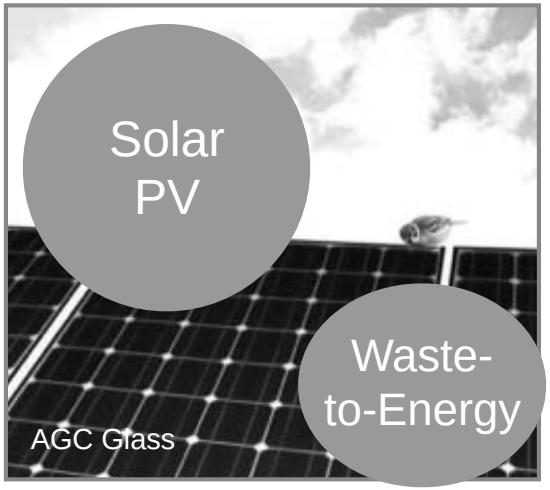
Today's Focus

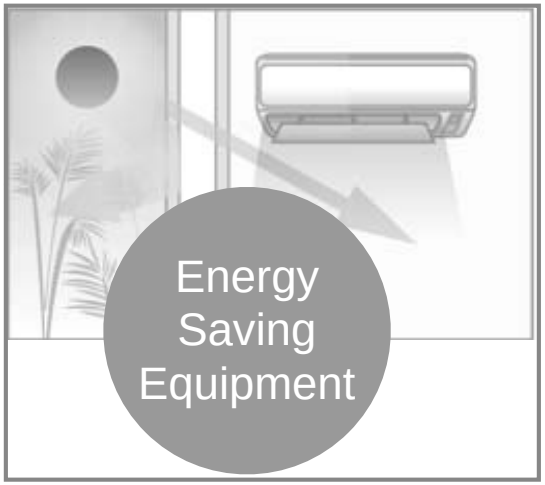
- To understand and share current status of master plan and development problems in Siem Reap City
- To clarify the objectives of, and, prospects for city-to-city collaboration (C2CC) between Siem Reap Province and Kanagawa Prefecture
- To introduce Japanese technologies and solutions focusing on the Energy and Transport Sectors
- To exchange ideas of project development, implementation and benefits under C2CC

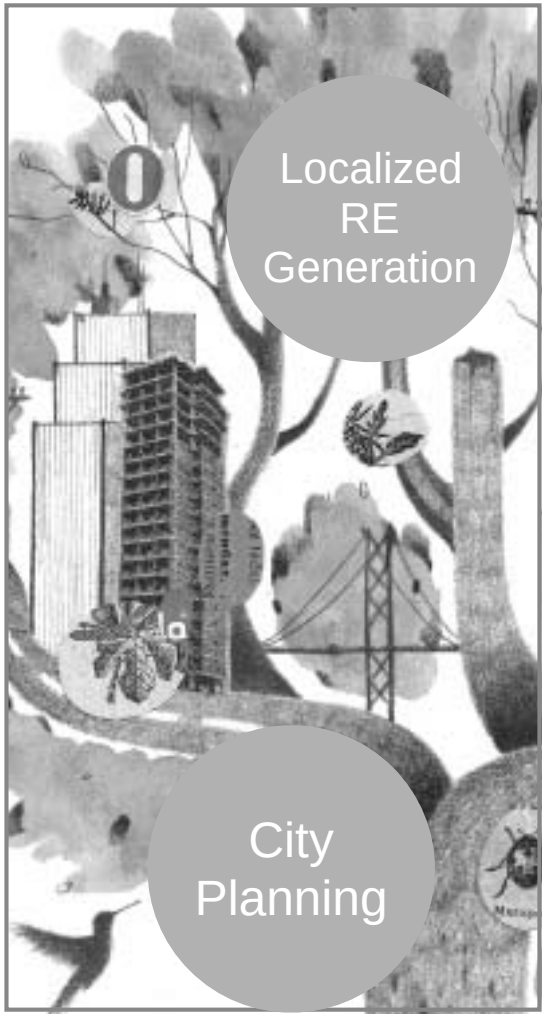


Identifying opportunities in the Energy Sector

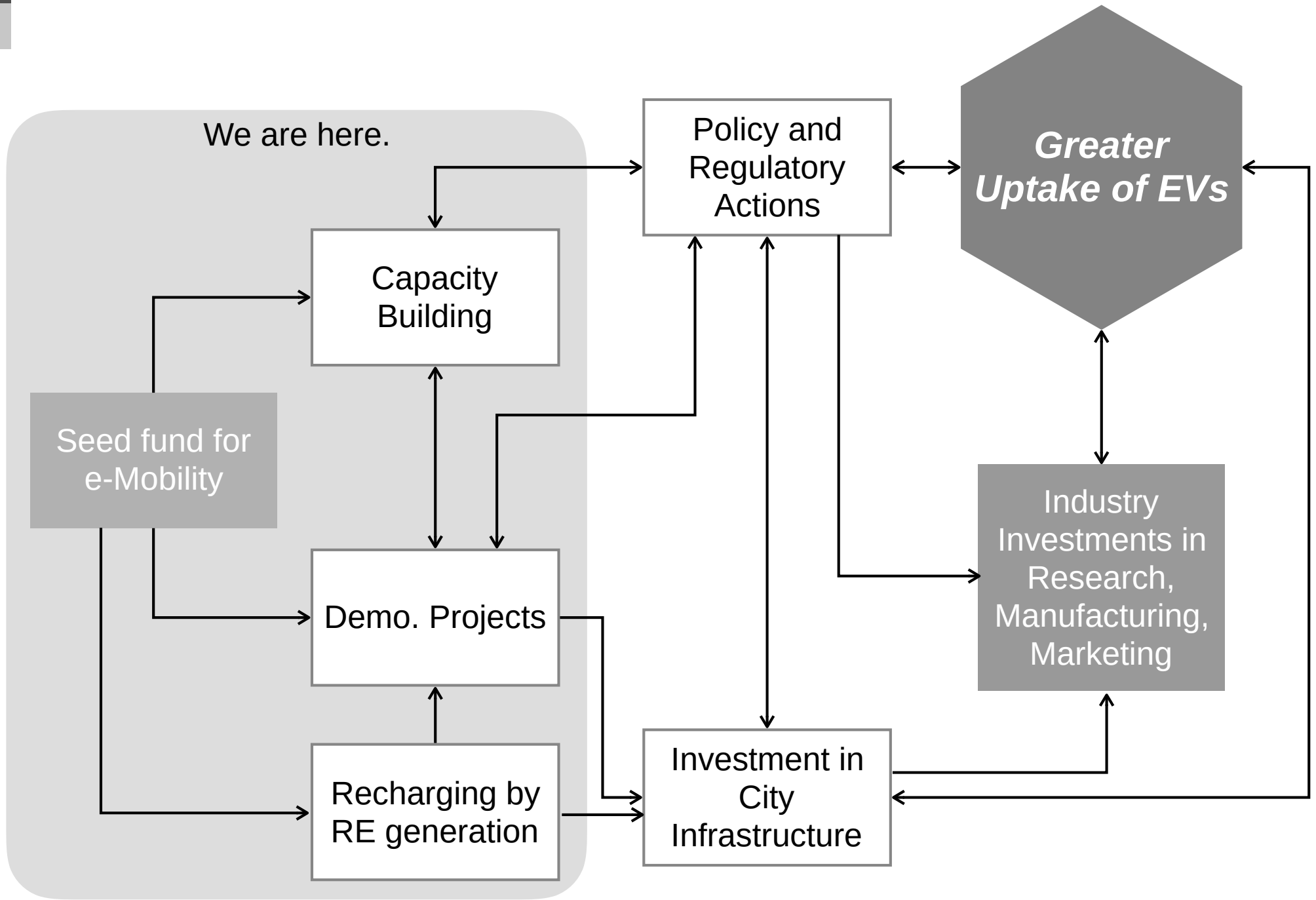
	Functions		Infrastructure		Behavior
Renewable Energy(RE)	Solar PV Waste-to-Energy	X	Localized RE Generation	X	• Decentralization by Rooftop Solar Energy in city • Electrification • Reliable and Affordable
Energy Efficiency & Conservation	Energy Saving Equipment	X	City Planning	X	• Efficient Applications • Integration of architecture and energy saving equipments



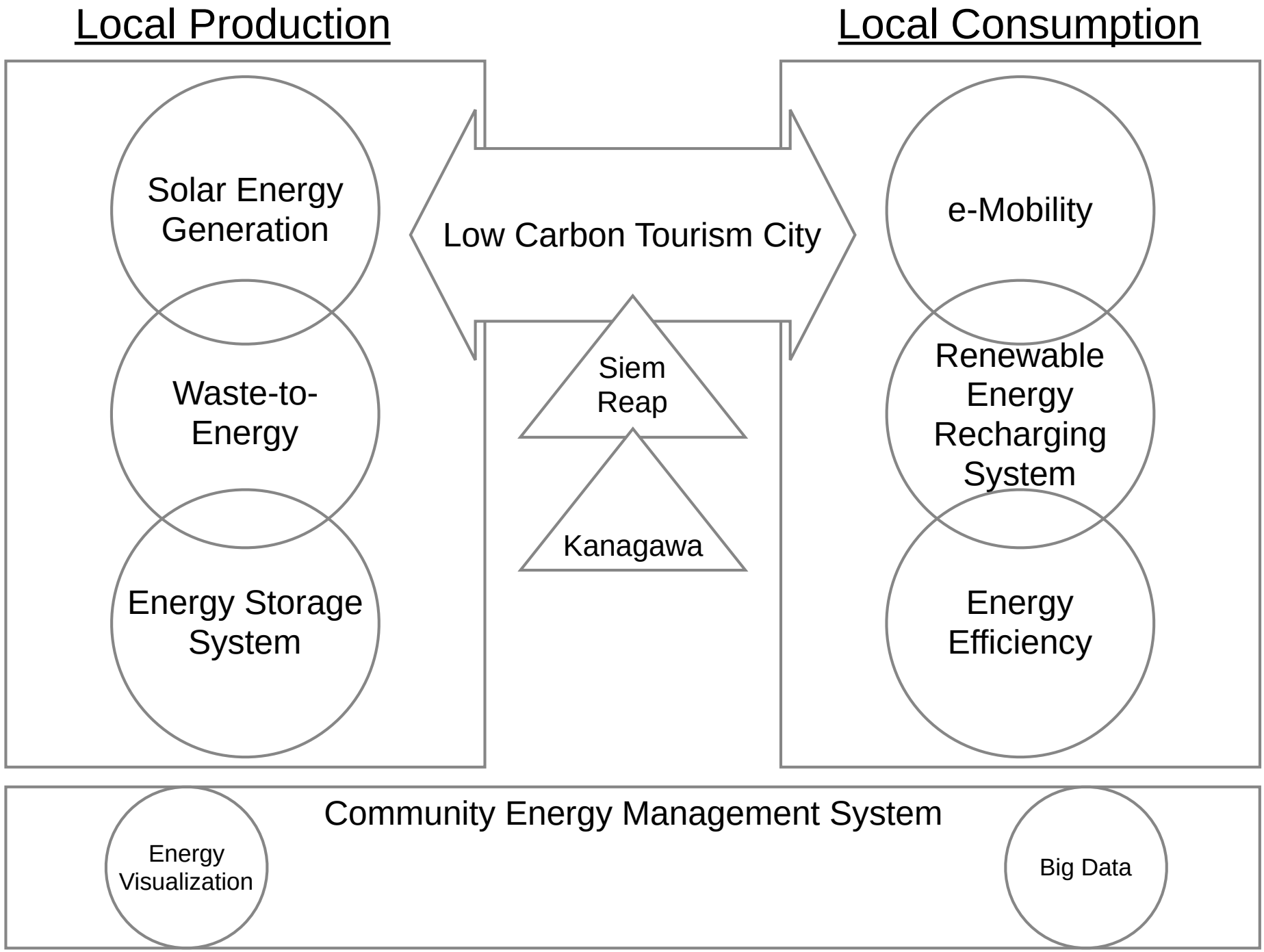




Identifying Opportunities in the e-Mobility Sector



Energy LP4LC(Local Production for Local Consumption)



JDI Japan Development Institute

We would like to hear from you and answer any questions that you might have.
kimura@jditokyo.com

Appendix 4

Solar Power Promotion and Tourism Promotion using EV ～Activities of Kanagawa Prefecture～

Energy Department, Industry and Labor Bureau,
Kanagawa Prefectural Government

World-famous Tourism Resources

Old capital:
Kamakura

Hot spring spot:
Hakone

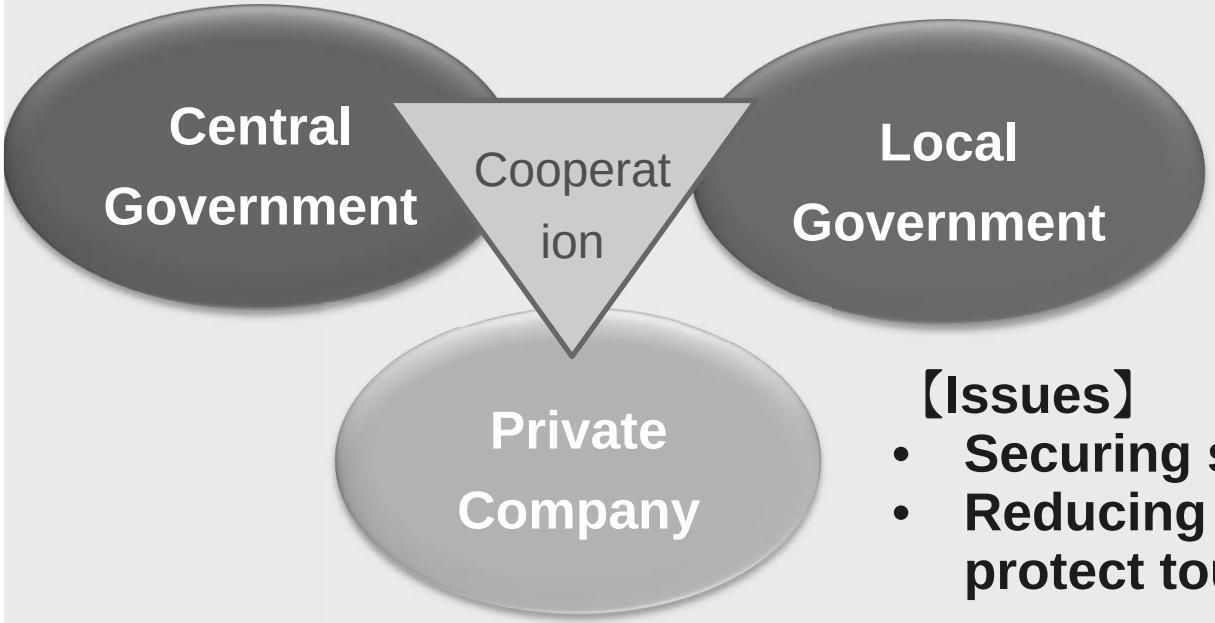
World-famous Tourism Resources

Night view of Yokohama

Giant elevator crossing the floor

Rolling outage
implemented after the earthquake (March 2011)

Low carbon tourism urban development and the role of local government from the perspective of energy sector



【Issues】
- Securing stable and reliable energy
- Reducing environmental impact to protect tourism resources

【Role of local government】
- Cooperation with the central government
- Effective planning which is suitable for the region
- Raising public awareness on the environment

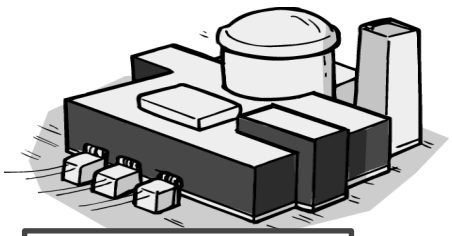
Kanagawa Smart Energy Plan

○ Background

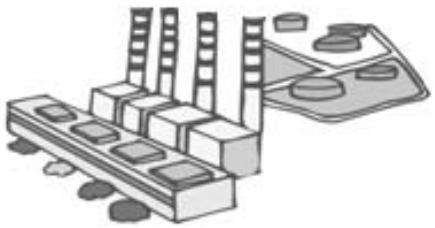
The plan was formulated as a basic plan of the energy policy based on "Ordinance on promoting renewable energy in Kanagawa (July, 2013)"

Three Principles
- **○ Less dependence on nuclear power**
- **○ Consideration for environment**
- **○ Promote local production for local consumption**

Centralization



Nuclear Power



Thermal Power

Decentralization

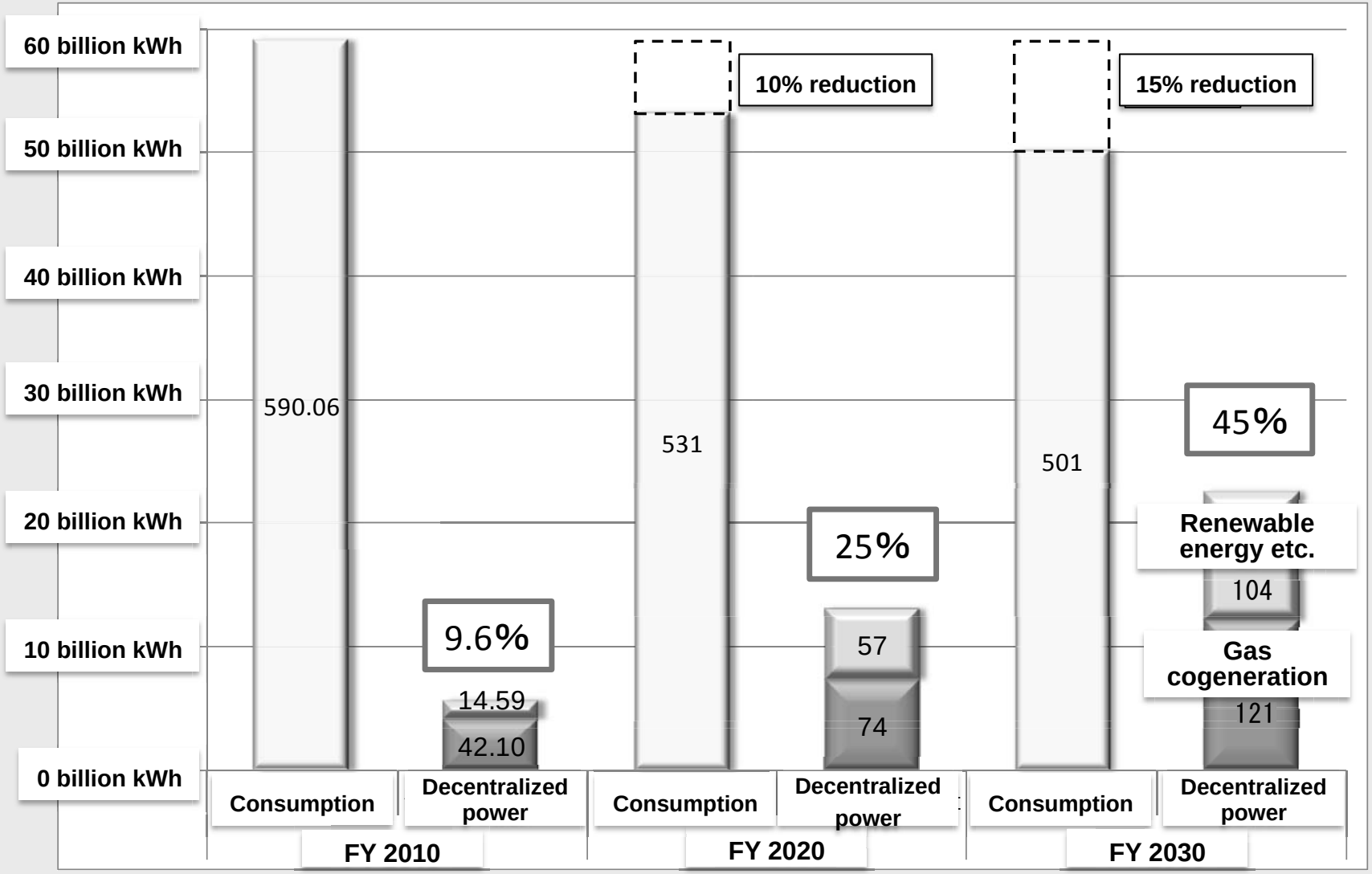
Solar Power

Wind Power

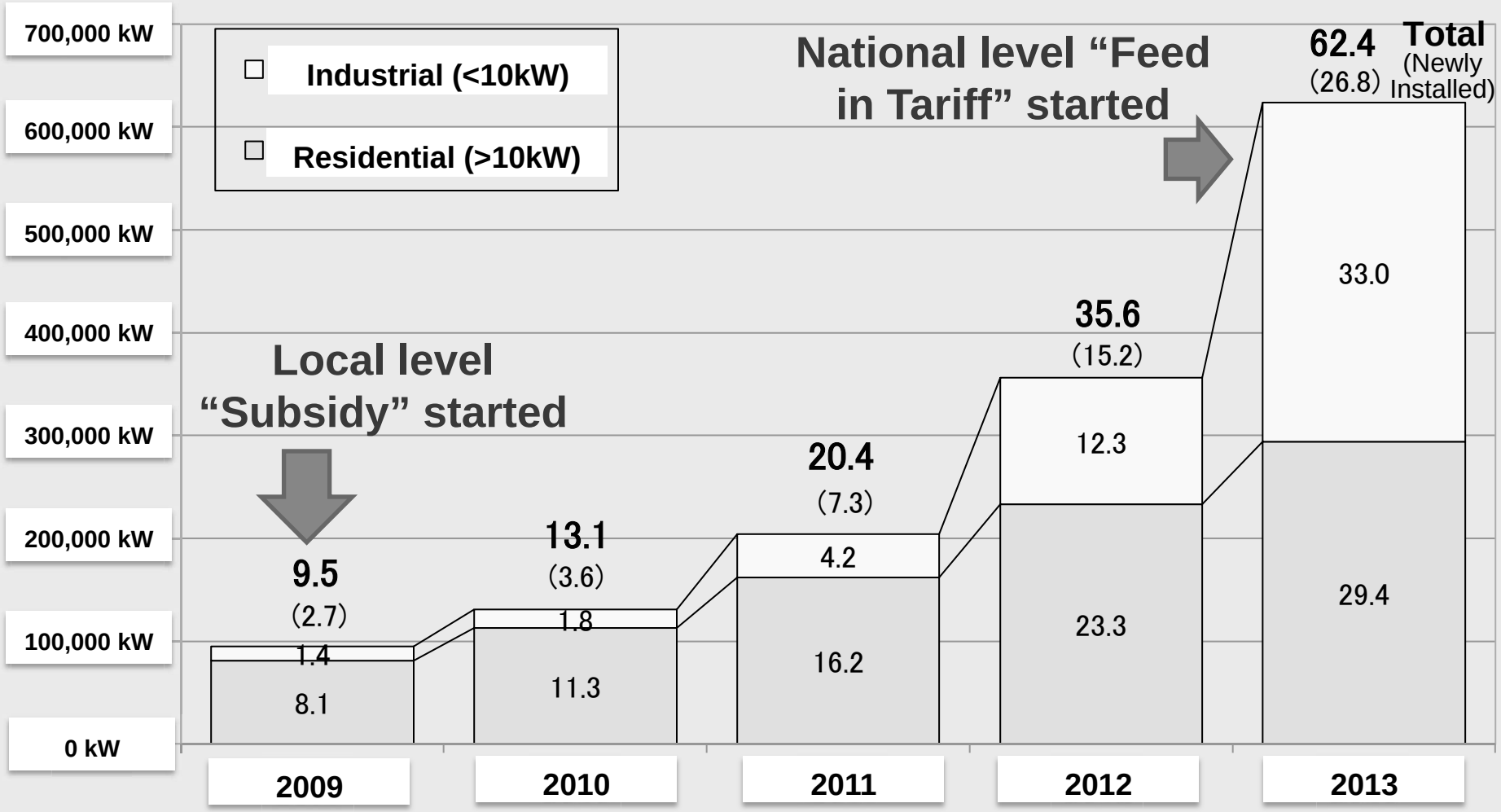
Gas Cogeneration

Kanagawa Smart Energy Plan

Electricity consumption and decentralized power generation in Kanagawa prefecture (Target)



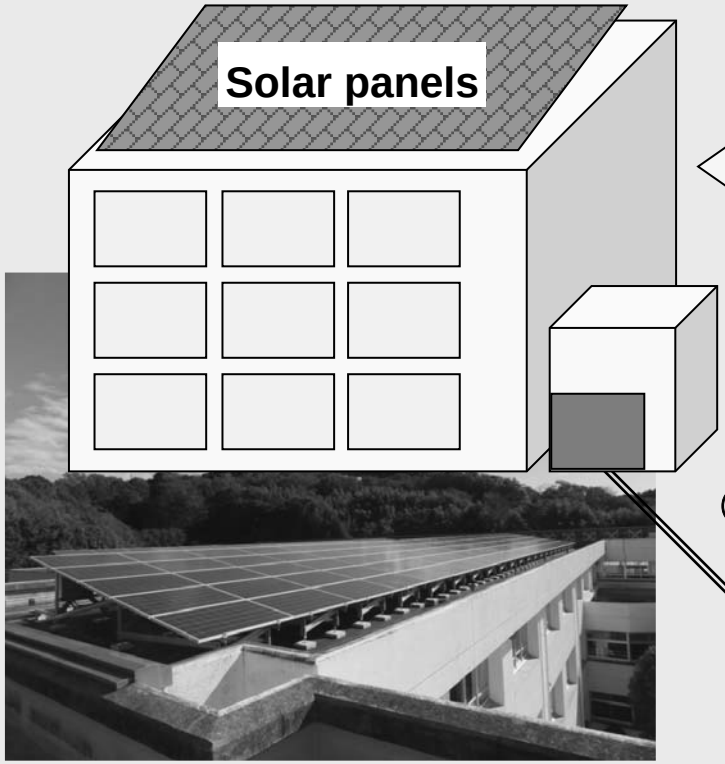
Solar power installed capacity in Kanagawa Prefecture



(Source) Regional Energy Department, Industry and Labor Bureau, Kanagawa Prefecture

“Roof Rental” Solar Power Project

The “Roof rental” solar power project is a solar power generation project, where the owner of a building leases a space such as roofs while a power producer rents the space for installing solar panels and produce power based on the “Feed-in-tariff”. The building owner benefits from rental fee etc.



