Fiscal Year 2016
JCM Project Formulation Study for Realizing Low Carbon Cities in Asia
(Project for Installing photovoltaic (PV) modules on Rental rooftops of public high school through the Joint Crediting Mechanism in Siem Reap)

Final Report

March 2017

Japan Development Institute Ltd.
Asian Gateway Corporation

<u>**Table of Contents**</u>

Table of Contents 2

List of Tables and Figures 6

Abbreviation 10

Summary 11

Main Report 17

1. Overview of Cambodia 18

1.1. General Situation 18

1.1.1. Political Situation 18

1.1.2. Economic Situation 18

1.1.3. Power situation 19

1.2. Energy Policy 25

1.2.1. Energy Policy 25

1.2.2. Energy Mix 26

1.2.3. Pricing Policy 28

1.3. Policy on Climate Change 29

1.3.1. Related policy and plan 29

1.3.2. Related organizational structure 32

1.3.3. Policy for renewable energy business promotion 33

2. Survey outline 35

2.1. Survey background and objective 35

2.1.1. Survey background 35

2.1.2. Survey Objective 37

2.2. Survey item and methodology 38

2.2.1. Survey item 38

2.2.2. Survey method and Survey outline 40

2.2.3. Survey Implementation Arrangement 48

2.2.4. Survey Schedule 49

3. Study for Power Generation Business by Community Solar 53

3.1. Next Action and Result of Market Research for Community Solar 53

3.2. Market research of the rooftop solar system......54
3.2.1. Market of the industrial rooftop solar......54
3.2.2. A-Hotel......54
3.2.2.1. Overview about A-Hotel......52
3.2.2.2. Lord Consumption......53
3.2.2.3. Power Consumption......53
3.2.2.4. PV Solar Design and Installation......56
3.2.2.5. Specification of PV module......57
3.2.2.6. Financial Plan......59
3.2.2.7. Energy Efficiency......60
3.2.2.8. CO2 Emission Reduction......62
3.2.3. B-Hotel......65
3.2.3.1. Overview about B-Hotel......65
3.2.3.2. Power Consumption......63
3.2.3.3. Solar Concept Design......64
3.2.3.4. Power Generation from Solar energy......65
3.2.3.5. Financial Plan of the project......67
3.2.3.6. CO2 Emission Reduction......68
3.2.4. A-Factory......70
3.2.4.1. Overview about A-Factory......70
3.2.4.2. Company energy Demand......70
3.2.4.3. Available roof Space......74
3.2.4.4. Specification of Sharp panel......74
3.2.4.5. PV system sizing......76
3.2.4.6. Estimate Energy Generation......77
3.2.4.7. Financial plan......77
3.2.4.8. Saving......**78**
3.2.4.9. CO2 reduction......78
3.2.5. B-Factory......
3.2.5.1.Overview of the B-Factory......80
3.2.5.2. Company Energy Demand......81
3.2.5.3.Available Roof Space......82
3.2.5.4. Specification of Sharp panel......83

3.2.5.5. PV system sizing 85
3.2.5.6. Estimate Energy Generation 86
3.2.5.7. Financial plan 87
3.2.5.8. Saving 88
3.2.5.9. CO2 reduction **88**
3.2.6. C-Factory 87
3.2.6.1. Overview about C-factory 87
3.2.6.2. Energy Demand **90**
3.2.6.3. Available roof space 91
3.2.6.4. Specification of Sharp panel 92
3.2.6.5. PV system sizing **93**
3.2.6.6. Estimate Energy Generation 94
3.2.6.7. Financial plan 95
3.2.6.8. Electricity Saving **96**
3.2.6.9. CO2 reduction **96**
3.3. Technical characteristics and superiority of the rooftop solar PV modules 96
3.3.1. Ultra-lightweight solar panel “Lightjoule” 96
3.3.2. Glass Integrated PV Solution SUNJOULE 99
3.4. Establishment of the subsidiary in Cambodia 107
3.4.1. Business plan 107
3.4.2. Risks and Analysis 108
3.5. Building a MRV Methodology for rooftop PVs 108
3.5.1. The scope of application 108
3.5.2 Eligibility criteria 108
3.5.3. Reference emissions 109
3.5.4. Project emissions 109
3.5.5. Calculation method for GHGs emissions reduction 109
3.5.6. Monitoring method 110
3.6. Economic effects 110
3.6.1. Effects of Introducing Rooftop PVs 110
3.6.2. Other economic effects 114
4. Significance and Action Policy of City to City Cooperation Between

Kanagawa Prefecture and Siem Reap Province.. 117
4.1. Purpose of City to City Cooperation.. 117
4.2. Capacity Building 117
4.2.1. Invitation to Japan.. 117
4.2.2. Workshop in Cambodia.. 117
4.2.3. Presentation at High Level Seminar on Environmentally Sustainable Cities in Kitakyushu, Japan 117
4.3. Action Policy in Future.. 118
5. Policy Proposals 119

List of Tables and Figures

List of Tables

Table 1-1：Power generation development plan in Cambodia 21
Table 1-2：Power demand forecast in Cambodia 24
Table 1-3：Plan for Reduction of Prices and Price Gap for Large Commercial and Industrial Usage (Unit: US$/kWh)..29
Table 1-4：Summary of CCCSP 30
Table 1-5：Mitigation actions in key sectors – aggregate reductions by 2030 31
Table 2-1 : Survey Implementation List 50
Table 3-1 : Primary Design of Solar System at Hotel-A 57
Table 3-2 : Mechanical Data of PV Module Panel 57
Table 3-3 : Electrical Data of PV Module Panel...58
Table 3-4 : Upper Limit of PV Module Panel...59
Table 3-5 : PPA by GY..60
Table 3-6 : Suggestion for installing as energy efficiency equipment from GY 61
Table 3-7 : the amount of CO2 reduction 62
Table 3-8 : Capacity of Solar after Design in Hotel-B...67
Table 3-9 : CO2 Emission Reduction 69
Table 3-10 : List of electric motors..71
Table 3-11 : Available roof space..72
Table 3-12 : Size of PV system...75
Table 3-13 : Monthly Averaged Insolation Incident on Horizontal Surface 75
Table 3-14 : Estimated Financial Investment...76
Table 3-15 : Annual Savings...76
Table 3-16 : CO2 Reduction 77
Table 3-17 : List of electric motors of the current plant 89
Table 3-18 : List of electric motors for the future plant...80
Table 3-19 : Available Roof Space...81
Table 3-20 : Size of PV system proposed 84
Table 3-21 : Monthly Averaged Insolation Incident on Horizontal Surface 84
Table 3-22 : Estimated Financial Investment...85
Table 3-23 : Annual Financial Saving...86

Table 3-24 : Annual CO2 Reduction....86
Table 3-25 : Estimated energy consumption per day....89
Table 3-26 : Size of PV system proposed....92
Table 3-27 : Monthly Averaged Insolation Incident on Horizontal Surface....92
Table 3-28 : Estimated financial investment....93
Table 3-29 : Annual financial saving....94
Table 3-30 : Annual CO2 reduction....94
Table 3-31 : Default value for calculating reference emissions....107
Table 3-32 : Values to be monitored and monitoring method....108
Table 3-33：Result of Balance simulation....113
Table 3-34：Result of Annual operation simulation....114
Table 3-35：Total project cost (not including VAT)....115

List of Figures

Figure 1-1：Trend of GDP growth and FDI inflow....17
Figure 1-2：Electricity tariffs in Cambodia and ASEAN neighbors....20
Figure 1-3：Electricity supply in Cambodia....20
Figure 1-4： Power Supply Trend....21
Figure 1-5：Power generated by energy sources....20
Figure 1-6：Breakdown of Installed Power....21
Figure 1-7：Sector wise electricity consumption....24
Figure 1-8：Electricity Consumption....25
Figure 1-9：Outlook of electricity supply and the energy mix by 2030 (GWh)....26
Figure 1-10：Complementally Energy mix of renewable energy....27
Figure 1-11：Regional solar irradiation....28
Figure 1-12：Potential suitable area for solar....28
Figure 1-13：Strategy for Low Carbon Strategy in Cambodia....30
Figure 1-14：NCSD formation....31
Figure 2-1 : Siem Reap Province Map and Main Focusing Area....33
Figure 2-2 : Area Map....39
Figure 2-3 : the potential for solar power system in Cambodia....40
Figure 2-4 : the speed to become popular for solar power in Cambodia....40
Figure 2-5 : the list for the Mega solar in Cambodia....41

Figure 2-6 : Khmer architectural 5 star hotel....41
Figure 2-7 : Methodology for the research....43
Figure 2-8 : outline for the research....43
Figure 2-9 : Implementation arrangement....47
Figure 3-1 : Hotel-A in Siem Reap Province....52
Figure 3-2 : Main Building of Hotel-A....53
Figure 3-3 : Electrical room in Hotel-A....53
Figure 3-4 : Monthly Consumption from the Grid EDC....54
Figure 3-5 : The Concept of Solar Configuration....56
Figure 3-6 : Primary Design of PV Solar Module on rooftop of Hotel-A....56
Figure 3-7 : Hotel-B....62
Figure 3-8 : Backup Generator Room at Hotel-B....63
Figure 3-9 : Power from grid step down by Transformer in Hotel-B....64
Figure 3-10 : Concept design of Power System in Hotel-B....65
Figure 3-11 : Yellow color is available space for installation PV module....66
Figure 3-12 : Structure of attic....66
Figure 3-13 : Part of flat rooftop available to install PV Module....67
Figure 3-14 : Inside of Factory-A....70
Figure 3-15 : Compressor with the rated power of 150kw....71
Figure 3-16 : New plant is being constructed....72
Figure 3-17 : Panel Specification....73
Figure 3-18 : Panel Specification....74
Figure 3-19 : Estimated energy production from PV....75
Figure 3-20 : Factory-B....78
Figure 3-21 : Brick Production Line....79
Figure 3-22 : Roof space available....81
Figure 3-23 : Panel Specification....82
Figure 3-24 : Panel Specification....83
Figure 3-25 : Estimated Energy Production from PV....84
Figure 3-26 : Village A....87
Figure 3-27 : Container Hydroponics Plant 3D and 2D view....88
Figure 3-28 : 3D view of Container Hydroponics plant....88
Figure 3-29 : Top view of the plant with PV panels....89

Figure 3-30 : Solar panel..90
Figure 3-31 : Panel Specification...91
Figure 3-32 : Estimated energy production from PV...92
Figure 3-33 : Structure of Lightjule..95
Figure 3-34 : Weight of PV module and load capacity per 1 ㎡...96
Figure 3-35 : Specification of ultra light weight module Lightdule...97
Figure 3-36 : Structure of SUNJOULE..99
Figure 3-37 : Comparison between SUDARE and crystalline cells...100
Figure 3-38 : Reference of SUDARE..101
Figure 3-39 : Installation Reference of SUNJOULE at school...102
Figure 3-40：Panel layout for C-Hotel...111
Figure3-41：Power generation simulation of Building ① (600 PV panels)..........................112
Figure 3-42：Power generation simulation of Building ② (256 PV panels) Based on the above generation results, the result of a balance simulations is shown below. 113
Figure 3-43：Estimation of balance of payments..116

Abbreviation

AGC	Asian Gateway Corporation
BIPV	Building-Integrated Photovoltaic
C2CC	City-to-City Collaboration
CDM	Clean Development Mechanism
EDC	Electricite Du Cambodge
EPC	Engineering、Procurement and Construction
IPP	Independent Power Producer
ISPP	International School of Phnom Penh
JCM	Joint Crediting Mechanism
LCOE	Levelized Cost of Electricity
O&MM	Operation and Maintenance, Monitoring
PPA	Power Purchase Agreement
WTE	Waste to Energy

Summary

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

The purpose of this study project was 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. Such collaboration would result in 'province-wide' emission reduction of CO2 coming from energy production sources. This will contribute directly to the protection of world heritage sites in the province through environmental conservation coincident with the development of a clean tourism city.

There were two objects of this study. The first object was to study the possibility and profitability of installing photovoltaic (PV) modules on rental rooftops of public high schools in Siem Reap city as a smart community project. The second was to study the suitability of installing biomass power generation using low carbon organic waste and rice husks, contributive to the reduction of urban waste. The study examined the possibility of constructing a show case resort village and hydroponic factory as zero-energy buildings with renewable energy technology, energy storage, and conservation in Siem Reap. The study also examined the possibility of collaboration with the "Eco-mobility (electric remork-motos (tuktuks)) project" implemented in FY2014, wherein 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 system interconnection of rooftop solar is the premise for rental rooftops of public high schools in Siem Reap city as a smart community project. With the cooperation of the Siem Reap government, we asked the EDC to offer us the allowance of the system interconnection. However, the EDC denied our request because the potential impact to the system's power network - overvoltage, lack of supply, power surges, frequency fluctuations, and concerns about adverse effects - have not been solved, technically, in the country. With the cooperation of ADB and AFD, the EDC has been carrying on the analysis of impact against the system interconnection since the end of

2016. After receiving the results of that analytic effort, the EDC may allow it during 2017 or 2018.

For these reasons, we are waiting for the announcement by the EDC before moving on to the introduction of rooftop PV which aims geographically distributed self-consumption. The results are mentioned below.

Also, we have studied the possibility and profitability of installing photovoltaic (PV) modules on rental rooftops of public high schools in Siem Reap city, the relevant project on which the Kanagawa prefectural government has been focused. Targeted public high schools understand the purpose of community solar, and, ensure that it is possible to get approval of commercially active rental rooftops with the cooperation of government.

Considering the above situations, and, upon approval of the EDC, AG carries on the JCM subsidy projects, initially, with 5-star hotels, then our aim is for distributed-generation in community-based, self-consumption solar systems and rented rooftop solar systems.

2) The preparation works have been done for applying the JCM subsidy projects with two 5-star hotels in Siem Reap city (A-Hotel and B-Hotel), two factories and an eco village. Those projects are ready to apply for “the Financing Program 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 two 5-star hotels, two factories and eco village (self consumption)
Content of JCM projects	The EPC and O&M for the rooftop PV systems of 1.2 MW in total at the four hotels, factories and eco village are commissioned to a local partner company.
Intended technology	Rooftop PV systems and BIPV
Approximate project cost	Approximately JPY 2.2 million ※USD1.2/ Wp (not including VAT) is assumed.

MRV methodology	A Draft Methodology for PV systems (see Appendix 1)
GHG emission reduction effect	Approximately 1,300 tCO2e/year
Co-benefit	Saving of electricity cost by replacing diesel power generation and soundproofing measures

Generally, the owners of the land and building are different from the hotel management company (tenant). While the international 5-star hotels are separated especially, most of local 5-star and 4-star hotels have similar commercial structures.

Average electricity charge in Siem Reap is 0.18 – 0.20 USD/Kw - causing great financial oppression and consternation among hotel management companies. Therefore, there is a high demand for rooftop solar PV and energy conservation. Although 5-star hotels have been trying to save the cost of electricity by installing PV and high efficient chillers to GHG emissions, they can't afford the CAPEX of solar PV. It is a very attractive alternative for them to contract PPA. In order to offer PPA, however, it is necessary to establish an IPP. We have explored the possibility of establishing a Joint Venture with AGC and discussed about cooperation with eternal IPP such as 5 turnkey providers based in Japan, Europe, Thailand, and Singapore.

The flow of applying for "the Financing Program for Joint Crediting Mechanism (JCM) Model Projects in FY2015 was (1) IPP foundation by the turnkey provider, (2) the IPP carry out EPC and O&M at three hotels, factories, and eco village. Then we developed a business model of selling electricity for more than 20 years and promote the approach with energy conservation.

The eco village is located in the new developing area named Run Ta-Ek, about 33km away from Siem Reap city. The land is 1,012ha developed and managed by APSARA National Authority. The authority promotes residents living in Angkor heritage areas and the Siem Reap River basin to move to eco village and AGC has been conducting the program of job creation for improving their living standards. AGC has gotten the right of 2 ha-land-use of eco village from the authority and has been promoting the development of an indoor hydroponics factory using LED. AGC sets rooftop solar PV on the factory and prospects the development of Biomass plant which enables to distribute electricity to villagers.

3) In order to achieve a low carbon society in Asian countries based on C2CC and secure the Joint Crediting Mechanism for the long term, it is necessary to establish cooperation in Cambodia. As at February 2017, a subsidiary of AGC is under the procedure of registration. The goal AGCC aims is to achieve a low carbon society by promoting local production of energy and food for local consumption. The main task of AGC is consulting on international development and conducting surveys for the project of Ministry of Environment or Ministry of Economy, Trade and Industry. The subsidiary of AGC is the entity which conducts adjustment, management, supervision, and monitoring of the projects with the local EPC especially it's important to negotiate with turnkey providers.

4) There are some derived project plans such as the introduction of a ground-solar farm which generates 10MW in Kampong Thom, 3MW solar PV in Poi Pet SEZ, solar LED streetlights at the developing area in Phnom Penh city, and the introduction of a solar PV system into the Nokor Tep Women's Hospital which is under construction. AGC is considering applying for JCM in 2017.

5) The Siem Reap provincial government and Kanagawa prefectural government agreed the "Upper Tier City-to-City Collaboration (C2CC)" in November 2015. The Siem Reap provincial and city governments request Japanese and Kanagawa prefectural governments to support capacity building, formulation of a master plan and implementation of a pilot project officially. Both governments assigned the person in charge and two of them joined workshop in Japan twice this year and made presentations. They visited solar LED streetlights in Kanagawa, factories lending the rooftops, a Zero Energy Building, and Fintech facilities and participated in the international meeting related a JCM.

6) AGC promotes local production and local consumption in three ways. The first is solar PV and biomass power generation targeted hotels and governmental facilities as renewable energy, and, the second is Lithium ion battery energy storage. The last is

the introduction of BIPV, double glazing and high efficient air conditioners and lighting as energy conservation. The introduction of smart grid systems with system interconnection leads moderation of balance of energy demand. Also, AGC promotes Electrical mobility with charging source produced by renewable energy to tourists as local consumption following the existing model project of EV in Hakone town, Kamakura, and Yokohama city in Kanagawa prefecture. AGC visualizes and monitors the effect of renewable energy and energy conservation by introduction of IoT into hotels and governments. These projects promote preservation of Angkor heritage and activate local economics and, in particular, the tourism industry.

From FY2017, Kawasaki city will join as a member of C2CC. With electric remork-motos with three wheels (tuktuks) manufactured by Kawasaki-based ElecTrike Japan Co.,Ltd, AGC reexamines and expands 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. In addition, one of the Japanese major internet providers will examine the possibility of electric remork-motos manufactured by Japanese major manufacturers in 2017. Based on these two studies, AGC promotes the development of low-carbon transportation in Siem Reap.

Local production and local consumption of food concentrates on leaf vegetables. AGC established the indoor hydroponic factory using LED with a solar PV system as a Zero Energy facility. There are many factors of less cultivation of leaf vegetables such as the low level of PH, clay, heavy rain, strong radiation and high temperature in Cambodia. Then more than 90% are imported from Vietnam, China and Thailand. Despite the low market price, the quality and taste is bad. So that AGC cooperates with APSARA National Authority to improve the situation.

Considering above statements, AGC proposes three development projects for the Joint Crediting Mechanism in FY2017 as follows.

Eco mobility	The study of the possibility and profitability of electric remork-motos manufactured by the Japanese major internet providers, manufacturers and ElecTrike Japan Co., Ltd, and

	EV tourism with IoT technology
Buildings integrated renewable, storage and conservation energy	The study of the possibility and profitability of conducting energy saving diagnostics at 5-star hotels, introducing high efficiency chillers, and rooftop solar PV systems with cooperation of JASE-World and ECCJ. The construction of a show case with the technology of BIPV of ASAHI GLASS and standard PV for the development of resorts and proposals for legislation of environmental law.
Systematic disposals of urban waste transformed into energy	The problem of less inspection remained as FY2016 ended. With cooperation of HJA（Hayashida Japan Agriculture） which copes with recycling in Phnom Penh, AGC investigates the systems and the amounts of the reduction of GHG. In addition, AGC continues the study of FY2016 with Finetech Co., Ltd.

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

Economic situation in Cambodia has been growing stably despite of the long 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 at the same time of joining ASEAN and WTO. GDP growth rate recorded double-digit from 2004 to 2007, and continued to sustain strong growth of 6-7.4% since 2010 after the Lehman shock, and it is expected to maintain 7% in 2017[1]. Foreign direct investment (FDI) was dropped to $500 million in 2009, but made a quick recovery and reached to $1.7 billion in 2015[2]. It is expected that the elimination of tariff barriers by ASEAN free trade agreement will stimulate the regional economic activities.

---

[1] ADB Key Indicators Cambodia 2015

[2] World Development Indicators, The World Bank 2016

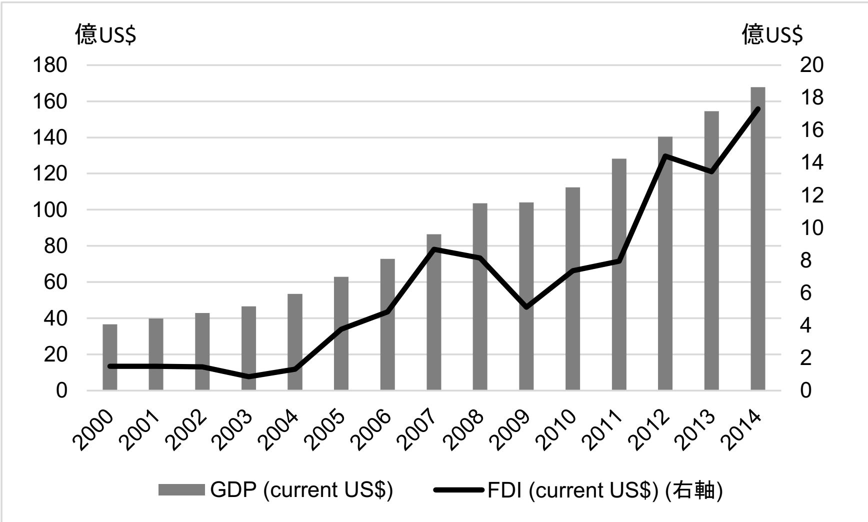


Figure 0-1：Trend of GDP growth and FDI inflow
(Source: World Development Indicators, World Bank 2015)

In terms of industrial composition of Cambodia, each sector accounts 28% for agriculture, 29% for manufacturing sector and 42% for service industry sector based on the GDP contribution[3]. From the investment view point, targeted sector for FDI has been diversified due to the shift of production area from neighboring countries to Cambodia. Not only the tourism and garment sectors, additionally automotive parts and agricultural processing sectors are getting more investment. However, tourism sector is still a driving force of Cambodian economy since 24.8% of the total investment was directed to tourism in 2014[4], and foreign visitors reached to more than 478 million people in 2015[5].

1.1.3. Power situation

Due to a strong economic development and stable 1.3% annual population growth, power demand in Cambodia is rapidly increasing in industrial sector and urban residential use. It has been increasing 20% every year since 2010, especially increasing of garment factory which consume huge amount of electricity is one of the main reason of this rapidly power demand increase in Cambodia. However, power infrastructure

3 Key Indicators for Asia and the Pacific, ADB 2016

4 JETRO World Trade Investment Report 2015

5 Ministry of Tourism Cambodia 2016

development in Cambodia is far from the sufficient compare to the neighboring countries. Especially limited capacity of power supply and under developed transmission and distribution network is a serious issue in Cambodia. Since a small diesel generation is the major source of power supply at non-grid connected area, the electricity tariff is high in the neighboring region.

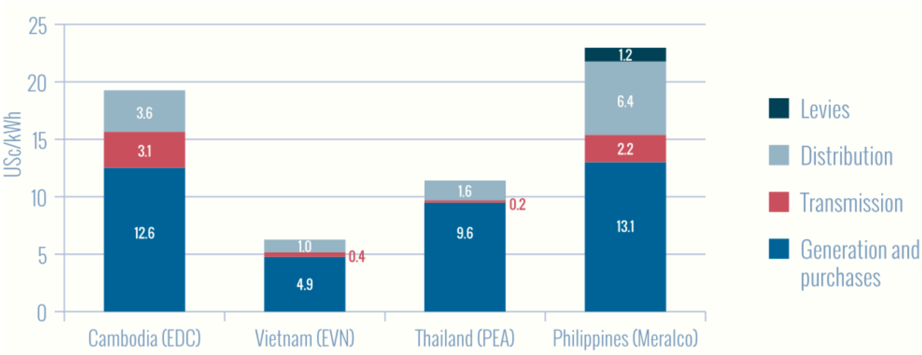


Figure 0-2：Electricity tariffs in Cambodia and ASEAN neighbors

（Source: Mekong Strategic Partners 2016.3）

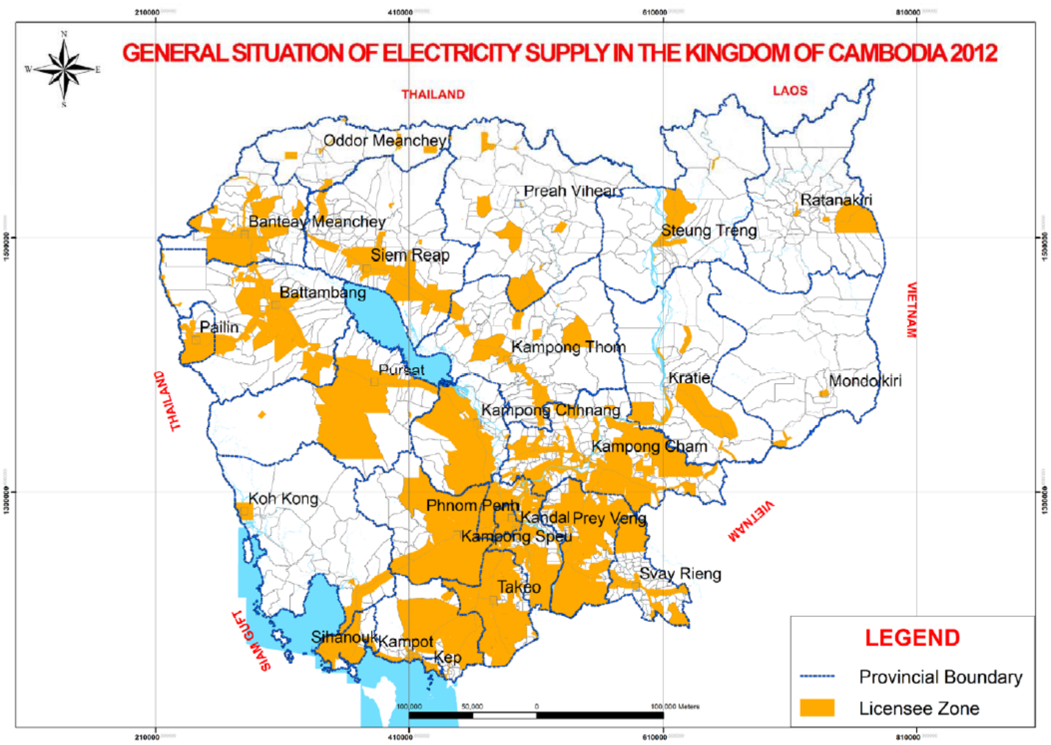


Figure 0-3：Electricity supply in Cambodia

(Source: EAC annual report 2012)

Total power generation capacity including the imported power is about 5000GWh in Cambodia. Cambodia started to import power from neighboring country since 2007 from Thailand, 2009 from Vietnam and 2010 from Lao. Imported power covered approximately 60% of total power generation in the Cambodia in 2010. However, the imported power covers only 25% in 2015, because of the strong effort to strengthen the domestic power generation capacity. It will be decrease significantly after 2017.