Yokohama Sakae High School

①Roof rental contract

②Solar panel installation

⑤Payment of rental fee

Power producer

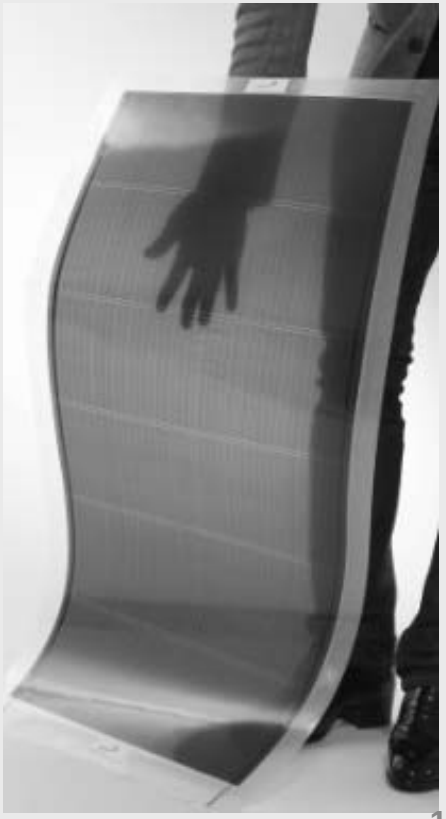
③Sale of electricity (total amount produced)

④Revenue from electricity sale

Power company

Thin Film Solar Cells

Thin film solar cells, which are lighter and thinner than conventional solar cells, can be installed on places such as factory roofs, slopes of railways/ roads, inside of glass windows of office buildings, handrails of balconies of apartments, where conventional solar cells could not be installed.



Thin Film Solar Cells Dissemination

Factory roof before installation

Factory roof after installation

Light weighted solar cells are installed on corrugated slate roof of the factories.

Solar cells which are integrated in an anti-weed sheet, are installed on railway slope.

Railway slope before installation

Railway slope after installation

Challenge for EV Dissemination

【 Initiative KANAGAWA】

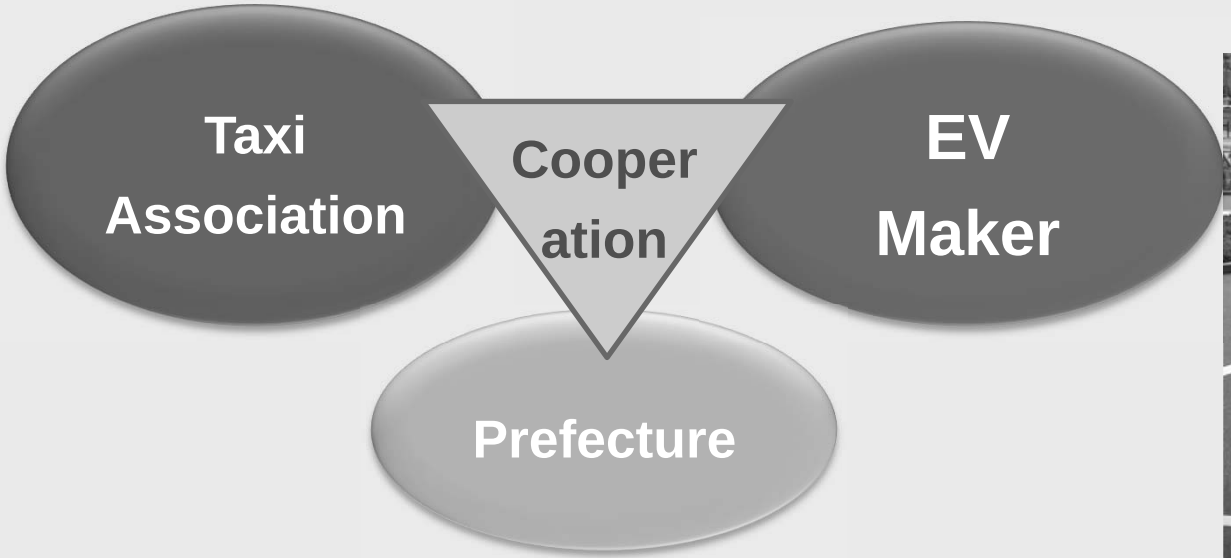
- **Creating initial demand**
- **Promoting infrastructure development**
- **Enhancing people's awareness**

Subsidy input

Target year	Item	Target	Result (end of 2014)
FY 2014	No. of EV registration	3,000 cars (0.1% of all cars)	6,855 cars
	No. of fast chargers	100 unit	362 unit

Highest in Japan

EV Taxi Project



（EV taxi shared stand)

【Issue】

- Installation cost
- Cruising distance
- Promote usage
- Lack of drivers

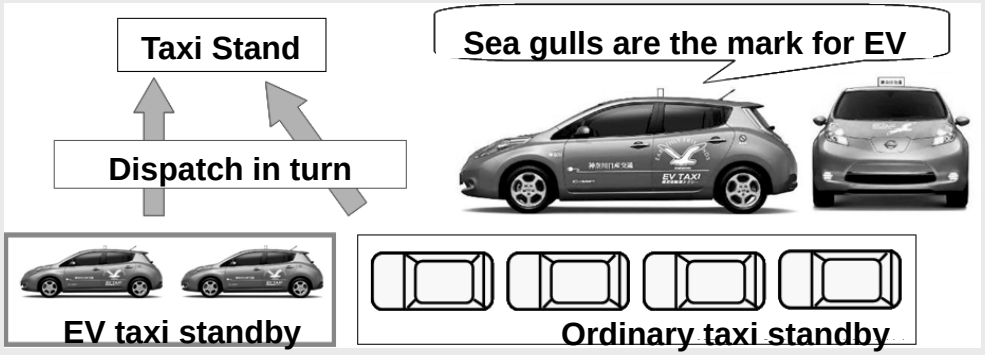
【Efforts by Prefecture】

- Provided subsidy to install vehicles and charger
- Developed EV priority stand
- Organized events to promote the use of EV
- Assisted training of EV drivers

EV Taxi Project

EV Taxi departure ceremony

Exhibition and Test drive event



Mixing EV taxi and ordinary taxi

Distribution of coupons for EV taxi as a campaign

EV Tourism Model

Conservation of tourism resources

Introduction of EV

Cooperation

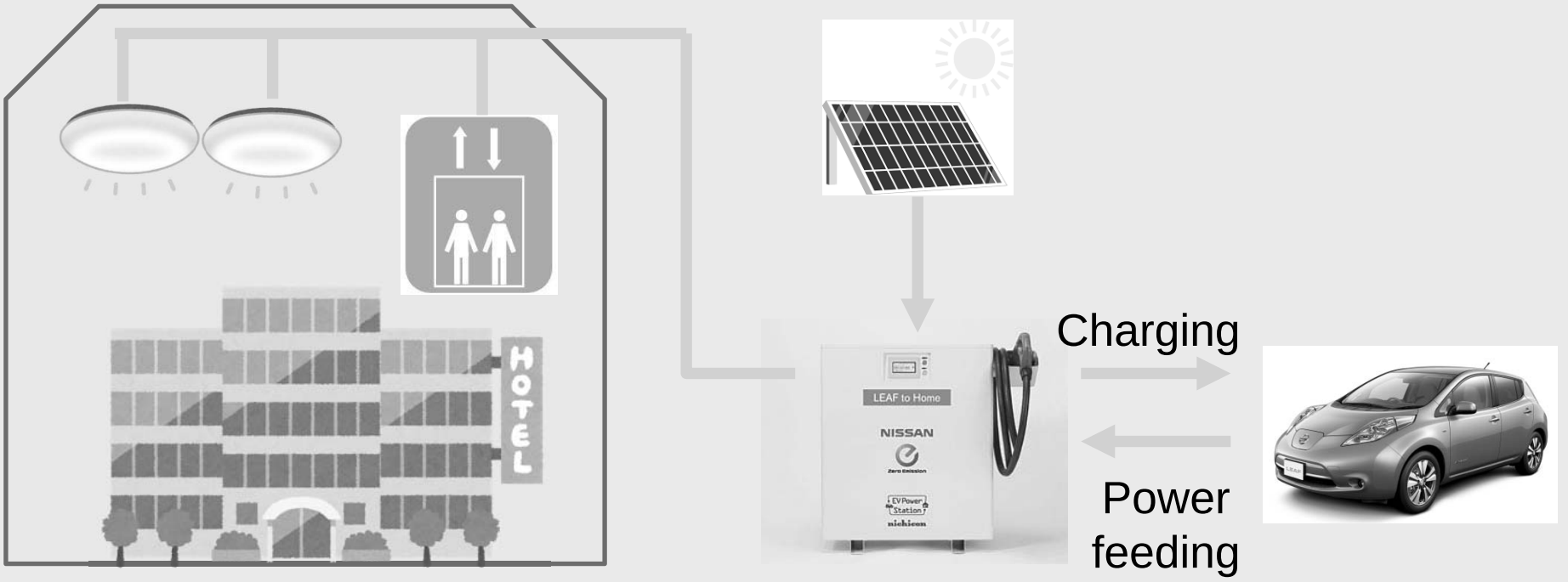
Tourism facilities

Tourism businesses

(Coupon can be used for tourism facilities)

(EV motorbike test drive)

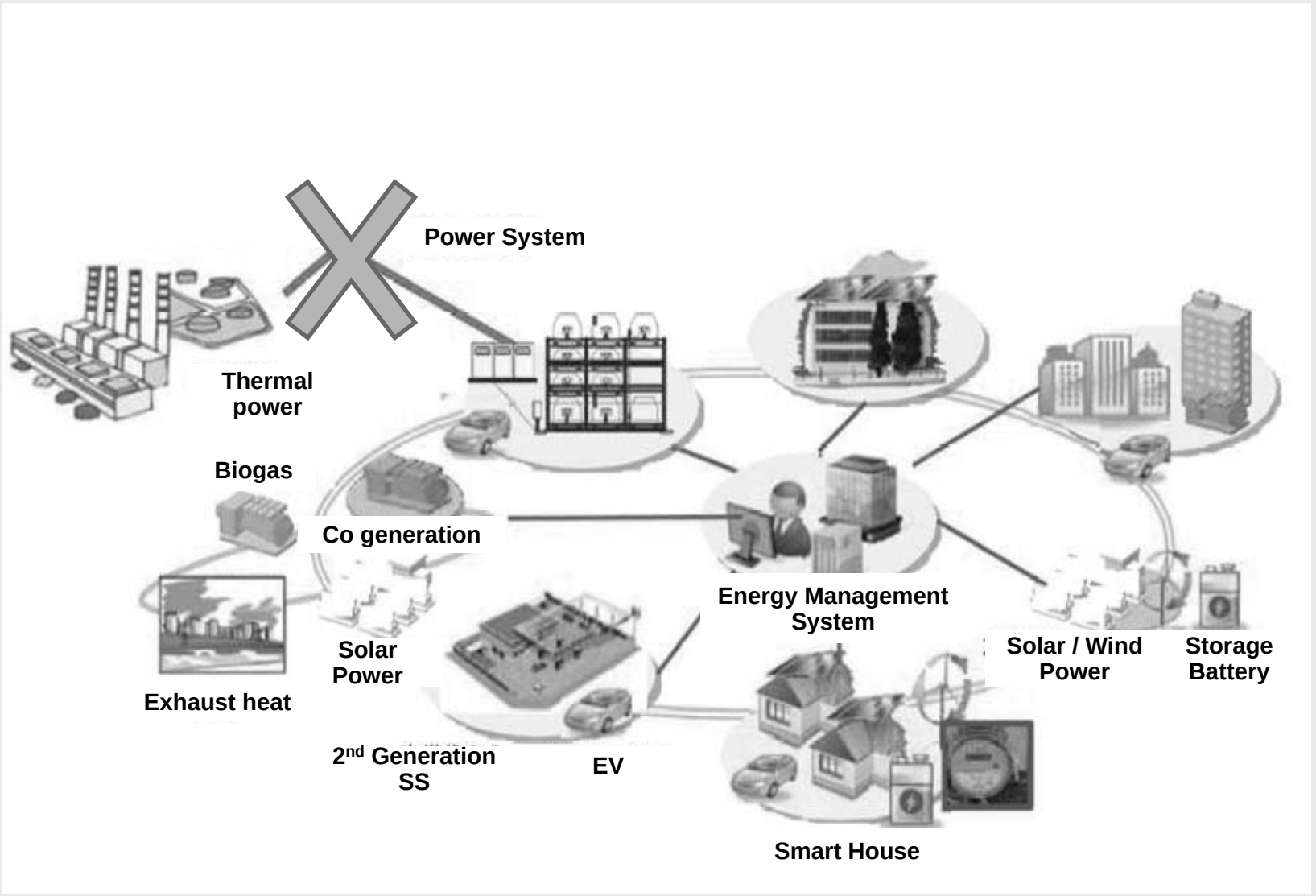
Utilization of EV as Storage Battery



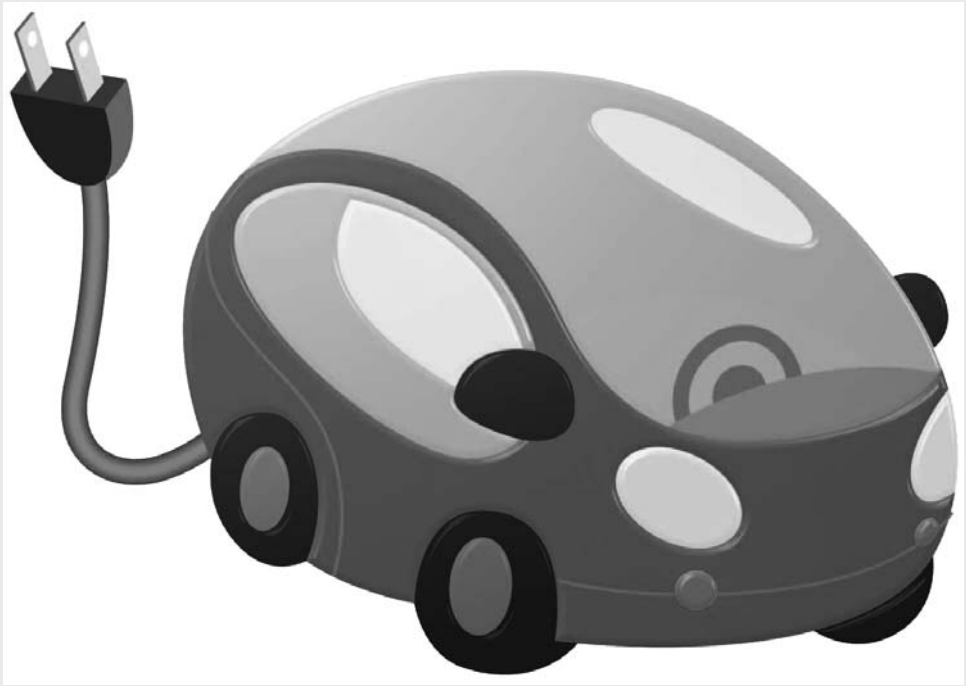
To supply power to institution

To supply power to factory

Centralized power system to Decentralized system of local production for local consumption



Thank you for your attention !



AGC

Appendix 5

Environmentally friendly products

Light Joule®
ライトジュール®

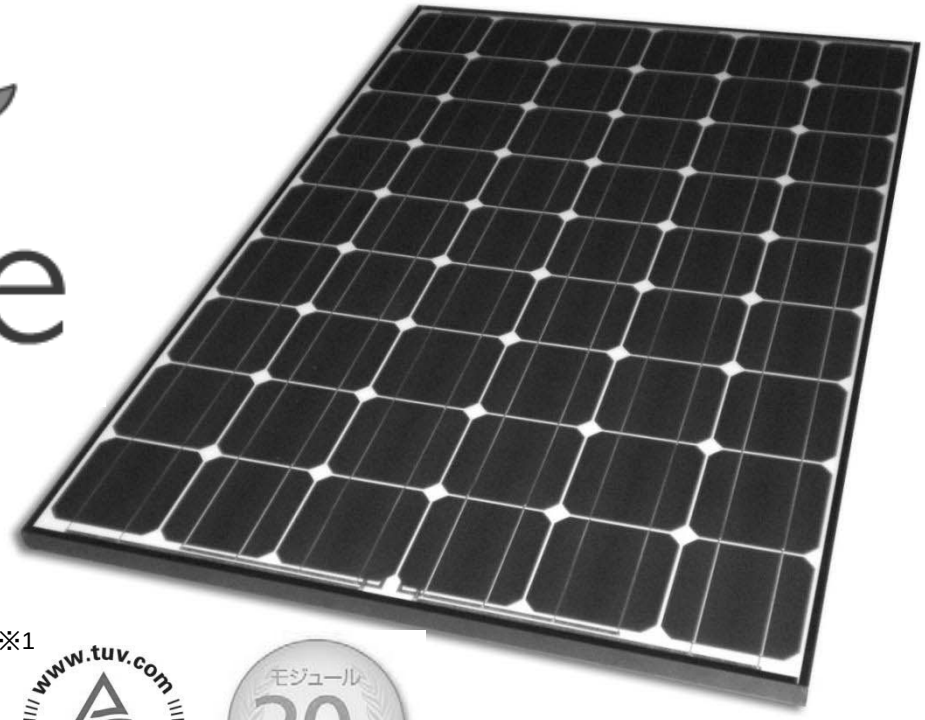
Takeshi Kawanobe
Director, Lightweight PV Group, System Solution BU,
AGC Glass Japan/Asia Pacific
Asahi Glass Co., Ltd.

Jan. 2016

AGC

Light Weight Solar Module

Light Joule



※1

www.tuv.com
TÜVRheinland
ID:0000023298

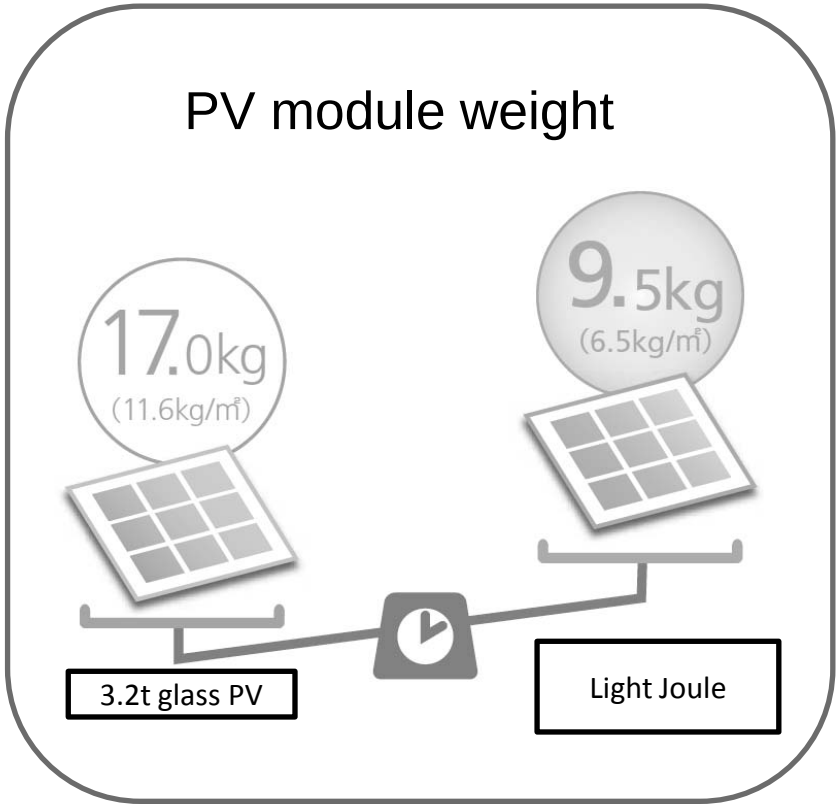
モジュール
20年
出力保証

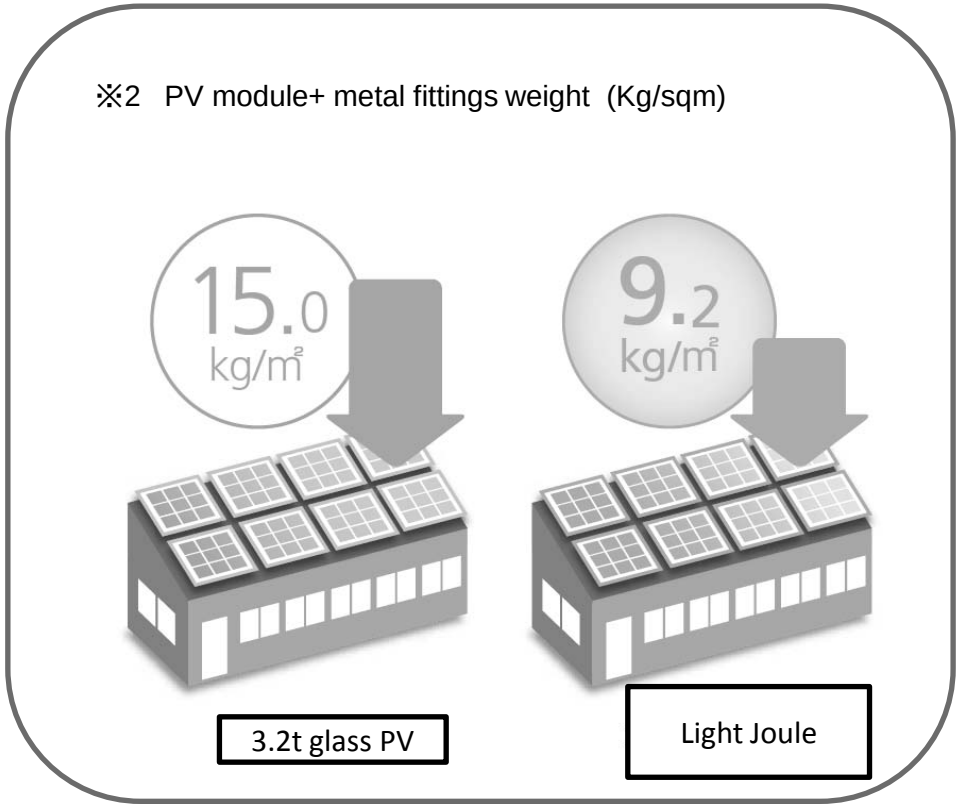
※1 製造元フジプレアムが取得

AGC 旭硝子

Needs for Light Weight Solar Module

Light joule decrease the load on the building.





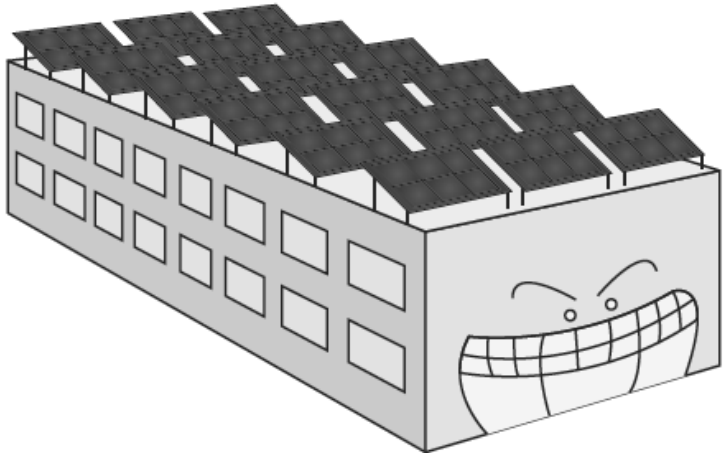
※1) 54 cell type comparison
※2) This weight is changeable depending on rooftop design.