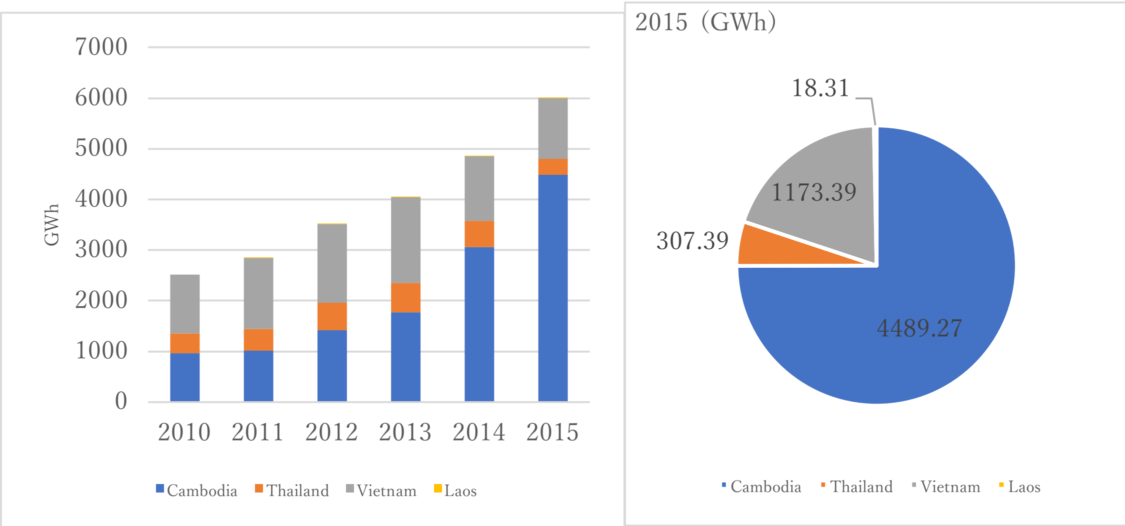


Figure 0-4： Power Supply Trend

(Source: EAC 2005-2015 Annual Report)

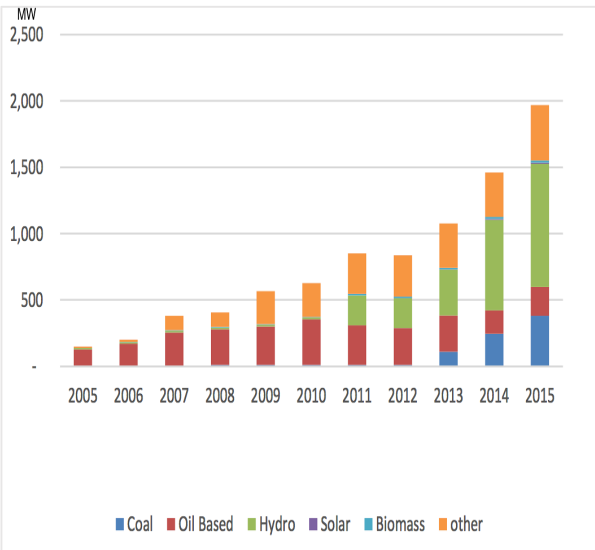
Table 0-1：Power generation development plan in Cambodia

No.	Generation Expansion Plan	Type of Fuel	Capacity (MW)	COD
1	Lower Stung Tatay Hydro Power Plant	Hydro	338	2015
2	700MW Coal Power Plant (Ⅱ) –Phase 1	Coal	270	2014~2015
3	700MW Coal Power Plant (Ⅱ) –Phase 2	Coal	100	2017
4	700MW Coal Power Plant (Ⅱ) –Phase 3	Coal	100	2018
5	200MW Coal Power Plant (Ⅰ) in Sihanouk Province – Phase 2	Coal	135	2016

6	Lower Se San Ⅱ Hydro Power Plant	Hydro	400	2017
7	700MW Coal Power Plant (Ⅱ) –Phase 4	Coal	100	2018
8	Stung Chay Areng Hydro Power Plant	Hydro	108	2019
9	700MW Coal Power Plant (Ⅱ) –Phase 5	Coal	100	2019
10	Sambor Hydro Power Plant	Hydro	450/2600	2019
11	Coal Power Plant (Ⅲ) or Gas Power Plant	Coal・Natural Gas	400	2020
12	Stung Treng Hydro Power Plant	Hydro	900	2020

（Source: MME Presentation 2016.12）

Before 2011, most of 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 were developed in order to meet the strong power demand in the country. The composition of the energy sources of domestic power generation are shifting as shown in below figure since those power plant started operation. Hydropower is covering 47%, coal power 19% and diesel power was reduced to 11% in 2015.



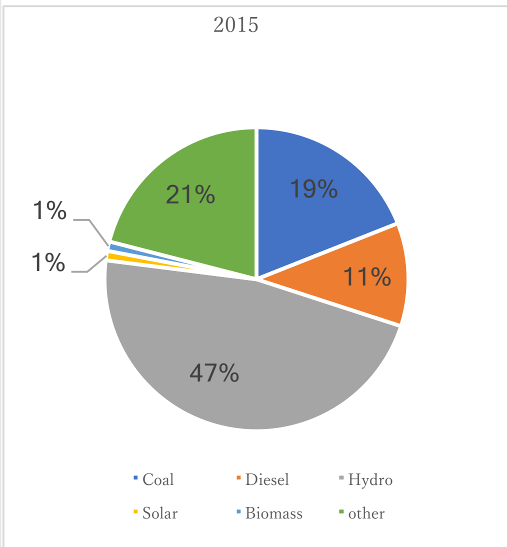


Figure 0-5：Power generated by energy sources

(Source: MME Presentation 2016.12)

Electricity in Cambodia is mainly supplied by the state-owned power company Electricite Du Cambodge (EDC) and Independent Power Producers (IPP). The composition of power installed capacity by the sources of supply are shown on below figure. IPP accounts for 91% of total electricity supply and the rest are EDC (7%) and others (2%). IPP has an important role in terms of the electricity supply in Cambodia.

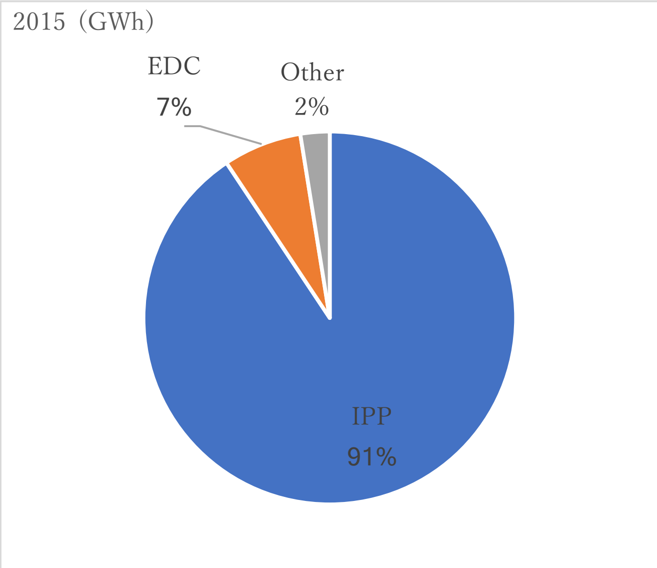


Figure 0-6：Breakdown of Installed Power

(Source: EAC 2015 Annual Report)

Power consumption is steadily increasing at the annual average of 20% since 2010. Power consumption in 2015 was 5,201GWh which is almost double of five years ago. In terms of power consumption in 2015, each sectors account for residential 30%, commercial 50%, industrial 20%. Compared with the situation in 2010, electricity consumption in the off-grid area is expanding through independent power distributors.

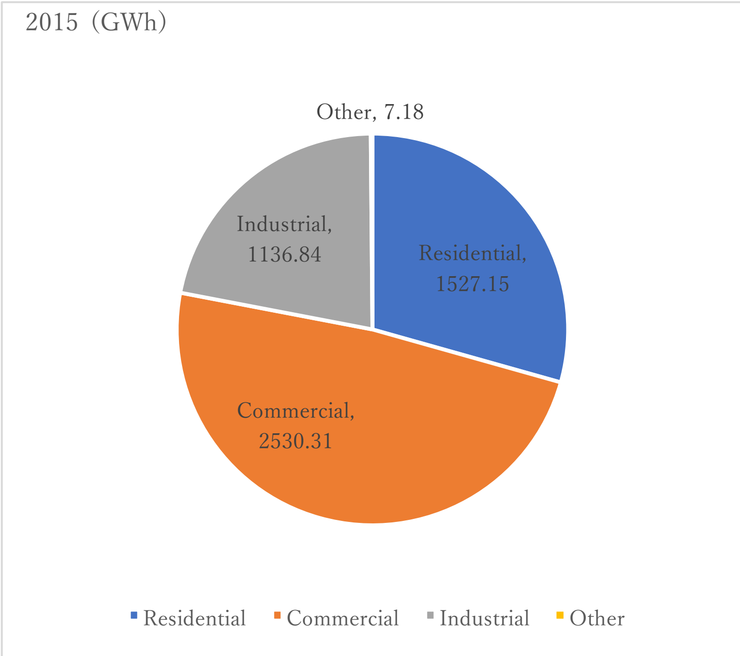
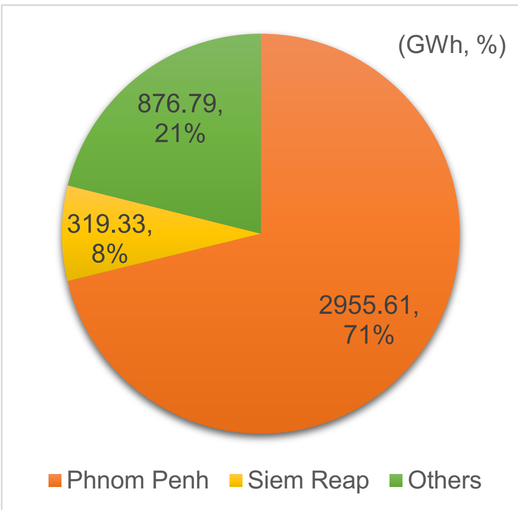


Figure 0-7：Sector wise electricity consumption

(Source: Cambodia National Energy Statistic, MME 2016)

Electricity consumption is centralizing in major cities, especially in Phnom Penh city. Based on the amount of electricity sold by EDC, electricity consumption in Phnom Penh city accounted for 71% which is 2,955.61GWh per year. Siem Reap province is 8% and other states area 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 0-8：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 grid, imported from Thailand and diesel power generation. Electricity suppling capacity in the area has improved since the beginning of operation of large scale hydropower in Koh Kong province. However, the electricity price is still high in the rural area since it is off grid, and it is supplied by independent power distributor who often uses small diesel generator for power generation.

1.2. Energy Policy

1.2.1. Energy Policy

Power Sector Strategy 1999-2016 is the relevant energy policy in Cambodia. Its 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

Rural electrification is positioned as an important component in the energy policy and Rural Electrification by Renewable Energy Policy which was formulated in 2007. The goal of rural electrification is to achieve that all villages will have the access to electricity by 2020, and 70% all rural household will have access to electricity as same as grid connection by 2030.

Power supply development plan and power transmission and distribution network development master plan until 2020 have being updated every year. Currently, power sector master plan was revised by MME and the latest edition was released in 2016. Since the growth of the current demand is larger than the assumption, it is mentioned on the revised master plan that the high demand case scenario is used for the base case of the demand forecast until 2035. Officially published base case scenario of the power demand forecast until 2035 is as follows.

Table 0-2：Power demand forecast in Cambodia

	Historical			Projection				Average Annual Growth Rates, %			
	1995	2005	2012	2015	2025	2030	2035	1995-2012	2012-2025	2025-2035	2012-2035
Industry	438	693	884	895	1,138	1,474	2,140	4.2	2.0	6.5	3.9
Transport	382	441	1,223	1,489	2,457	3,135	3,976	7.1	5.5	4.9	5.3
Other Sector	1,716	1,653	2,904	3,073	3,819	4,312	4,889	3.1	2.1	2.5	2.3
Commercial	3	20	72	91	192	262	343	21.2	7.8	6.0	7.0
Residential	1,712	1,629	2,822	2,971	3,601	4,014	4,498	3.0	1.9	2.2	2.0
Others	1	4	9	12	25	36	48	14.5	7.9	6.5	7.3
Non-energy	8	10	14	17	25	30	36	3.7	4.2	3.8	4.0
Total	**2,543**	**2,798**	**5,025**	**5,473**	**7,438**	**8,951**	**11,041**	**4.1**	**3.1**	**4.0**	**3.5**

(Source: Cambodia National Energy Statistic, MME 2016)

1.2.2. Energy Mix

Cambodia set a policy to achieve 100% power self-sufficiency in 2020 by reducing imported power. The latest plan of energy mix shows its intention to actively increase the capacity of hydroelectric power and also coal-fired power to supplement unstable power supply in the dry season. It is also considered that coal-fired power might be replaced by natural gas if the natural gas is available from 2024.

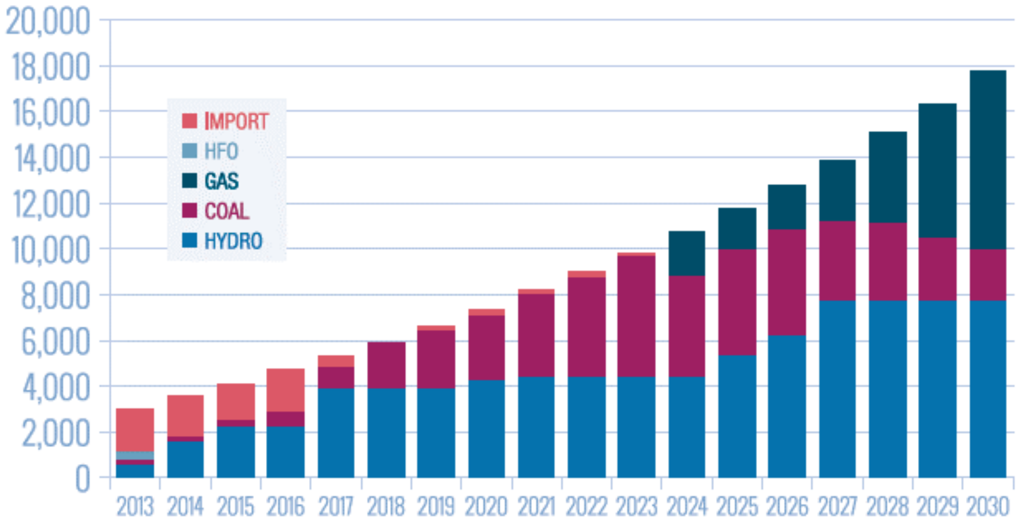


Figure 0-9：Outlook of electricity supply and the energy mix by 2030 (GWh)

(Source: Mekong Strategic Partners 2016.3)

Renewable energy in Cambodia is heavily relying on hydropower generation. The importance of solar and biomass power generation is recognized in the rural electrification policy. In order to secure the stable power supply in dry season, commercial scale renewable energy development except hydropower is discussed between the Cambodian government and international donors. Cambodian government mentioned that solar power, can cover 10% of the peak demand as a target until 2020 which is around 100MW.

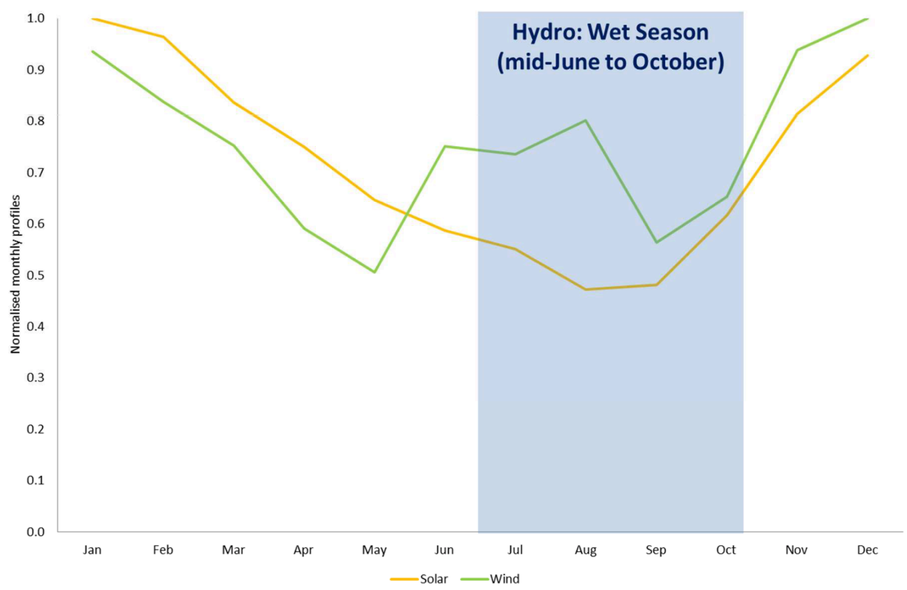


Figure 0-10：Complementally Energy mix of renewable energy
(Source: MME Presentation 2016.12)

Cambodia has a significant solar resource (5kWhs/m^2/day) compared to other South East Asian countries. According to the report by ADB, Cambodia has a high degree solar irradiation with the potential of 8,100MW peak demand and 12,000GWh potential annual yield[6]. It is also expected to develop more decentralized renewable energy because of the excising large scale hydropower plant or coal fire plant are losing 7 to 8% for its distribution.

[6] Renewable Energy Developments and Potential in the Greater Mekong Subregion, ADB, 2015

Figure 0-11：Regional solar irradiation

(Source: Mott MacDonald presentation to Asia Solar Energy Forum, 2015.6)

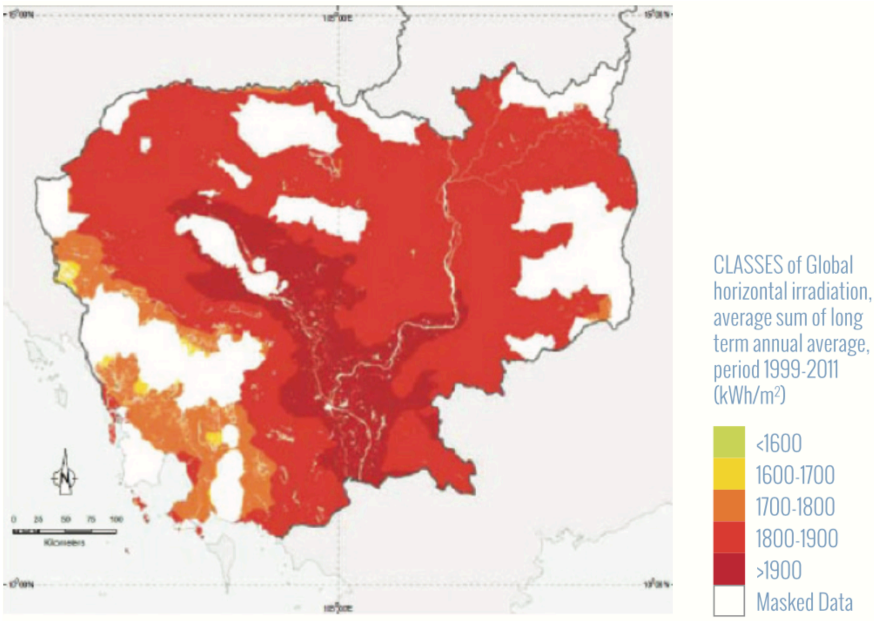


Figure 0-12：Potential suitable area for solar

(Source: Mekong Strategic Partners 2016.3)

1.2.3. Pricing Policy

Cambodia is trying to reduce electricity tariff to attract FDI and to promote economic growth and industrial development. The government has announced that they gradually decrease the electricity tariff as shown in below table by upcoming further hydropower developments. Furthermore, the target for the end user price is 750 riel/kWh by minimizing the price gap between urban and rural areas by 2020.

Table 0-3：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: SREP Investment Plan 2015.5)

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 fundamental 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. JCM and CDM are positioned as part of the specific schemes for the implementation of the projects.

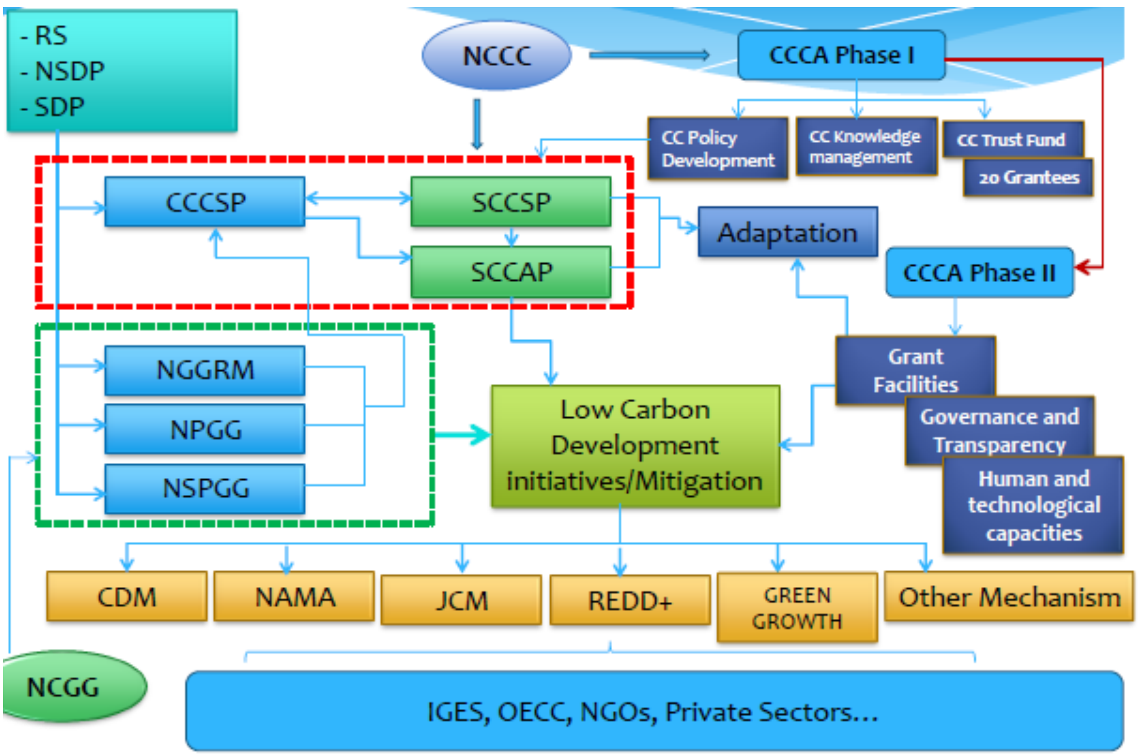


Figure 0-13：Strategy for Low Carbon Strategy in Cambodia
(Source: Towards Low Carbon Strategy in Cambodia, Seminar document of LoCARNet, 2014)

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 balanced development between economic development and environmental protection, cultural preservation, social stability and sustainable 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 in October 2013 for the climate change adaptation. The objective of this 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. The detail action plan by each ministry was made in 2016. Following table shows the summary of CCCSP.

Table 0-4：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;	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/programs in key sectors Long term (2019-2023)

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.	• research and learning to scale up success cases • mainstreaming climate change into national and sub-national programs

(Source: CCCSP 2014-2023)

Cambodian government submitted mitigation plan for climate change to COP 21 under the framework of UNFCCC. Following table shows the priority actions and CO2 reduction target identified in each industrial sector.

Table 0-5：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)

At COP22 in 2016 held in Morocco, Cambodian environmental minister Mr. Say Samal has mentioned that the implementation of CCCSP is important to achieve the target of INDC's. Furthermore, he also mentioned that Cambodia should make a long-term road map until 2030. On the other hand, he added more financial support is necessary for the mitigation of climate change, thus Cambodian government will simplify the process of applying to Green Climate Fund.

1.3.2. Related organizational structure

As an organization for implementing above policy and strategy, National Climate Change Committee (NCCC) and National Council of Sustainable Development (NCSD) were established at initial stage. However, the responsible organization for planning and implementing climate change related policy and program is now integrated into only NCSD due to the task duplication between NCCC and NCSD. NCSD is a cross cutting organization 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.

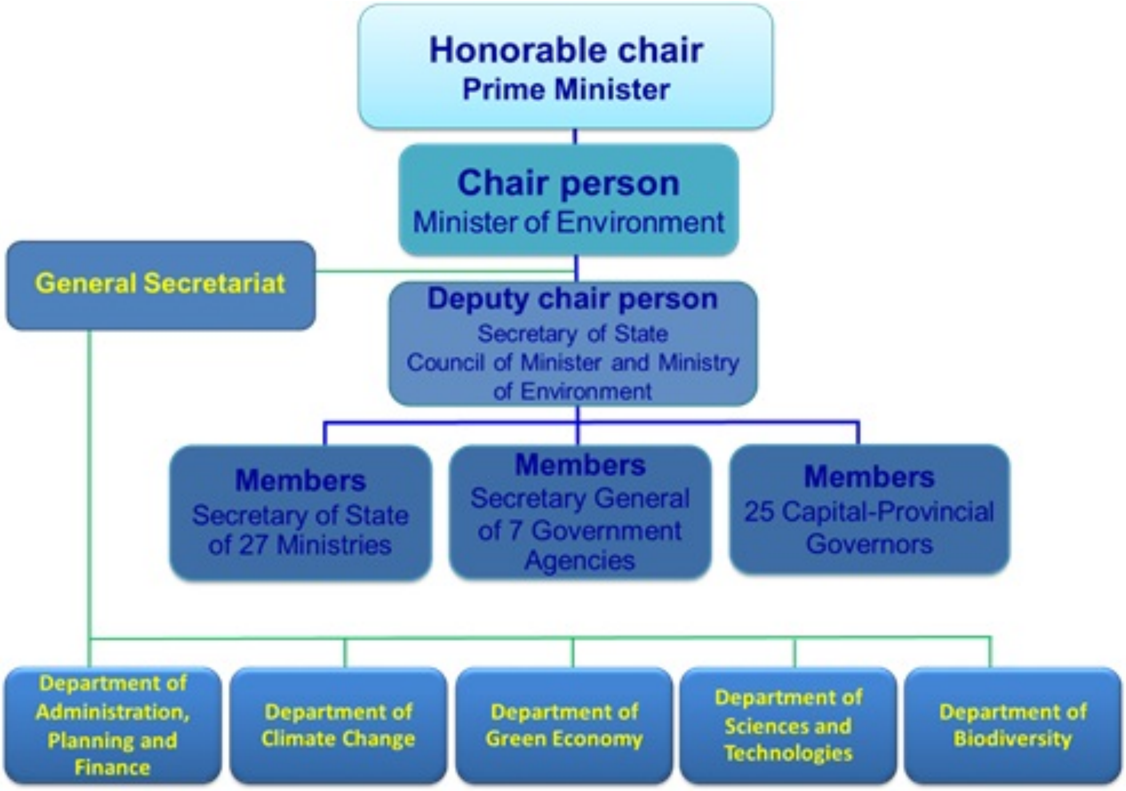


Figure 0-14：NCSD formation

(Source: Department of Climate Change website)

1.3.3. Policy for renewable energy business promotion

As a preferential treatment for promoting the renewable energy business, import duty of solar power generation equipment has been reduced from 30% to 7% in 2009. However, further policy support is necessary for the deployment of renewable energy business in Cambodia. At this moment, exemption of the import duty for the renewable energy-related equipment has been discussing in Cambodian government initiated by donor agencies.