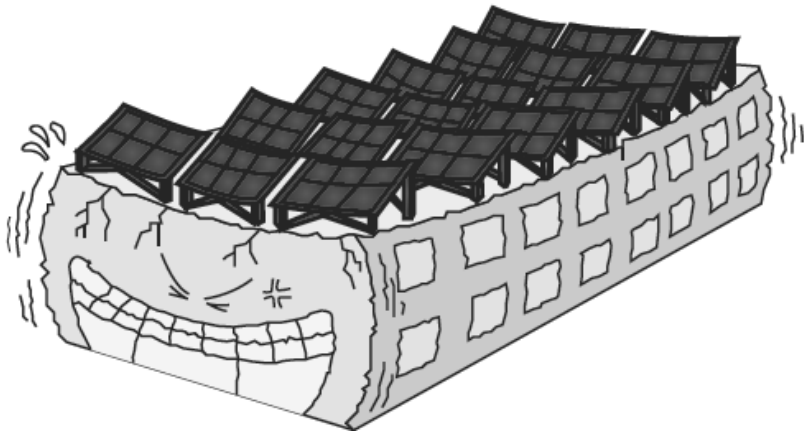
AGC ASAHI GLASS

Merit for Lightjoule

太陽電池パネルを軽量化すれば、
建物への負荷を減らすことができます。

Lighter-weight solar panels will reduce the weight load on the building.





Light joule can be installed where standard modules can not be installed due to building structures.

AGC 旭硝子

Lightjoule

Lightjoule is an ultra-lightweight solar panel.

AGC Kansai Factory (Roof Top)

Daikoku Pier T-4 Transit shed,
Port of Yokohama, Kanagawa Pref.

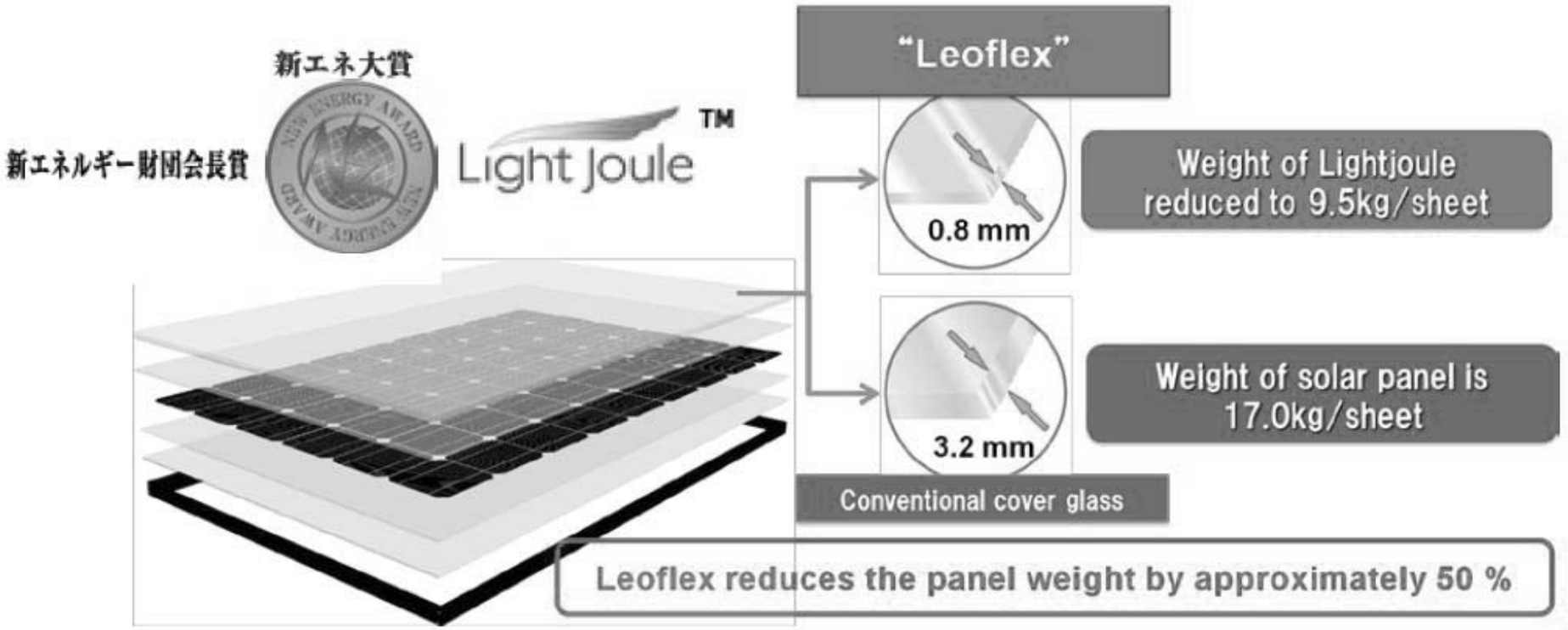
Why is Lightjoule so light?

Lightjoule uses「Leoflex」Glass, made by AGC

「Leoflex」Glass is Chemically Tempered Glass ,
glass technology for “Smart Phone”
the thickness of glass is 0.8mm

AGC ASAHI GLASS

Structure of Lightjoule



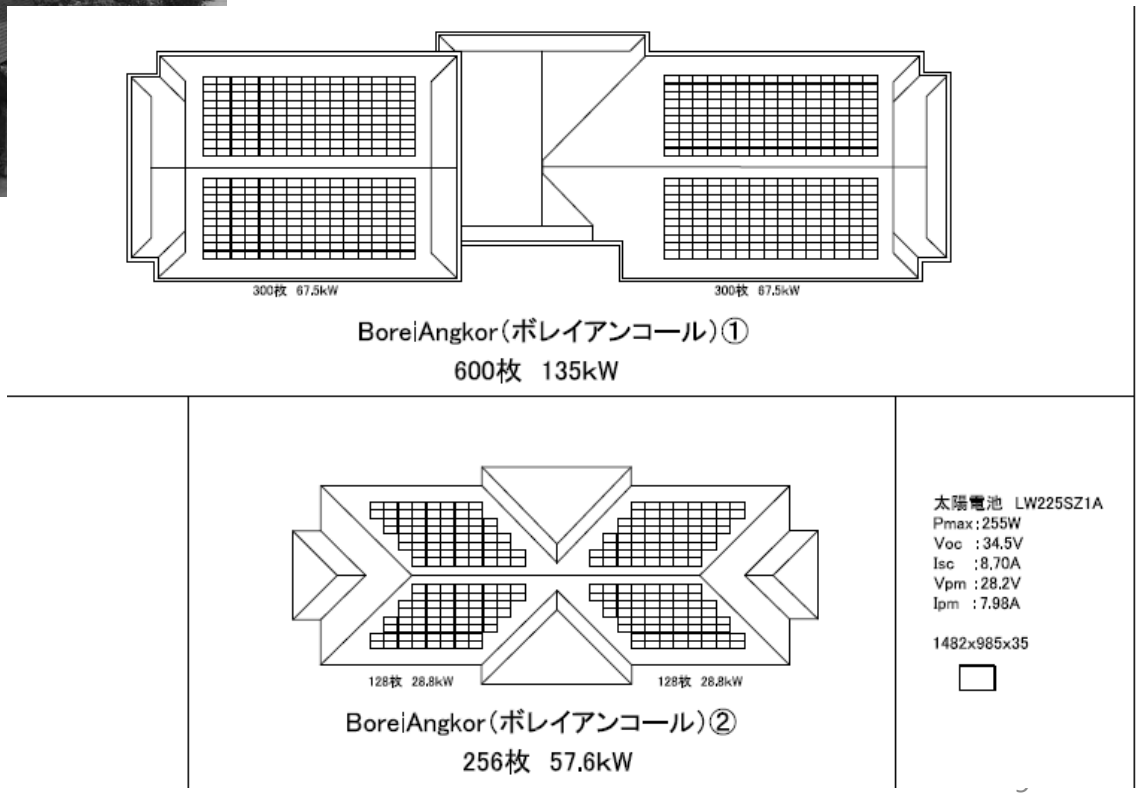
Kanagawa lightweight photovoltaic penetration project

About 2MW nominated projects
within 2015 FY using Lightjoule

1. AGC Namamugi Warehouse rooftop :645kW
2. KIRIN Yokohama Factory rooftop : 700kW
3. Shonan Gakuen (school) rooftop: 330kW

AGC

Borei Angkor



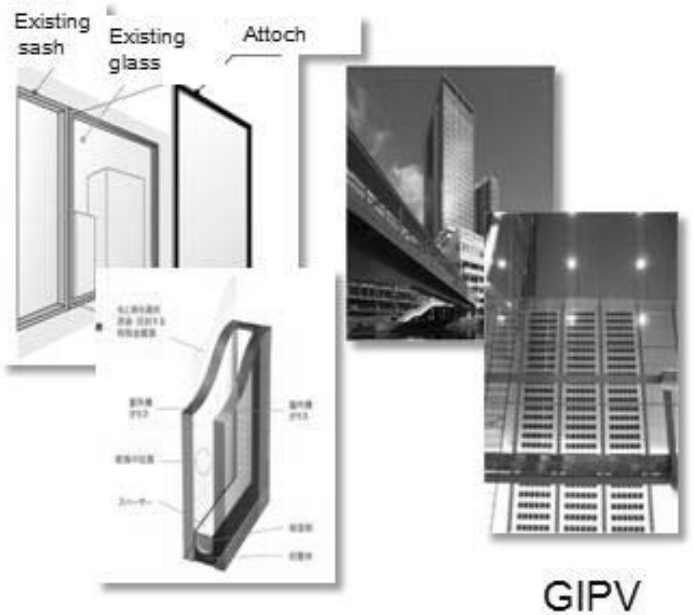
856pcs estimated Mounting

↓

6.4 ton reduction vs. normal module

AGC

Other products for sustainability



Architectural glass

GIPV

Fluoropolymer resin for coating

ETFE Film
(Tetra fluoroethylene - ethylene copolymer)

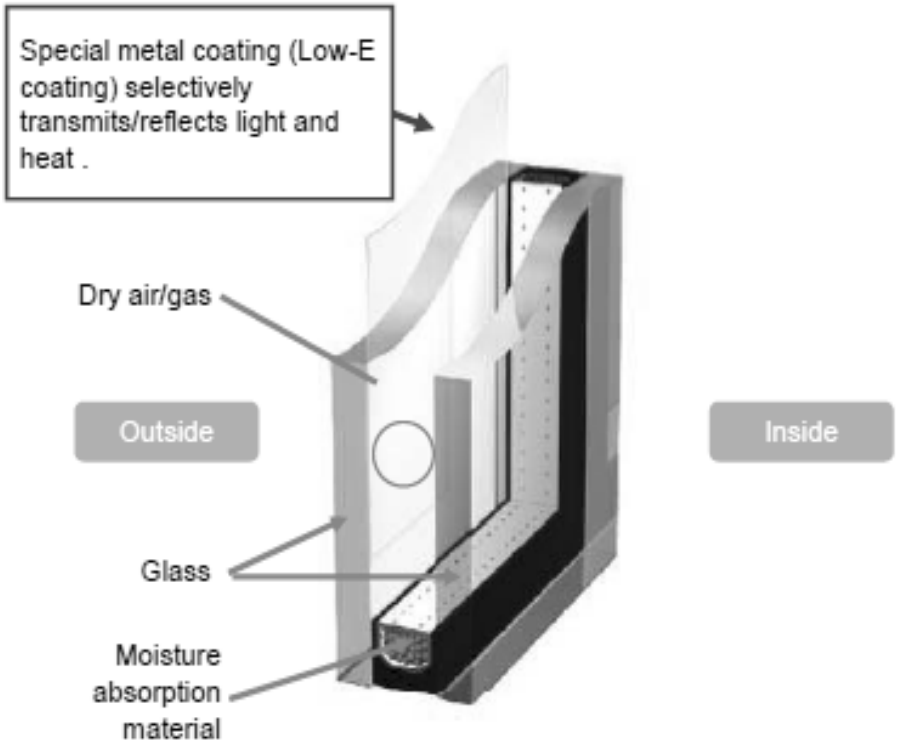
Ceramic color aggregate

LUMIFLON

Fluon ETFE FILM

Low-E Insulated Glass Units

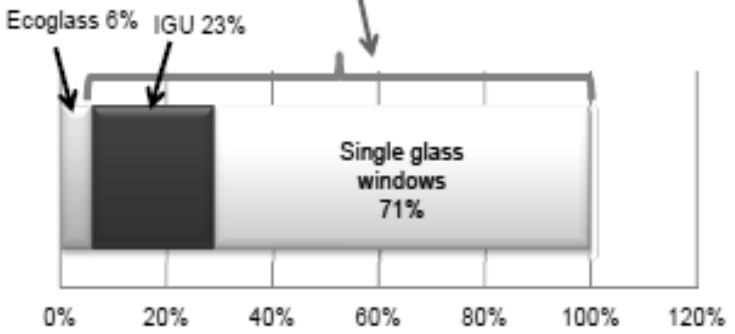
Ecoglass



A greater heat insulating/shielding performance achieved with a special metallic coating (Low-E coating) between the IG unit.

Energy-saving with Ecoglass (in Japan)

If every household in Japan uses Ecoglass,



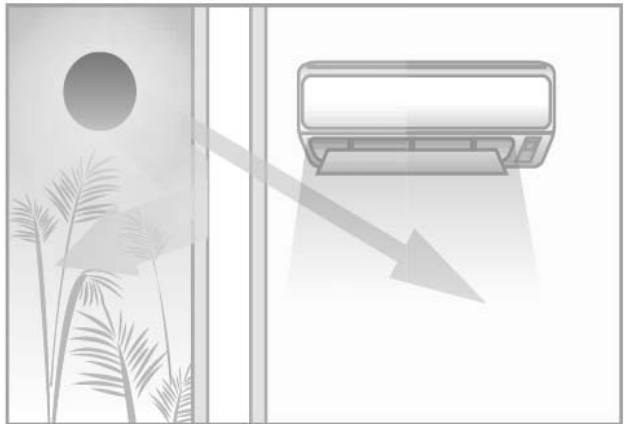
Household Ecoglass use in 2010 (estimated based on approx. 5000 households in total)

We can save the electricity equivalent to the amount generated by two nuclear reactors*.

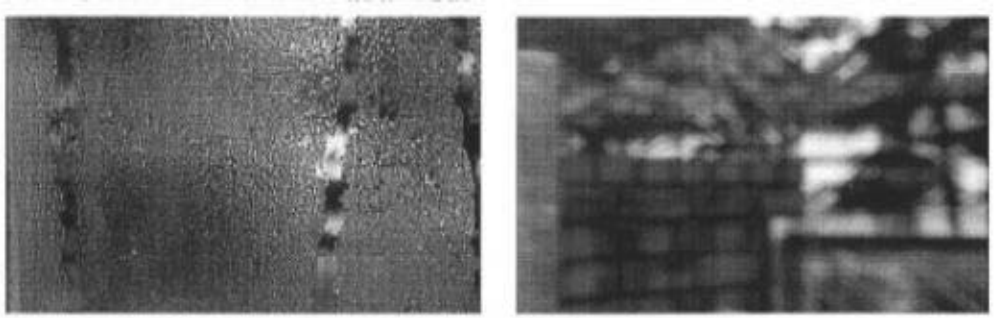
*100 million kilowatt/reactor

AGC

Benefits of Low-E Insulated Glass Units

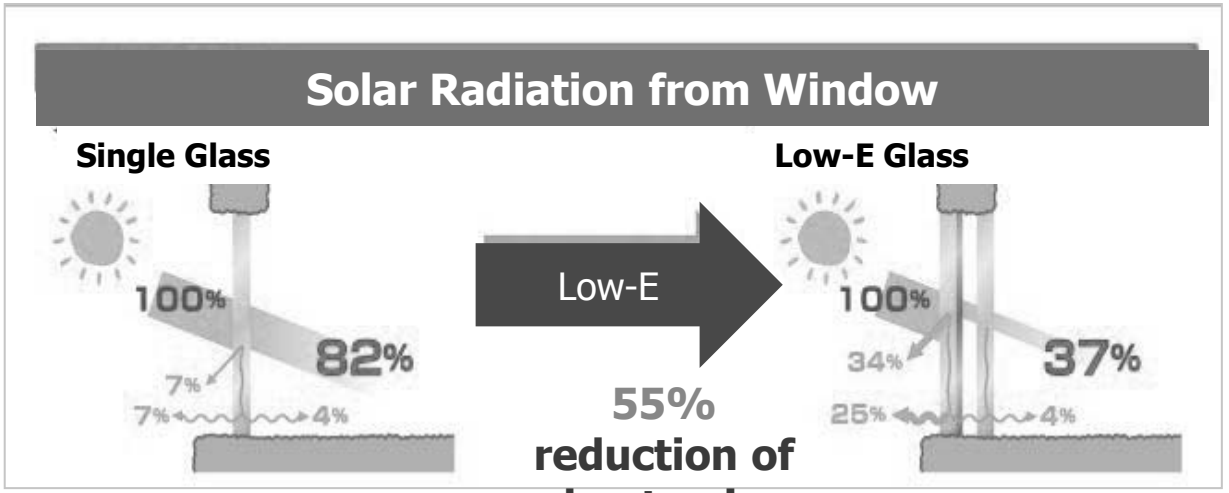


Cuts down direct sunlight and protects guests and building from UV



Contributes to providing spectacular riverside view to hotel guests

Halves the heat from the sun, and reduces 55% of air conditioning load



http://www.ecoglass.jp/s_about/can.html

Corporate Profile

Corporate Information

As of March 27, 2015

Trade Name	Asahi Glass Co., Ltd.
Head Office	〒100-8405 Shin-Marunouchi Bldg., 1-5-1Marunouchi, Chiyoda-ku, Tokyo, JAPAN Tel : +81-(0)3-3218-5741 Corporate Communications & Investor Relations Div. (Shin- Marunouchi Bldg. 31F) Tel : +81-(0)3-3218-5603 Fax : +81-(0)3-3201-5390
Incorporated	June 1, 1950【Founded : September 8, 1907】
President & CEO	Takuya Shimamura
Book closing date	December 31
Capital	90,873 million yen【Number of shares outstanding : 1,186,705,905 shares】 (as of December 31, 2014)
Subsidiaries	Subsidiaries:219 including 175 companies overseas (Consolidated subsidiaries 194 including 156 companies overseas) Affiliate companies: 46 including 32 companies overseas
Employees of consolidated companies	51,114

AGC belongs to MITSUBISHI Group

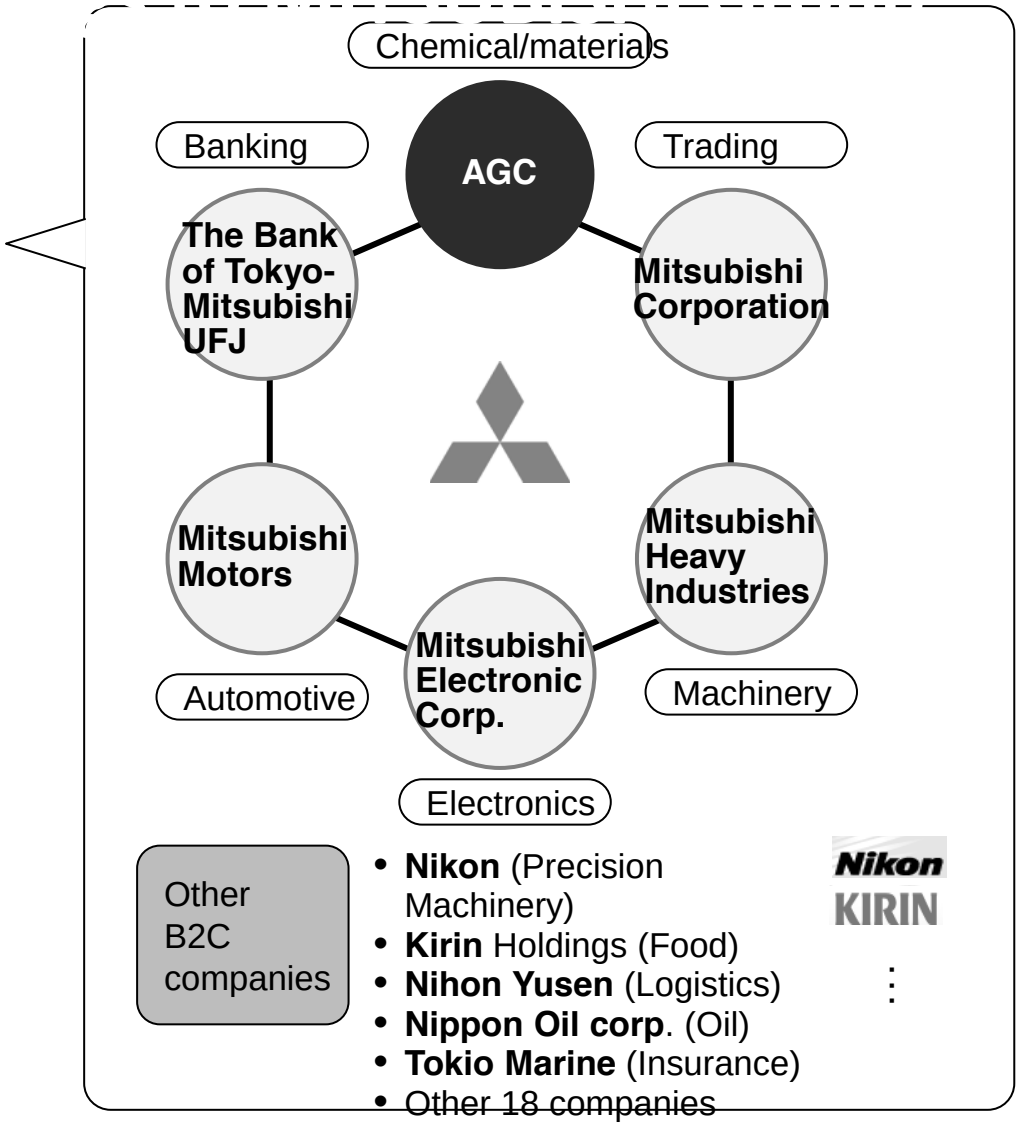
Foundation

1st Mitsubishi president
Mr. Yataro Iwasaki

2nd Mitsubishi president
Mr. Yanosuke Iwasaki

September 8th, 1907
AsahiGlass

Mr. Toshiya Iwasaki



15

AGC Group's Global Network

The Group operates in approximately 30 countries and regions in the world.

Total 194 consolidated subsidiaries (38 in Japan/156 overseas)

As of December 31, 2014

Europe 89 **Japan/Asia 86** **Americas 19**

Major subsidiaries

Europe		Japan/Asia		Americas	
Company	Country	Company	Country	Company	Country
AGC Glass Europe S.A	Belgium	AGC Glass Products Co., Ltd.	Japan	AGC Glass Company North America	The United States
AGC Automotive Europe S.A.	Belgium	AGC Glass Kenzai Co., Ltd.	Japan	AGC Glass Brazil, Inc.	Brazil
AGC Flat Glass Czech a.s., clen AGC Group	Czech Republic	AGC Techno Glass Co., Ltd.	Japan		
AGC Flat Glass Klin LLC	Russia	AGC Display Glass Yonezawa Co., Ltd.	Japan		
OJSC AGC Bor Glassworks	Russia	Ise Chemicals Corporation	Japan		
		AGC Ceramics Co., Ltd.	Japan		
		Asahi Glass Fine Techno Korea Co., Ltd.	Korea		
		AGC Display Glass Taiwan Co., Ltd.	Taiwan		
		PT Asahimas Chemical	Indonesia		
		AGC Flat Glass (Thailand) Public Co,.Ltd	Thailand		

Business Overview

AGC Group

Glass

Flat Glass

- Float flat glass
- Figured glass, Polished wired glass
- Low-E glass
- Decorative glass
- Fabricated glass for architectural use (Heat Insulating/shielding glass, safety/security glass, fire-resistant glass), etc.

Automotive Glass

- Automotive glass

Electronics

Display

- LCD glass substrates
- Specialty glass for display applications
- Display related materials
- Glass for solar power system
- Fabricated glass for industrial use

Electronic Materials

- Semiconductor process materials
- Optoelectronics materials
- Lighting glass products, laboratory glass, etc.

Chemicals

Fluorochemicals & specialty chemicals

- Fluorinated resins
- Water and oil repellents
- Gases
- Solvents
- Pharmaceutical and agrochemical intermediates & active ingredients
- Iodine-related materials, etc.

Chlor-alkali & urethane

- Raw materials for vinyl chloride polymer
- Caustic soda
- Urethane, etc.

Ceramics/Other

- Ceramic products
- Logistics and financial services, etc.