At COP22 in 2016, Cambodian government officially joined International Solar Alliance. International Solar Alliance is established by India Prime Minister Modi and French President Orland in 2015. It is aiming to enhance the support policy for solar, development cooperation and sharing of new technologies for solar, and reducing the solar generation cost. It is expected to obtain those benefits in Cambodia in the future.

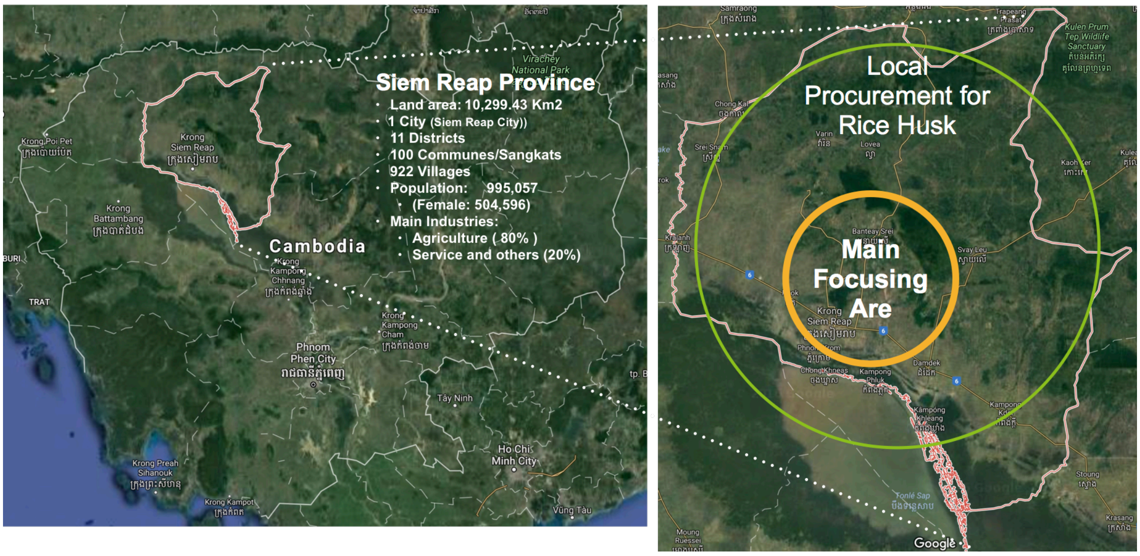
Cambodian government also announced that they are promoting 10MW solar project at Bavet in Cambodia. According to EDC, with the support of ADB and AFB, they can complete this project and feasibility study for connecting solar generated electricity to national grid by the middle of 2017. Depend on this feasibility study result, they will make a conclusion of grid connection from solar and also FIT system. Solar Energy Association Cambodia has sent a proposal of net metering system to MME to start FIT in Cambodia as soon as possible.

2. Survey outline

2.1. Survey background and objective

2.1.1. Survey background

Siem Reap City locates north-west part of the Kingdom of Cambodia, 314km far from Phnom Penh capitol city, using National Road No, 6. According to the document from Mr. Sophean, who attended the City to City Collaboration Seminar in Japan, Siem Reap City has a land area of 10,299km^2, and has a population of 1,042,286. About the growth rate of population, it is increasing by 3%. The overview is as follows:



Angkor Wat, world heritage site, is a temple complex located at the suburb of Siem Reap city. 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 17 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 Mr. 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.

22th Conference of the Parties (COP22) was held in Morocco Marrakech from 7th November, and Mr. Yamamoto, Minister of the Environment, as a representative of Japanese government, contracted “Paris agreement”. In the conference, Japan as a country assured to promote JCM more as one of the most significant issue. It is important to continue negotiation on the implementation guidelines of the Paris Agreement.

2.1.2. Survey Objective

Based on the mentioned background above, following survey objective were set for the "Fisical Year 2016, JCM Project Formulation Study for Realizing Low Carbon Cities in Asia, Project for Developing Low-CarbonTourism Cities through the Joint Crediting Mechanism in Siem Reap (thereafter called "the project").

- Reduce the amount of energy-origin CO2 through "whole city approach", faceted deployment and continuous project formulation in Siem Reap City. Performing two investigations for possibility survey, "Project for Installing photovoltaic (PV) modules on Rental rooftops of public high school", and "Project for Developing Low-carbon biomass power generation using urban organic solid waste and rice husks to contribute a reduction for urban solid waste and taking adequate measures"
- Conduct survey to understand their needs as JCM Project Formulation Study for Realizing Low-Carbon Tourism City, for MME (Ministry of Mines and Energy), EAC (Electricity Authority Cambodia), EDC (Electricite Du Cambodge), and MOE (Ministry Of Environment)
- Conduct survey for Rooftop solar on the 5star Hotels and Hydroponic cultivation machinery in Eco village, aiming to acquire the Joint Crediting Mechanism in Siem Reap
- Conduct survey to apply for an equipment subsidy project using credits between 2 countries for next FY2017 (hereinafter JCM equipment subsidy).
- Conduct survey for realizing JCM equipment subsidy, "Survey to detect projects for installing solar power generation", "Survey to promote eco mobility project and to improve the situation of tourism city traffic", and "Survey to realize the indoor hydroponic farming using LED lighting", as to seek the potential for JCM equipment subsidy collaterally

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 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" and “Biomass 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, Bavet and Poipet.

Asian Gateway Corporation (hereinafter AGC) implemented to consult for Global Environmental Center Foudation (hereinafter GEC) to realize the project, in order to apply for the JCM equipment subsidy for FY2017. Furthermore, AGC prepared to establish its subsidiary inside of Cambodia, in order to implement solar power generation facilities introduction projects in Siem Reap Province as well as within Cambodia.

The contents of the survey of this project are summarized as follows:

(1) Community Solar Power generation feasibility study using Rental Rooftop (hereinafter Solar power generation facilities introduction projects)

- Based on the survey on potential solar power producers, survey targeted 5-star and 4-star hotels in Siem Reap City and public facilities including schools

- Divided the business into Engineering, Procurement and Construction (hereinafter EPC), Operation, Maintenance and Monitoring (hereinafter O&MM), and Independent Power Producer (hereinafter IPP), for rooftop solar power installation & maintenance, 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 AGC on the premise of collaborating with local EPC / O & MM companies. Currently, AGC 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 to assess the needs of rooftop solar power in Cambodia and investigated current renewable energy promotion activities of the Cambodian government, also investigate the prospects of rooftop solar power projects in Phnom Penn.

(2) Surveys on the needs of potential JCM project

- 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 2 wheeled electric bikes
- Feasibility study for the promotion of 3 wheeled electric bikes

(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.
- Surveyed to realize the low carbon tourism city using renewable-energy and saving-energy technology, introduced by Japanese government Kanagawa prefecture and its municipalities' law and technology.
- Attended to the JCM Seminar in Japan two times, from October 17th to 22th 2016, January 23th 2017, hosted by Ministry of Environment Japan.

2.2.2. Survey method and Survey outline

Survey procedures and outline of the survey content are summarized as follows.

As shown in the figure bellow, we surveyed focusing on 3 areas, inside of the Siem Reap city.

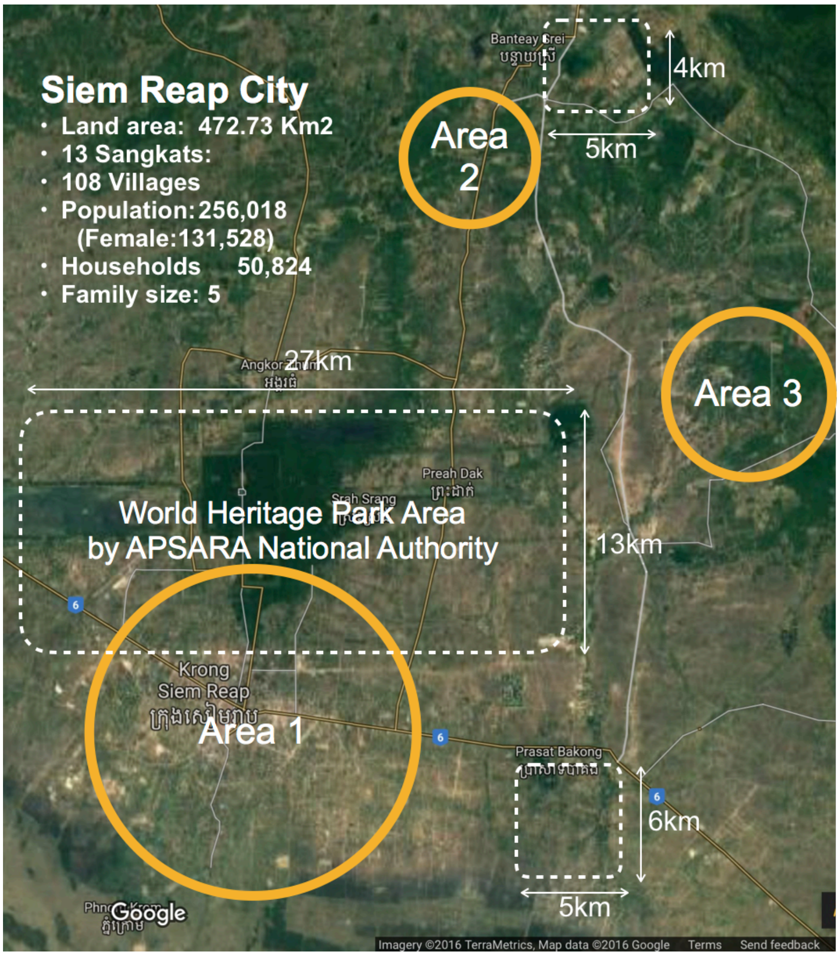


Figure 2-2: Area Map

(Source：Google Map, and edited)

(1) Survey for Solar Power Poject (Area 1, 2 and 3 is targeted)

Survey was focused on the Community Solar mainly. The situation in Cambodia about installing photo voltanic has come to proceed properly since last year, and the amount of mega solar farm which does not connect to the national grid increases its demand. According to the date in 2014 from Asian Development Bank (hereinafter ADB), the Levelized Cost of Electricity (hereinafter LCOE) in Cambodia for solar power system is from US$0.16-US$0.18/kWh. The average sunshine time in Cambodia is from 6 to 9 hours, and the amount of solar radiation is abundant as follows.

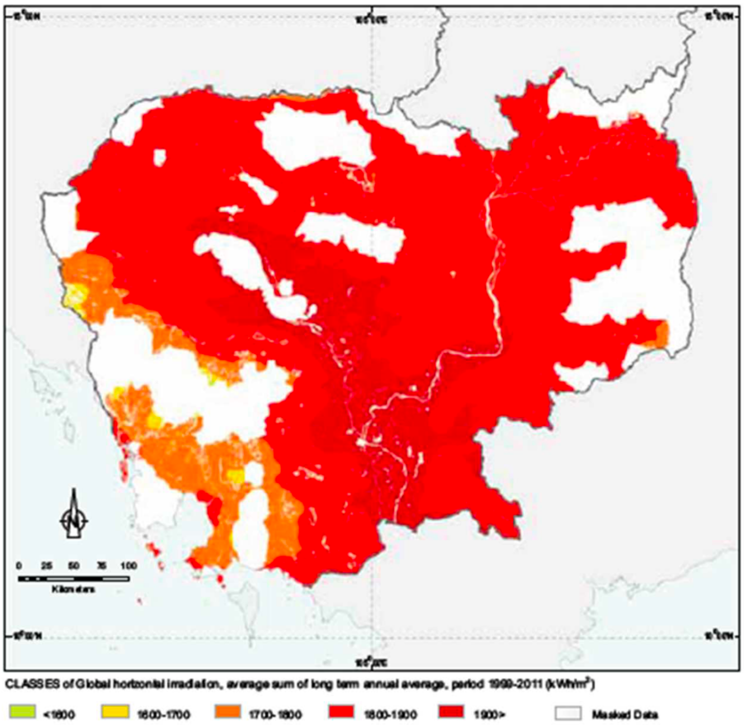


Figure 2-3: the potential for solar power system in Cambodia
(Source: Clean Energy in Cambodia: An Economic Opportunity for the Private Sector)

Because of this situation, solar power system in Cambodia is spreading rapidly, and 10MW ground mounted solar power is going to be the first case to connect to EDC grid in Cambodia, in Bavet district in Svay Rieng Province this year FY2017. Furthermore, the electricity price for EDC is so low, US$0.091/kWh.

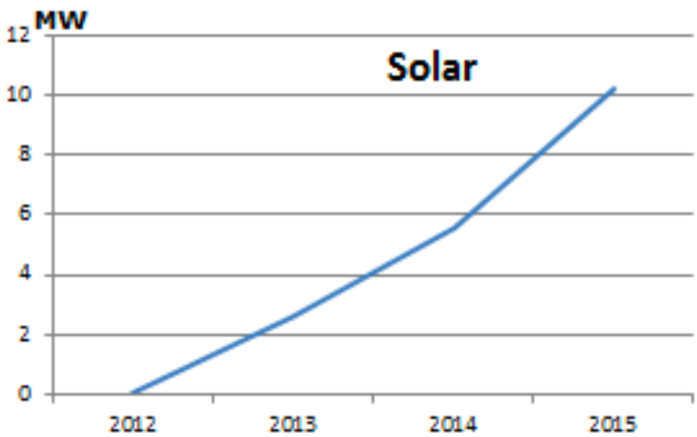


Figure 2-4: the speed to become popular for solar power in Cambodia

Developer	Status	Project Name	City/Province	Online Date	Capacity (MW)
IFEC	Under Development	Solar Photovoltaic	Kompong Spur	Present	10
Global Purity Power Co., Ltd	Under Development	Solar Photovoltaic	- Kom Pong Chhanng - Kom Pong Spur - Takeo	Present	10
Sunseap International Pte., Ltd	Under Development	A bidding on Solar Farm	Bavet City, Svay Rieng Province	Present	10
SOMA Energy	Under Development	Solar Photovotaic	Kompong Thom province	Present	5

Figure 2-5: the list for the Mega solar in Cambodia

(Source: by MME http://www.irena.org/eventdocs/Cambodia%20presentation.pdf)

Community Solar is the system to promote the off takers to use solar power virtually. The number of electric consumers, who want to decrease the amount of electric bill, who want to deal with the climate change by using renewable energy by themselves, is increasing. However, the land price is increasing rapidly in the central city, and there is no space to install the ground mounted solar. On the other hand, the space for the rooftop solar is limited, and the Khmer styled rooftop is not suitable for installing solar panels and its landscape will be damaged.

Figure 2-6: Khmer architectural 5 star hotel

“Community Solar” is to use electricity in a wide area as a community not only using the rooftop of hotels and houses, but also using the public school and the province government’s building. Electricity from community solar can be sold to EDC. And, the person who invested to community solar can reduce the amount of electric fee every month.

To spread community solar, we should be allowed by EDC, and at first should be connected to the interconnection. It means, at first installing solar power system, secondly installing net metering system, thirdly installing to interconnection, and fourthly returning the money back for the amount of electricity generated by solar power system. And one of the problem is that who will set the community solar system and who will organize it. It is conceivable that a private electric power company such as Japanese company which is listing its stock, a public electric power company governed by local government, and a cooperative electric power company owned by local region people. Community Solar is to promote the amount of electricity as the local production and local consumption, and it also promotes the local activation and self-reliance, and escapes the risk of power outage in wide area.

However, through this survey, it turns out to be clear that getting the license from national grid is difficult, even after negotiating with EDC, MME and EAC. Therefore, we asked EDC to connect to the national grid from solar power system, supported by Siem Reap provincial government. However, EDC did not allow to connect to it. The reason is that the impact for the electric power network is not solved enough technologically in Cambodia, as over voltage and shorter voltage are concerned, and it affects to the frequency of rising and falling and is also affects to the total power quality of the entire system. In such a situation, EDC implements the survey for analyzing the impact for the national grid from FY2016 to FY2017, supported by EDC, Asian Development Bank (hereinafter ADB) and Agence Française de Développement (hereinafter AFD). After the survey, EDC will allow to connect to some part of the national grid in FY 2018.
AGC and AGC’s subsidiary surveyed as following scheme to implement the project:

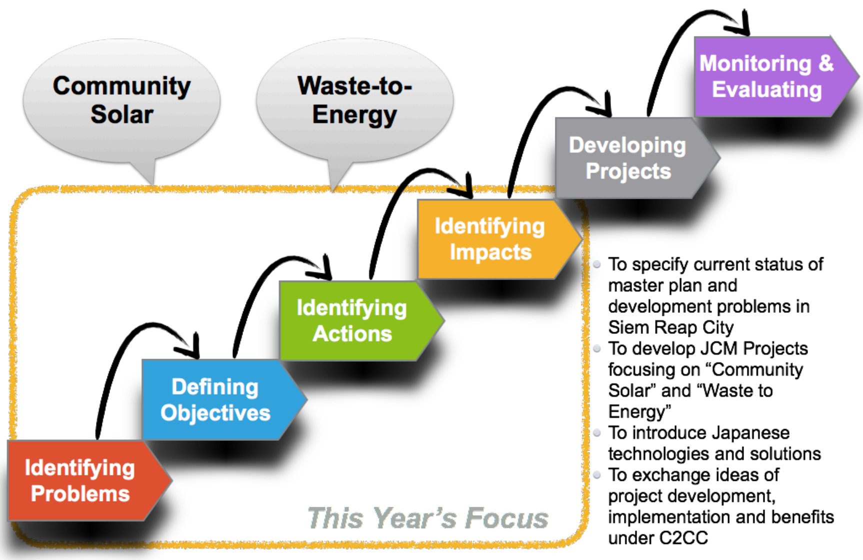


Figure 2-7: Methodology for the research

Outline for the project is systemized as follow. We had a kick off meeting with Siem Reap provincial government at May 20th, 2016, and shared the purpose and policy for this project together. Subsequently, we implemented each factor "Indentifying Problems", "Defining Objectives", "Indentifying Actions" and "Identifying Impact".

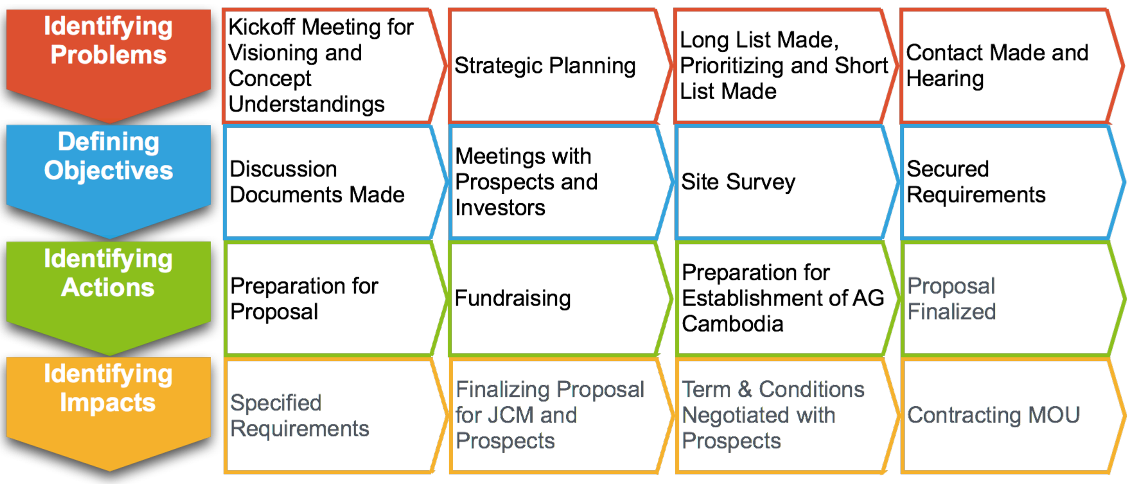


Figure 2-8: outline for the research

Inside of this outline, important points are follow:

(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) Collaborated with Kanagawa prefecture as City to City Collaboration (hereinafter C2CC), we invited the very important 2 persons from Siem Reap province to Japan twice, introduced Kanagawa's experience and implemented case study for them by visiting certain companies. The 2 persons joined to the seminar in Japan, and they had a presentation about "Green City" which tries to realize the low carbon society, and also explained about the system of waste treatment in a city, eco-mobility and installing solar panel on the rooftop.

(iv) Surveyed the possibility to collaborate with a local EPC partner and a turnkey provider which come from foreign country (including EPC and O&M, and they also provide project financing). Implemented the due diligence especially for financing with turnkey provider.

(v) Started to register AGC's subsidiary in order to implement JCM facility support project in Cambodia. The business plan for AGC's subsidiary will include EPC for rooftop solar (installing project), direct power marketing as Independent Power Provider (hereinafter IPP) including O&M, providing energy efficiency equipment, Hydroponic indoor farming using LED lighting and electric mobility, as they are all integrated. To have a clear view for those project, we implemented formulation of the projects, considering the risk and counterplan, financial projection and financial planning.

(vi) Prepared for the JCM facility support project, we signed cooperative business partnerships between some EPC partners and turnkey providers, and considered to make business plans and financing plans to install solar panels, depending on each prospective. Constituted International Consortium for each project as an organization to implement JCM facility support projects.

(vii) Experienced to formulate performances and skills, and constructed implementation system to become a representative of International Consortium.

(viii) Considered whether to utilize the financial supporting scheme (such as JCM facility support project by MOEJ, cooperation project with JICA and Japan Fund JCM by ADB) with installer project, direct power marketing as IPP and Integration project.

(ix) MRV and PDD was done mailnly by OECC with JDI. Calculated the reduction amount of energy origin GHG emission based on JCM's MRV methodology. About the MRV methodology, we prepared in English to be able to submit to JCM joint committee after requiring from MOEJ immediately. About PDD methodology, we also prepared in English to be able to submit to the third party selected by JCM joint committee immediately.

Other investigations to realize this project are summarized as bellow:

(a) Considering the diversification of fundraising

Implemented for AGC's subsidiary to start a business in Cambodia, made a business plan for JCM facility support project, and procured fund to expand business not only in Cambodia but also Thai, Singapore and Philippine. Require advice from angel investor (a personal investor who invests for an establishing company), local relationship company, private investor (turnkey provider or local bank), and development assistance agencies (JICA or ADB). Especially focused on considering the possibility to realize the project scheme supported by MOEJ (JCM facility support projects and JFJCM by ADB).

(b) Considering the tourism city transportation development project to realize as JCM

Implemented preparation to start the projects controlling running and promoting to reuse batteries. Experimented by using e-moto in Siem Reap 5star hotel, renting it to tourists. Suggested companies and schools to purchase e-moto as business to business scheme, and made proposal to rent e-moto for coworkers and employees to commute by e-moto. Considered an innovation for mobility service by substituting e-tricycle for Roumok Moto (tuk tuk, as para transit), and chose a good driver supported by Roumok Moto Association.

(c) Considering the project to install high efficiency transmission and distribution equipment (hereinafter amorphous transformer) to realize as JCM

Implemented the survey to realize installing amorphous transformer, which needs Japanese technical skill, to Cambodia, and focused especially on cooperating with local company technically. Some suppliers, such as ABB, Thai Patanakit and THIBIDI, already implemented to import normal transformer to EDC.

2.2.3. Survey Implementation Arrangement

(i) Implementation agency

Cambodia:	Siem Reap provincial government, Siem Reap city council, and APSARA Authority
Japan:	Japan Development Institute Ltd., Asian Gateway Corporation (AGC), Asahi Glass Co., Ltd, Finetech Co., Ltd, and Overseas Environmental Cooperation Center (OECC)

(ii) Relevant government agencies

Cambodia:	Electricite Du Cambodge (EDC), Electric Authority Cambodia (EAC), Ministry of Mines and Energy (MME), Ministry of Environment (MOE), Siem Reap rice millers association, and Siem Reap Tuk Tuk drivers 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 follow:

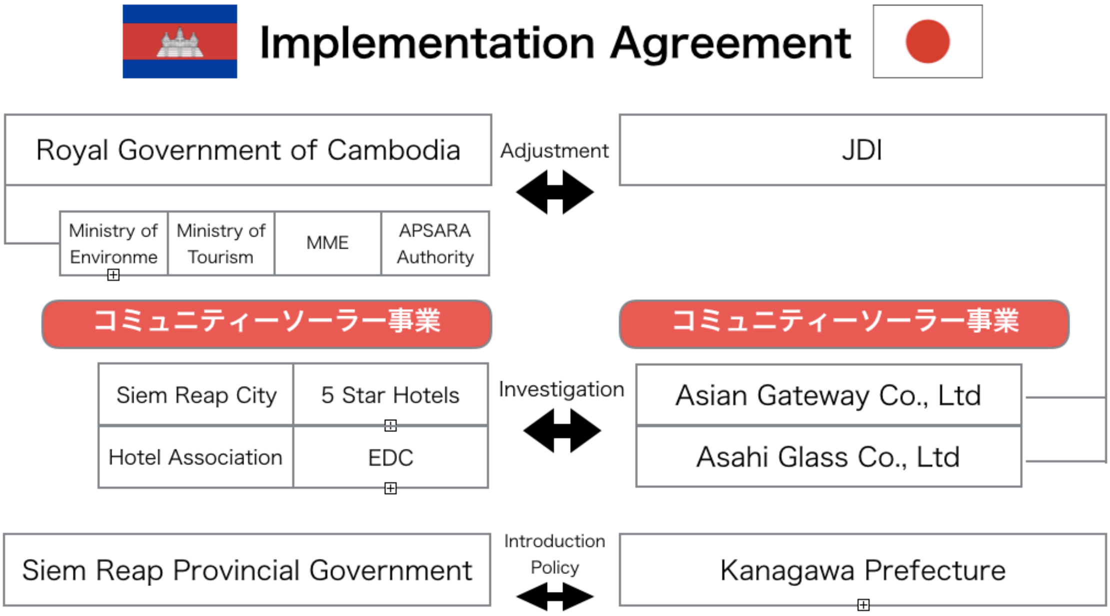


Figure 2-9: Implementation arrangement

2.2.4. Survey Schedule

Survey implementation list for this year is follow:

Day	JCM Formulation survey	Seminar on policies and regulations, Training in Japan	Presentation in the seminar specified by MOEJ
April, 2016	・Considering the strategy to realize the low carbon tourism city using JCM scheme ・Discussing with Japanese and Cambodian institution, and agreed for the investigation plan	・Preparing and adjustment for kick off seminar	
May, 2016 (1st Visit)	・Evaluated existing projects in Siem Reap City, and forecasted for future supply and demand ・Implemented survey for connecting solar to the national grid, the electric price, and the other law	・Kick off meeting with Siem Reap Provincial government	-

	concerning project		
June,201 (2nd Visit)	・Implemented survey about Hotels in Siem Reap ・Surveyed the possibility to cooperate with local companies (In Siem Reap and Bangkok) ・Discussed with Siem Reap city government how to proceed ・Survey for new project in Phnom Penh and Bavet	・Exchanging opinion between Siem Reap Provincial government ・Briefing Session in a hotel	-
July, 2016 (3rd Visit)	・Surveyed the possibility to cooperate with local company (in Siem Reap and Bangkok) ・On site verification in certain 5 hotels ・Surveyed to realize the project in Area 2 and Area 3 ・Considered the possibility to install solar on the hotel rooftop in Siem Reap city ・Fundraising(in Bangkok and Phnom Penh) ・Investigated new project in Poi Pet	・Shared statement with Siem Reap Provincial and City government ・Kick off seminar in Cambodia	・Prepared interim reporting to MOEJ
August, 2016 (4th Visit)	・On site verification to certain 5 star hotels ・Surveyed to realize cooperation with local company (In Siem Reap, Bangkok and Singapore) ・Surveyed to realize the project in Area2 and Area3 ・Fundraising (in Bangkok, Singapore and Phnom Penh) ・Fundraising for AGC's subsidiary (by angel investor)	・Shared statement with Siem Reap Provincial and City government ・Prepared for seminar in Japan	・Interim reporting to MOEJ
September, 2016 (5th Visit)	・Produced planning for solar power project ・Surveyed to realize the project in Are 2 and Area 3 ・Investigation MRV and PDD scheme	・Shared statement with Siem Reap Provincial and City government ・Prepared for	-

	・Inspected for Poi Pet ・ Fundraising (in Bangkok, Singapore and Phnom Penh) ・ Fundraising for AGC's subsidiary (by angel investor)	seminar in Japan	
October, 2016 (6th Visit)	・Offered advice for Japanese company ・ Surveyed to realize the project in Area 2 and Area 3 ・Fundraising (in Bangkok and Phnom Penh) ・ Fundraising for AGC's subsidiary (by angel investor)	・ Shared statement with Siem Reap Provincial and City government ・ Prepared for seminar in Japan ・ Shared statement with Kanagawa-prefecture and Yokohama-city ・ Inspection for companies in Kanagawa-prefecture	・ Attended City to City Collaboration seminar in Kita-Kyushu-city
November, 2016 (7th Visit)	・ Surveyed to realize the project in Area 2 and Area 3 ・Fundraising (in Bangkok and Phnom Penh) ・Offered advice for Japanese company ・Considering the project risk and countermeasure ・Made financial planning and financial plan for this project ・Prepared to establish AGC's subsidiary	・ Shared statement with Siem Reap Provincial and City government	・ Interim reporting to MOEJ
December, 2016 (8th Visit)	・ Surveyed to realize the project in Area 2and Area 3 ・ Considering project with turnkey provider ・Considered MRV and PDD scheme ・ Agreed establishing AGC's	・ Shared statement with Siem Reap Provincial and City government	-

	subsidiary with local investor and made a contract		
January, 2017 (9th Visit)	・Surveyed to realize the project in Area 2and Area 3 ・Discussed to realize project with concerning companies ・Considering project with turnkey provider ・Started preparation for registering AGC's subsidiary ・Consolidating the result of investigation ・Considering MRV and PDD scheme	・Attended to Seminar in Japan ・Shared statement with Siem Reap Provincial and City government	・Final reporting to MOEJ
February, 2016 (10th Visit)	・Considering project with turnkey provider ・Consolidating the result of investigation ・Started preparation for registering AGC's subsidiary ・Wrote final report	・Shared statement with Siem Reap Provincial and City government	

Table 2-1: Survey Implementation List

3. Study for Power Generation Business by Community Solar

Solar power generation is one of the solution for CO2 emission reduction. All the electricity produced by solar system does not discharge CO2 at all, and it can be effectively utilized by connecting to the grid by its reserve power flow system. Solar energy has a big potential in all around the place in Cambodia because solar has less regional differential compared to other renewable energy system.