AGC ASAHI GLASS

Market Position in Global

※FY2014 company estimates

Flat Glass

No.1 **AGC** Group
No.1 Saint-Gobain + Central Glass
No.1 Nippon Sheet Glass Group
No.4 Guardian
:

} 65%

* Exclude China

Automotive Glass

No.1 **AGC** Group
No.1 Saint-Gobain + Central Glass
No.1 Nippon Sheet Glass Group
:

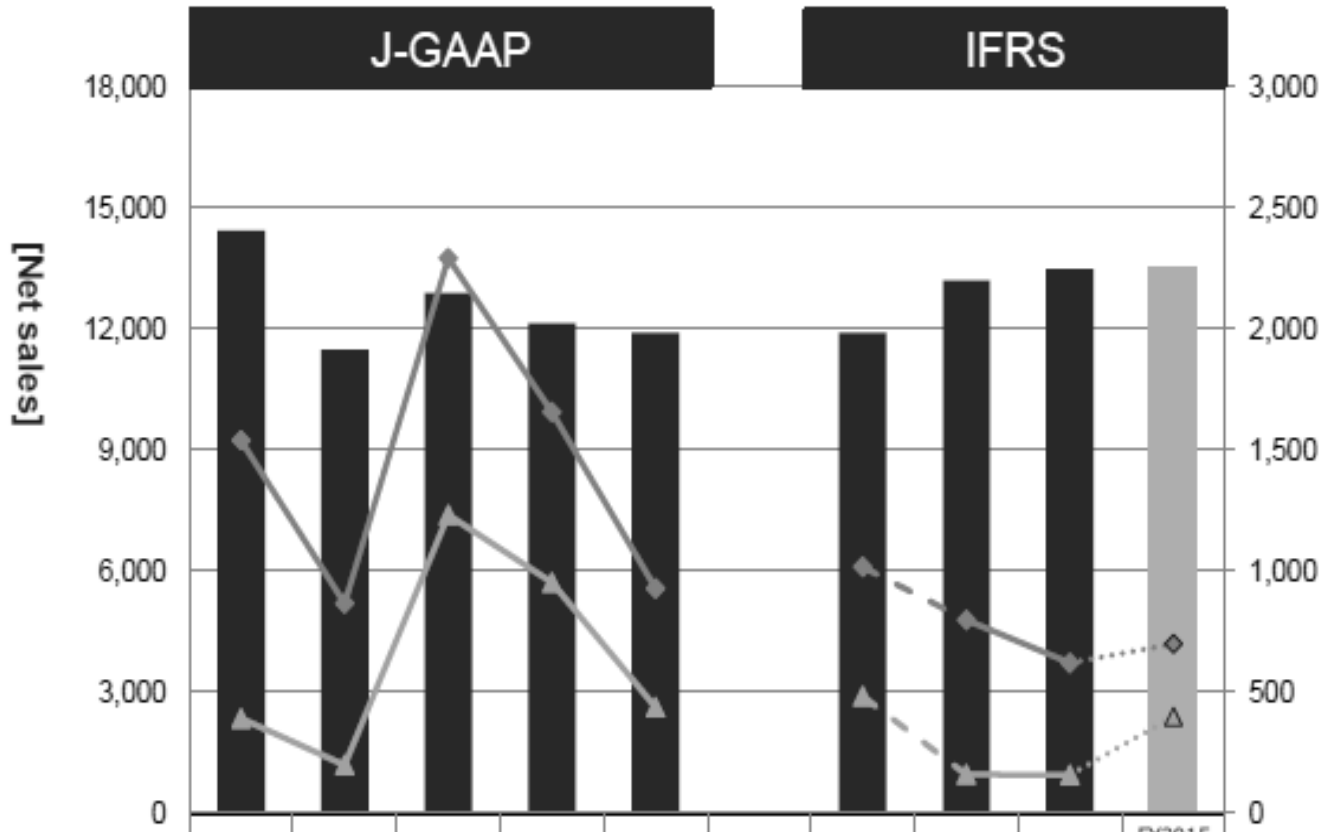
} 65%

Glass Substrate for TFT-LCD

No.1 Corning
No.2 **AGC** Group
No.3 Nippon Electric Glass
:

Changes in the Financial Results

(100 million yen)



	FY2008	FY2009	FY2010	FY2011	FY2012		FY2012	FY2013	FY2014	FY2015 Forecast
Net sales	14,443	11,482	12,889	12,147	11,900		11,900	13,200	13,483	13,550
Operating profit	1,540	867	2,292	1,657	929		1,018	799	621	700
Profit for the year attributable to owners of the parent *	392	200	1,232	953	438		484	161	159	400
Operating profit margin	10.7%	7.5%	17.8%	13.6%	7.8%		8.6%	6.1%	4.6%	5.2%
Dividend per share	¥24	¥16	¥26	¥26	¥26		¥26	¥18	¥18	¥18

* Net income in J-GAAP.

AGC

PV Hybrid System

Proposal of Fuel Save Solution

京セラは、技術力で
エネルギーを変える。

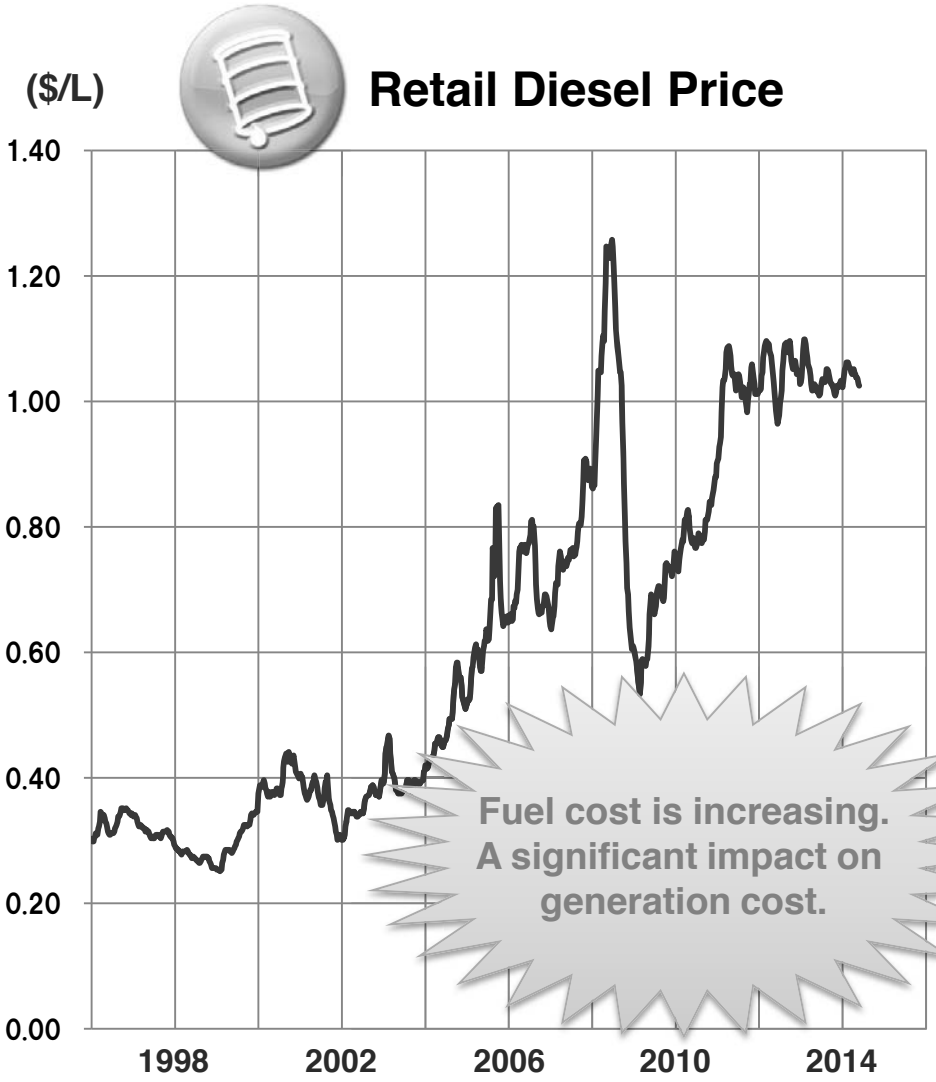
KYOCERA THINKING ENERGY

KYOCERA Corporation
Solar Energy Group

Agenda

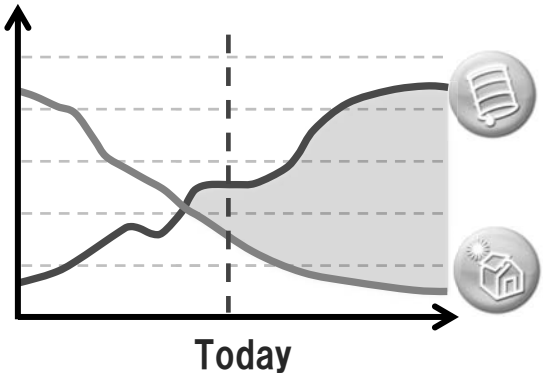
1. Why PV Hybrid System ?
2. What Fuel Save Controller Does ?
3. Maximization of PV Penetration
4. Diesel Fuel Saving － Simulation
5. Benefits of Kyocera Proposed Hybrid System

Background



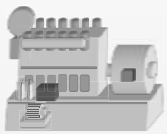
PV price ; Decreasing

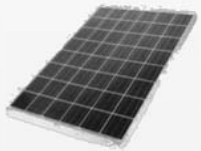
Image



In order to reduce fuel consumption,

Diesel Gensets(Exsiting) + PV system





※Max capacity of PV was 20% to diesel gensets capacity

Advantage of PV Hybrid System

	Diesel Gensets	PV	Gensets+PV Hybrid System
Elec. Stability	○	X	○
Load Tracking	○	X	○
Generation Cost	△	○	△
Environmental Free	X	○	△

» Need to reduce more diesel consumption……

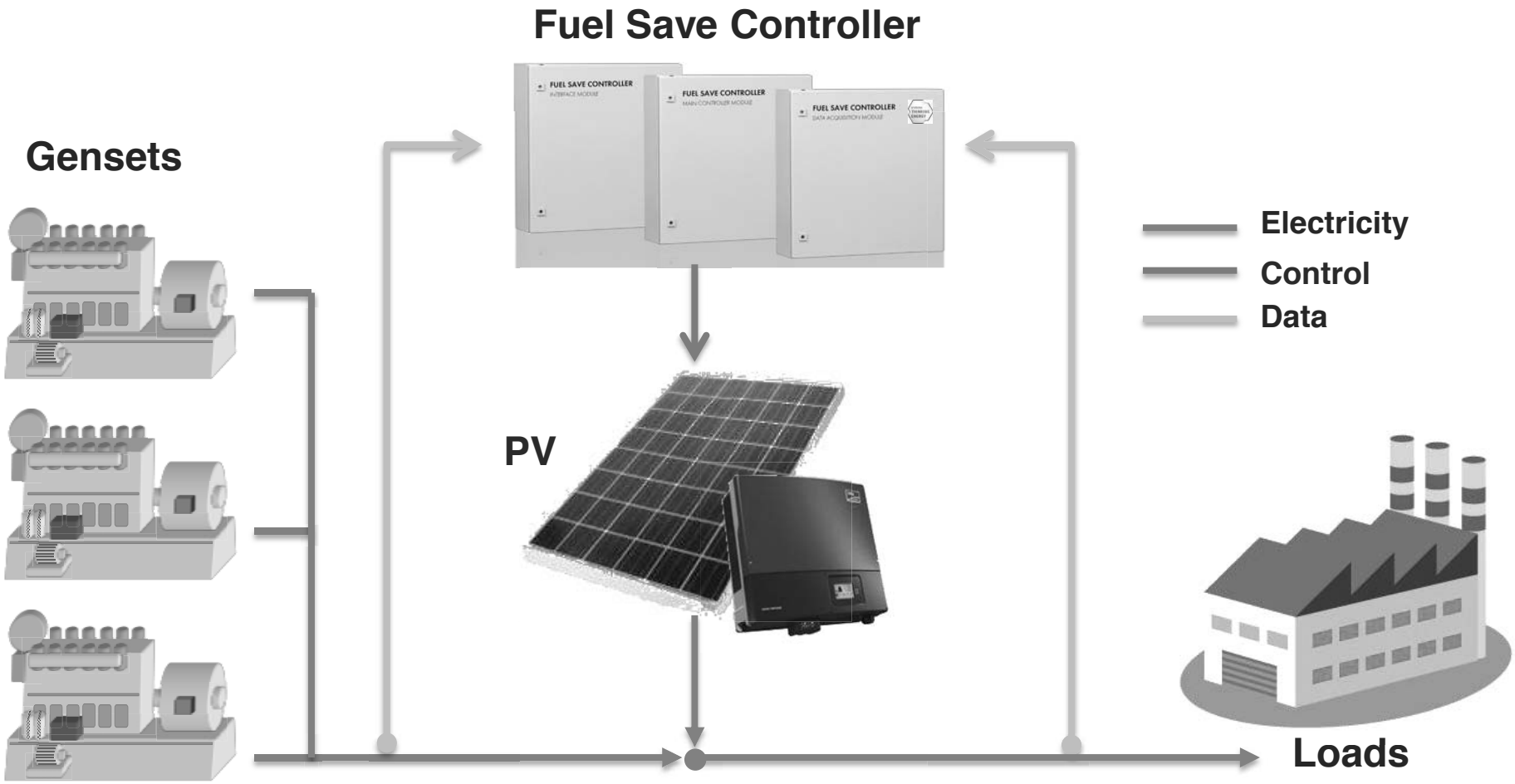
In order to increase PV...

Diesel Gensets＋PV＋Fuel Save Controller

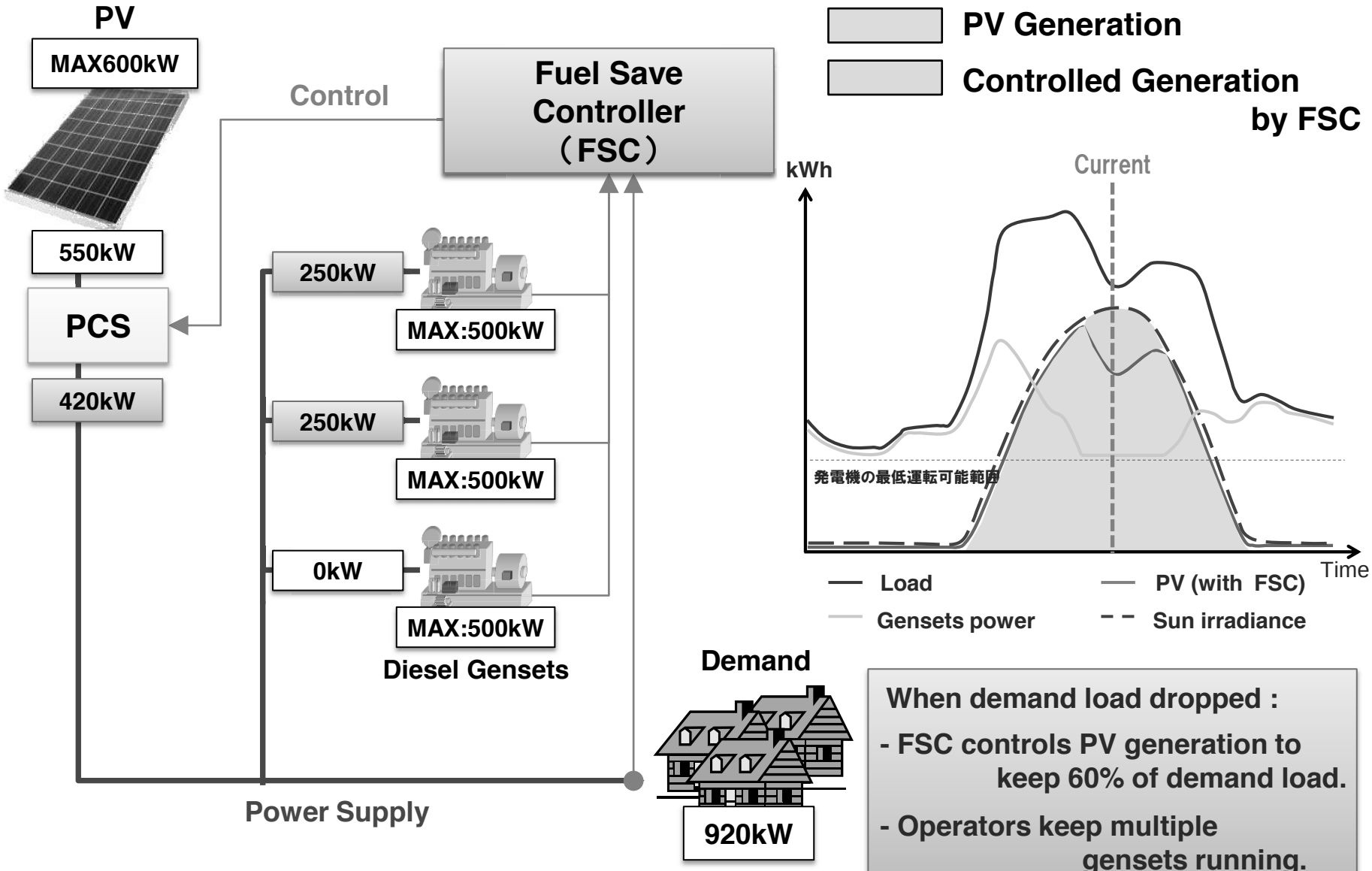
Fuel Save Controller can increase
PV penetration from 20% to 60%

2. What Fuel Save Controller Does?

1. Data Gathering
2. PV Generation Control



3. Maximization of PV Penetration



When demand load dropped :

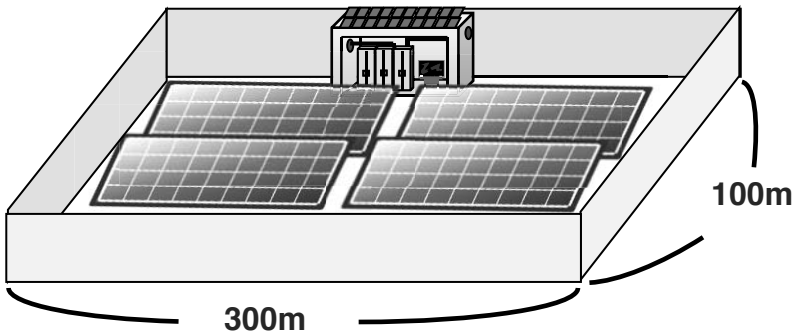
- FSC controls PV generation to keep 60% of demand load.
- Operators keep multiple gensets running.

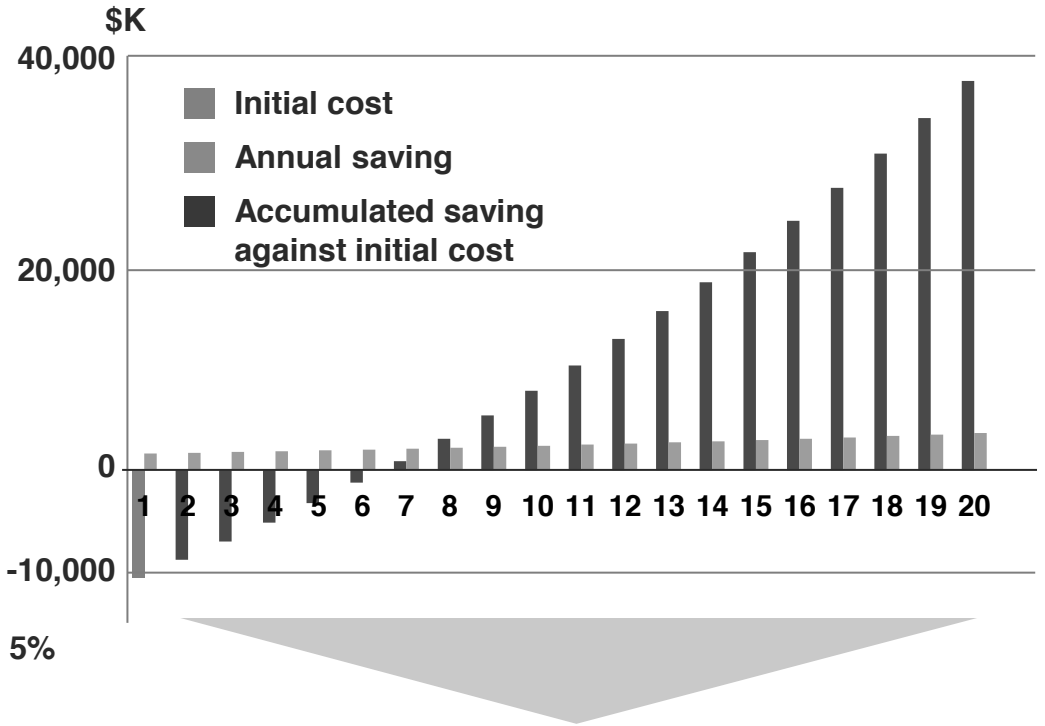
4. Diesel Fuel Saving — Simulation

Assumptions

Site type	Mining
Solar irradiation	1,814kWh/m^2
Peak load	3,150kW
Gensets Capacity	1,000kVA x 5
Gensets efficiency	3.77kWh/L
Fuel cost	$1.20/L
PV size	3,000kW
PV system layout	Below

* Annual Inflation Rate ; 5%





- Pay Back Time : 7years
- Total saving for 20years : $50,000,000--
- Annual Fuel Saving : 1,300,000L
- Annual CO^2 Emission Saving : 3,600t

Detailed simulation to be provided, on your further info.

5. Benefits of Kyocera Proposed Hybrid System

1. **Simple System Configuration**
   -Can be hybrid with existing diesel gensets.
   -Does not control gensets directly.
   -Can operate without batteries.
   -Expandable from smaller size to larger size.

2. **Solar generation is not additional to gensets generation.**
   - Can reduce fuel cost.
   - Can reduce CO2 emission.

3. **Sunlight available everywhere**
   -Does not require transportation all the way to Customer's site.