According to the New Growth Strategy by Japanese government, infrastructure system exporting is promoted as one of the important policy to obtain the order of not only each equipment, delivery and installation, but also design, engineering, operation and maintenance.

Asian Gateway Corporation (AGC) is promoting infrastructure exporting notably on energy sector with government. Solar business is the first project of AGC business. Solar business can contribute to promote the low-carbon city and solution for the environmental issues in all around the world especially in developing countries in Asia, Africa and South America. It is also very important activity for the industry growth strategy in Japan.

AGC is promoting solar system implementation from Cambodia. Solar system can be categorized by three types such as ground mounted, rooftop, and floating. AGC is focusing on the rooftop solar in urban area, and trying to achieve the sharing solar between shopping mall, hotel, school, hospital, and public facilities. Special Economic Zone (SEZ) and Industrial Park also have big potential for solar. AGC is aiming to apply for the JCM subsidy program. AGC establishes the subsidiary in Cambodia to carry out the responsibility as a leader of international consortium. The solar business of AGC and AGCC (subsidiary of AGC in Cambodia) is summarized as below.

3.1. Next Action and Result of Market Research for Community Solar

If the solar system is a self-sufficiency model, the electricity produced by solar can reduce the electricity cost from EDC. On the other hand, community solar can be an effective solution for the people or area that cannot install the solar system by themselves.

Decentralized self-sufficient solar system has no restriction as long as not connecting to the grid. However, EDC has not officially approved the grid connection yet. Thus, community solar is difficult to realize except the 10MW solar generation plant in Bavet.

We've negotiated to EDC to promote community solar in this year with a cooperation of Siem Reap government.

This FY2016, we implemented self-sufficient solar system as PPA and we keep negotiation to get approval of the grid connection from EDC in 2017.

3.2. Market research of the rooftop solar system

The targets of installation are usually divided into three as utility scale (the large power plants of electricity companies), the industrial (hotels, factories, and buildings for self consumption and sales), and the residential (households). Our targets are the rooftops of the industrial buildings especially 5-star or 4star hotels, SEZ and industrial estates.

3.2.1. Market of the industrial rooftop solar

We can promote self-production and consumption of energy by installing rooftop solar into unused spaces of buildings not by an increase of plants and power grid.

3.2.2. A-Hotel

3.2.2.1. Overview about A-Hotel

Located along the way to Angkor Temple, A-Hotel is one of the famous and 5-Stars Hotel in Cambodia with 213 rooms, Lobby lounge, a bar and Cambodia swimming pool inspired by Khmer Structure. It takes about 20 minutes from Siem Reap International Airport(REP) to A-Hotel, about 10 minutes from Siem Reap City (Krong Siem Reap), and 10 minutes away from Angkor Wat Temple. The Hotel is owned by Thai Beverage Plc and managed by Marriott Hotels and Resort Worldwide.

Figure 3-1. Hotel-A in Siem Reap Province

3.2.2.2. Load Consumption of Hotel

The consumption of the Hotel is mostly from the Chiller System, Boiler, Air Handler Unit (AHU), Freezing Units for Food Storages, Lighting system (More than 10 Years). This consumption mostly comes from usage of operation and service in the main building.

Figure 3-2 : Main Building of Hotel-A

Currently, A-Hotel has two sources of electrical supply. First source is from the National Electrical Company, Electricité du Cambodge and another one is on-site diesel generators. Hotel purchases the medium voltage 22kV power from EDC (Electricité du Cambodge) at contracted price, then steps down the 22kV to 0.4kV to supply to main distribution board in the Electrical room nearby EDC Substation. Due to the outage of local power system, the hotel also has their own three Diesel Generators at Capacity 1000kVA each.

Figure 3-3 : Electrical Room in A-Hotel

3.2.2.3. Power consumption

The annual consumption of A-Hotel is about 3,658 MWh in 2016 excluding the energy generated by Diesel Generator. It cost them about 612,834 USD in 2016. The Diesel consumed by the generator is about 3,681,727kWh (11,690L) in 2016. The graph below will show about the annual energy consumption (Only EDC Energy Consumption).

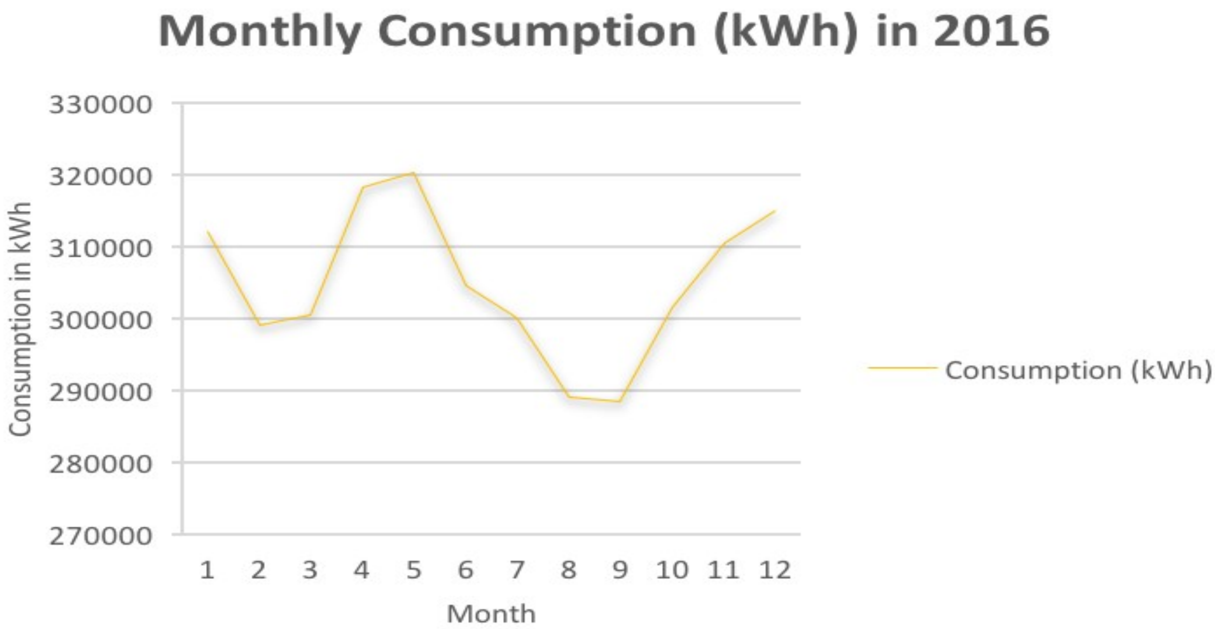


Figure 3-4 : Monthly Consumption from the Grid EDC

According to the calculation, estimated load survey at the hotel, and interview the engineer, the power consumption varies from 400kW to 500kW in 2016, which is better than 2014 (Min. 200kW and Max 600kW) because Marriott Resort Worldwide want to save the energy in this hotel (before A-Hotel was managed by Starwood Worldwide Resort but now it is managed Marriott Resort Worldwide). Based on the Marriott's management concept, they want to save the energy up to 20% of current situation by 2020.
‘

With these criteria above, it is possible to offer to the hotel solar solutions combined with energy efficiency solutions. based on a hybrid PV-grid-genset system, replacement and optimization of electrical equipment (chiller, lighting, VSDs), improved operating conditions with a Building Management System (BMS) and constant remote control and monitoring to maintain energy savings over time. An integrated hybrid PV-grid-genset solution combined with energy efficiency solutions would significantly reduce the cost of electricity from grid and diesel, while improving the stability of power supply for A-Hotel.

3.2.2.4. PV Solar Design and Installation

Some criteria design is considered as below:

- The available space rooftop of the building.
- Shading of the structure building and tree nearby
- Strength of the rooftop structure
- The slope or tilt rooftop of the building
- The peak demand and peak production

(i) Concept Design of Solar System in A-Hotel

Most of the hotels in Siem Reap have diesel generators for backup power supply when there are unstable or shortage of power from the grid. The concept of solar study aims at reducing Green House Gas (GHG) emissions in Siem Reap province and from the collaboration and support from Siem Reap government to promote the green city in Siem Reap province. Feasible study of the PV solar project considers hybrid system to each hotel in Siem Reap where solar energy generation, fuel generator and grid are connected to supply the load at hotel. Battery bank storage are not recommended in this condition due to high price and life cycle of battery still limited comparing to the cost of investment. The figure below the show the overall concept design of the PV hybrid system and system configuration at each hotel in Siem Reap.

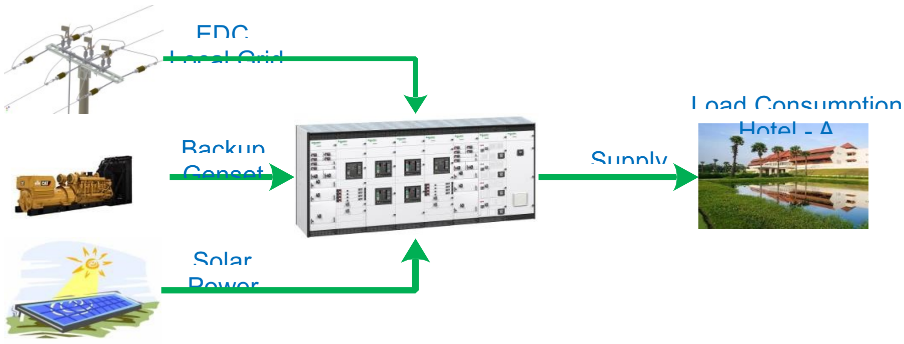


Figure 3-5. The Concept of Solar Configuration

(ii) The availability of the rooftop of A-Hotel

The available of the roof at A-Hotel is good for installation PV System on the roof because the rooftop is flat. However, each side of the building is limited to install PV module due to slope roof and shading. The study of the design has proposed the PV solar module using 315 W-peak of SHARP solar panel. Below the typical design of PV solar module on the rooftop of the A-Hotel.

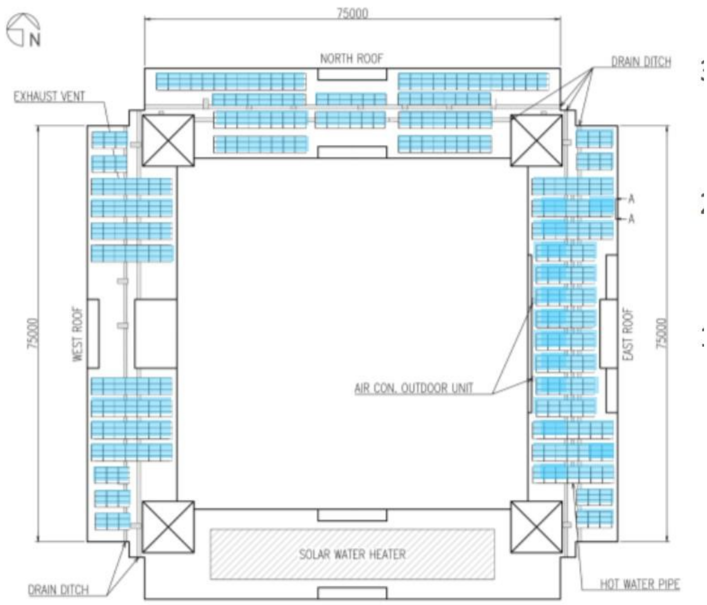


Figure 3-6 : Primary Design of PV Solar Module on rooftop of A-Hotel

Based on the design and calculation using SHARP solar PV module, we can estimate the primary electrical generation of the system in the table below:

Primary Design and Concept Base on the Data and Site visit	
Capacity of Solar Power	228kW$_{peak}$ (220 to 250kW$_{peak}$ potential)
Amount of PV module	725 Sharp Solar panel 315W$_{peak}$
Amount of Inverter	4 ABB Inverter
Performance Radio	80%
Annual estimated Production	351Mwh/year (About 10% of yearly Hotel consumption)

Table 3-1: Primary Design of Solar System at A-Hotel

3.2.2.5. Specification of PV Module

The proposed proposal calculation is using Sharp solar panel ND-AH315 which produces one panel consists of 72 cells and capacity 315kW$_{peak}$. Please see the table below for the detail specification of PV module panel:

Mechanical Data	ND-AH315
Cells	Polycrystalline,156mm Square
No. of cells and connections	72 in series (6 Strings)
Dimensions (L x W x D)	1,956x992x40mm
Weight	22.5kg
Front Glass	Low Iron-tempered glass, 3.2mm
Frame	Anodized Aluminum Alloy, Silver
Connection Box	IP-67, 3 bypass diodes
Cable	4mm^2/ 1200±50mm
Connector	Renhe connector

Table 3-2 : Mechanical Data of PV Module Panel

Electrical Data (at STC)		ND-AH315	
Maximum Power	Pmax	315	Wpeak
Tolerance P_{max}	%	+5%/-0%	
Open-circuit Voltage	VOC	45.6	V
Short-circuit Current	ISC	9.08	A
Voltage at point of maximum power	Vmpp	32.2	V
Current at point of maximum power	Impp	8.42	A
Module efficiency	ŋm	16.2	%

STC = Standard Test Conditions: Irradiance m^2, AM 1.5, ell temperature 25^o C
1,000w/ c

Electrical Data (at NOCT)		ND-AH315	
Maximum Power	Pm(W)	227.1	W_p
Power Output Tolerance	Pm(W)	+5%/-0%	W
Maximum Power Voltage	Vm(V)	33.8	V
Maximum Power Current	ISC	6.72	A
Open Circuit Voltage	VOC(A)	42.2	V
Short Circuit Current	ISC(A)	7.3	A

NOCT: Ir. 800W/m^2, Am. Temperature 20^{o}C, Wind 5

Table3-3: Electrical Data of PV Module Panel

Limit Values	ND-AH315	Temperature Coefficient	ND-AH315	

Limit Values	ND AH315	Temperature Coefficient	ND AH315	
Maximum System Voltage	1,000 VDC	Pmax	-0.42	%/^{o} C

Over Current Protection	15A	VOC	-0.32	%/° C
Temperature Range	-40~+85°C	ISC	+0.05	%/° C
Maximum mechanical Load	2,400Pa			

Table 3-4: Upper Limit of PV Module Panel

Standards and Certification

• IEC 61215

• IEC 61730-1/61730-2 (ed.1)

• IEC 60904-1/60904-3

3.2.2.6. Financial Plan

There are two options of investment for this project. First option is Power Purchase Agreement (PPA) and second is the self-investment from A-Hotel.

(i) Power Purchase Agreement

Power Purchase Agreement (PPA) is a contract between two parties, the Power Producer (Green Yellow) and the off-taker (A-Hotel). The Power Producer offers turnkey solutions that comprise the financing, EPC and O&M and sell to the off-taker energy at a price lower than EDC's.

The off-taker provides required space on the rooftop to Green Yellow and commits to purchase all the electricity produced by the solar plant at a fixed rate.

Based on the primary study from Green Yellow, they have proposed the PPA Agreement which the period about 20 Years, then handed over the System to the owner. Joint Crediting Mechanism (JCM) is period about 17 year after starting operation of the system. JCM subsidy will hand over to Green Yellow Energy Solution as the financier and project owner.

Type of Contract	**Power Purchase Agreement (PPA)**
Specification of Condition	Take-or-Pay basis
Contract Period	20 Years
Scope of work	Green Yellow • Study and Design • Investment • Procurement, Installation • Operation and Maintenance
Solar Selling Price	Lower than EDC. (Local price is 16.75cUSD/kWh) The selling price proposed by the developer is confidential until final contract signature

Table 3-5 : PPA by GY

(ii) Self-Investment

In this case, A-Hotel needs to secure the own finance to do engineering, procurement, and construction. The saving energy consumption from solar energy is 351MWh/year. With EDC price at 16.75cUSD, we can estimate the project to generate an annual energy savings of 58,000 USD/year

3.2.2.7. Energy Efficiency

A-Hotel has been in commercial operation since 2004. The hotel has been using inefficient equipment operated in non-optimal conditions. These issues cost them about of energy lost and consumption cost lost. Green Yellow proposed them an energy efficiency solutions to reduce the power and energy consumption of the hotel. Below items are the proposed item to change in order to get energy saving in the hotel.

item	Picture	Action	Specification

1		▪ Replace one water cooled chiller York ▪ 400TR by magnetic – oil free VSD compressor chiller for the same size of 400 TR	▪ Magnetic – Oil free ▪ VSD compressor ▪ 400 RT water cooled chiller
2		▪ Replace all common area lights with LEDs ▪ Replace all guest room lights with LEDs	▪ LED T8: 18W/1,800 lumen ▪ Decoration lights ▪ 5 years warranty
3		▪ Install VSD on condenser water pump	▪ Optimize water flow with differential temperature transmitter ▪ Variable speed drive size of 30 kW
4	CDWP 	▪ Building Automation System on the chiller plant and lighting	▪ Control all the chiller plant in automatic mode, new control logic automation ▪ Control lights in automatic

Table3-6: Suggestion for installing as energy efficiency equipment from GY

Green Yellow and Asian Gateway have joined a study on this Energy Efficiency in A-

Hotel. The potential of Saving energy from the item above is up to 725,000 kWh/year which corresponds to 20% Energy Consumption.

3.2.2.8. CO2 Emission Reduction

Using the solar energy and energy efficiency can reduce the CO_2 Emission The mission factor in Cambodia is about 0.533kgCO_2/kWh. With the amount of saving energy in A-Hotel is around 30% of 2016 consumption (10% from solar energy and 20% from energy saving in the building), we can assume that the energy saving from EE and solar energy is 30% of 2016 energy consumption.

Energy Saving from Energy Efficiency	725,000 kWh/year
Energy Saving from Solar Energy	351,000 kWh/year
CO_2 in kWh	0.533 kg-CO_2/kWh
Total CO_2/year	573 T-CO_2 /Year

Table 3-7: the amount of CO2 reduction

3.2.3. B-Hotel

3.2.3.1. Overview about B-Hotel

Final construction works are under way to open the international branded hotel in Cambodia with 233-room. Hotel B in Siem Reap is expected to be the brand-new hotel in Cambodia. It takes us about 15 minutes away from the UNESCO World Heritage Site of Angkor Archaeological Park. B-Hotel Siem Reap is expected to be grand opening on this April. This Hotel is part of Marriott Resort Worldwide management.

Figure 3-7 : B-Hotel Siem Reap Along National Road No.6

General Manager of the B-Hotel is interested to promote the Solar Energy in Hotel as long as there is no effect to the operation and customer. Apart from this, electricity cost in the hotel is still a big concern for hotel energy consumption due to the high cost of local electrical provider. Also, the diesel fuel is very expensive in the market nowadays.

3.2.3.2. Power Consumption

Currently, there are two available power sources supplying to this hotel, one is from local grid and the other is backup generators inside the hotel. Power consumption of the hotel is not exact known because the hotel is still under construction. However, based on the study and interviewing to the engineering team, they expect that the power consumption is around 1000kVA (1MVA) at the high season (each room inside hotel are fully occupied). We cannot determine the exact load consumption of B-Hotel at this moment above reason.

Figure 3-8 : Backup Generator Room at B-Hotel

Figure 3-9 : Power from grid step down by Transformer in B-Hotel

3.2.3.3. Solar Concept Design

The design of the system is based on the existing system. As we know B-Hotel has already used to power source. Below concept is that we add one more source of solar energy to the existing system to use as hybrid network with generator and local grid. This design can provide more stability to power distribution network for B-Hotel.

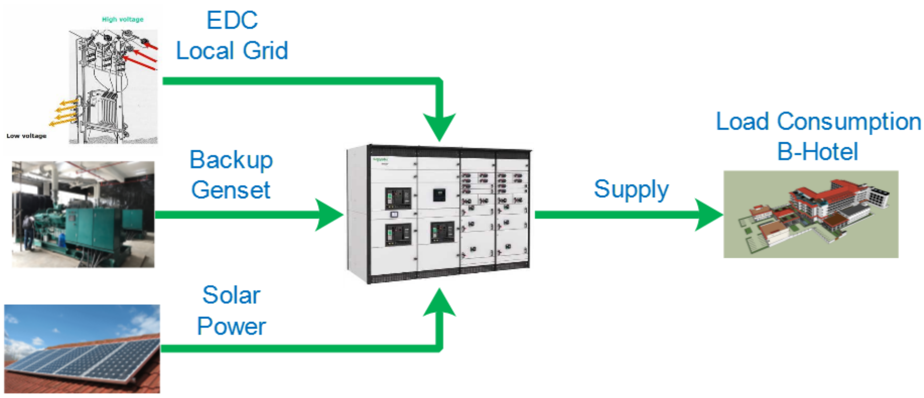


Figure 3-10 : Concept design of Power System in B-Hotel

In case of outage from the grid, B-Hotel can use the energy from both generator and solar at day-time and from diesel generator at night-time. This design can reduce the cost of the diesel petroleum whenever they start running the generator in day-time.

3.2.3.4. Power Generation from Solar Energy

Solar power generation is based on the amount of PV module installation on the rooftop of B-Hotel. The availability of the rooftop has much space. However, the space availability for the solar installation is very less because the roof is tilt, slope and not strong enough to installation PV module above the them.

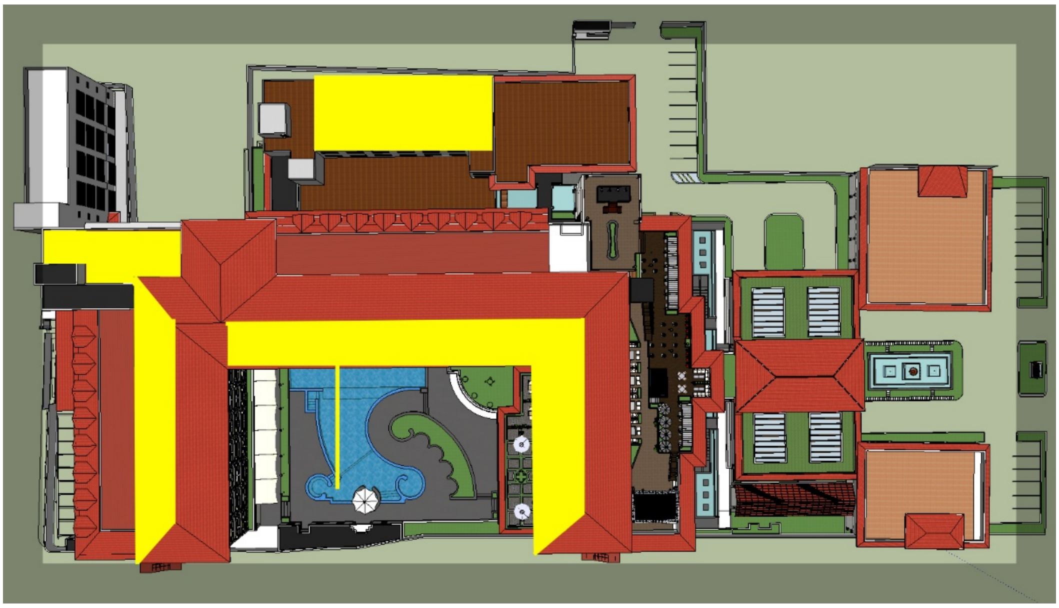


Figure 3-11 : Yellow color is available space for installation PV module

Figure 3-12 : Structure of attic

Figure 3-13 : Part of flat rooftop available to install PV Module

According to the study of this project with GY and AGC, we found out there are about 1,250m^2 available for the rooftop.

Available Rooftop	**1,250 m^2**
Sharp Solar Module	Sharp PV ND-AH315
Potential of Solar Panel	625 PV Module Units
Potential of Solar Energy	196 kW
Yearly energy production	301h/year

Table 3-8 : Capacity of Solar after Design in B-Hotel

3.2.3.5. Financial Plan of the project

There are two options provided as financial investment in this project, one is Power Purchase Agreement and the other is EPC investment by the hotel itself. If the hotel chooses to enter a power purchase agreement, JCM subsidy will hand over to the owner of project (Financial investor). However, if B-Hotel wants to be the project owner and secure the financial investment in the project on their own, they would be the one applying for the JCM subsidy. Below is the detail of condition between PPA and EPC investment in this project.

(i) Power Purchase Agreement

Power Purchase Agreement (PPA) is a contract between two parties, project developer finances, design, procurement, construction, operation and maintenance the project and generates electricity for B-Hotel against monthly payments over on time duration. The PPA target is to get the electricity cost lower than the local price in the period time on the agreement. In this case, B-Hotel is no need to any investment. They just provide available space or rooftop to the project developer to do the solar installation. Based on the primary study, Power Purchase Agreement's period is about 20 years, then handed over the system to the owner. JCM period is about 17 years after starting commercial operation of the system. JCM subsidy will hand over to project developer who is also the investor of the project.

(ii) EPC Investment

EPC stands for Engineering, Procurement, and Construction. EPC is a prominent form of contracting agreement in the construction. The engineering and construction contractor will carry out the detailed engineering design of the project, procure all the equipment and materials necessary, and then construct to deliver a functioning facility or asset to their clients. Companies that deliver EPC Projects are commonly referred to as EPC Contractors. In the EPC investment, the project owner need to be secured for finance to do this project, since the EPC investment will cost them.

3.2.3.6. CO_2 Emission Reduction

Using solar energy is not only to lower the electricity bill but also to protection the plant. In this point, solar energy can use to replace the power generation by diesel. By saving energy of hotel, we can calculate the CO_2 emission reduction on this project. In Cambodia, CO_2 is about 0.533 kg-CO_2. Table 2 below will show us the CO_2 emission reduction at

B-Hotel.

Amount of CO_2 in kWh	0.533 kg-CO_2/kWh
Amount of saving energy at B-Hotel	301 MWh/year
CO_2 Emission Reduction	165 T-CO_2/year

Table 3-9 : CO_2 Emission Reduction

3.2.4. A-Factory

3.2.4.1. Overview of A-Factory

A-Factory, which is located at Siem Reap province in Cambodia, was established to produce block ice and tube ice. A-Factory has installed capacity of around 100 ton/day maximum block ice machine and 50 ton/hour tube ice machine (it is produced depend on demand). The operating hour is 24 hour per day but one compressor will shut down when ice is form and the demand is not very high. Factory has one transformer with capacity of 800 kVa. The factory started operating less than three months. With the electricity cost of 0.1675$/kW, it is reported that factory spend around $10,000-20,000/month (59,701-119,403 kWh/month).

Figure 3-14 : Inside of A-Factory

3.2.4.2. Company Energy Demand

The factory owner always seeks the way to improve efficiency of his ice production plant. When he knows about rooftop solar panel project, he was very interested. Owner worry about high energy consumption and want to reduce electricity cost using electricity generating from solar panels. It is reported by the owner that factory spend around $10,000 – 20,000/month.

Figure 3-15 : Compressor with the rated power of 150 kW

It is reported that the total energy demand is around 800 kVa. Below is the list of electric motors of the factory.

Type of Motor	Rated (kW)	No.	Total (kW)
Compressed motor	150	3	450
Unknown motor	132	1	132
Stir motor	11	1	11
Crane motor	10	3	30
Unknown motor	10	1	10
Pump motor	15	3	45
Pump motor	10	3	30
Total			708

Table 3-10 : List of electric motors

3.2.4.3. Available roof space

The factory located on the land of 7,000 m2. The roof surface availability for solar panel installation is garage, car wash, new plant (currently being constructed), existing plant and office.

Figure 3-16 : New plant is being constructed

Roof space	Width (m)	Length (m)	Surface (m2)
Garage	8	12	96
Car wash	5	8	40
New plant	12	30	360
Exiting plant	17	30	510
Office	8	28	224
Total			1230

Table 1-11 : Available roof space

3.2.4.4. Specification of Sharp panel

Product features:

- Positive power tolerance: Production controlled positive power tolerance from 0- to +5%. Only modules will be delivered that have the specific power or more for high energy yield.
- High-performance PV module: Made of polycrystalline(156mm2) silicon solar cell with module efficiency up to 16.2 %.
- PID (potential-induced degradation) free: Sharp delivers convincing performance in independent test by Fraunhofer.
- 4 bus bars technology for enhancing the power output

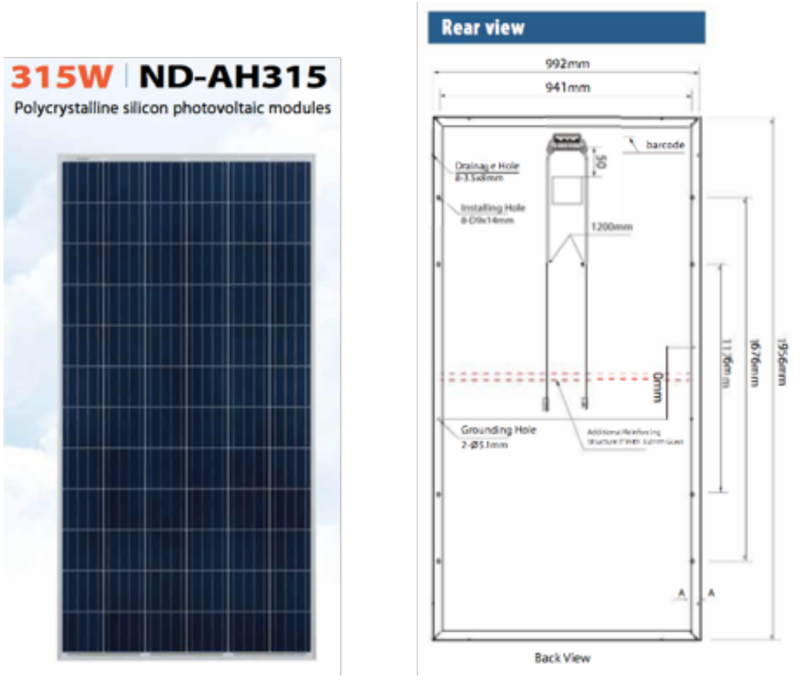


Figure 3-17 : Panel Specification

MECHANICAL DATA	ND-AH315
Cells	polycrystalline, 156 mm square
No. of cells and connections	72 in series(6strings)
Dimensions ((LxWxD)	1,956x992x40 mm
Weight	22.5 kg
Front glass	Low iron tempered glass, 3.2 mm
Frame	Anodized aluminium alloy, silver
Connection Box	IP-rating 67, 3 bypass diodes
Cable	4mm² /1200±50 mm
Connector	Renhe connector

Electrical data (at STC*)		ND-AH315	
Maximum power	P_{max}	315	W_p
Torerance of Pmax		+5% / -0%	
Open-circuit voltage	V_{oc}	45.6	V
Short-circuit current	I_{sc}	9.08	A
Voltage at point of maximum power	V_{mpp}	37.2	V
Current at point of maximum power	I_{mpp}	8.47	A
Module efficiency	η_m	16.2	%

STC = Standard Test Conditions: irradiance 1,000 W/m², AM 1.5, cell temperature 25 °C

Electrical Data (NOCT)			
Maximum power	Pm(W)	227.1	W
Power Output Tolerance	Pm(W)	+5%/-0%	W
Maximum Power Voltage	Vm(V)	33.8	V
Maximum Power Current	Im(A)	6.72	A
Open Circuit Voltage	Voc(V)	42.2	V
Short Circuit Current	Isc(A)	7.30	A

NOCT: Irradiance at 800W/m², Ambient Temperature 20C, Wind Speed 1m/s.

Figure 3-18 : Panel Specification

3.2.4.5. PV system sizing

Based on roof space available, we can install 603 of sharp panels which is equivalent to 190 kWp.

Sharp PV	315	Wp
Available roof space	1230	m2
No. of PV module	603	modules
Inverter	6	pcs
Total kWp	190	kWp

Table 3-12 : Size of PV system

3.2.4.6. Estimate Energy Generation

The calculation of energy generation is based on monthly average insolation incident on horizontal surface (kWh/m2/day) by NASA. With the 190 kWp PV system we can produce on average around 472 kWh/day.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.4	5.7	5.8	5.9	5.6	5.2	5.1	4.8	4.6	4.7	5.0	5.0

Table 3-13 : Monthly Averaged Insolation Incident on Horizontal Surface (kWh/m2/day) by NASA

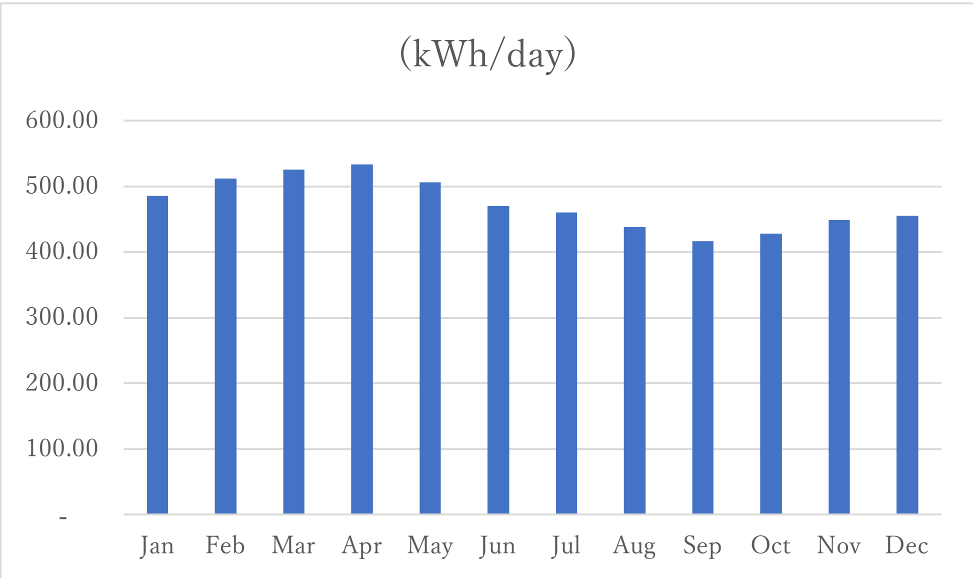


Figure 2-19 : Estimated energy production from PV

3.2.4.7. Financial plan

No.	Item	Qty	Unit	Price/unit	Total ($)
1	PV module				
	Sharp, poly-crystalline, 315 Wp	190,000	W	0.94	178,600
2	Inverter				

	Huawei, 33 kW	6	pcs	3,374.00	20,244
3	Mounting component				
	For PV module	603	module	40.00	24,127
4	Cable & accessories	190,000	W	0.10	19,000
5	Installation & labor cost	603	module	30.00	18,095
6	Transportation & store, other	603	module	4.00	2,413
	Total				262,479

Table 3-14: Estimated Financial Investment

3.2.4.8. Saving

With the 190 kWp solar panel system, energy around 170,365 kWh will be produce annually. Based on the electricity cost of 0.1675 $/kWh the factory will be able to save around $28,536/year.

Electricity cost	0.1675	$/kWh
Annually energy production	170,365.98	kWh/year
Monetary saving	28,536.30	$/year
Simple payback period	9.20	years

Table 3-15: Annual Saving

3.2.4.9. CO2 reduction

The amount of electrify generated from PV system will replace a small portion of the existing electricity from EDC, this reduction will equivalent to CO2 reduction. n case the PV system in a proposed project activity is connected to an internal grid which is not connected to the national grid, the emission factor is set to 0.533 tCO2/MWh.

Emission factor	0.533	kgCO2/kWh

Annually energy production from solar panel	170366	kWh/year
Total emission reduction	90	TCO2/year

Table 3-16: CO_2 Reduction

3.2.5. B-Factory

3.2.5.1. Overview of the B-Factory

Factory B is located at Siem Reap province, Cambodia. The main product of the factory is brick. The operating hour is from 7:00 am to 5:00 pm. During the night time, only a few air blowers are in operation. There are four roof spaces available which have the same size (44m x 100m). Currently, the factory has one existing transformer with the capacity of 400 kVa. And the factory owner plant to add another transformer with the same capacity in a very soon future. Based on electric bill, the factory consumed electricity 43,851 kWh/month and 62,717 kWh/month on November and December 2016 respectively.

Figure 3-20 : Brick Factory

3.2.5.2. Company Energy Demand

The factory owner always seeks the way to improve efficiency of his production plant. When he knows about rooftop solar panel project, he was very interested. Owner worries about high energy consumption and want to reduce electricity cost using electricity generating from solar panels. It is reported by the owner that factory spend around 62,717 kWh/month (based on electricity bill of Dec 2016).

Figure 3-21 : Brick Production Line

It is reported that the total energy demand is around 400 kVa. Below is the list of electric motors of the factory.

Type of Motor	Rated (kW)	No.	Total (kW)
Roller crush	30	1	30

Double Shaft Mixer	30	2	60
Extruder	110	1	110
Cutting Machine	30	1	30
Transfer Conveyor 1	1.5	7	10.5
Transfer Conveyor 2	3	7	21
Air Blower for Brick Burning	30	2	60
Water pump	22.5	1	22.5
Total			344

Table 3-17 : List of electric motors of the current plant

The factory owner plan to double his production in very soon future.

Type of Motor	Rated (kW)	No.	Total (kW)
Roller crush	30	1	30
Double Shaft Mixer	30	2	60
Extruder	110	1	110
Cutting Machine	30	1	30
Transfer Conveyor 1	1.5	7	10.5
Transfer Conveyor 2	3	7	21
Water pump	22.5	1	22.5
Total			284

Table 3-18 : List of eclectic motors for the future plant

3.2.5.3. Available Roof Space

The factory located on the land of 160,000 m2. There are 4four roof spaces available (44m x 100m) for solar panel installation.

Figure 3-22 : Roof space available

Roof space	Width (m)	Length (m)	Surface (m2)
Roof area 01 (wooden structure)	44	100	4400
Roof area 02 (steel structure)	44	100	4400
Roof area 03 (steel structure)	44	100	4400
Roof area 03 (steel structure)	44	100	4400
			0
Total			17600

Table 3-19 : Available Roof Space

3.2.5.4. Specification of Sharp panel

Product features:

- Positive power tolerance: Production controlled positive power tolerance from 0- to +5%. Only modules will be delivered that have the specific power or more for high energy yield.
- High-performance PV module: Made of polycrystalline(156mm2) silicon solar cell with module efficiency up to 16.2 %.

- PID (potential-induced degradation) free: Sharp delivers convincing performance in independent test by Fraunhofer.
- 4 bus bars technology for enhancing the power output

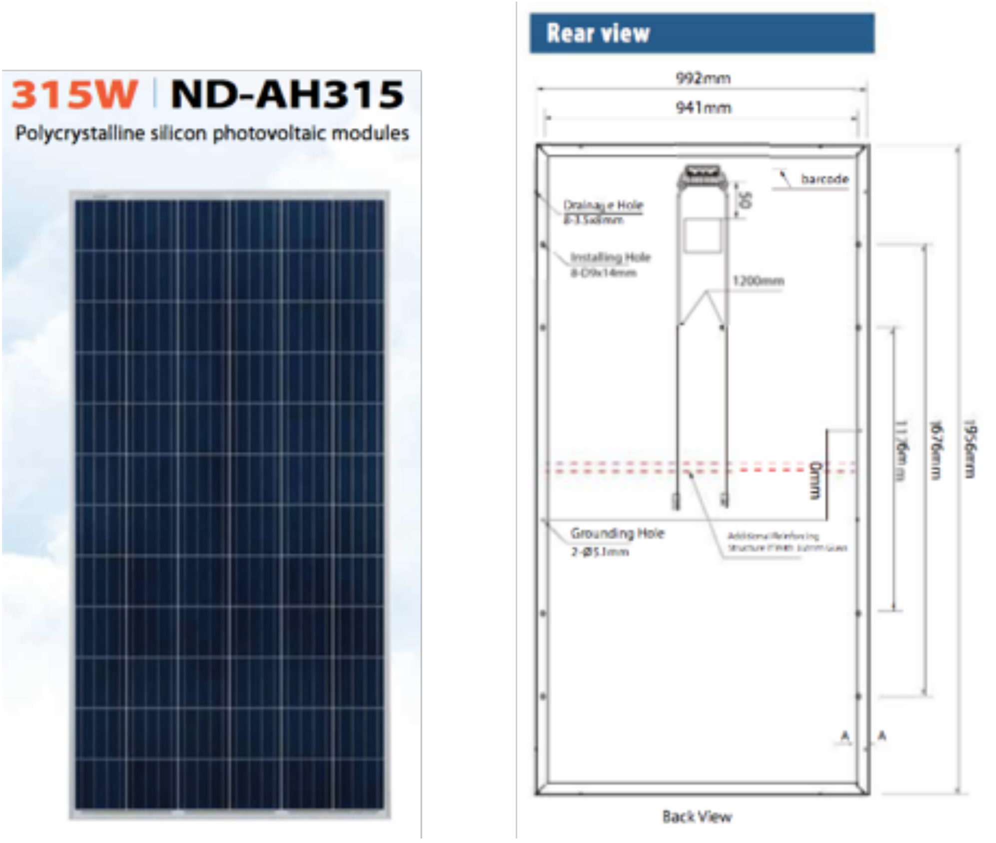


Figure 3-23 : Panel Specification

MECHANICAL DATA	ND-AH315
Cells	polycrystalline, 156 mm square
No. of cells and connections	72 in series(6strings)
Dimensions ((LxWxD)	1,956x992x40 mm
Weight	22.5 kg
Front glass	Low iron tempered glass, 3.2 mm
Frame	Anodized aluminium alloy, silver
Connection Box	IP-rating 67, 3 bypass diodes
Cable	4mm² /1200±50 mm
Connector	Renhe connector

Electrical data (at STC*)		ND-AH315	
Maximum power	P_{max}	315	W_p
Torerance of Pmax		+5% / -0%	
Open-circuit voltage	V_{oc}	45.6	V
Short-circuit current	I_{sc}	9.08	A
Voltage at point of maximum power	V_{mpp}	37.2	V
Current at point of maximum power	I_{mpp}	8.47	A
Module efficiency	η_m	16.2	%

STC = Standard Test Conditions: irradiance 1,000 W/m², AM 1.5, cell temperature 25 °C

Electrical Data (NOCT)			
Maximum power	Pm(W)	227.1	W
Power Output Tolerance	Pm(W)	+5%/-0%	W
Maximum Power Voltage	Vm(V)	33.8	V
Maximum Power Current	Im(A)	6.72	A
Open Circuit Voltage	Voc(V)	42.2	V
Short Circuit Current	Isc(A)	7.30	A

NOCT: Irradiance at 800W/m², Ambient Temperature 20C, Wind Speed 1m/s.

Figure 3-24 : Panel Specification

3.2.5.5. PV system sizing

Based on current energy demand, we can install 1,270 of sharp panels which is equivalent to 400 kWp.

Sharp PV	315	Wp
No. of PV module	1270	modules
Inverter, 33 kW	12	pcs
Total kWp	400	kWp

Table 3-20 : Size of PV system proposed

3.2.5.6. Estimate Energy Generation

The calculation of energy generation is based on monthly average insolation incident on horizontal surface (kWh/m2/day) by NASA. With the 400 kWp PV system we can produce on average around 993 kWh/day.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.4	5.7	5.8	5.9	5.6	5.2	5.1	4.8	4.6	4.7	5.0	5.0

Table 3-21 : Monthly Averaged Insolation Incident on Horizontal Surface (kWh/m2/day) by NASA

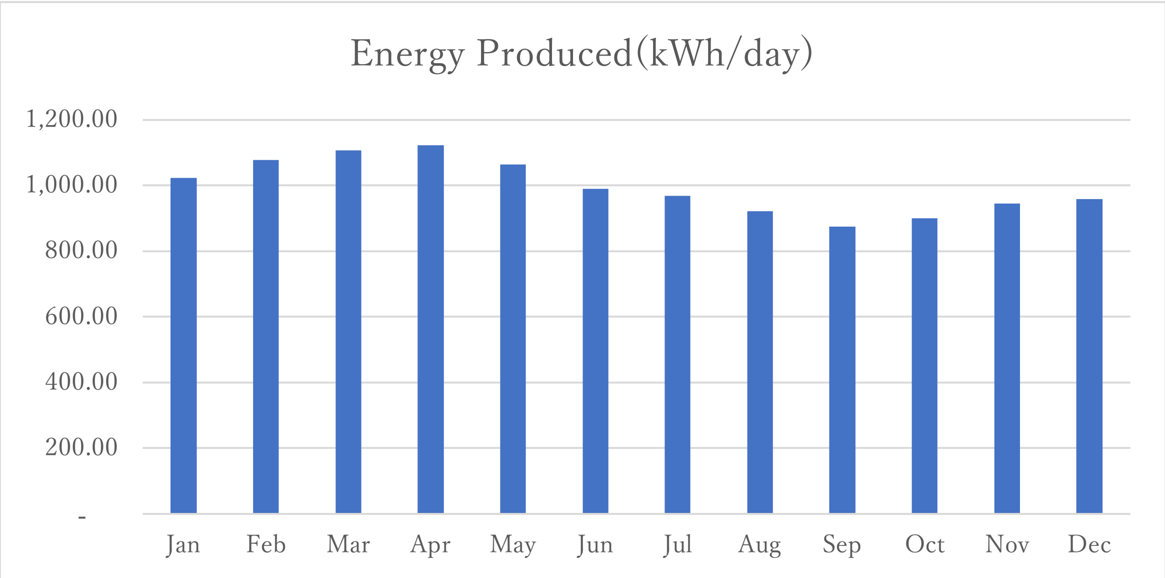


Figure 3-25 : Estimated Energy Production from PV

3.2.5.7. Financial plan

Investment

No.	Item	Qty	Unit	Price/unit	Total ($)
1	PV module				
	Sharp, poly-crystalline, 315 Wp	400,000	W	0.94	376,000
2	Inverter				
	Huawei, 33 kW	12	pcs	3,374.00	40,488
	Huawei, 20 kW	-	pcs	2,200.00	-
3	Mounting component				
	For PV module	1,270	module	40.00	50,794
4	Cable & accessories	400,000	W	0.10	40,000
5	Installation & labor cost	1,270	module	30.00	38,095
6	Transportation & store, other	1,270	module	4.00	5,079
	Total				550,456

Table 3-22 : Estimated Financial Investment

3.2.5.8. Saving

With the 400 kWp solar panel system, energy around 358,665 kWh will be produce annually. Based on the electricity cost of $0.1675/kWh the factory will be able to save around $60,076/year.

Electricity cost	**0.1675**	**$/kWh**
Annually energy production	358,665	kWh/year
Monetary saving	60,076	$/year
Simple payback period	9.1	years

Table 3-23 : Annual Financial Saving

3.2.5.9. CO2 reduction

The amount of electrify generated from PV system will replace a small portion of the existing electricity from EDC, this reduction will equivalent to CO2 reduction. In case the PV system in a proposed project activity is connected to an internal grid which is not connected to the national grid, the emission factor is set to 0.533 tCO2/MWh.

Emission factor	**0.533**	**kgCO2/kWh**
Annually energy production from solar panel	358,665	kWh/year
Total emission reduction	191	TCO2/year

Table 3-24 : Annual CO2 Reduction

3.2.6. C-Factory

3.2.6.1. Overview of C-Factory Project Profile

Eco Village C is located at Siem Reap province, Cambodia. The project is plan by company A in order to implement indoor container hydroponics plant by using LED lighting. This project will be the first indoor hydroponics plant in Cambodia. The total of 9 of 40 feet containers will be used to make the plant. Two container will be used be office and meeting room and the other 5 containers will be used for indoor hydroponics plant which will operated 24 hours per day to produce many kind of vegetable and herb for supply to the high-class restaurant in Siem Reap. And the other 2 containers will be used for restaurant. On the rooftop of the hydroponics plant solar panels will be installed with battery storage system to supply electricity to the whole plant. Around the plant there is also free space of land available for solar ground mounted to complete the total consumption of the plant.

Figure 3-26 : A-Village

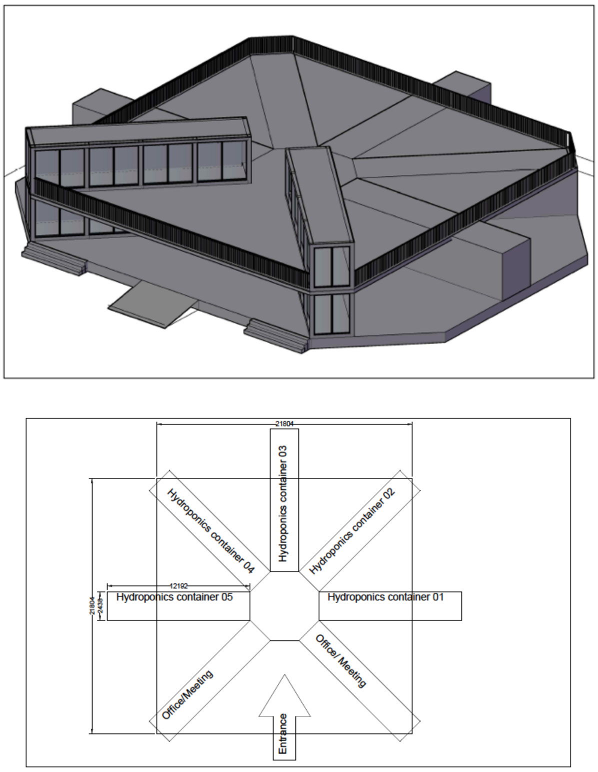


Figure 3-27: Container Hydroponics Plant 3D and 2D view

3.2.6.2. Energy Demand

The plant will be an off-grid system which will be depend 100% on electricity generated from solar panels.

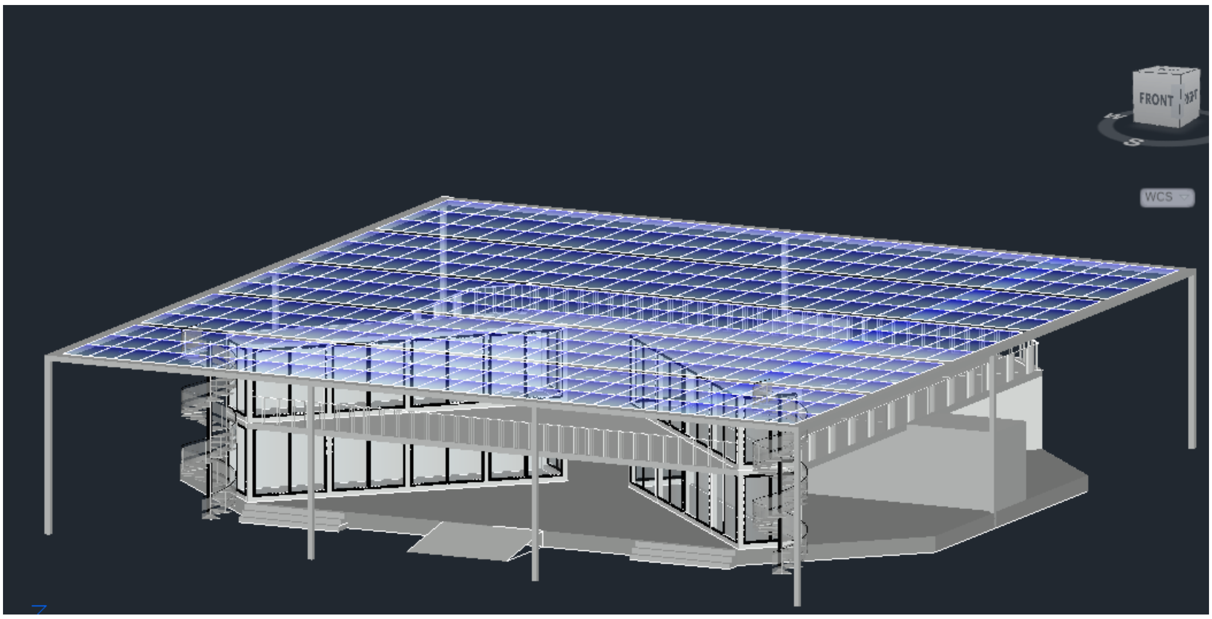


Figure 3-28 : 3D view of Container Hydroponics plant

Based on existing container hydroponics plant from other country, the whole plant will consume around 523 kWh/day (24 hours).