4. **Cost of Sunlight ……. Available for free & no risk of inflation.**

5. **Can improve a penetration of solar generation against gensets capacity, from 20% (conventional) upto 60% (Kyocera)**

6. **Kyocera as 39-year-experienced player in solar industry, as the pioneer !**

Appendix 7

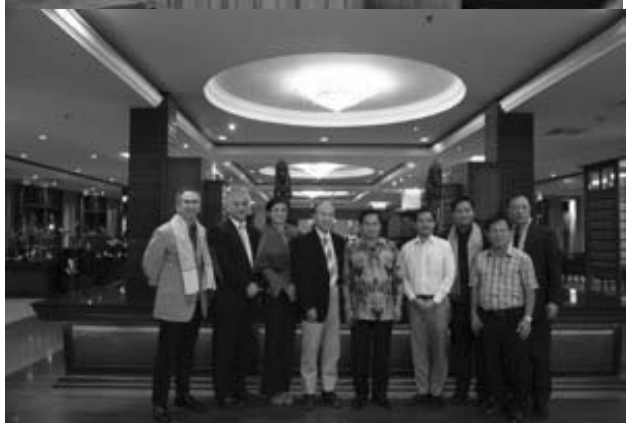
City-to-City Cooperation with Siem Reap and Kanagawa

Japan Development Institute Ltd.,
March 3, 2016

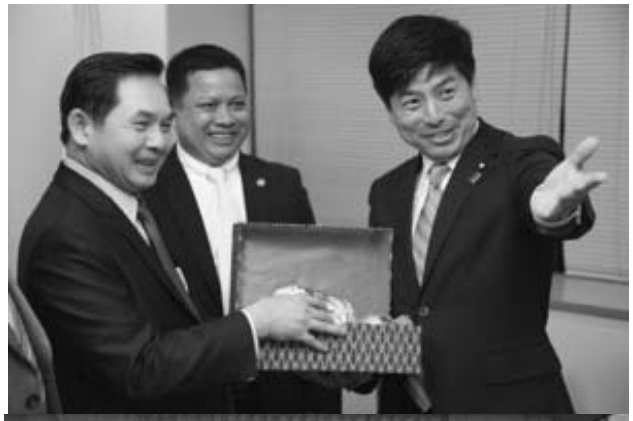
JDI Japan Development Institute

Siem Reap in Cambodia and Kanagawa in Japan

Sep. 30, 2013



Nov. 19, 2014

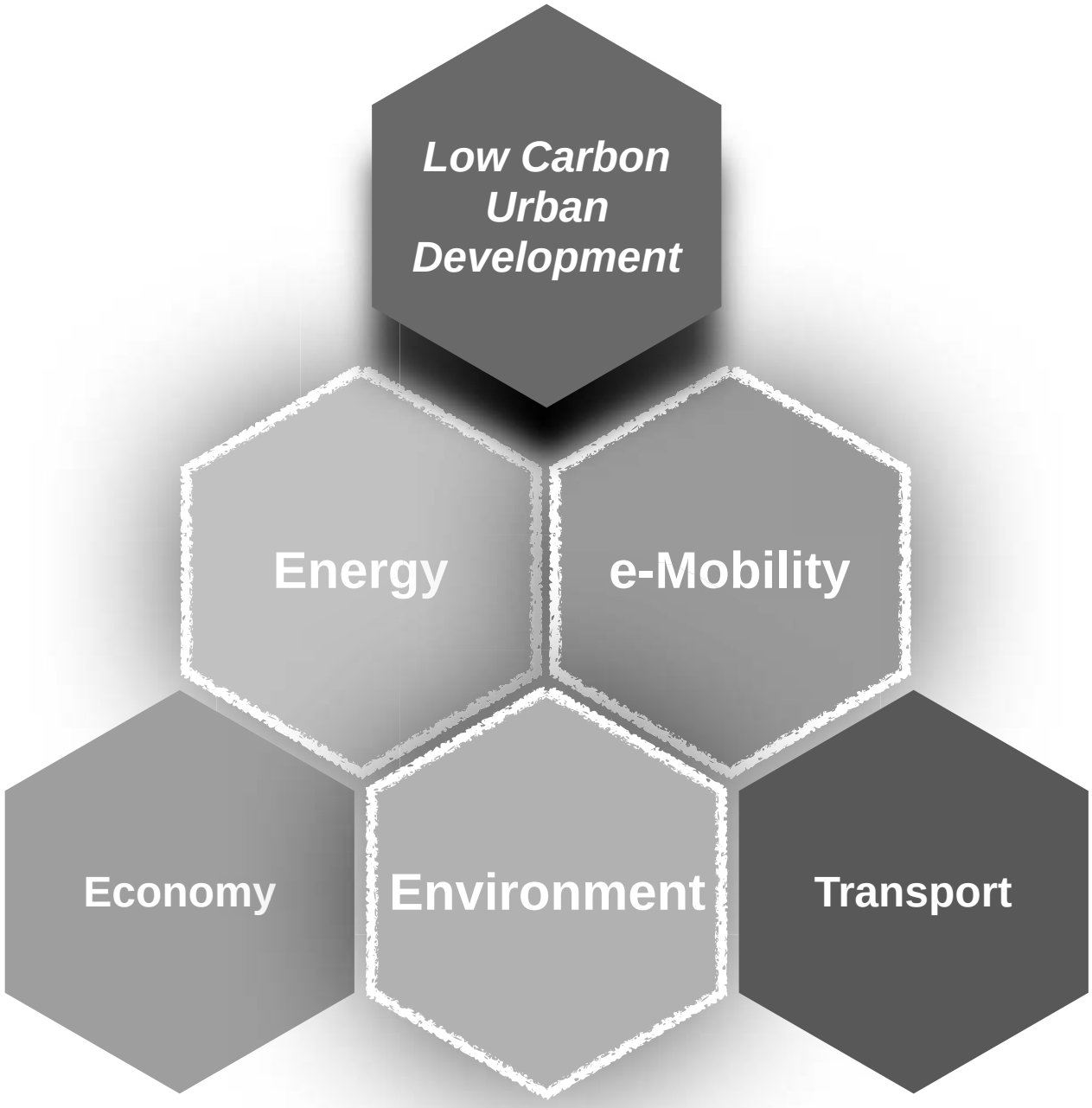


Nov. 5, 2015

C2C Cooperation with Siem Reap and Kanagawa

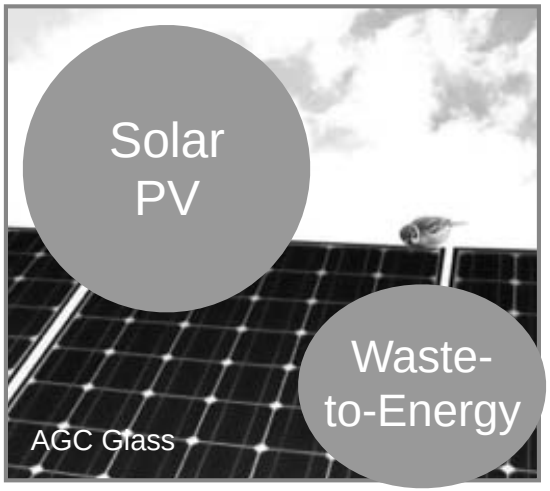
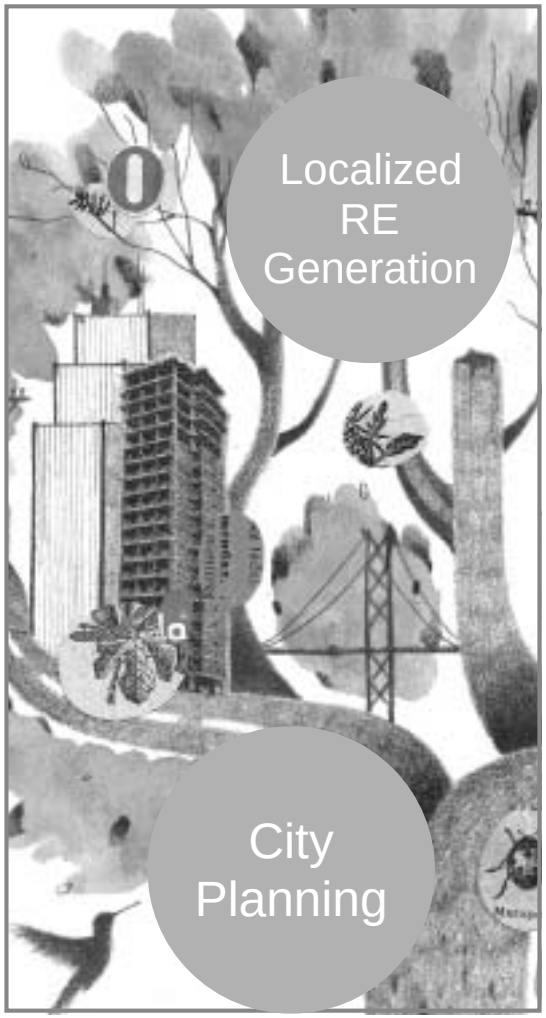
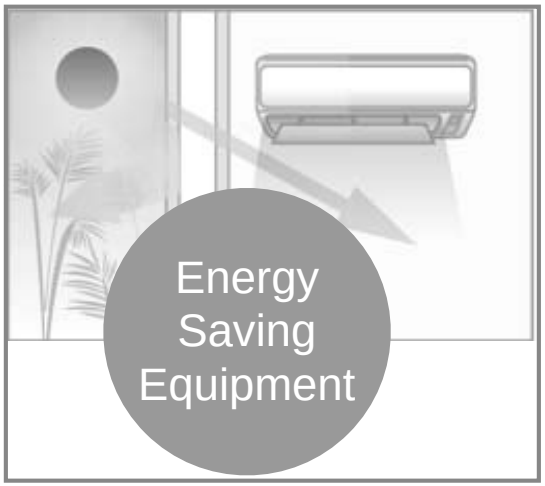
Objectives

- Creating low-carbon tourism city development in Siem Reap Province;
- Benefitting from the results of Feasibility Studies on Joint Crediting Mechanism Projects;
- Aiming to promote mutual understanding and friendship; and,
- Undertaking development of the two regions in collaboration



Rooftop Solar Projects in the five stars hotels

Identifying opportunities in the Energy Sector

	Functions		Infrastructure		Behavior
Renewable Energy(RE)		X		X	• Decentralization by Rooftop Solar Energy in city • Electrification • Reliable and Affordable
Energy Efficiency & Conservation					• Efficient Applications • Integration of architecture and energy saving equipments

e-Mobility using Electric Reumork-Moto

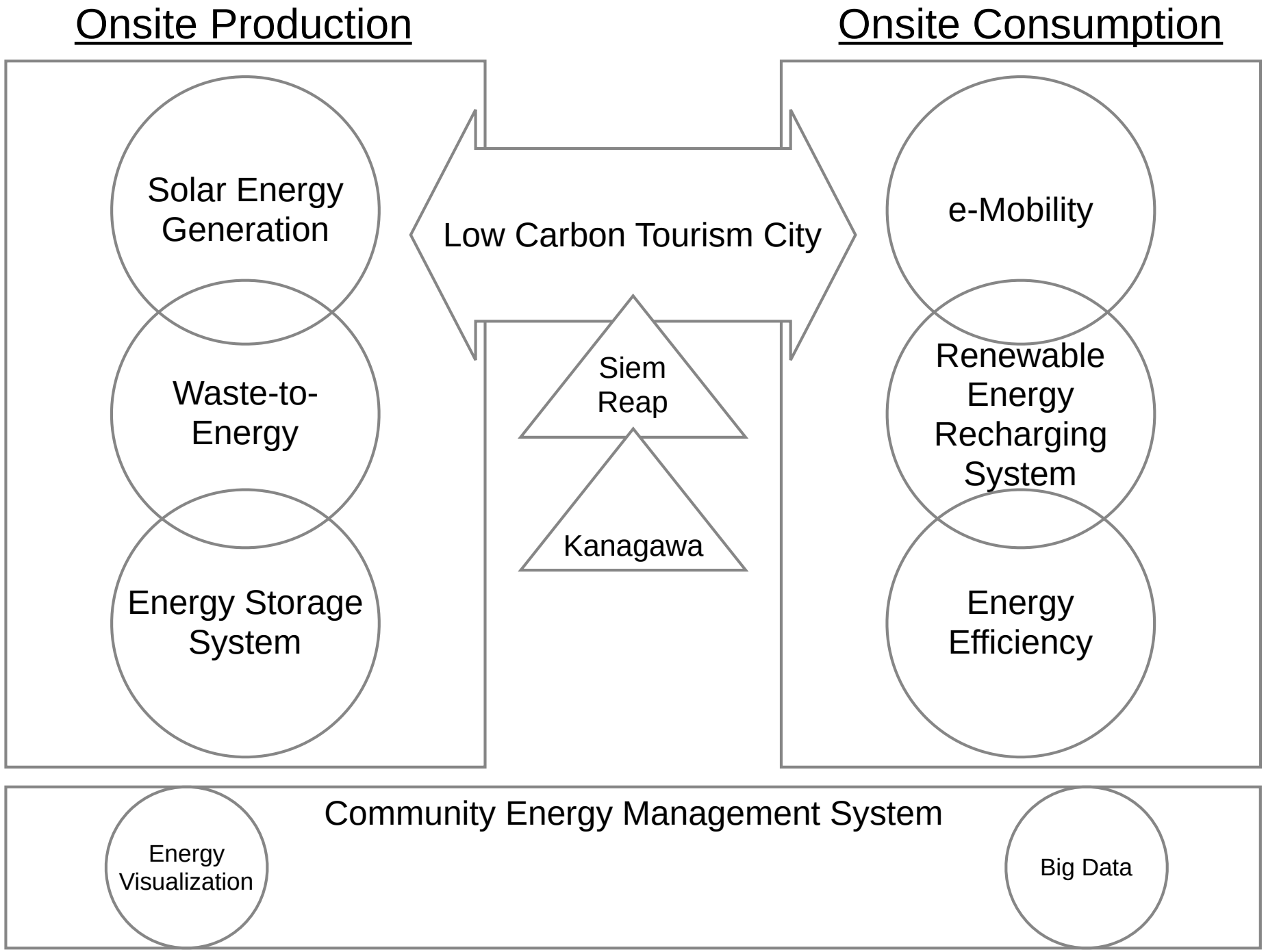
- ✓ **Improve the Angkor tourism experience with better mobility and less congestion.**
- ✓ **Reduce negative impacts on Angkor Heritage Park.**
- ✓ **Social contributions for current Reumork Moto drivers are lower fuel costs and higher income.**

Target-generated objectives for “Eco Mobility” as following key points are examining and making solutions by Japanese JCM (Joint Crediting Mechanism) Team in 2014;

Angkor Mobility like Kamakura-City's Tourism

Special Experience Just For You!

Onsite Production for Onsite Consumption



JDI Japan Development Institute

We would like to hear from you and answer any questions that you might have.
kimura@jditokyo.com

Asian Gateway Corporation and Business Plan in Cambodia

Asian Gateway Corporation | February 2016

AsianGateway

Contents

Asian Gateway Corporation (AGC)
Tokyo based.

Background and Objective in Establishing the Asian Gateway

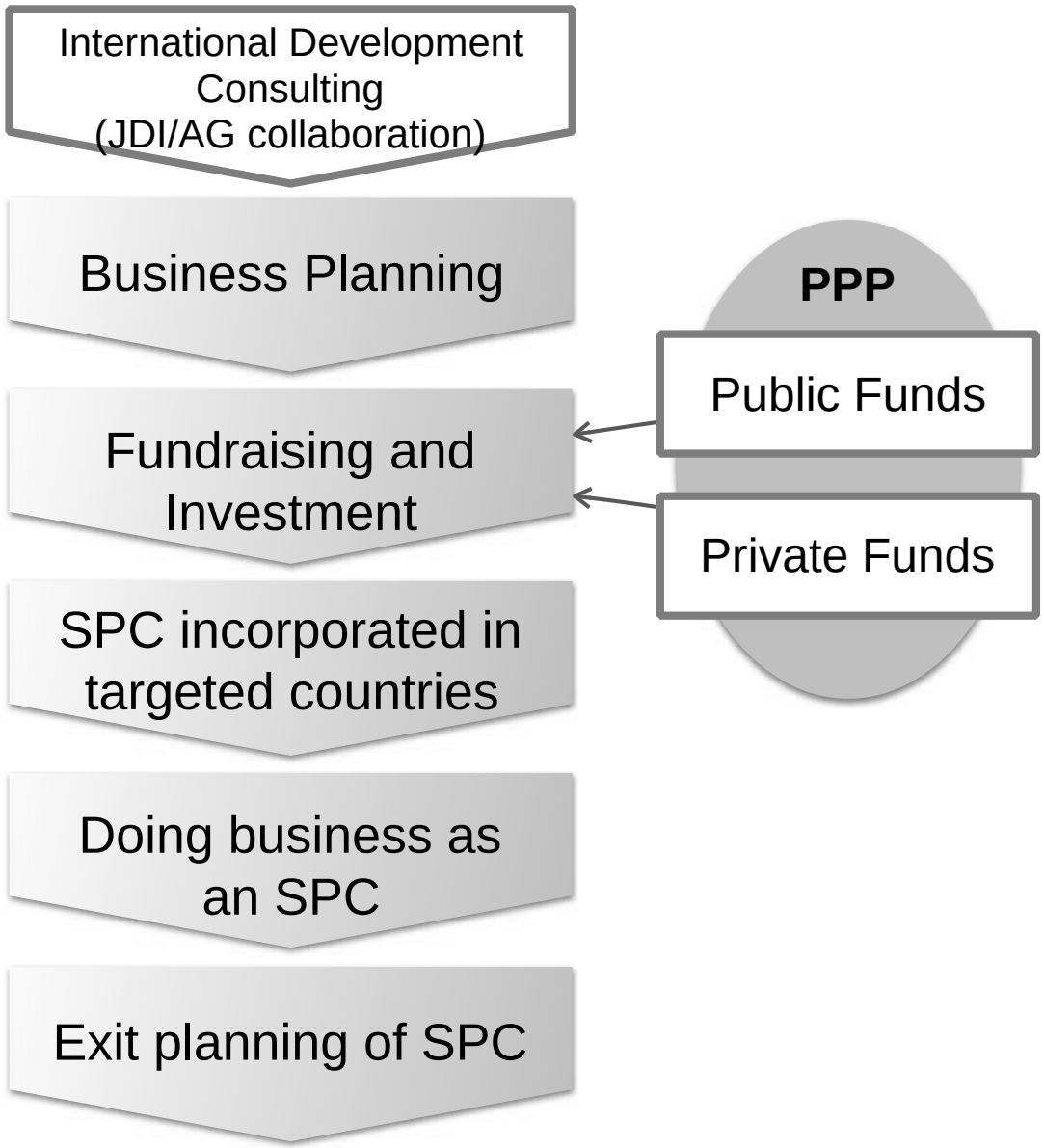
Asian Gateway (AG) was incorporated to promote “the Strategy of Japanese Infrastructure System Export” on March 10th of 2015.

Background

Systemic infrastructure export in Southeast and South Asia by Japanese companies has accelerated, and, the business promotion and fundraising by public-private partnerships (PPP) controls the degree of success of the endeavor.

Objective

AG provides international development consulting services in tandem with JDI - breeding projects leading to infrastructure systems export, and doing business after careful financial planning and focused fundraising



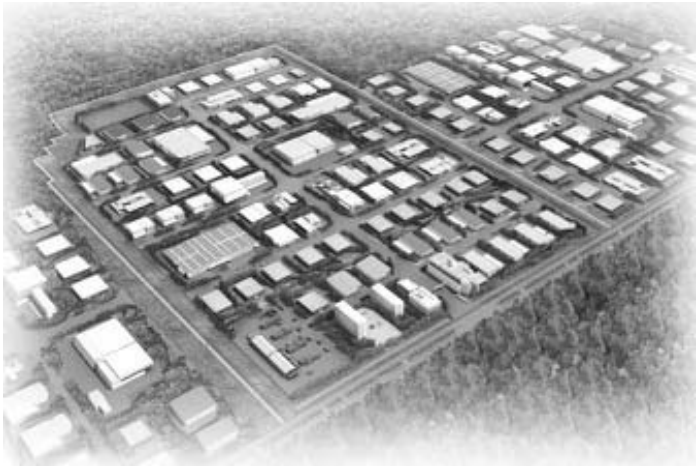
JDI; Japan Development Institute Ltd. （株式会社日本開発政策研究所）
SPC; Special Purpose Company （特別目的会社）

AG's domain for ISE = JDI's cultivated targets

AG focuses on the domain JDI has carefully cultivated for industrialization and composition for Infrastructure System Export (ISE).

The domain for ISE

- Industrial Park or Special Economic Zone
- Urban Transportation and Mobility
- Urban Development
- Societal Eco-systems
- Communication and Security
- Agriculture Development



Corporate Philosophy

To contribute to the development of the social economy and concurrent prosperity of Asia.

Therefore, we orchestrate professional interventions to produce responsible yet robust outcomes in pursuit of coincident healthy profits for our country and a variety of host countries, while maximizing benefits to the local society.

Our Vision

Job Creation

Urban Development

Environmental Improvement

Realization of sustainability in Asia's societal environment

PPP Initiative for doing business

Systemic infrastructure export in Southeast and South Asia by Japanese companies has accelerated; and, the business promotion and fundraising by public-private partnerships (PPP) controls the degree of success of the endeavor.

PPP Scheme

- National Strategic Development Plan
- Government Aid Policy
- JCM(Joint Crediting Mechanism)

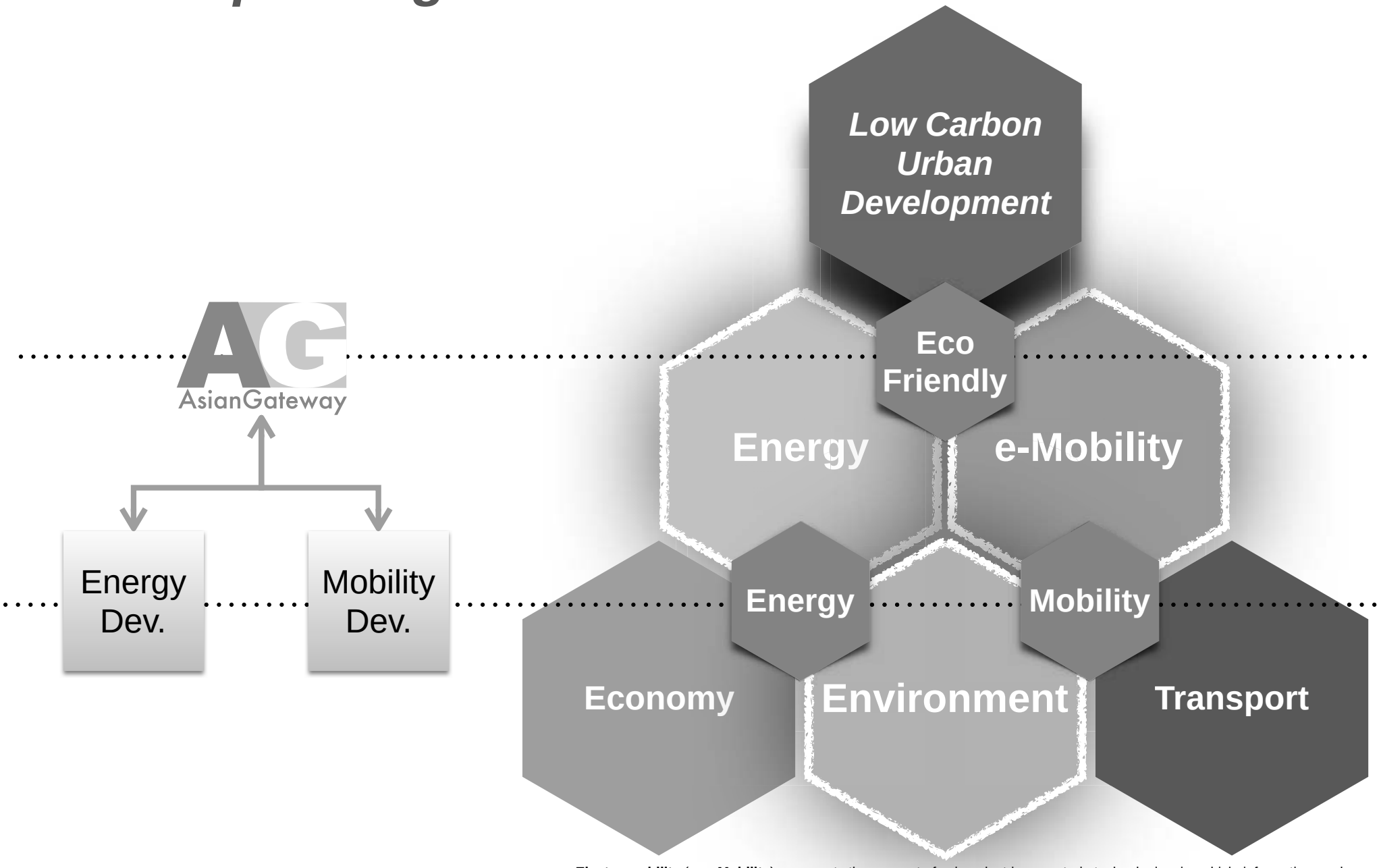
- City to City Collaboration
- EV Tourism and RoofTop Solar

- International Consortium for JCM
- Business Partnership with Asian Gateway
- Consulting and Trading for Sustainable Energy

City-to-City Cooperation on November 5th of 2015

Cooperation towards Low-Carbon Tourism City Development between Kanagawa Prefecture of Japan and Siem Reap Province of the Kingdom of Cambodia

AG Group's Target Domains

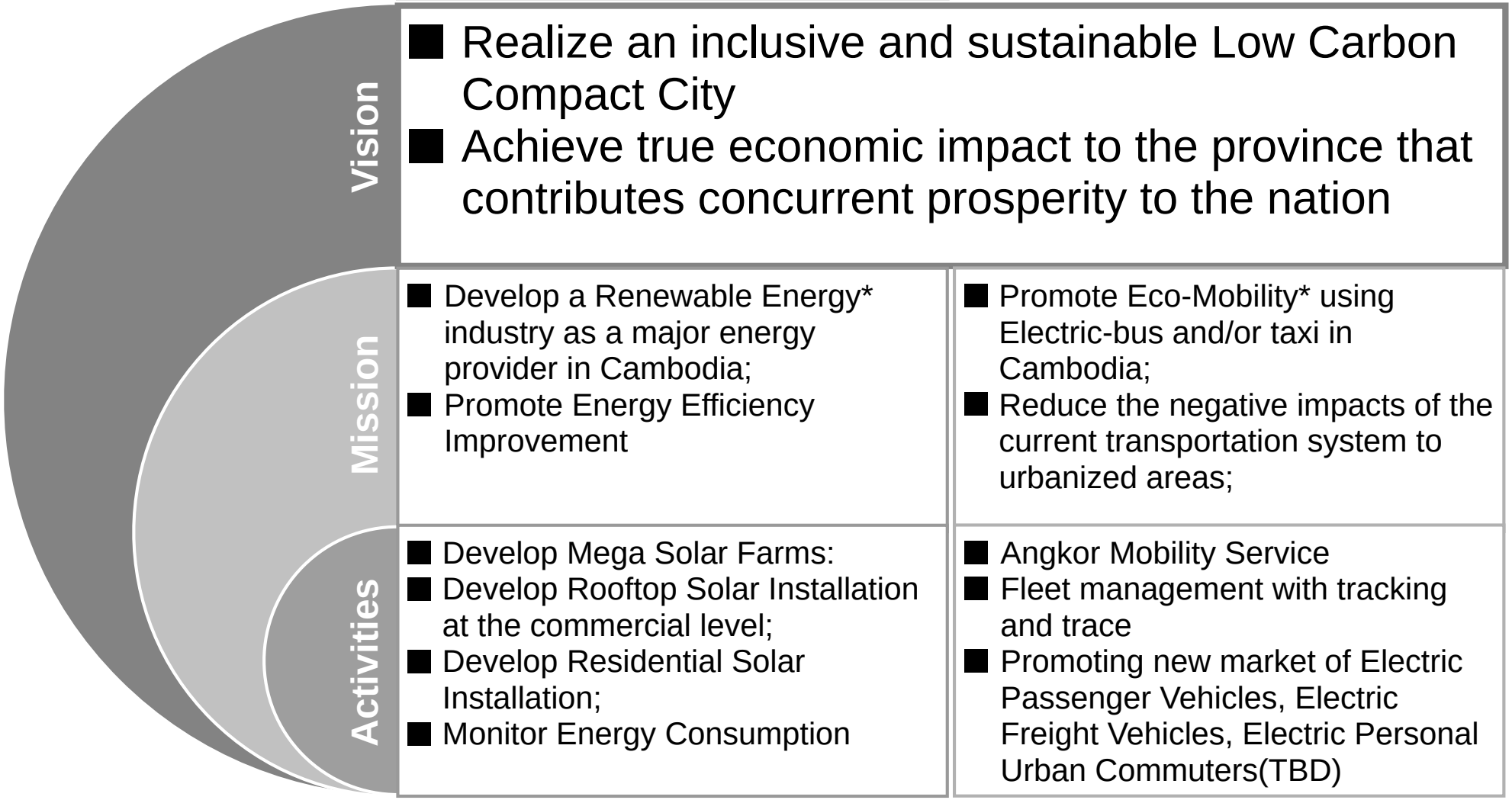


AG: Asian Gateway Corporation
AGE: Asian Gateway Energy Inc.
AGM: Asian Gateway Mobility Inc. (to be incorporated)