Type of container	No.	Energy consumption(kWh/day)	Total (kWh/day)
Hydroponic	5	100	500
Meeting	1	7	7
Office	1	16	16
Restaurant	2	(will be done in future)	
		Total	523

Table 3-25 : Estimated energy consumption per day

3.2.6.3. Available roof space

The hydroponics plant will be located at the eco-village. Based on the plant drawing the roof space of the plant is 985.31m2 (32.54mx 30.28m). Solar ground mounted will also be need to meet the whole consumption of the plant.

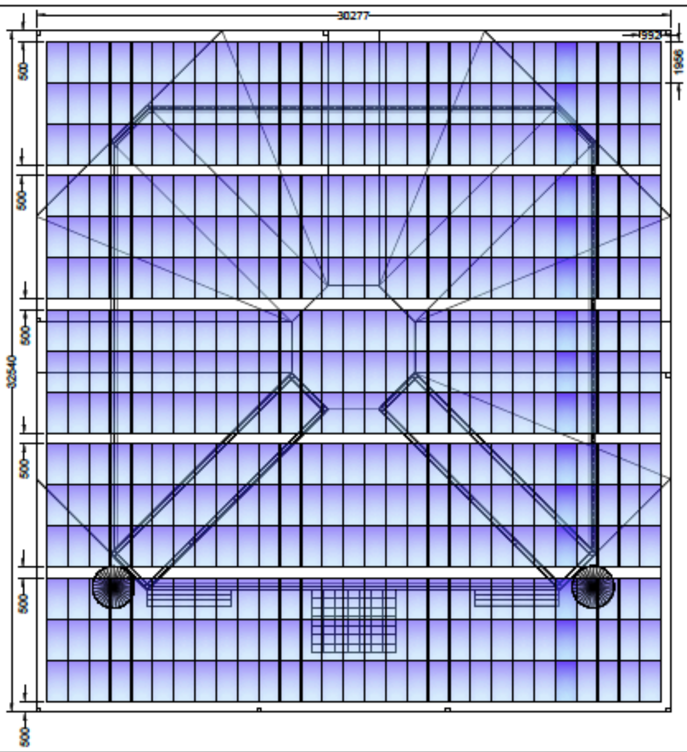


Figure 3-29 : Top view of the plant with PV panels

3.2.6.4. Specification of Sharp panel

Product features:

- Positive power tolerance: Production controlled positive power tolerance from 0- to +5%. Only modules will be delivered that have the specific power or more for high energy yield.
- High-performance PV module: Made of polycrystalline(156mm2) silicon solar cell with module efficiency up to 16.2 %.
- PID (potential-induced degradation) free: Sharp delivers convincing performance in independent test by Faunhofer.
- 4 bus bars technology for enhancing the power output

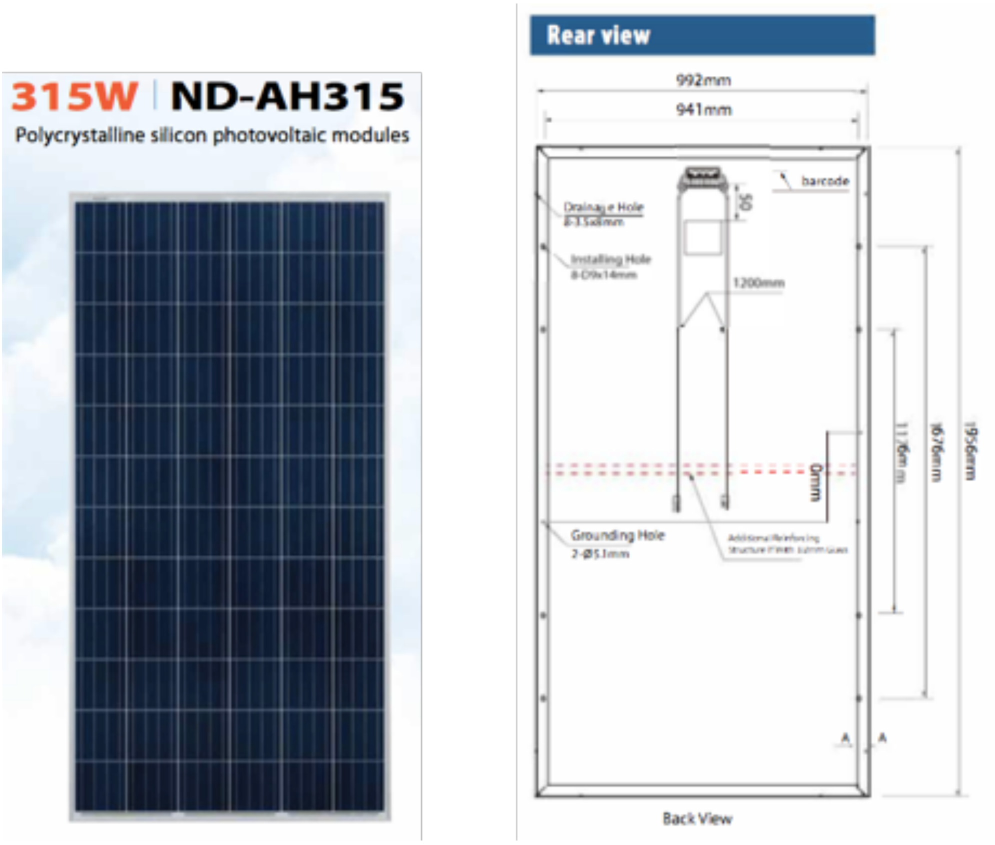


Figure 3-30 : Solar panel

MECHANICAL DATA	ND-AH315
Cells	polycrystalline, 156 mm square
No. of cells and connections	72 in series(6strings)
Dimensions ((LxWxD)	1,956x992x40 mm
Weight	22.5 kg
Front glass	Low iron tempered glass, 3.2 mm
Frame	Anodized aluminium alloy, silver
Connection Box	IP-rating 67, 3 bypass diodes
Cable	$4mm^2$ /1200±50 mm
Connector	Renhe connector

Electrical data (at STC*)			
		ND-AH315	
Maximum power	P_{max}	315	W_p
Torerance of Pmax		+5% / -0%	
Open-circuit voltage	V_{oc}	45.6	V
Short-circuit current	I_{sc}	9.08	A
Voltage at point of maximum power	V_{mpp}	37.2	V
Current at point of maximum power	I_{mpp}	8.47	A
Module efficiency	η_m	16.2	%

STC = Standard Test Conditions: irradiance 1,000 W/m², AM 1.5, cell temperature 25 °C

Electrical Data (NOCT)			
Maximum power	Pm(W)	227.1	W
Power Output Tolerance	Pm(W)	+5%/-0%	W
Maximum Power Voltage	Vm(V)	33.8	V
Maximum Power Current	Im(A)	6.72	A
Open Circuit Voltage	Voc(V)	42.2	V
Short Circuit Current	Isc(A)	7.30	A

NOCT: Irradiance at 800W/m², Ambient Temperature 20C, Wind Speed 1m/s.

Figure 3-31 : Panel Specification

3.2.6.5. PV system sizing

Based on energy demand, we will need around 630 panels of 315 Wp Sharp panel. We can install 435 modules on the rooftop of container and another 195 modules will be ground mounted PV modules.

Sharp PV	**315**	**Wp**
No. of PV module,	630	modules
Inverter, 33 kW	6	pcs
Total kWp	200	kWp

Table 3-26 : Size of PV system proposed

3.2.6.6. Estimate Energy Generation

The calculation of energy generation is based on monthly average insolation incident on horizontal surface (kWh/m2/day) by NASA. With the 200 kWp PV system we can produce on average around 486 kWh/day.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.36	5.65	5.80	5.89	5.58	5.19	5.08	4.83	4.59	4.69	4.56	4.43

Table 3-27 : Monthly Averaged Insolation Incident on Horizontal Surface (kWh/m2/day) in the location by NASA

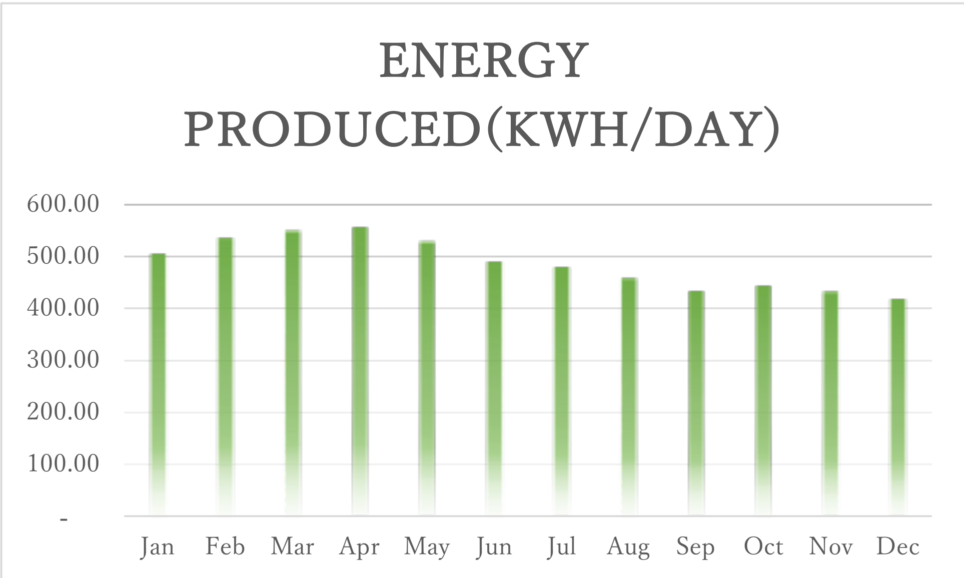


Figure 3-32 : Estimated energy production from PV

3.2.6.7. Financial plan

The plant will operate for 24 hours, the battery system will be needed. The whole system cost will be much higher than the system without battery system.

No.	**Item**	**Qty**	**Unit**	**Price/unit**	**Total ($)**
1	PV module				
	Sharp, poly-crystalline, 315 Wp	200,000	W	0.94	188,000
2	Inverter				
	Huawei, 33 kW	6	pcs	3,374.00	20,244
	Huawei, 20 kW	-	pcs	2,200.00	-
3	Mounting component				
	For PV module	630	module	40.00	25,200
4	Cable & accessories	200,000	W	0.10	20,000
5	Installation & labor cost	630	module	30.00	18,900
6	Transportation & store, other	630	module	4.00	2,520
7	Storage system	200,000	W	N/A	N/A
	Total				TBC

Table 3-28 : Estimated financial investment

3.2.6.8. Electricity Saving

With the 200 kWp solar panel system, energy around 358,665 kWh will be produce annually. Based on the electricity cost of 0.1675 $/kWh the factory will be able to save around 29,323 $/year.

Electricity cost	**0.1675**	**$/kWh**
Annually energy production	175,064	kWh/year
Monetary saving	29,323	$/year
Simple payback period	N/A	years

Table 3-29 : Annual financial saving

3.2.6.9. CO2 reduction

The amount of electrify generated from PV system will replace a small portion of the existing electricity from EDC, this reduction will equivalent to CO2 reduction. In case the PV system in a proposed project activity is connected to an internal grid which is not connected to the national grid, the emission factor is set to 0.533 tCO2/MWh.

Emission factor	**0.533**	**kgCO2/kWh**
Annually energy production from solar panel	175,064	kWh/year
Total emission reduction	93	TCO2/year

Table 3-30 : Annual CO2 reduction

3.3. Technical characteristics and superiority of the rooftop solar PV modules

The fundamental equipment of rooftop solar system is as follows.

3.3.1. Ultra-lightweight solar panel "Lightjoule"

Lightjoule is an ultra-lightweight solar panel. By using thin and chemically strengthened glass Leoflex as a cover glass of the PV panel, Asahi Glass Company successfully reduced the panel weight of Lightjoule by nearly 50% compared to conventional solar panels. Lightjoule received New Energy Award 2014 from New Energy Foundation.

Crystal silicon solar cell module mainly consists of cover glass, solar cell, encapsulant,

back sheet, and aluminum frame. Two third of total weight is only by the temper cover glass. It is possible to manufacture the light solar panel if the glass can be lighter, however it is normally difficult because the glass requires certain thickness to keep its strength. The world standard of glass thickness is 3.2mm now.
Asahi Glass Company developed 0.8mm thickness temper glass Leoflex which can be replaced of 3.2mm glass. Now it is used for their solar PV module by passing all quality tests.

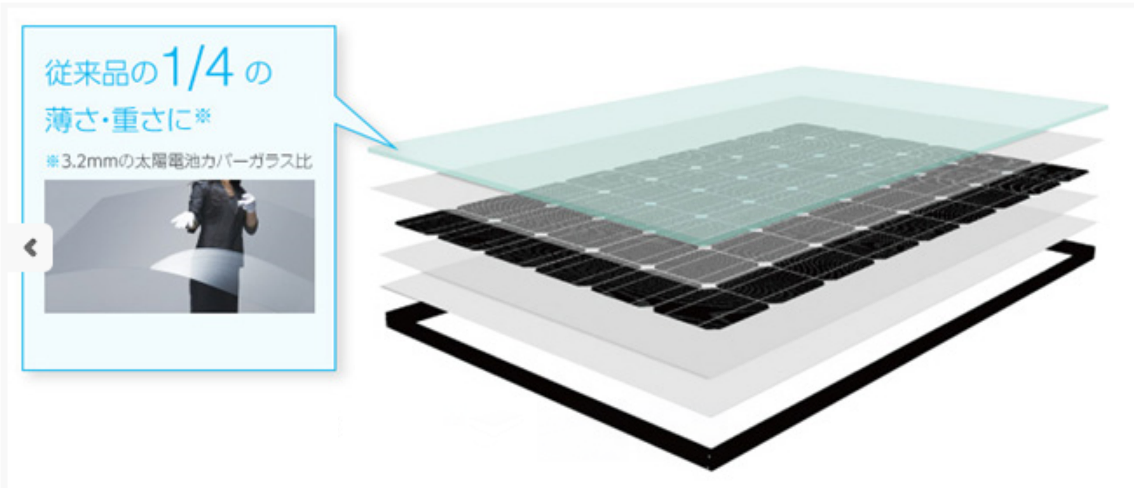


Figure 3-33 : Structure of Lightjule
(Source : http://www.nef.or.jp/award/kako/h26/p05.html)

Lightjoule ultra-lightweight photovoltaic module expands the solar installation possibilities for the building which has not enough load capacity such as metal sheet roofing of factories, warehouses, stores, and carports, and secondary structures (parking areas, bus stops).

There are three advantages of Lightjoue.

- Approximately 50% lighter than conventional solar panels (Convertible solar panel: 17.0kg/sheet => Lightjoule: 9.5kg/sheet)
- Possible to install on the small load capacity rooftop without reinforcement work
- Easy to carry and high installation efficiency

Chemically strengthened glass Leoflex is used on Lightjoue. This achieved a significant weight reduction while passing snow accumulation and wind pressure tests up to 2400Pa. It achieved top world-class quality by combining latest technologies of glass and photovoltaic module.

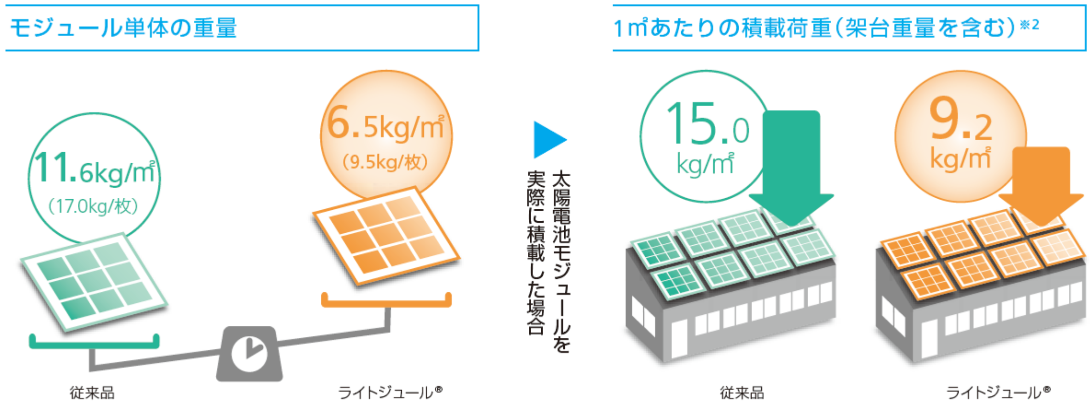


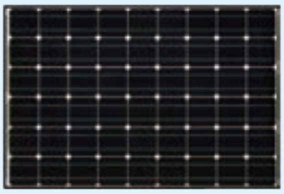
Figure 3-34：Weight of PV module and load capacity per 1m^2

(Source : Asahi Glass Company)

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

Ultra-lightweight photovoltaic module Lightjoule uses Leoflex, which is a chemically strengthened glass manufactured by AGC. Leoflex attains a higher strength than conventional tempered soda-lime glass. It is hard to break even the thickness is thinner. This technology makes possible to manufacture the lighter-weight glass. Leoflex is strengthened by transfering Na+ ions contained around the surface of glass to K+ ions which has a larger diameter. This has helped to achieve the high level of thinness and strength that was previously unachievable in physically tempered glass.

LW225SZ1A



単結晶

公称最大出力	セル実効変換効率	モジュール変換効率
225W	17.43%	15.41%

品番	LW225SZ1A
セル種類	単結晶シリコン
セル枚数	54枚
公称最大出力	225W
公称開放電圧	34.5V
公称短絡電流	8.70A
公称最大出力動作電圧	28.2V
公称最大出力動作電流	7.98A
外形寸法 W×D×H	1482×985×35mm
質量	9.5kg

Figure 3-35 : Specification of ultra light weight module Lightdule

(Source: Asahi Glass Company)

Reference site of Lightdule

① Asahi Glass Company Kansai Factory Takasago Office

② Hanshin Electric Railway Oishi Station

③ Yamabishi Kogyo Co., Ltd Yasutomi Factory

3.3.2. Glass Integrated PV Solution SUNJOULE

SUNJOULE is a building integrated photovoltaics, in which structure is laminated safety glass embedded solar cells. It can be used for many types of location for its lighting and durability.

Main characteristics of SUNJOULE are;

・High durability and long life module

(As SUNJOULE is a laminated safety glass type, high durability is realized. EVA with high durability is used as interlayer film. Solar cells are designed to have enough distance from glass edge to secure long life.)

・Creation of unique space and flexibility of design

(SUNJOULE is custom product with free design and offer design of solar cell as per request. Supporting method of SUNJOULE is basically either by aluminum frame or by frameless.)

・Comfortable lighting and shielding effect

・Large size module (Maximum 1800mm×2400mm)

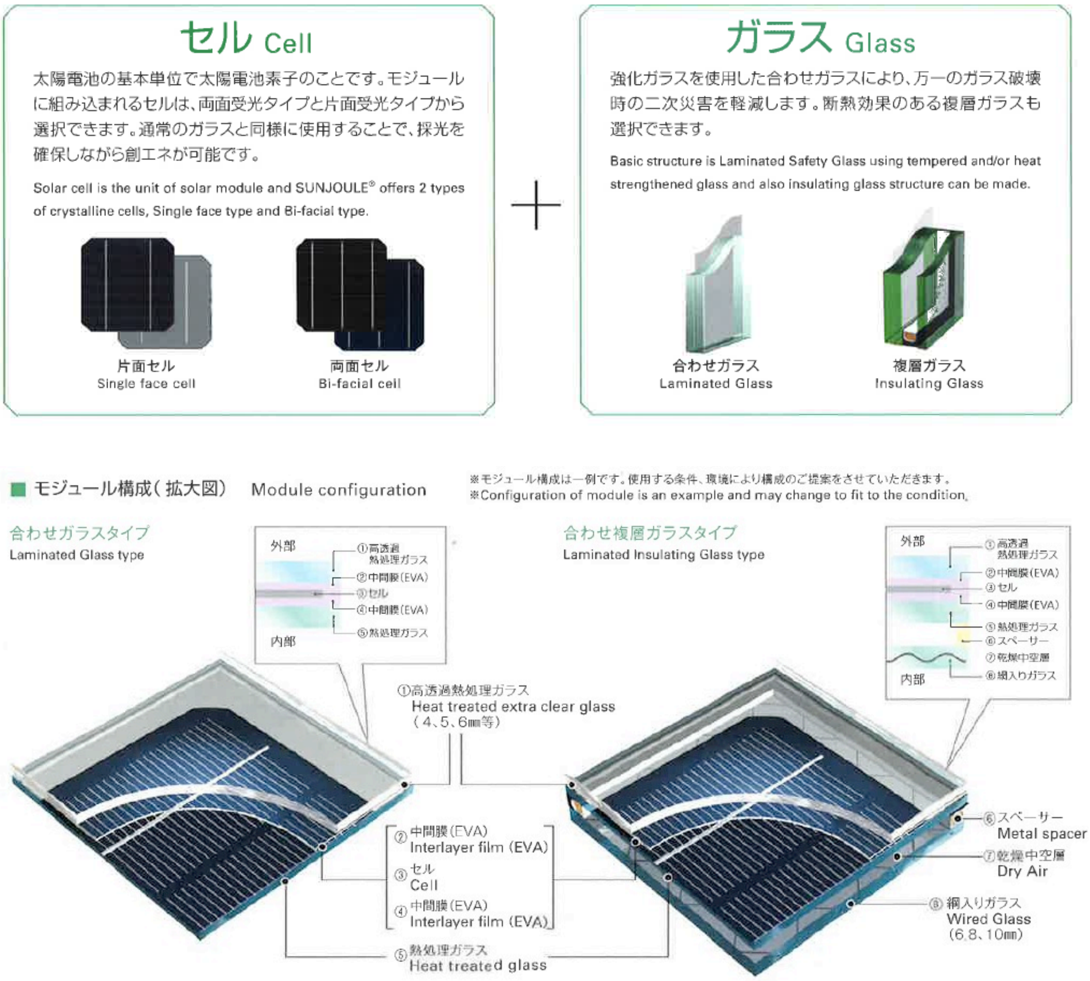


Figure 3-36 : Structure of SUNJOULE

(1) Proposal of SUDARE and SUNERGY based on C2CC

The issue of power generation on the rooftop of public school or public architecture that was found in the feasibility study based on C2CC is that electrical generation amount is limited because of the small size rooftop.

The size of rooftop of school or public architecture are small compare to the factory or warehouse. It is possible to install solar panel only on the south side of the rooftop since the public architecture in Siem Reap area are mostly using gable roof.

Therefore, SUNJOULE has a potential of generating electricity in Siem Reap by installing it on the wall or window. By installing it vertically on the south part of the building, it is expected to generate much more energy equivalent to the whole space of rooftop. Notably SUDARE is effective on the window.

SUJOULE SUDARE is using single-crystal silicon cell. It is a new type of module which can keep the power generation effectiveness with see through glass. Its cells can be connected as per customer request.

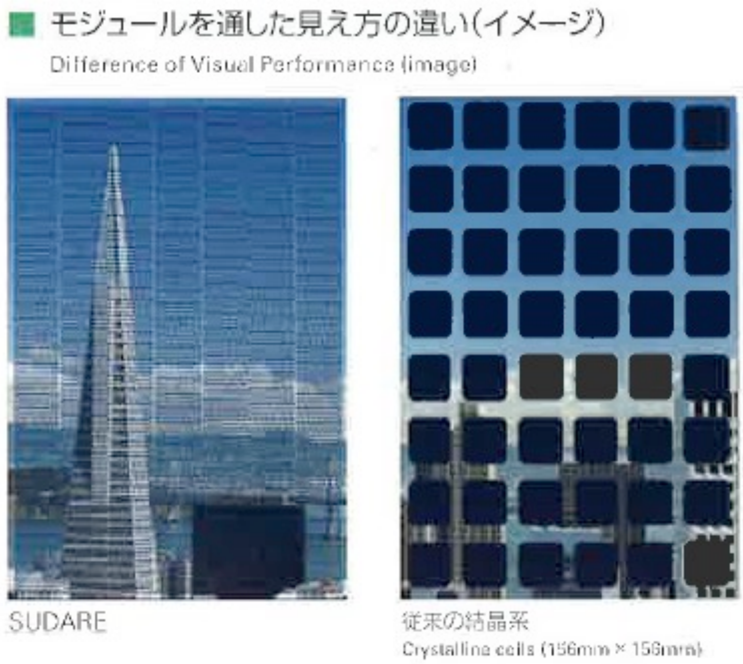


Figure 3-37 : Comparison between SUDARE and crystalline cells

If the crystalline cells are used for the window, it is hard to see the outside. However, SUNJOULE SUDARE solves this problem. The first installation project of this product was in Kirin Beer Yokohama Factory in Kanagawa prefecture in 2016.

Figure 3-38: Reference of SUDARE

On the other hand, Cambodia has much more insolation compare to Japan. Normal SUNJOULE SUDARE might be not enough for solar shading. Thus, Asahi Glass Company combined their online coating heat shielding glass SUNERGY with SUDARE. This module can achieve both of solar shading and heat insulation.