Electro mobility (or **e-Mobility**) represents the concept of using electric powertrain technologies, in-vehicle information, and communication technologies and connected infrastructure to enable the electric propulsion of vehicles and fleets. Powertrain technologies include full electric vehicles and plug-in hybrids, as well as hydrogen fuel cell vehicles that convert hydrogen into electricity. e-Mobility efforts are motivated by the need to address corporate fuel efficiency and emission requirements, as well as market demands for lower operational costs. (Source: Gartner)

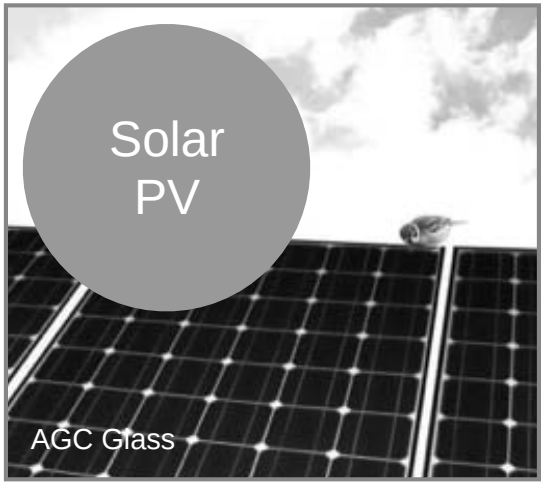
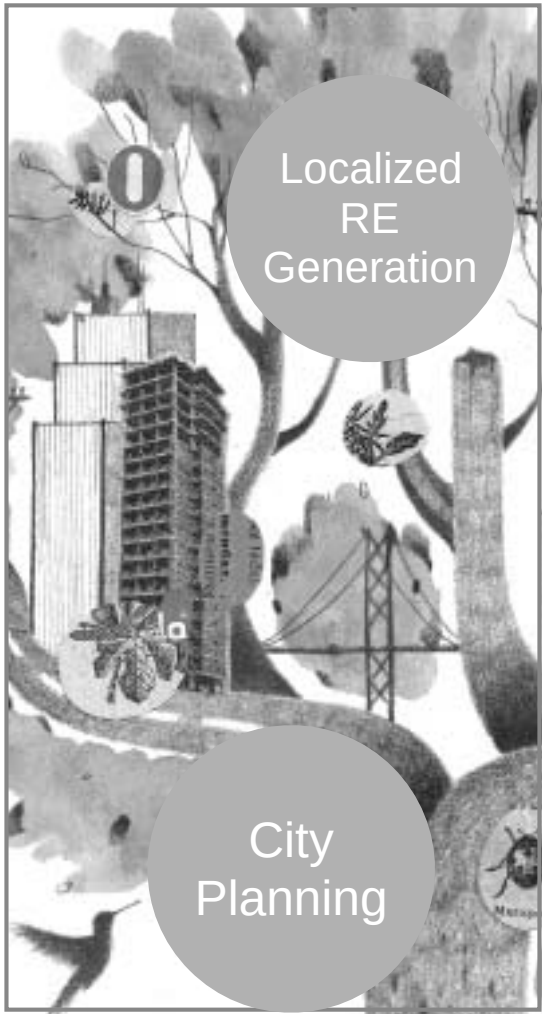
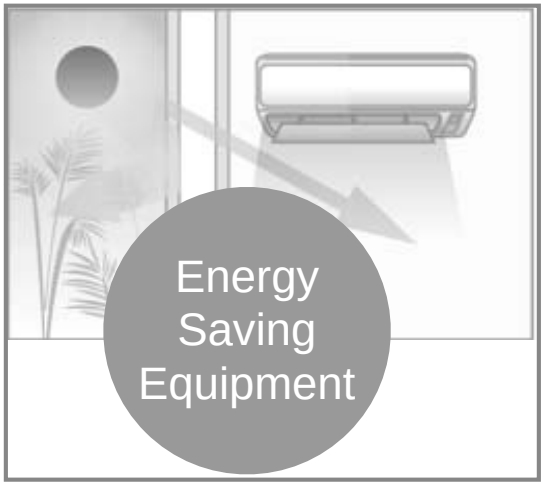
Vision, Mission, and Activities

Asian Gateway (Cambodia)

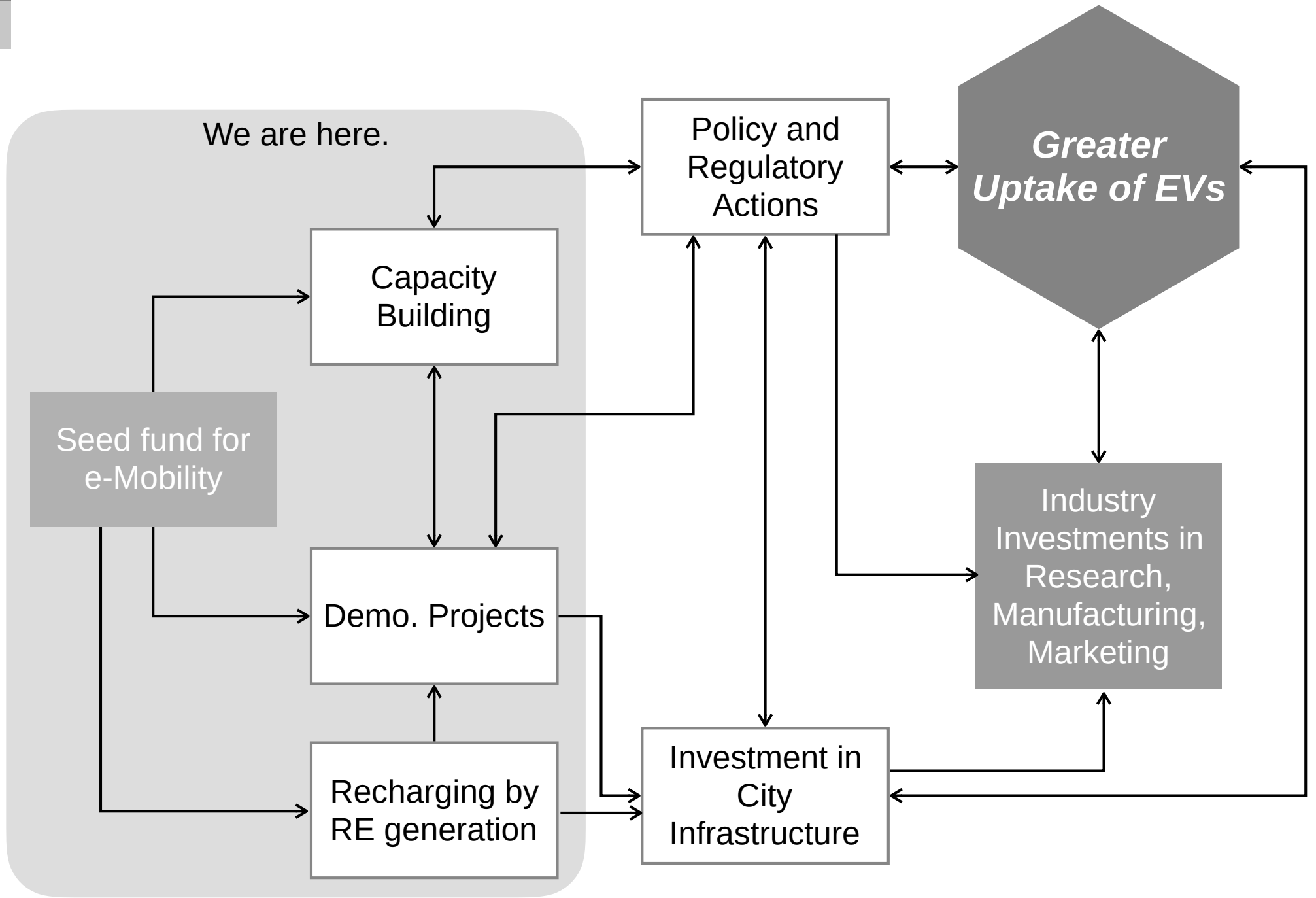


＊1; **Renewable energy** is generally defined as energy that comes from resources which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat.
＊2: **Eco-Mobility** is a term used to describe travel through integrated, socially inclusive, and environmentally friendly transport options, including and integrating walking, cycling, wheeling, and flying.

Identifying opportunities in the Energy Sector

	Functions	X	Infrastructure	X	Behavior
Renewable Energy(RE)					• Decentralization by Rooftop Solar Energy in city • Electrification • Reliable and Affordable
X					
Energy Efficiency & Conservation					• Efficient Applications • Integration of architecture and energy saving equipments

Identifying Opportunities in the e-Mobility Sector



AG Board members

Name	Dr. Shoichi KOBAYASHI	Mr. Tomonori KIMURA	Mr. Koji TERADA	Mr. Yasuo IZUMI
				
Job Title	Chairman	CEO	CFO	Auditor
Another Office	CEO and Chairman of JDI	Senior Partner of JDI	Managing Director of Forval	Vice Chairman of JDI

Summary of Asian Gateway Corporation

Item	Corporate Profile of AG
Company Name	Asian Gateway Corporation
Establishment	March 10th, 2015
Board members	Dr. Shoichi KOBAYASHI (Chairman) Mr. Tomonori KIMURA (CEO) Mr. Koji TERADA (CFO) Mr. Yasuo IZUMI (Auditor)
Address	Itsuro Build. 5F, 3-7-2, Kanda Nishiki Cho, Chiyoda-ku, Tokyo 〒101-0054
Telephone	81-(0)3-5280-7707
Main Stockholders	JDI Forval Shin-Fuji Shoji
Subsidiary	To be incorporated in Cambodia soon

Company Logo and Colors

AG
AsianGateway

Contents

Asian Gateway (Cambodia) Corporation （AGCC)

Phnom Penh based.

Company name and Head office

Name

Asian Gateway (Cambodia) Corporation

To be established March of 2016

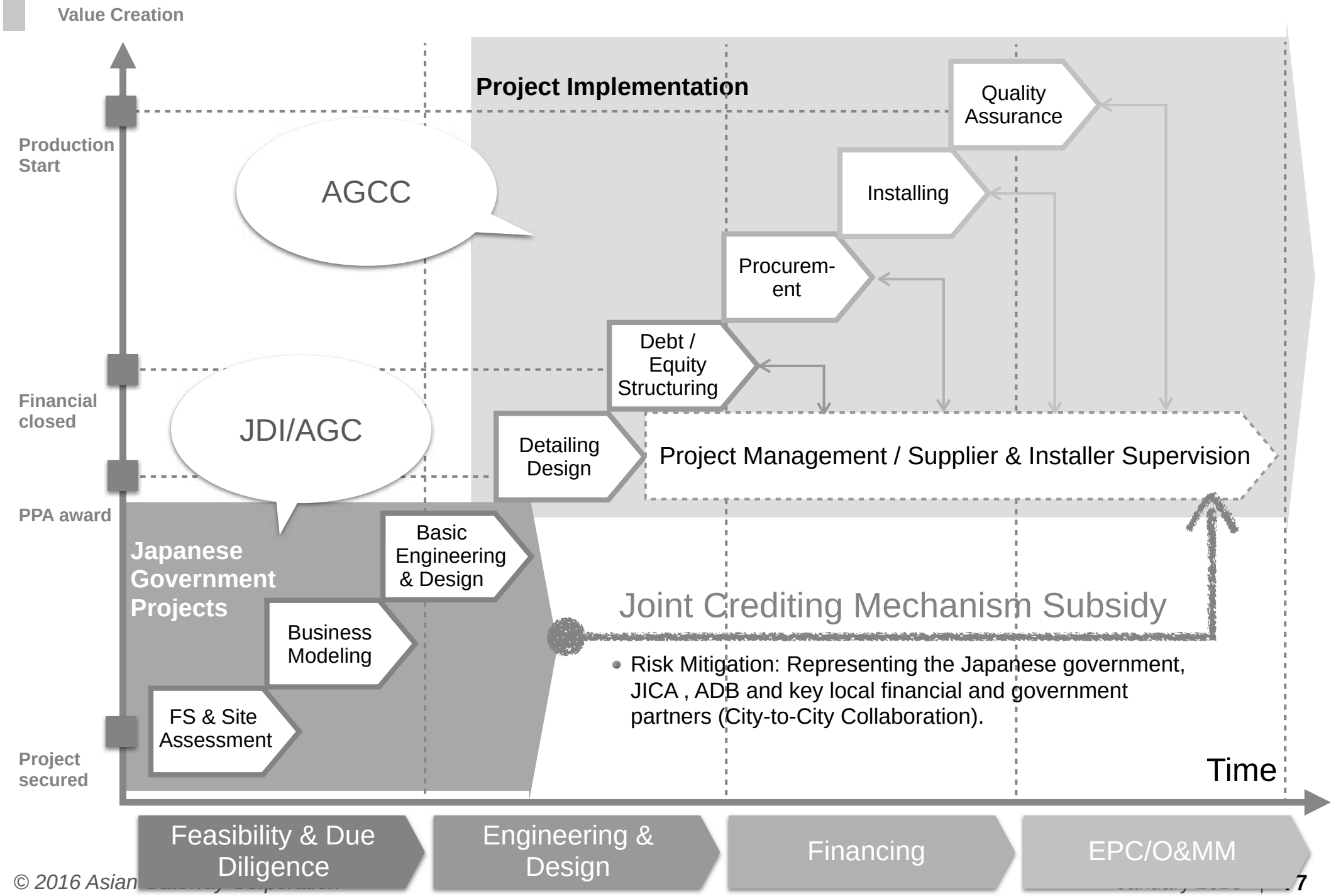
Head office
TBD

Company Logo

AsianGateway

Domain Name
@asiangateway.co.jp

Integrated approach captures the full project value

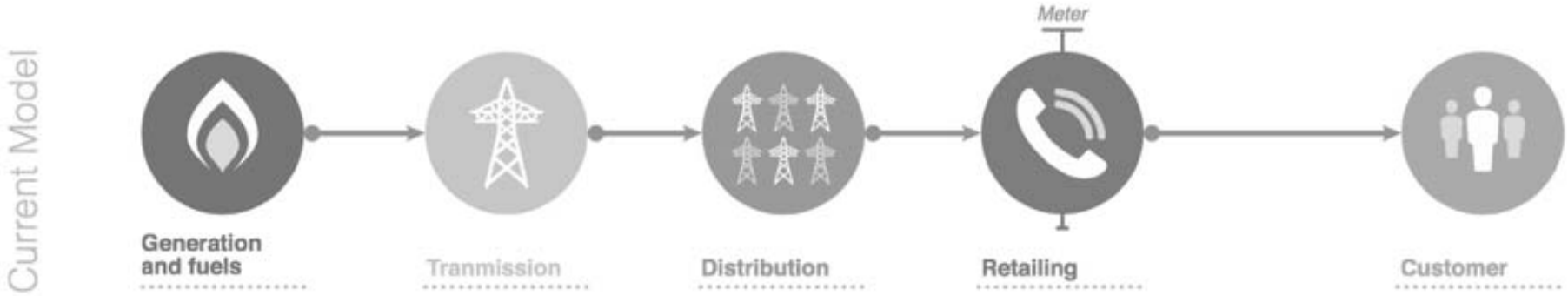


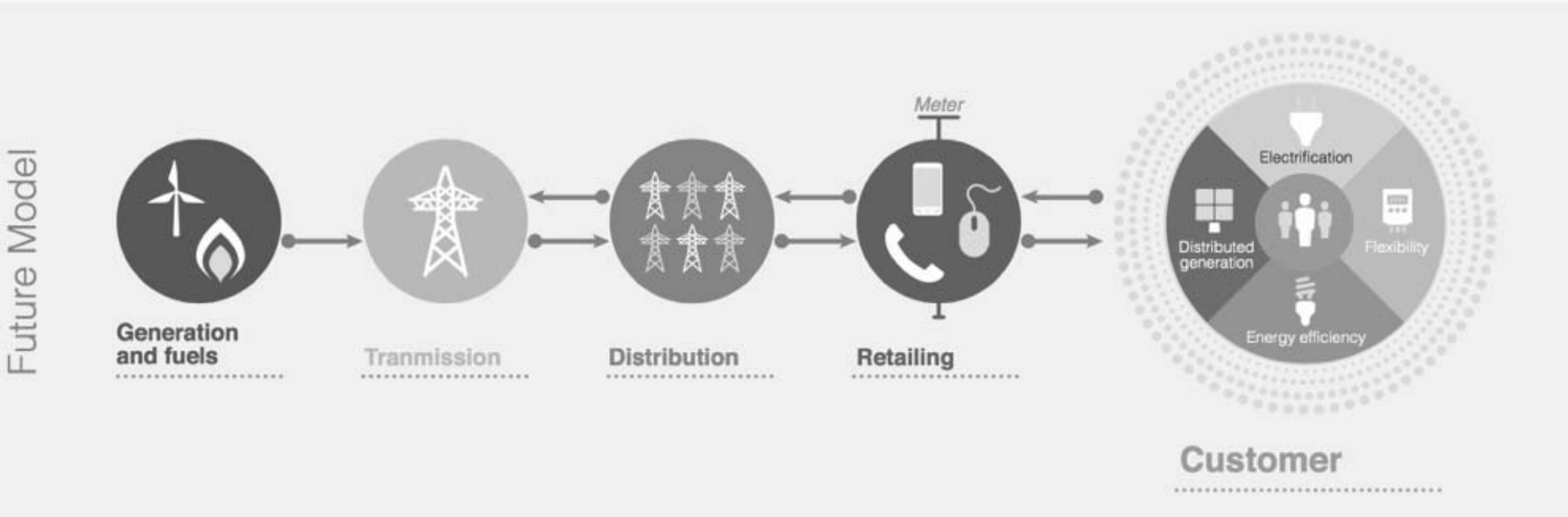
Contents

Energy Business by AGCC

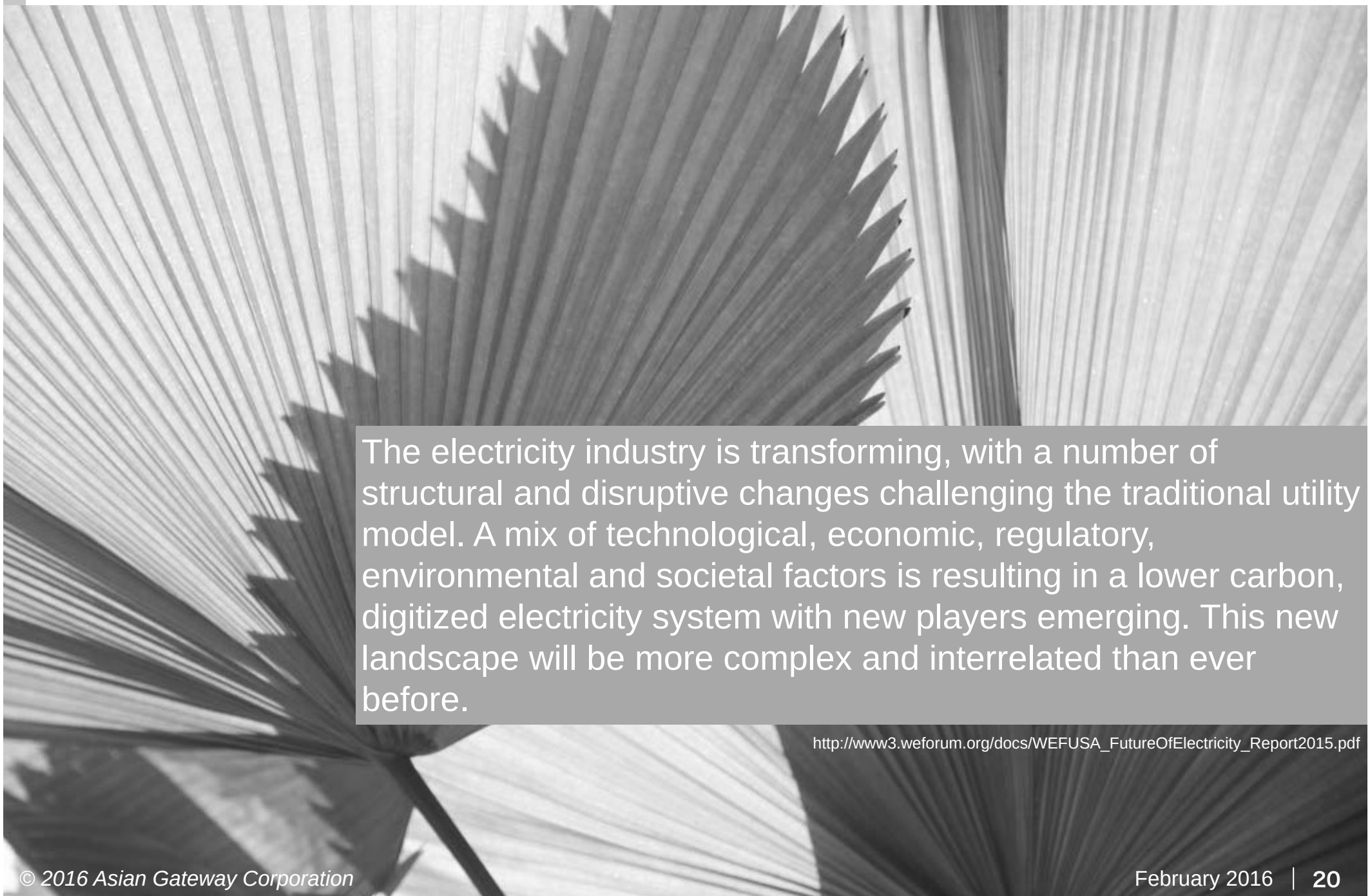
New business and investment models are required

New business and investment opportunities are emerging close to the customer





The Future of Electricity

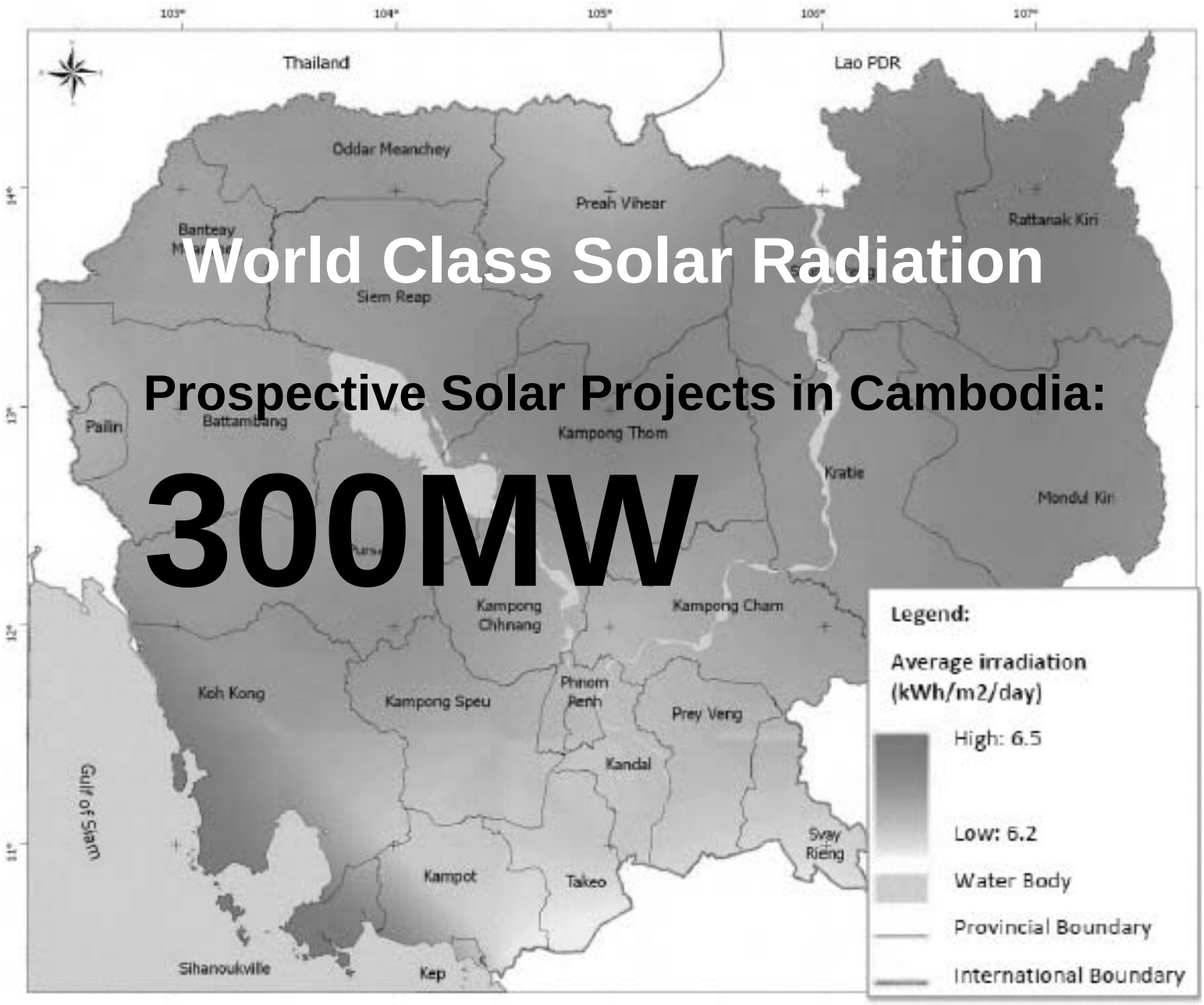


The electricity industry is transforming, with a number of structural and disruptive changes challenging the traditional utility model. A mix of technological, economic, regulatory, environmental and societal factors is resulting in a lower carbon, digitized electricity system with new players emerging. This new landscape will be more complex and interrelated than ever before.