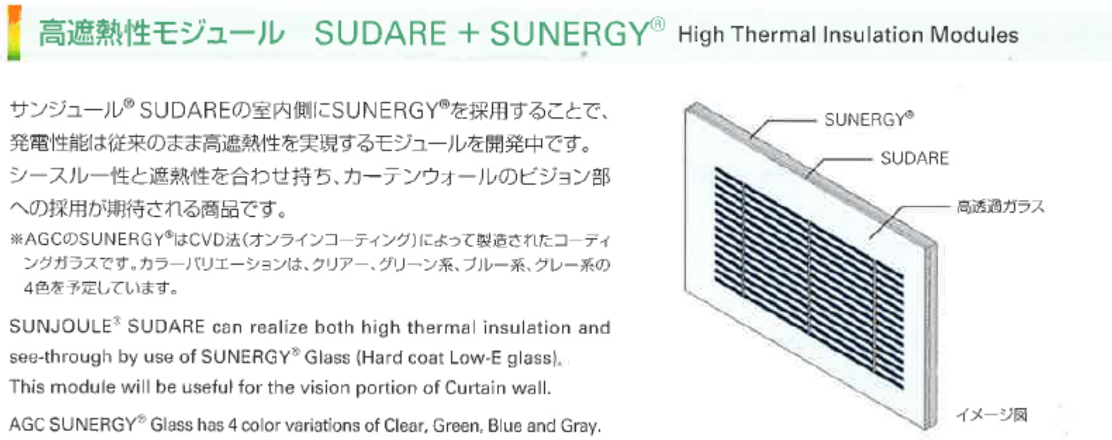
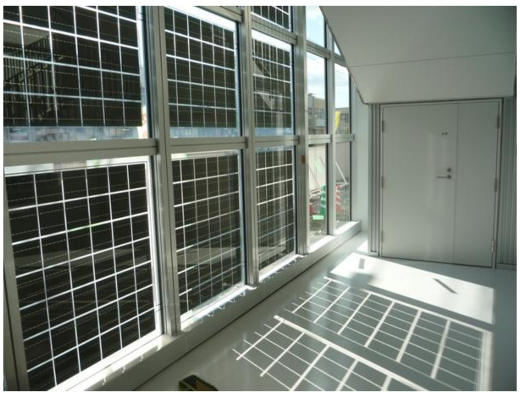


Figure 3-39 : High Heat Insulation Module

(2) Installation Reference of SUNJOULE at School

Asahi Glass Company have already installed SUNJOULE to many schools.

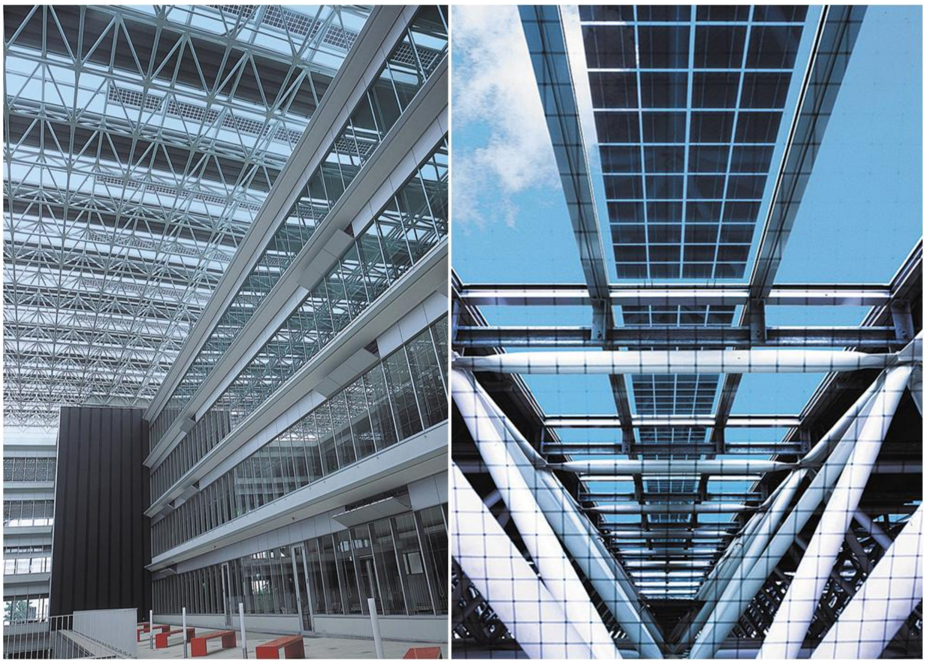
① Okayama city west elementally school (Okayama)



② Ariake Elementally Schoo (Tokyo)

③ Ogikubo Elementally School (Tokyo)

④ Keio University (Kanagawa)



⑤ Tama Art University (Tokyo)

⑥ Seitoku Gakuen (Chiba)

3.4. Establishment of the subsidiary in Cambodia

3.4.1. Business plan

Asian Gateway (Cambodia) Co., Ltd.（AGCC）, the subsidiary of Again Gateway, is the company pursuing decentralized power development which designs, constructs and operates rooftop PVs for self-production and consumption of energy. Business concept of AGCC is as follows.

A) The main target segments are the rooftops of hotels, schools and factories
B) Standardization of installation techniques for rooftops (light-weight and easy-to-install racks and jigs) and education of local installers for higher quality
C) Package sales of Japanese PV equipment and systems (PV modules, power conditioners, inverters, hybrid systems, batteries, monitoring etc.) and one-stop maintenance services
D) Targeting off-grid self-consumption (without grid connection) as main customers.
E) 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
F) Services of stabilizing grid connection for decentralized powers (ancillary services)
G) Direct selling to a rooftop factory owner based on a Power Purchase Agreement (PPA)
H) Providing energy management services and selling power saving equipment

3.4.2. Risks and Analysis

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

A) possibilities to secure the stable business foundation under the local legal policies, economics, technology, and customs
B) possibilities to differentiate from other renewable energies
C) possibilities to make win-win relationships among rooftops owners of hotels, commercial facilities, schools, factories and industrial parks developers
D) Possibility of differentiation, competition against later comers with the same business model

3.5. 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.

3.5.1. The 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.

3.5.2 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.

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

3.5.3. Reference emissions

The reference emissions of the method 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).

3.5.4. Project emissions

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

3.5.5. 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 3-31 : Default value for calculating reference emissions

Parameter	Content	Value	Source
EF_{RE}	The emission factor of the grid and captive electricity	0.533 tCO2/MWh	In case the PV system in a proposed project activity is connected to an internal grid which is not connected to the national grid, the emission factor is set to 0.533 tCO2/MWh. (https://www.jcm.go.jp/kh-jp/methodologies/46)

3.5.6. 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 3-32 : 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.

3.6. Economic effects

3.6.1. Effects of Introducing Rooftop PVs

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

- Based on the drawings obtained from C-Hotel, 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”.

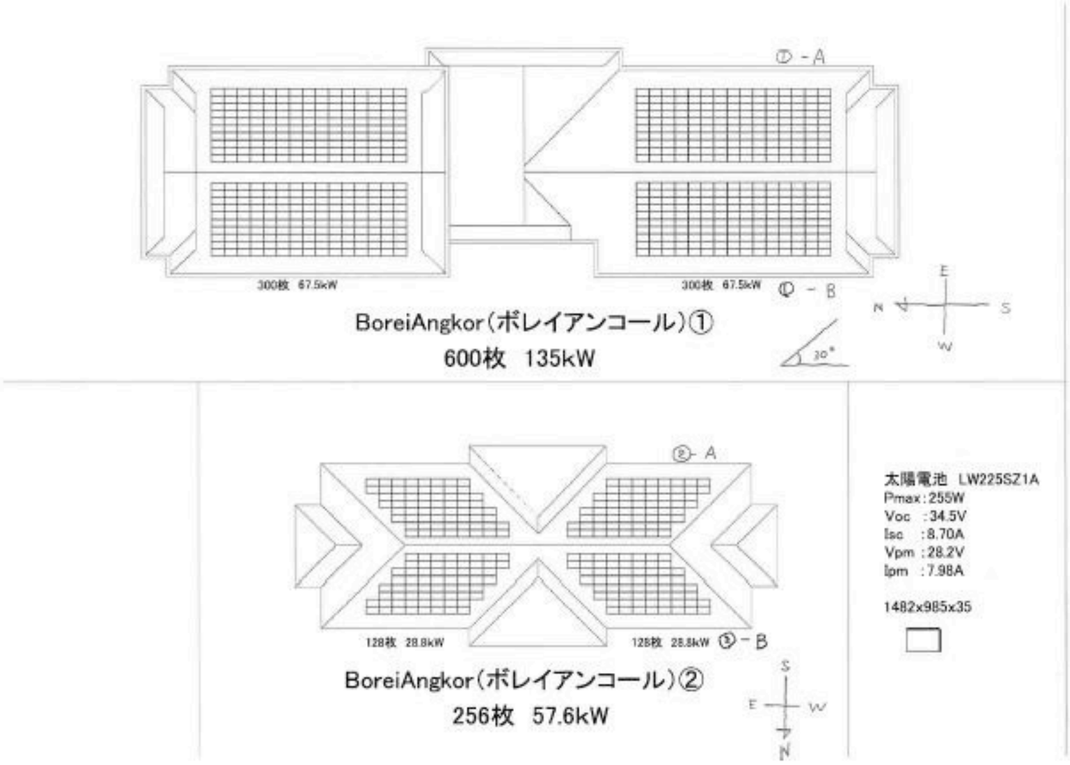


Figure 3-40：Panel layout for C-Hotel

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

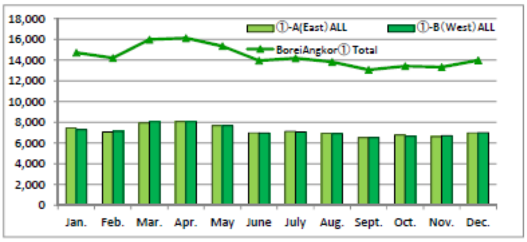
Annual power generation simulation of PV system

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'	$=K_{HD}\times K_{PD}\times K_{PM}\times K_{PA}\times \eta_{INO}$
T_{CR}	$=T_{AV}+\Delta T$
K_{PT}	$=1+\alpha_{Pmax}\times(T_{CR}-25)/100$
K	$=K'\times K_{PT}$
H_{Am}	$=H_S\times d$
E_{Pm}	$=K\times P_{AS}\times H_{Am}/G_S$

【Various coefficient list】

Symbol	Name	Numeric value	Unit
K_{HD}	: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 3-41：Power generation simulation of Building ① (600 PV panels)

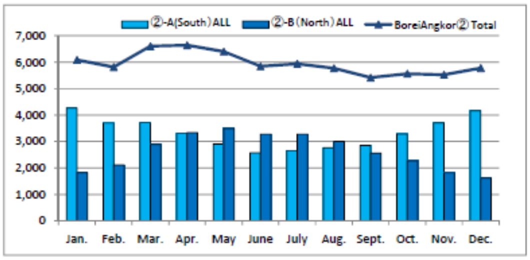
Annual power generation simulation of PV system

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'	$=K_{HD}\times K_{PD}\times K_{PM}\times K_{PA}\times \eta_{INO}$
T_{CR}	$=T_{AV}+\Delta T$
K_{PT}	$=1+\alpha_{Pmax}\times(T_{CR}-25)/100$
K	$=K'\times K_{PT}$
H_{Am}	$=H_S\times d$
E_{Pm}	$=K\times P_{AS}\times H_{Am}/G_S$

【Various coefficient list】

Symbol	Name	Numeric value	Unit
K_{HD}	: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 3-42：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 3-33：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)

3.6.2. Other economic effects

(1) System operation result

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

① The PV output is to be controlled so that the minimum operational power output is maintained at 300kW for the diesel power generator.

② The actual time period of power cuts in 2014 is used.

③ The average price of 1.05USD/Liter is used as the diesel price for 2014.

④ The 2014 average tariff of 0.175USD/kWh is used as the tariff of the grid for 2014.

Table 3-34：Result of Annual operation simulation

	Inclined irradiation [kWh/m^2]	Averaged ambient temp.	PV Output [kWh]	Fuel reduction [Liter]	Fuel cost reduction [USD]	Electricity reduction	Electricity cost reduction
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 3-35：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

1. 3.6.2.3. 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.

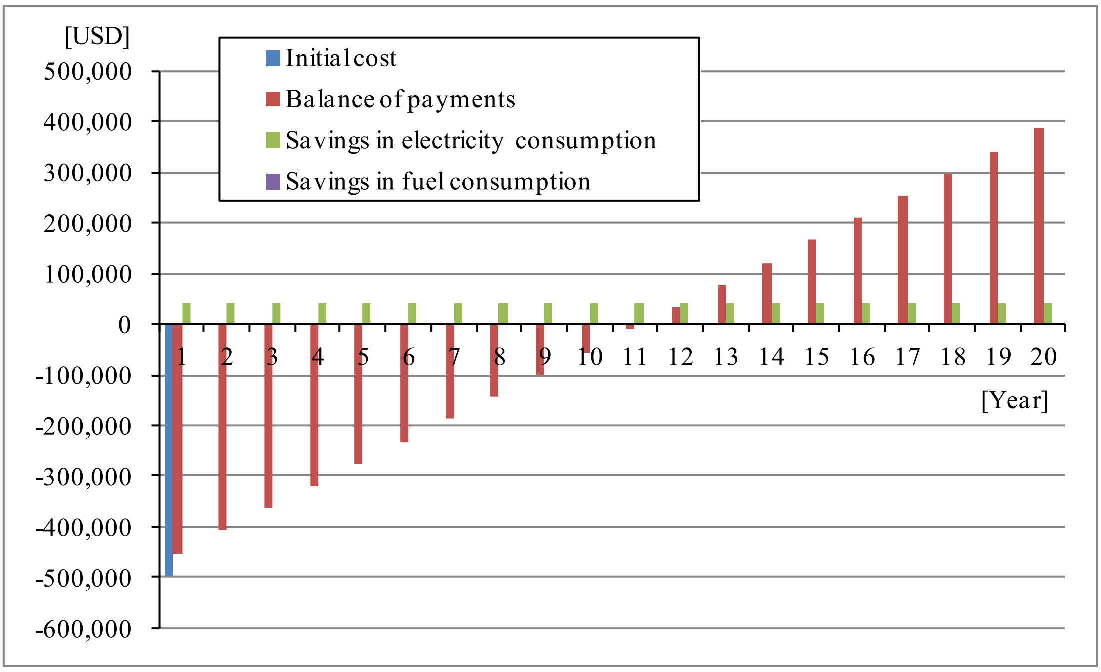


Figure 3-43：Estimation of balance of payments

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

4.1. Purpose of City to City Cooperation

Purpose

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

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)

4.2. Capacity Building

4.2.1. Invitation to Japan

2 persons of Siem Reap Province were invited to Kanagawa Prefecture from 16th -22nd October 2016. They learned related institutions of the Prefecture in order to apply it in Cambodia in the future. During this training program, they exchanged opinions with the Industry and Energy department, the Industry and Labor Bureau of Kanagawa Prefecture and went to inspection.

4.2.2. Workshop in Cambodia

Several seminars were organized for the 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 with 50 participants was held in 20th May. After that, meetings were held every month and the final seminar was in 17th February.

4.2.3. Presentation at High Level Seminar on Environmentally Sustainable Cities in Kitakyushu, Japan

The study team made a presentation in order to disseminate the activities of this project at High Level Seminar on Environmentally Sustainable Cities in Kitakyushu, Japan from 20th and 21st October 2016.

We introduced our projects and discussed the significance of C2CC for a low-carbon society. (Appendix number is)

4.3. Action Policy in Future

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

1) Support to instruct prevalence of community solar PV on rental rooftops
    - A community development for a low-carbon city as a whole
    - Capacity building for implementing and managing the community
    - Invitation of Siem Reap Provincial staff to Kanagawa prefecture and practical training on policy development and administrative guidance

2) Support to promote tourism city transport
    - Introduction of EV vehicles for tourism activation which is conducted in Hakone town, Kanagawa
    - Inspection and promotion of EV mobility and system such as EV taxi, EV bike, EV rental, and EV sharing
3) Disposal system of urban waste
    - Introduction of systematic disposal
4) 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.

5. Policy Proposals

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 agricultural area and the fishing area near Tonle Sap Lake. In the province, there are many areas with no connection to the national grid. Besides, the land is not fertile and disparity is serious. 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.

As an increase of tourists in recent years, the problems of disposals of urban waste is getting worse. In conclusion, important policy proposal is disposal system utilizing organic solid waste for a low-carbon society.

Appendix 1 ：Proposed Methodology Form

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.
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：Proposed Methodology Form of Amorphous

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	Project emissions are calculated by no-load losses of the project

emissions	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, $\mathrm{RE_p}$, during the period *p* are given by:

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

Where:

$\mathbf{RE_p}$: 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
$\mathbf{NLL_{RE,i,j,k}}$	: No-load losses of the reference transformer i of capacity category k for the power company j [W]
$\mathbf{H_{i,p}}$	: Energizing time of the project transformer i during the period p [hour/p]
$\mathbf{Br_p}$	: Blackout rate during the period p [fraction]
$\mathbf{EF_{grid}}$	: 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:

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

Where:

$\mathbf{PE_p}$	: 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
$\mathbf{NLL_{PJ,i,j,k}}$	: No-load losses of the project transformer i of capacity category k for the power company j [W]
$\mathbf{UNC_i}$	: Maximum allowable uncertainty for the no-load losses of the project transformer i [fraction]
$\mathbf{H_{i,p}}$	: Energizing time of the project transformer i during the period p [hour/p]
$\mathbf{Br_p}$	: Blackout rate during the period p [fraction]
$\mathbf{EF_{grid}}$	: 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: $\mathbf{ER_p}$: Emission reductions during the period p [tCO_2/p] $\mathbf{RE_p}$: Reference emissions during the period p [tCO_2/p] $\mathbf{PE_p}$: 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.

Tentative schedule of a study tour in Japan
16 October - 22 October 2016

Participant: Mr. Sophean Ung and Mr. Kemchun Chek/Ms. Chandany Sen No. of participants : 3 persons

Duration: From 16 Octoberr to 22 Octoberr 2016 Language: Khmer-English-Japanese

As of September 24 2016

Date	Time			Contents	Person in charge	Place	Stay
17-Oct (Mon)	19:00 (16-Oct)	~	11:00	Siem Reap > Phnom Penh > Narita > Yokohama	-		Washington Hotel Yokohama Sakuragicho (http://yokohama-s.washington-hotels.jp)
	12:00	~	13:30	Lunch	-	Minato Mirai	
	13:30	~	15:00	Solar and Wind Hybrid LED Street Lighting at Minato Mirai	Mr. Kimura and Mr. Nagata of Asian Gateway	Shin Takashima Station	
	15:00	~	17:00	Workshop with Kanagawa Pref. and Yokohama City	Ms. Matsuura of Kanagawa Prefecture	Kanagawa Prefecture Government Hall	
	18:00	~	20:00	Dinner	-	Minato Mirai	
18-Oct (Tue)	10:00	~	12:00	Taisei ZEB (Zero Energy Building) in Totsuka	Mr. Kawaguchi of Kanagawa Prefecture	Totsuka	Washington Hotel Yokohama Sakuragicho (http://yokohama-s.washington-hotels.jp)
	12:00	~	13:00	Lunch	-		
	13:00	~	15:00	Smart House and Solar LED Street Lighting by Mitsubishi Electric	Mr. Kojima of Mitsubisi Electric	Ohfuna	
	16:00	~	17:30	Solar Energy and Energy Saviing at KIRIN Beer	Mr. Kawanobe of Asahi Glass	Namamugi	
	18:00	~	20:00	Welcom Diner	-	Namamugi	
19-Oct (Wed)	9:00	~	11:00	Move to Ashikaga City of Tochigi Prefecture	-	Ashikaga	Rihga Royal Hotel Kokura (http://www.rihga.com/kitakyushu)
	11:00	~	12:00	Finetech Smart Green Park in Kitakanto	Mr. Okada of Finetech		
	12:00	~	13:00	Lunch	-		
	13:00	~	14:00	Weast to Energy in Finetech Smart Green Park	Mr. Okada of Finetech		
	14:00	~	17:00	Move to Haneda Airport	-	Haneda	
	17:00	~	19:00	Fly to Kitakyusyu City from Haneda	-	Kitakyusyu City	
20-Oct (Thu)	9:00	~	17:00	**JCM-C2CC Workshop**	IGES	Kitakyusyu City	Rihga Royal Hotel Kokura (http://www.rihga.com/kitakyushu)
21-Oct (Fri)	9:00	~	17:00	**JCM-C2CC Workshop**	IGES		Rihga Royal Hotel Kokura (http://www.rihga.com/kitakyushu)
22-Nov (Sat)				Kitakyusyu > Narita > Phnom Penh > Siem Reap			

2016 年 9 月 23 日版

二国間クレジット制度（JCM）都市間連携ワークショップ

10 月 20 日（木）　JCM 都市間連携ワークショップ

●場所：リーガロイヤルホテル小倉 「オーキッド」（3階）

〒 802-0001　北九州市小倉北区浅野 2-14-2　TEL：（093）531-1121 （代）

アクセスマップ：http://www.rihga.co.jp/kokura/access/index.html

●目的：

・ 主として都市間連携 F/S 参加の自治体の都市間連携事業に関する理解を深め、円滑な事業運営を図ることを目的とする。（先行事例については、F/S 及び事業化に向けた課題や解決策を中心に提供してもらい、新規（後発）事業は、活動内容と課題の共有を図り、それぞれの事業運営に役立ててもらう。）

・ 特に、海外の自治体には JCM 資金支援事業の概要や都市間連携 F/S の狙いをきっちり理解してもらい、事業を円滑に進めるために自らがどのような行動を起こすべきかについて考えてもらう機会とするとともに、アジアの都市間で低炭素化に向けた取り組みについて情報交換をすることで、自らの取りくみの更なる推進を図る動機付けとする。

・日本の自治体については、相互の事業進捗や展開についての情報交換の場とする（特に新規参入自治体）

●プログラム（案）

※日英同時通訳付

9:30　開会挨拶（環境省）

9:35　JCM 都市間連携事業及び JCM 資金支援スキーム

①JCM 都市間連携事業概要と期待されるアウトプット（環境省）（10 分）

②資金支援スキーム：設備補助事業（GEC）（10 分）

③資金支援スキーム：JFJCM（環境省）（10 分）

（時間があれば、質疑の時間をとる（5 分程度））

10:10　JCM 設備補助事業に進んでいる成功例に学ぶ、JCM 事業の案件化事例

（日本自治体又は担当事業者（企業））（発表 15 分＋質問 5 分×2 件）

①北九州市／ハイフォン市、スラバヤ市の設備補助事例（NTT データ経営を想定）

②横浜市／ダナン市、バタム市、（バンコク都）の設備補助事例（企業を想定）

10:50　コーヒーブレイク（15 分）

11:05　話題提供：一般廃棄物処理における技術選択と予算化～一般廃棄物処理を事例に～

（北九州市） 25 分＋質疑応答 15 分＝40 分

11:45　平成 28 年度都市間連携事業に参加の海外自治体の取組事例紹介①（各 10 分×4 都市＋質疑 5 分）

各都市の低炭素化計画・指針、その計画や指針（方針）における JCM 都市間連携事業の位置づ

け、期待について紹介いただく。

12:30　昼食休憩（会場「クリスタル」（3 階））

13:30　平成 28 年度都市間連携事業に参加の海外自治体の取組事例紹介②（続）
（各 10 分×5 都市＋質疑 5 分）

14:30　ディスカッション１：「F/S 調査実施の状況及び事業化等における課題」
（北海道庁/札幌市、福島市、神奈川県の 3 事業から 2 名ずつ登壇いただき、パネル形式で実施）

- 今年度の活動予定と目標
- JCM 活用の可能性
- アジア都市の低炭素化を進める上での都市間連携の意義など

15:30　コーヒーブレイク（15 分）

15:45　ディスカッション 2 「F/S 調査実施・事業化における課題と解決策」
（川崎市、横浜市の 2 事業から 2 名ずつ、北九州については 4 事業から 2 名程度に登壇いただき、パネル形式で実施）

- 参加者間における運営課題共有（事前質問への回答を含む）
- 先行事例から課題克服のための取組の紹介
- アジア都市の低炭素化を進める上での都市間連携の意義など
（具体的な解決を図るために、都市間連携の枠組みをどのように活用できるか？）

17:30　閉会

18:00　歓迎レセプション（リーガロイヤルホテル小倉 「リーガトップ」（29 階））

2016 年 9 月 23 日版

10 月21日（金） 視察：日本の自治体の低炭素化の取組（北九州の事例）

●プログラム（案）

★逐次通訳

9:00　リーガロイヤルホテル発

9:30　環境ミュージアム

09:30-10:15　ミュージアム見学（45 分程度）

10：20　環境ミュージアム発

11：00　エコタウンセンター着（別館）

11:00-11:30　レクチャー（マスタープランに基づいた低炭素化社会への取組（仮題））

11:30-11:45　質疑応答

11:45　昼食　（弁当） ※エコタウンセンター別館の利用は 12:30 まで

12:30　エコタウンセンター本館へ移動（徒歩）・本館 1 階展示見学など

12:45　次世代エネルギーパーク

12:45-13:00　次世代エネルギーパーク概要説明（エコタウンセンター本館）

13:00-14:30　視察

①市民太陽光発電所

②風力発電

③EV バス充電ステーション

14:30　次世代エネルギーパーク発

15:00　皇后崎工場着・視察

16:30　皇后崎工場発

17:00　リーガロイヤルホテル着／解散

上記プログラムは変更となることがあります。

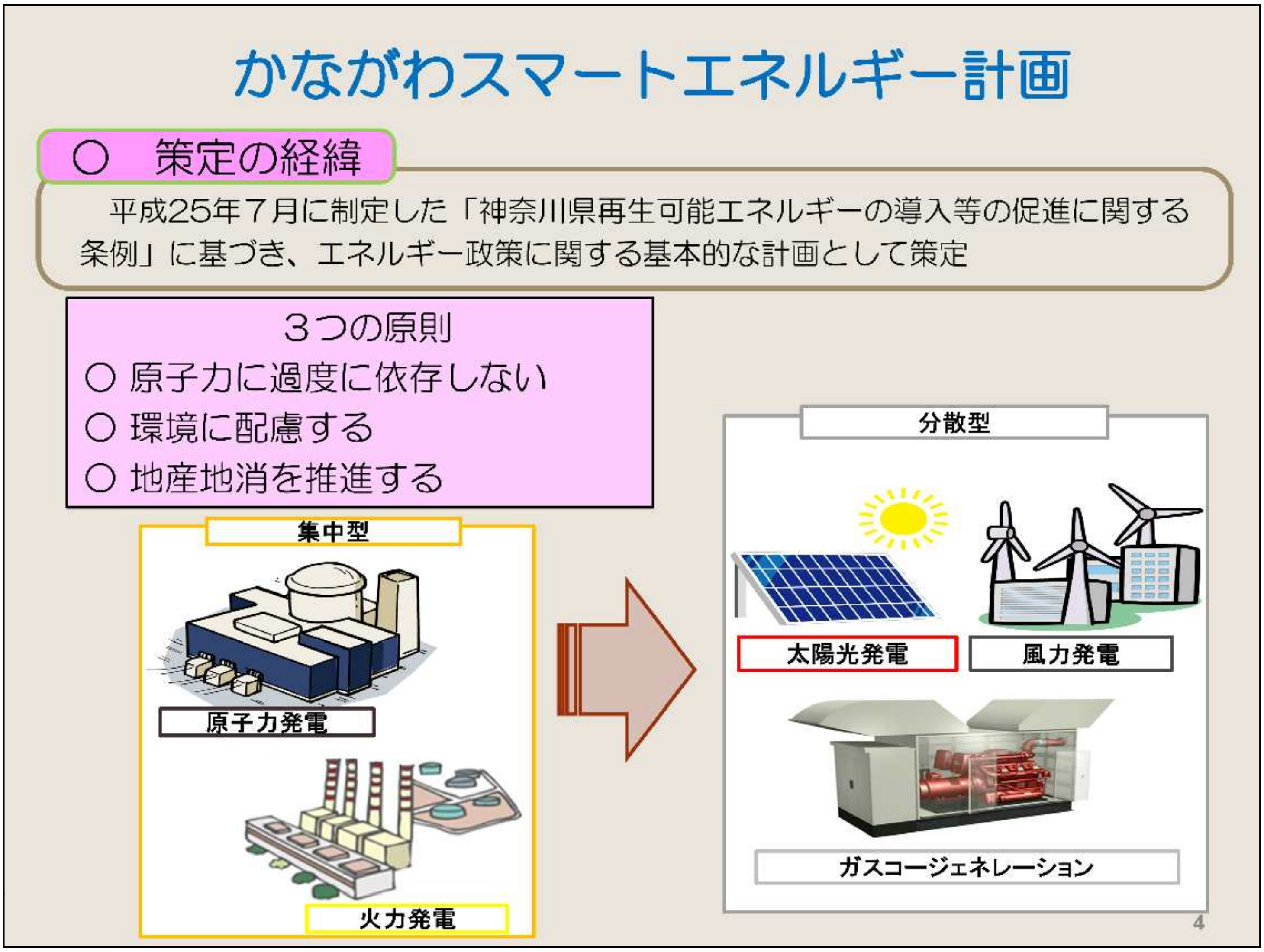
○　それでは、低炭素観光都市づくりのための神奈川県の取組について、
太陽光発電の普及と電気自動車を活用した観光振興の取組を中心にご説明いたします。