http://www3.weforum.org/docs/WEFUSA_FutureOfElectricity_Report2015.pdf

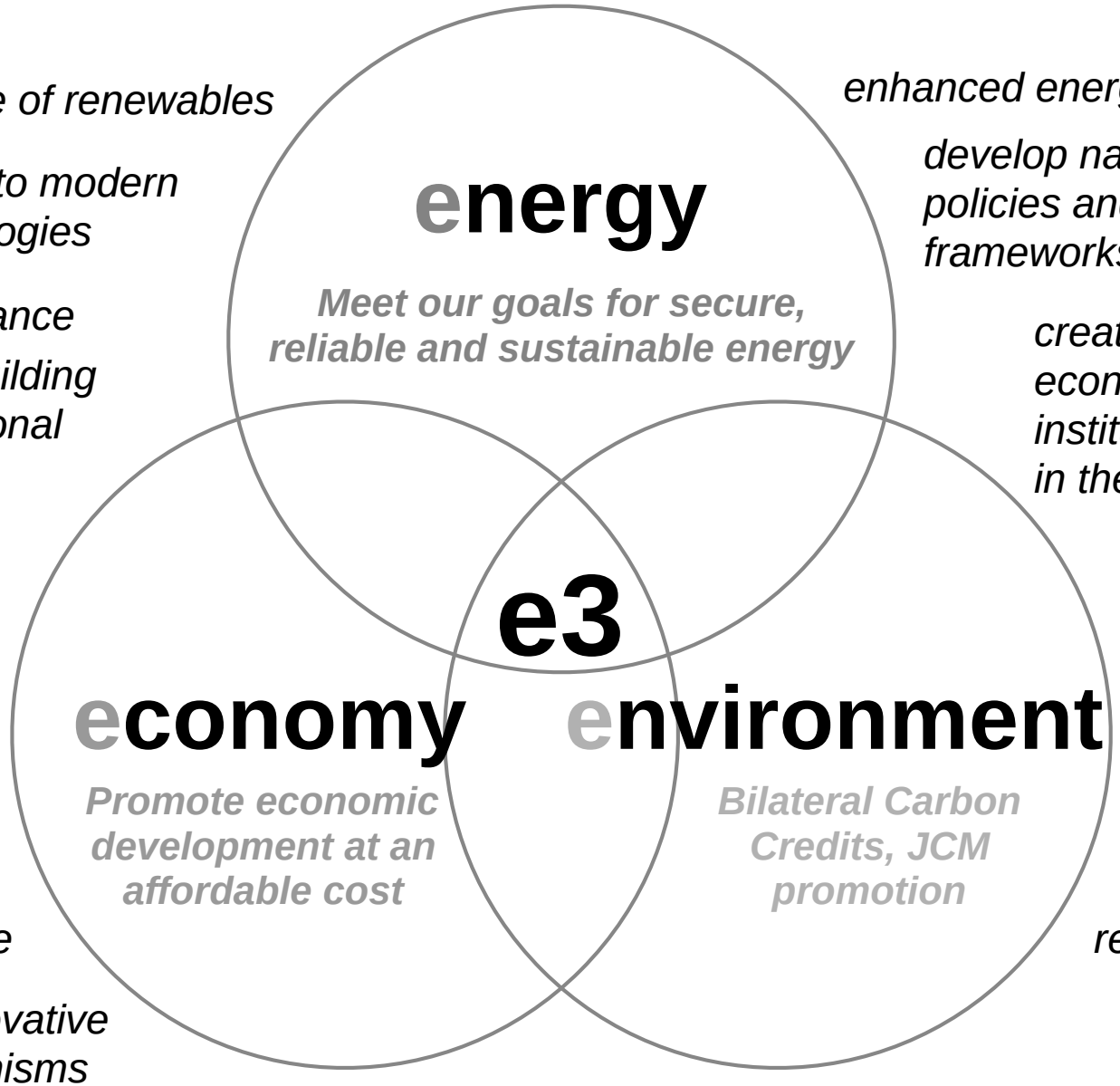
Why Develop Solar Energy Generating in Cambodia?

- High electricity tariffs
- Uncertain fossil fuel prices
- Low rates of electricity access
- Declining costs of solar PV



PV; Photovoltaic

AGCC provides “e3” solutions



increased use of renewables

improve access to modern biomass technologies

technological assistance

develop capacity-building at national and regional level

promote public-private partnership

improve access to reliable, affordable, economically value, socially acceptable and environmentally sound energy service

financial and innovative financing mechanisms

enhanced energy efficiency

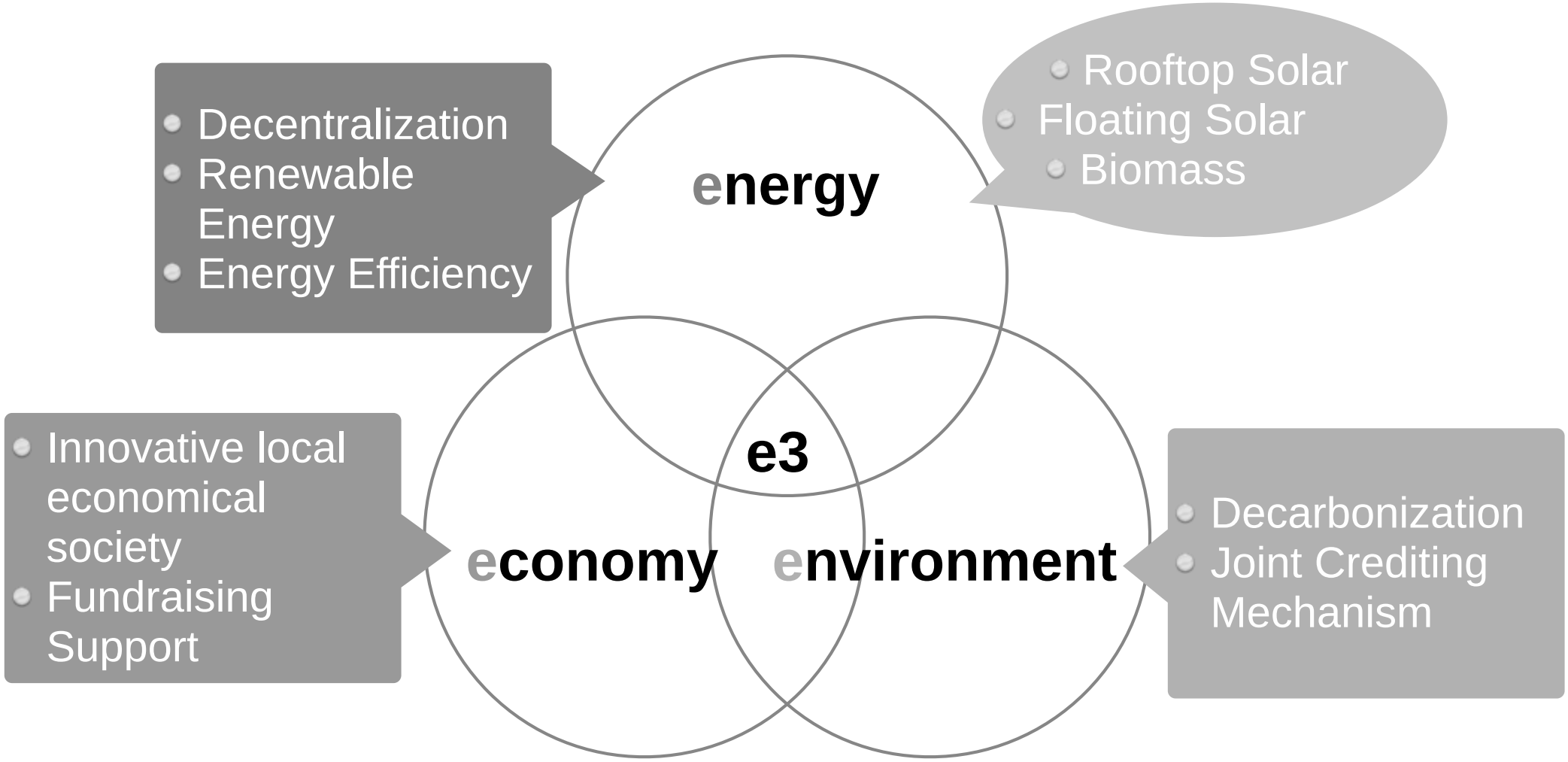
develop national energy policies and regulatory frameworks

create the necessary economic, social and institutional conditions in the energy sector

provide environmentally sound technology transfer

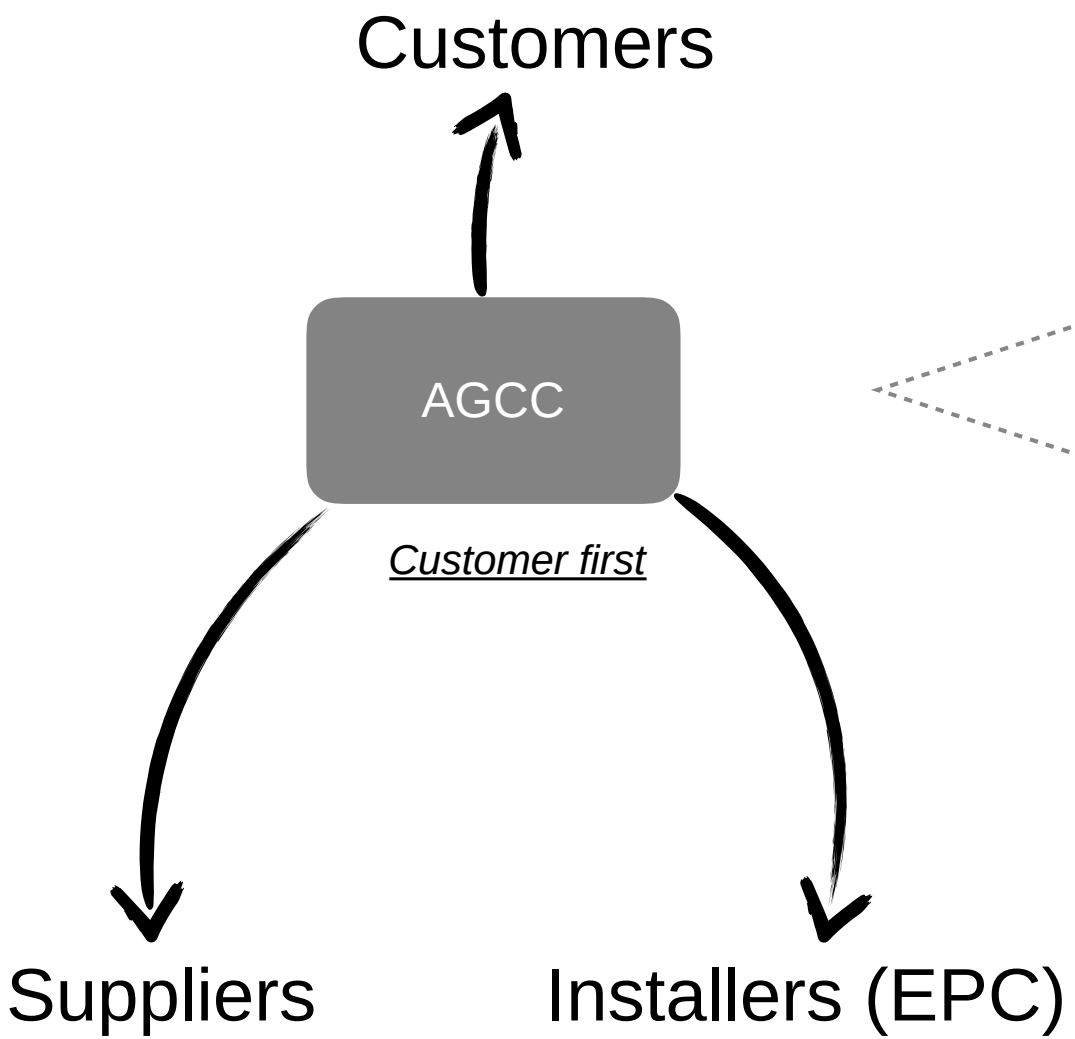
reducing pollution

AGCC's valuable services



AGCC is an independent energy integrator and orchestrator using Japanese technologies from a base in Cambodia.

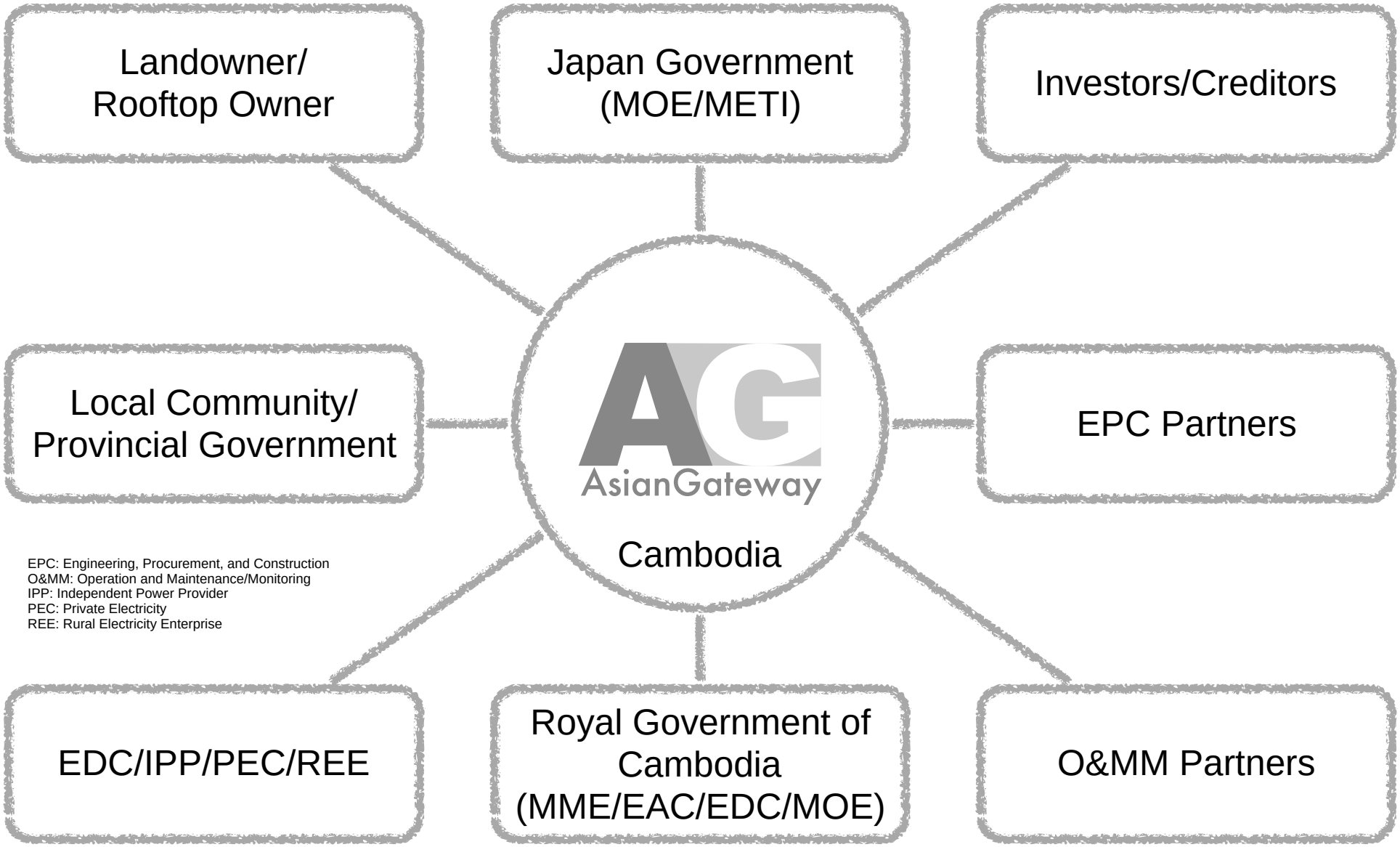
AGCC standpoint and advantages



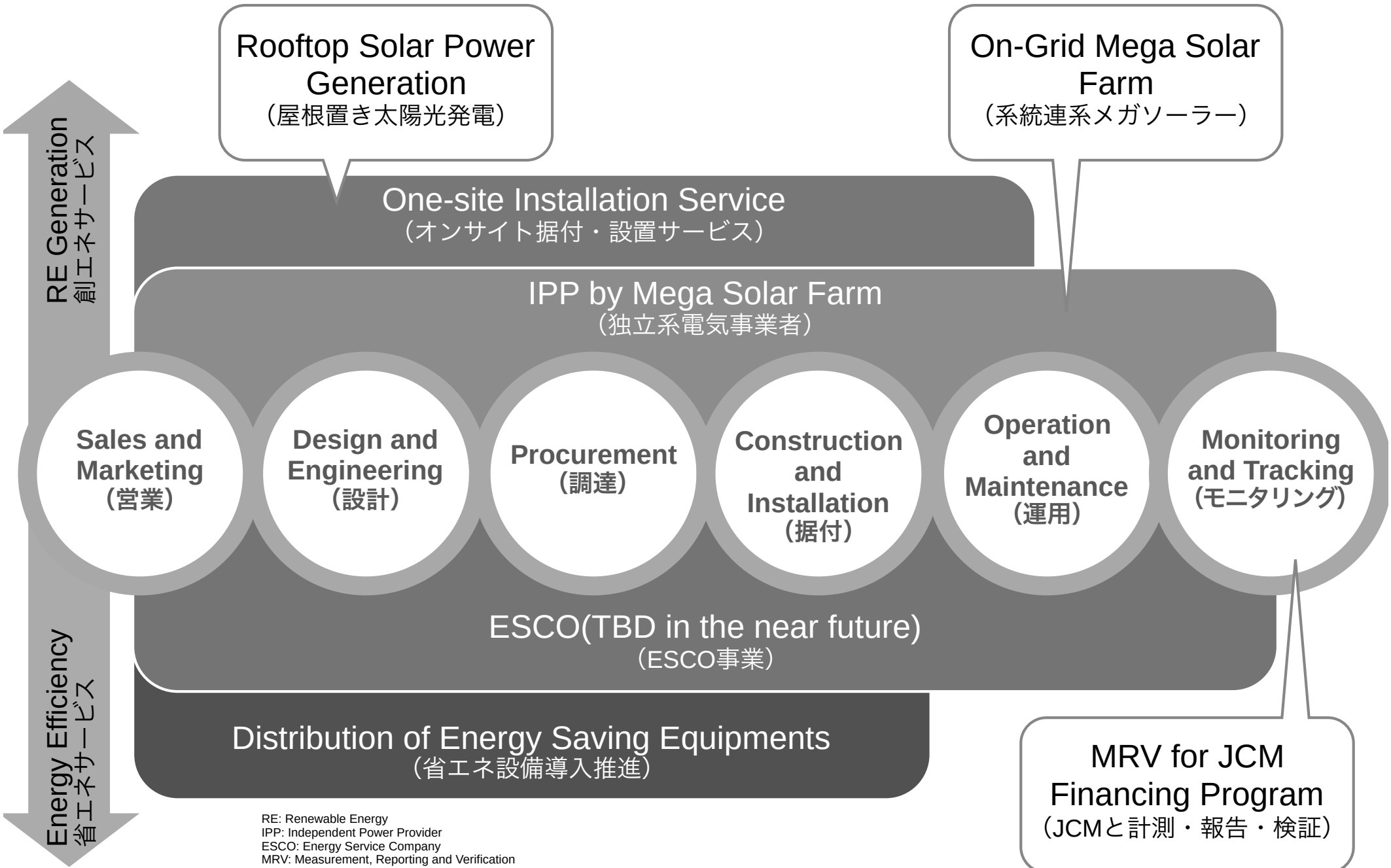
- **Consulting**
- **Joint Crediting Mechanism**
- **Government Relationship**
- **PPP Initiative**
- **Technological Assistant**
- **Select local installers**
- **Interventions**
- **Trading and Transfer Japanese Technologies**
- **Project Management (Project implementation progress)**
- **EPC's construction supervision program**
- **EMS**

Positioning of AGC Cambodia

Orchestration by AGC Cambodia from planning to operation.



Energy Service

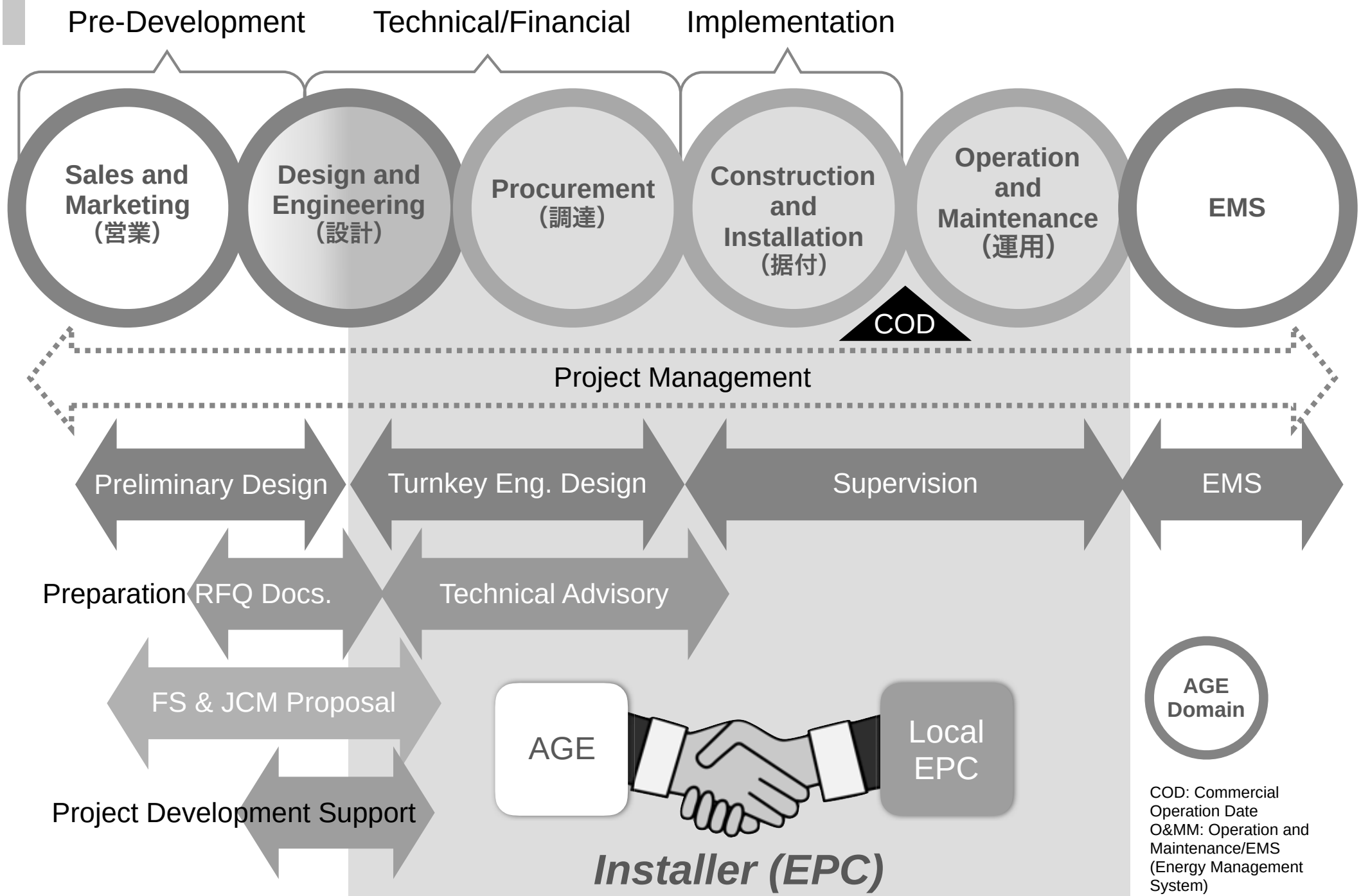


RE: Renewable Energy
IPP: Independent Power Provider
ESCO: Energy Service Company
MRV: Measurement, Reporting and Verification
JCM: Joint Crediting Mechanism
TBD: To Be Decided

Our target Solar Power Generation Sites

Installation Site	Commercial	Utility-scale	Residential
Rooftop	• Hotels • Hospitals • Schools • Factories • Shopping Malls • District Centers • Restaurants • Bus Stations • Banks	• Factories inside Special Economic Zones • Shopping Malls • Airports • Military Facilities • Government buildings	Not applicable below 200kW
Floating	• Factories • District areas	• Pondage • Reservoir • Lakes • Dums	Not applicable below 200kW
Ground-mounted	• Used golf courses • Idle places	• Wastelands • Sharing Solar with agriculture	Not applicable below 200kW

AGE's Service Scheme for Solar Projects



COD: Commercial Operation Date
O&MM: Operation and Maintenance/EMS (Energy Management System)

Value Chain and Strategic Partnership

Self-Financing/ Solar Leasing

- Solar System Owner

Electricity Reseller (Off-Taker)

PPA

IPP (Third Party Ownership)

- Owns Facility Management
- Generation electric power for sale to utility and end users with PPA
- Community Energy Management

AGC's domain

Local Partner

Integration Service*

- Equipment Commission and Test
- Cost Trend Analysis
- Capability Building
- Stakeholder Management, including users, and government,
- Procurement
- etc.

EPC

- Detailed Engineering
- Procurement and Logistics with Integration Servicer
- Importing
- Construction and Installation
- Assignment of local workforce

O&M

- Operation
- Maintenance
- Monitoring the project variables (cost, electricity generation, etc.) against the project performance baseline

EMS

- Performance Monitoring and Controlling

* Regard to the Integration Service, AGC needs local partner's assistants, especially to guarantee long term warranty of solar system as required.

Project Mangement / Supervision / MRV

- Creating the Work Breakdown Structure (WBS)
- Construction Management
- Cost Engineering
- Project Workforce Management
- Management and Monitoring of Construction Process
- Scheduled Analysis and Optimization
- Operational and Maintenance Review
- Measurement, Reporting and Verification (MRV) of JCM program

Consulting Service

- Project Evaluation, Feasibility and Planning
- Offering JCM and organizing International Consortium
- Preliminary Design and Engineering
- Financing Analysis of the costs and benefits including a budget (Annual Electricity Cost Savings Analysis)
- Risk-profile Analysis

AGC: Asian Gateway Corporation
IPP: Independent Power Provider
PPA: Power Purchase Agreement
EPC: Engineering, Procurement, and Construction
O&M: Operation and Maintenance
EMS: Energy Management System
MRV: Measurement, Reporting and Verification
JCM: Joint Crediting Mechanism

Mobility Service

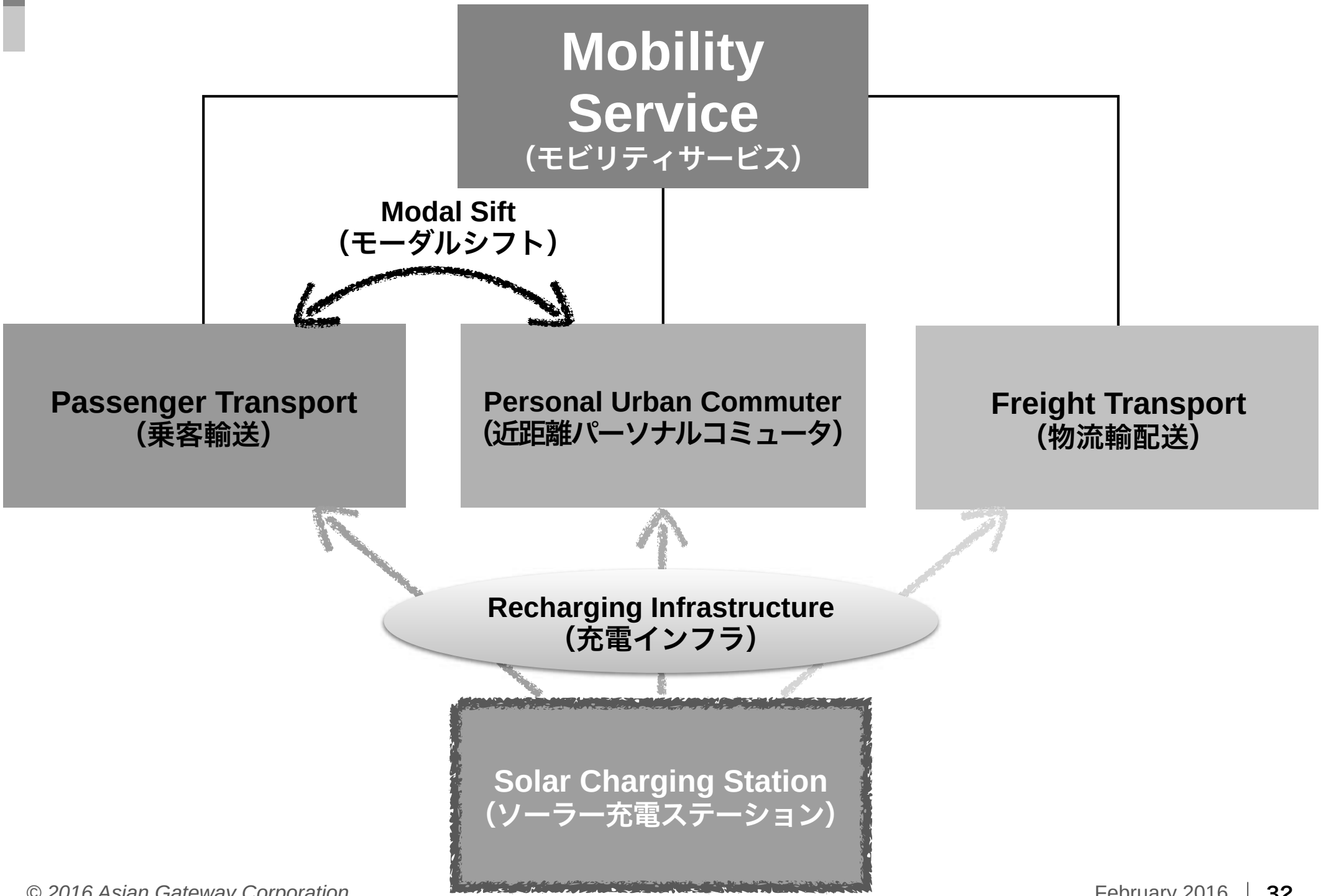
The Future of Transportation

- **Low Carbon Transport Service**
- **Using Electric Vehicles**
- **Reduce Traffic Congestion by Fleet management**

The power that drives vehicles will transition from oil to electric and later to binary power. Electri vehicles will start to make major market inroads around 2015 because of improved battery technologies and because of the fact that the electric infrastructure is already in place for rapid “refueling”. Hydrogen will make some inroads but will not become anything more than a niche industry.

By 2050 oil and gas will remain plentiful as demand drops precipitously with the emergence of alternative sources. Oil & gas will remain as an energy source, but will only be used in niche industries.

Mobility Service and Solar Charging Station



Basis for targeted numbers of Reumork Motos

No. of International Tourists Arrivals in Siem Reap

- Year-over-Year Growth Rate of International Tourist is 5% from 2015 to 2020

Ratio of International Tourists to use a Reumork Moto

- 33 % of International Tourists who use a Reumork Moto as a billable unit, based on our traffic volume survey.
- Average is 2 passengers for Reumork Moto

Market Share of Reumork Moto in billable units by AG Cambodia

- 20 % available because of closed relationship with CLC-CIWA/CCDA, CHA, and CATA

Our Vision of Angkor Mobility Service

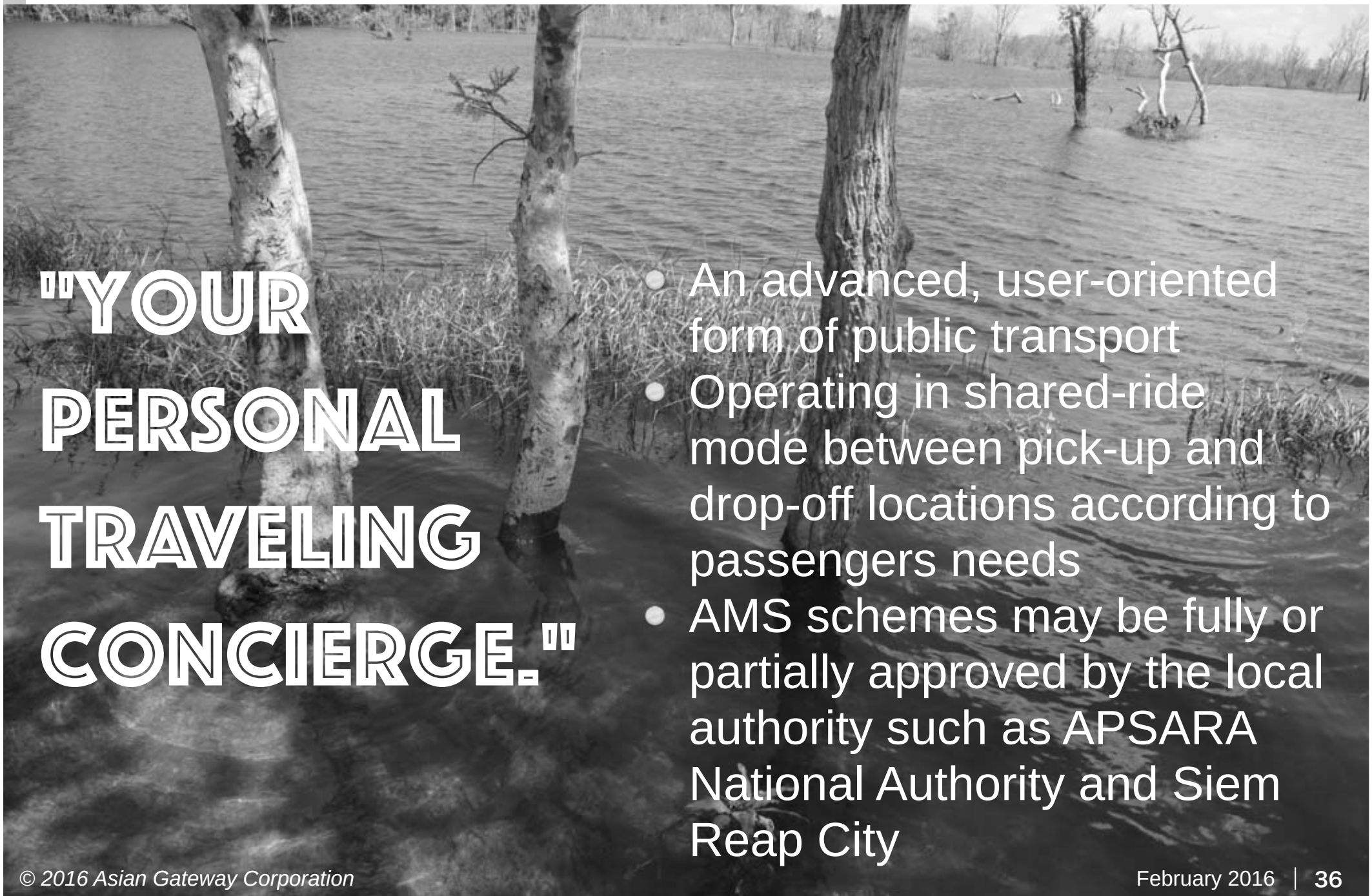
- ✓ **Improve the Angkor tourism experience with better mobility and less congestion.**
- ✓ **Reduce negative impacts on Angkor Heritage Park.**
- ✓ **Social contributions for current Reumork Moto drivers are lower fuel costs and higher income.**

Target-generated objectives for “Eco Mobility” as following key points are examining and making solutions by Japanese JCM (Joint Crediting Mechanism) Team in 2014;

AMS will be a main Angkor tourist attraction.

Special Experience Just For You!

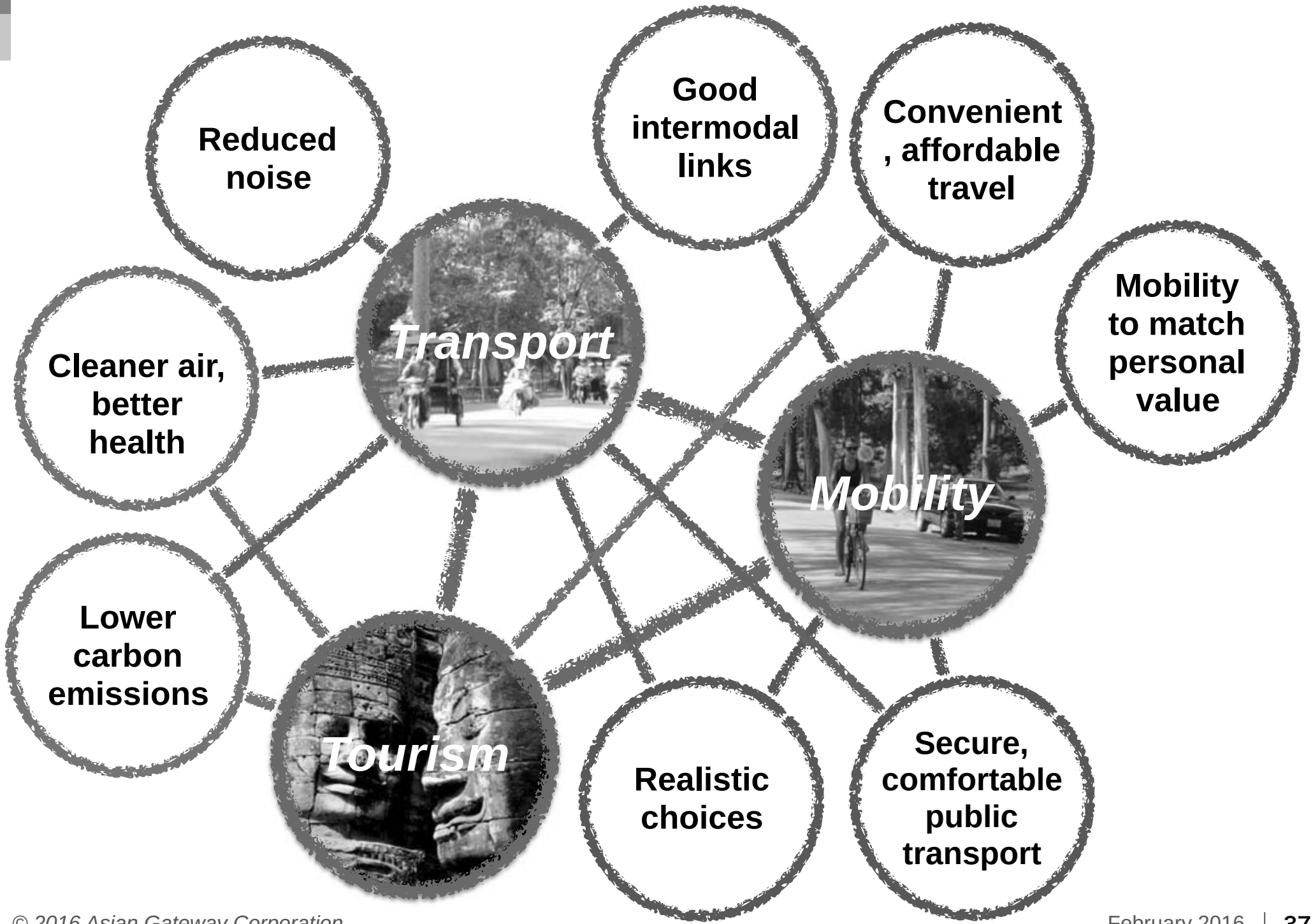
AMS is the "Demand Responsive Mobility" Service



"YOUR PERSONAL TRAVELING CONCIERGE."

- An advanced, user-oriented form of public transport
- Operating in shared-ride mode between pick-up and drop-off locations according to passengers needs
- AMS schemes may be fully or partially approved by the local authority such as APSARA National Authority and Siem Reap City

Objectives of Angkor Mobility Service



Eco Mobility to promote e-Moto Reumork

Gasoline traditional model

Pure electric base

Driving distance per US$1 of fuel

22km

Driving distance per US$1 electric charge

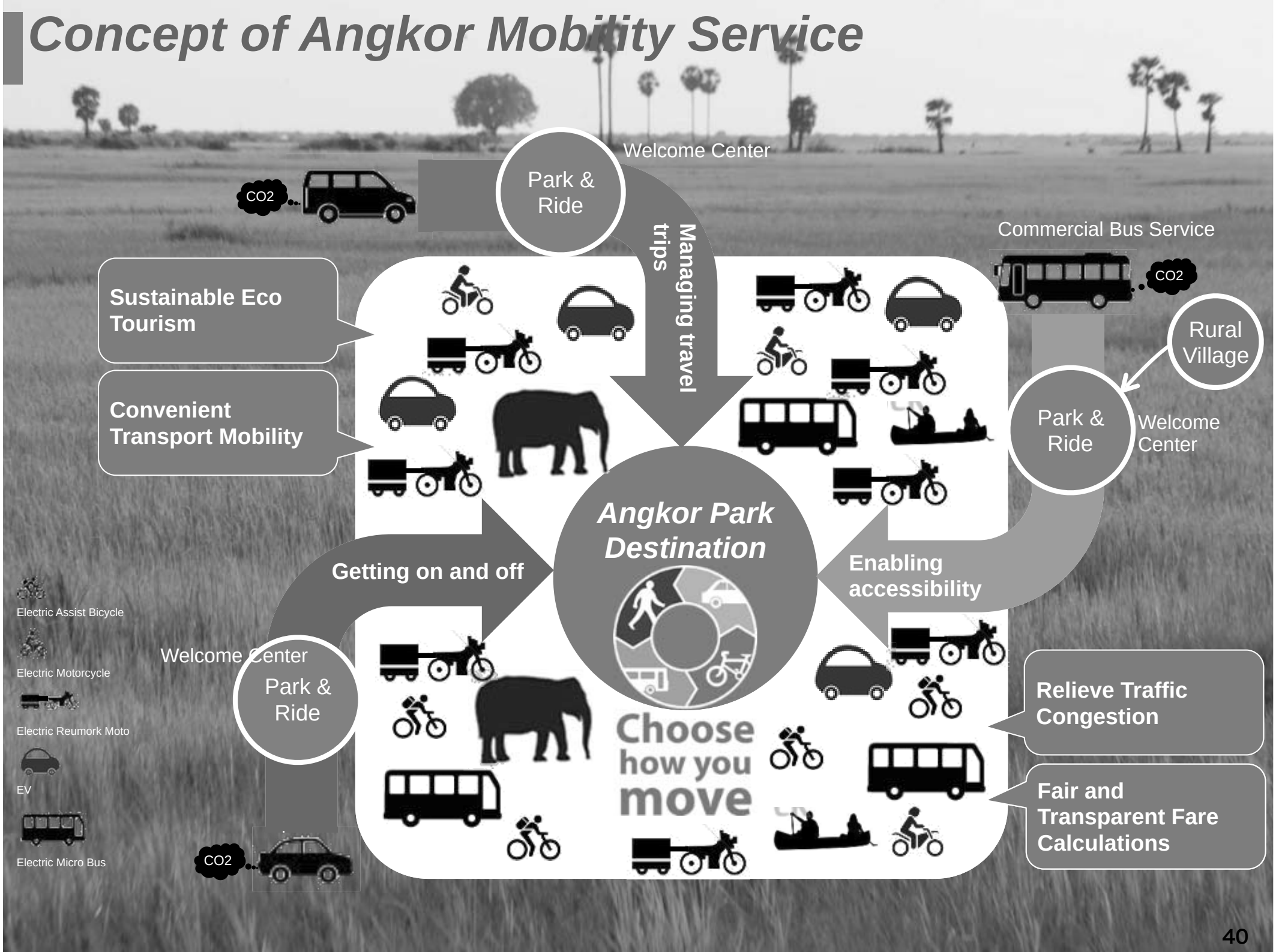
120km

AMS is "Simple, Safe, delightful"

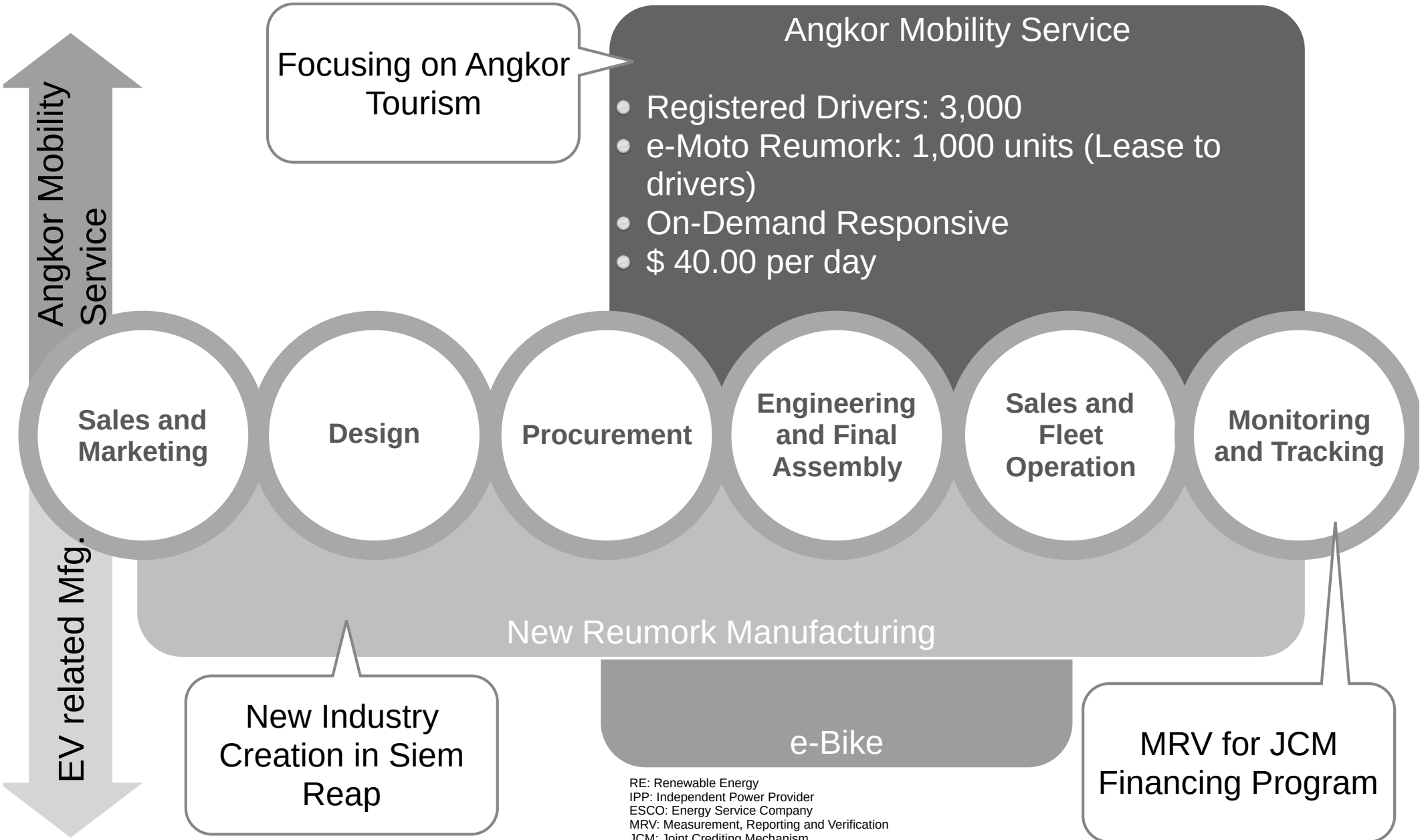
Angkor Mobility Service (AMS) is a simple, safe, and delightful way to experience the Angkor Complex.

Improve the Angkor tourism experience with better mobility and less congestion.

Concept of Angkor Mobility Service



Mobility Service



RE: Renewable Energy
IPP: Independent Power Provider
ESCO: Energy Service Company
MRV: Measurement, Reporting and Verification
JCM: Joint Crediting Mechanism

We would like to hear from you and answer any questions that you might have.
kimura@asiangateway.co.jp