○まず、神奈川県の概要を簡単にご説明します。

神奈川県は、人口が約９１０万人で４７都道府県のうち全国２位ですが、面積は２，４１６ｋ㎡で、全国４３位、５番目に小さい県です。

○シェムリアップ州は、世界遺産であるアンコールワット遺跡など、
世界各地からたくさんの観光客が訪問されていますが、
神奈川県にも、古いお寺や大仏で有名な鎌倉、
夜景のきれいな横浜や温泉で知られている箱根など
たくさんの観光資源があります。

○神奈川県では、産業経済の発展だけでなく、
こうした観光資源を守るために、
環境に配慮した低炭素型の街づくりを進めています。

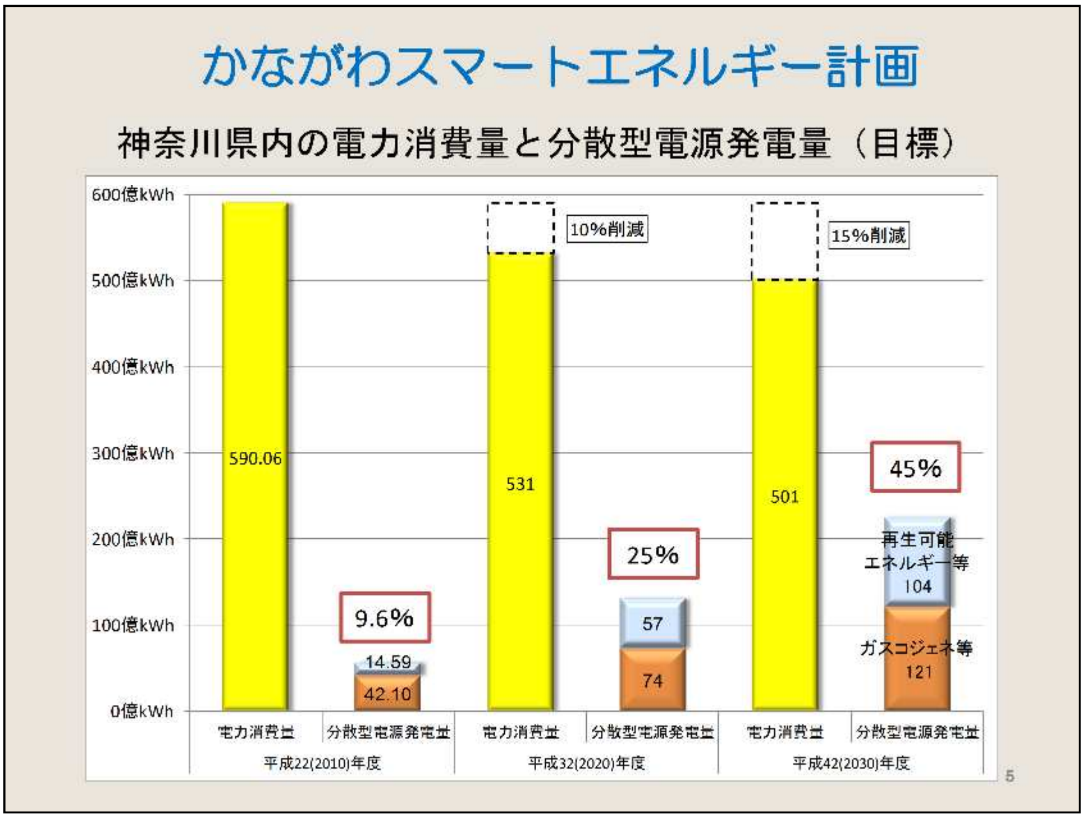


○皆さまは、2011年3月に起こった、東日本大震災をご存知でしょうか。

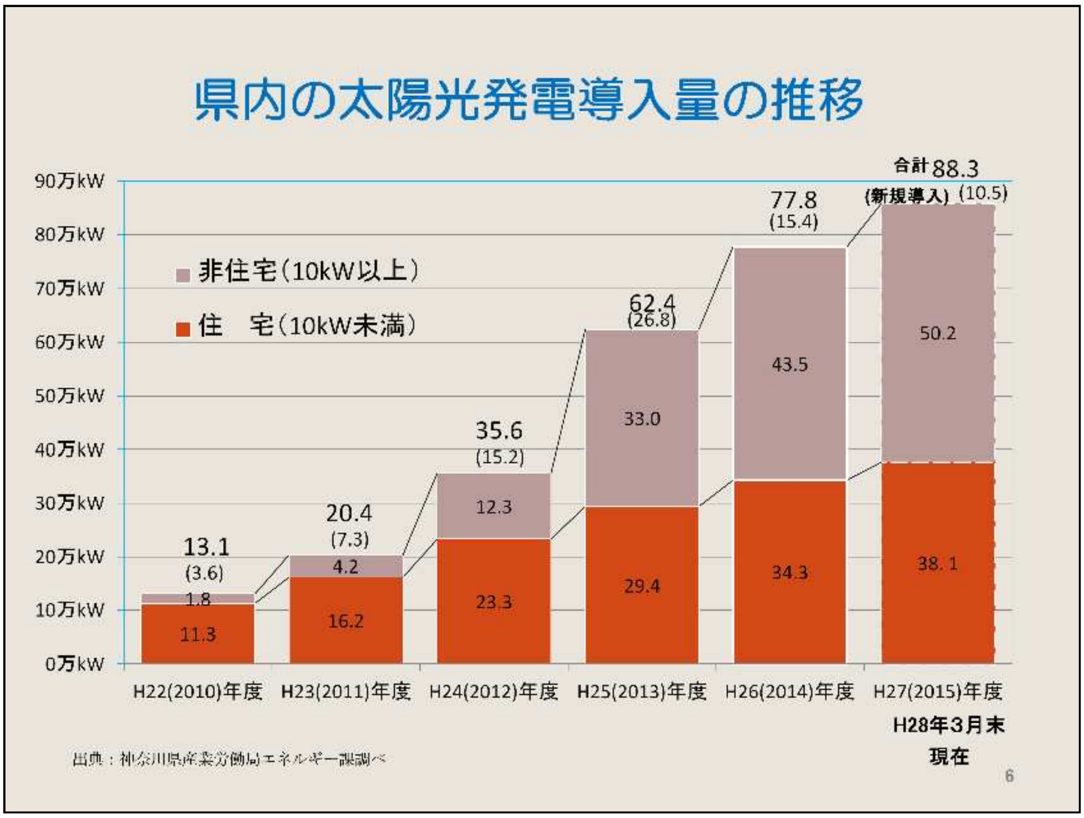
○日本は、電力系統が安定しているので、停電はほとんど起きないのですが、
この東日本大震災のときには、原子力発電が停止し、電力供給が不足したために、広い範囲で計画的に停電が実施されました。
神奈川県内でも、市街地も観光地も、停電になりました。

○そこで、この経験を契機として、安定した電源を確保するために、
神奈川県では、「かながわスマートエネルギー計画」を策定しました。
この計画は、　「原子力に過度に依存しない」、
「環境に配慮する」、　「エネルギーの地産地消を推進する」
という、3つの原則に基づいた内容となっています。

○左側の図のような、遠くの原子力発電所や火力発電所で作った電気を
消費地に送る集中型の電力システムから、右側の図のような太陽光発電など、
電気を使う場所の近くで発電する分散型システムへの転換を進めています。
分散型のシステムは、エネルギーを地産地消するので、

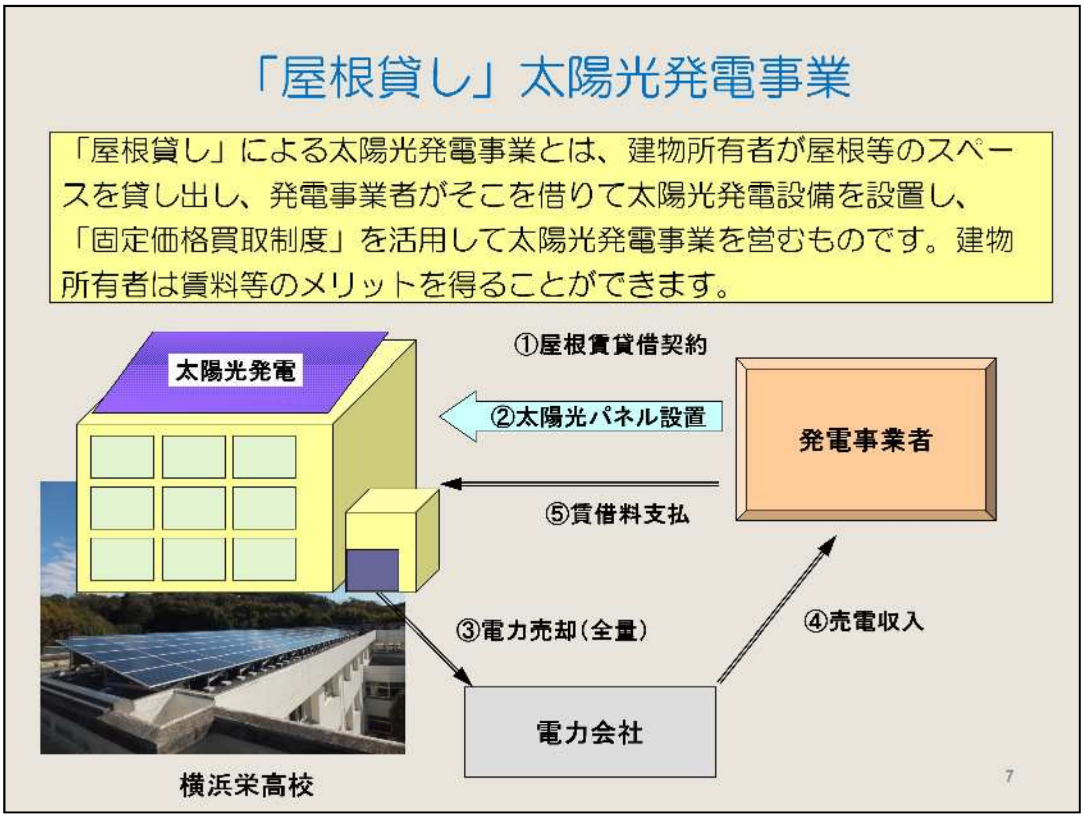


○「かながわスマートエネルギー計画」では、県内の電力消費量を、
　２０３０年度には、２０１０年度に比べて、１５%削減するという目標を立てています。
　さらに、先ほどご説明した分散型電源による発電量を、
　電力消費量の４５%まで増やすという目標も立てています。



〇分散型電源の中の太陽光発電の県内の導入量は、ご覧のとおりです。

〇2009年度に県が補助制度を開始して、少しずつ増えていき、
東日本大震災後の2011年度から急速に増えています。
2013年度には、太陽光で発電した電気を
国が高い価格で買い取る「固定価格買取制度」がスタートした影響で、
増加が加速しました。



〇神奈川県が実施する太陽光発電の普及拡大の取組をいくつか、ご紹介いたします。

　広い土地があるところでは、地面に直接太陽光発電設備を設置できますが、神奈川県は、空いている広い土地が少ないので、建物の屋根への設置を進めています。

〇神奈川県では、建物の所有者が屋根を発電事業者に貸し出し、

　発電事業者がその屋根に太陽光発電設備を設置して作った電気を売電し

　収益の中から建物所有者に賃料を支払う、「屋根貸し太陽光発電事業」を進めています。

　この屋根貸し太陽光発電事業は、神奈川県が全国に先駆けて、県の施設で実証し、事業モデルとして成立することが確認でき、

　全国の自治体や民間事業者に、この事業モデルが広がっていきました。

〇次の取組ですが、神奈川県には工場や倉庫がたくさんありますが、

　こうした建物は、耐荷重が低いために、通常の太陽光パネルを設置できないことがあります。

　そこで、従来の太陽光パネルよりも薄くて軽い薄膜太陽電池の導入に力を入れています。

〇薄膜太陽電池は、工場の屋根だけでなく、今まで太陽光パネルが設置できなかった、窓ガラスや、岸壁の壁面、マンションのバルコニーの手すりなどにも設置することができます。

　神奈川県では、こうした薄膜太陽電池の設置費用の1/3を補助し、さまざまな場所への設置を促進し、薄膜太陽電池のＰＲをしています。

◯上の写真は、通常のパネルが設置できない工場の屋根に設置した事例です。

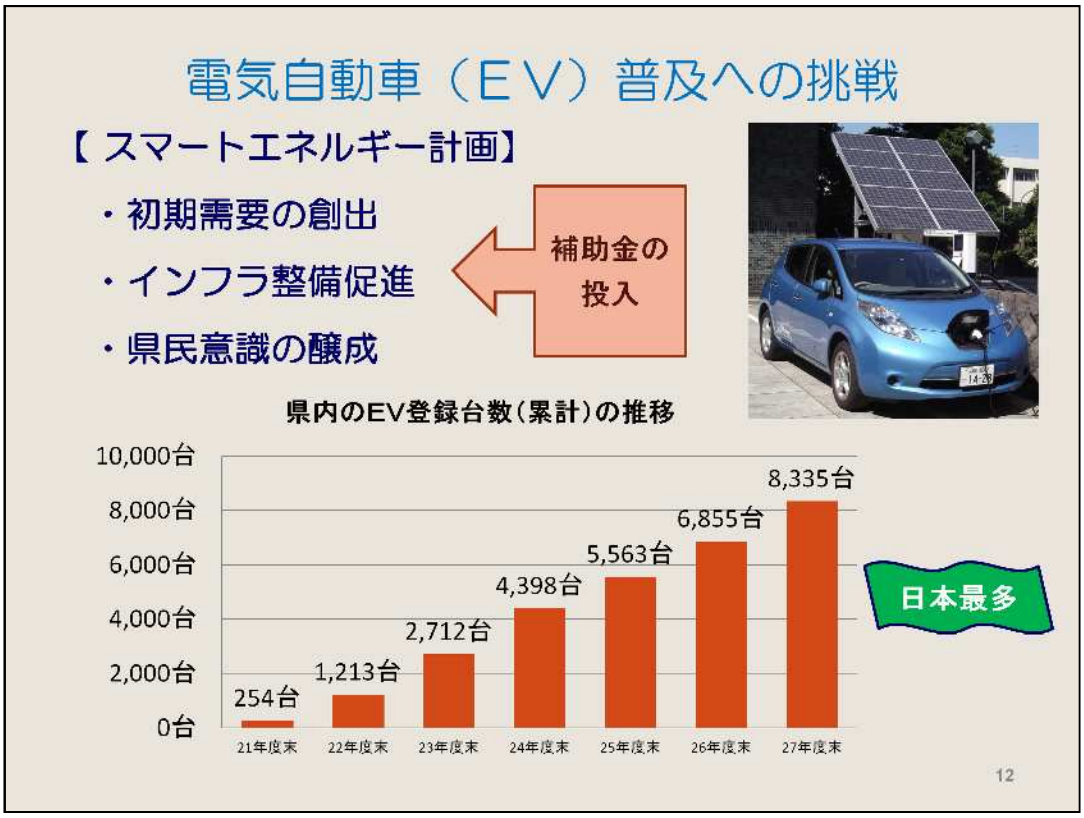
**　下の写真は、鉄道の法面に、草が生えるのを防ぐシートと一体になった薄膜太陽電池を設置した事例です。**

**　こうして、いろいろな場所に太陽光発電設備を設置できることをPRすることで、太陽光発電の導入が加速していくことを期待しています。**

〇このほか、土地の有効活用という観点で、平面の駐車場に屋根を設置し、その屋根に太陽光パネルを載せて発電する、ソーラーパーキング事業にも取り組んでいます。

駐車場や駐輪場に屋根をつけることで、日除けや雨除けになり、発電した電気を売電した収入で、屋根の設置費用を回収できます。

○農地の有効活用として、農地で農業を続けながら、
その上に太陽光パネルを設置する「ソーラーシェアリング」事業にも
取り組んでいます。

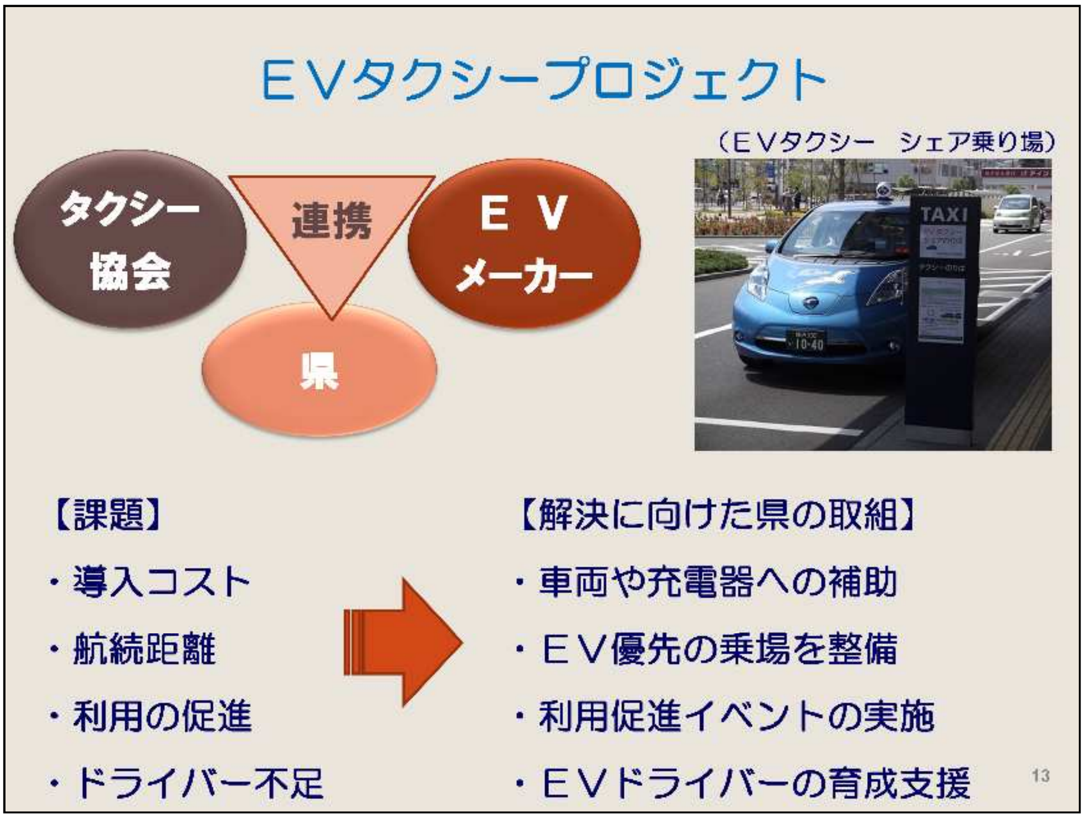


○次に、低炭素型の街づくりのために、神奈川県が力を入れている電気自動車の普及の取組についてご説明します。

　電気自動車は、日本では、２００９年に一般に発売されましたが、神奈川県では、その発売前から、民間企業や大学等と連携して、普及に向けた検討を始めました。

　県民や県内企業が、電気自動車を購入する場合や、急速充電器を設置する場合には補助する制度を立ち上げて、積極的な取組を展開しました。

　その結果、２０１５年度末には県内の電気自動車の普及台数は8,３３５台となり、日本の都道府県の中で最多となっています。



○さらに、県民の方に電気自動車に乗る機会を増やすために、タクシーに電気自動車を導入するプロジェクトを実施しました。

電気自動車をタクシーに導入する場合、課題がいくつかありました。

・通常の車に比べて、電気自動車の価格が高いので導入コストがかかる

・１回の充電で走れる航続距離が200キロメートル程度と短い

・ＥＶタクシーが知られていないので、利用を促進する必要がある

・ＥＶタクシーの特徴を上手く利用できるノウハウを持ったドライバーがいない　などの課題です。

○そこで、解決に向けて、

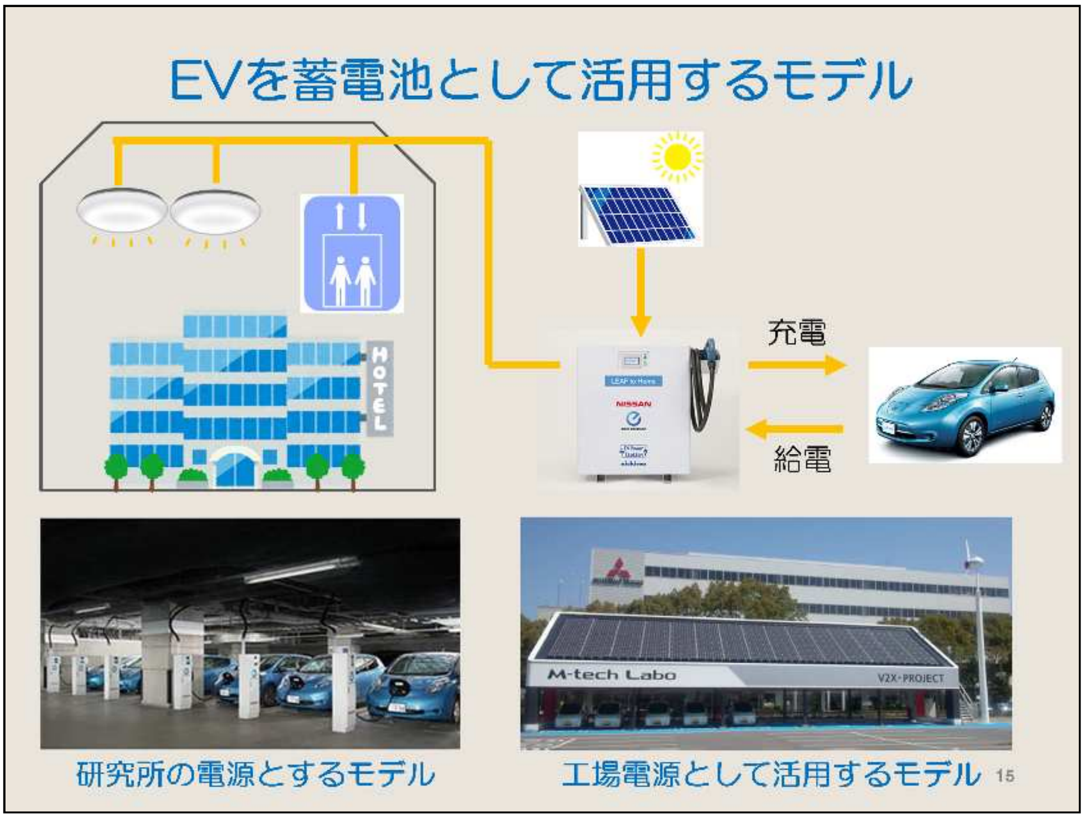
・車両や充電器への補助、

・ＥＶタクシーのための乗場の整備、

・ＥＶタクシーの利用促進のイベントの実施、

・ＥＶドライバーの育成の支援　などの取組を実施しました。

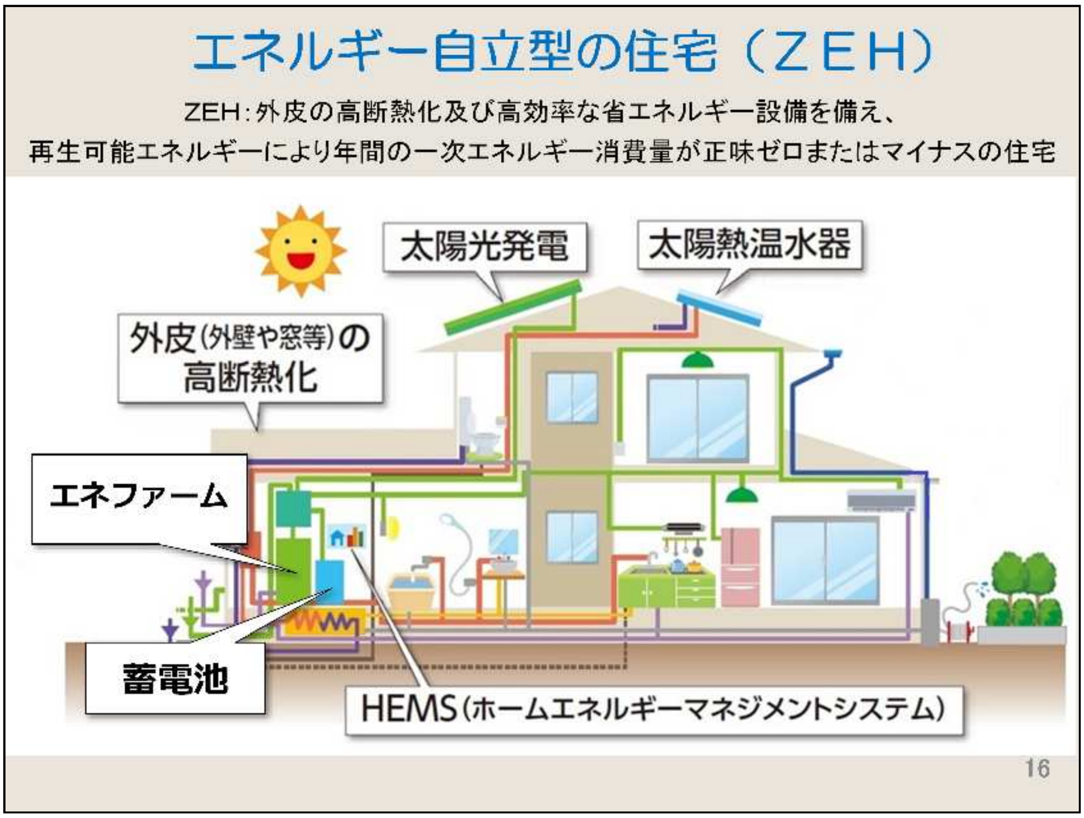

EVを活用した観光モデル
（観光地で使えるーポン）
ecoクーポン
¥1,000
観光資源の保全
電動車両の導入
観光施設
観光事業者
協力
ホテルにEVを配置し、従業員と観光客等が利用するシェアリング事業
14



○さらに、ＥＶは、電気で走るだけでなく、搭載しているバッテリーから、家やビルに電気を供給することもできます。

　急に停電したときにも、ホテルなどにＥＶから電気を供給することで、最低限の電源を確保することができます。

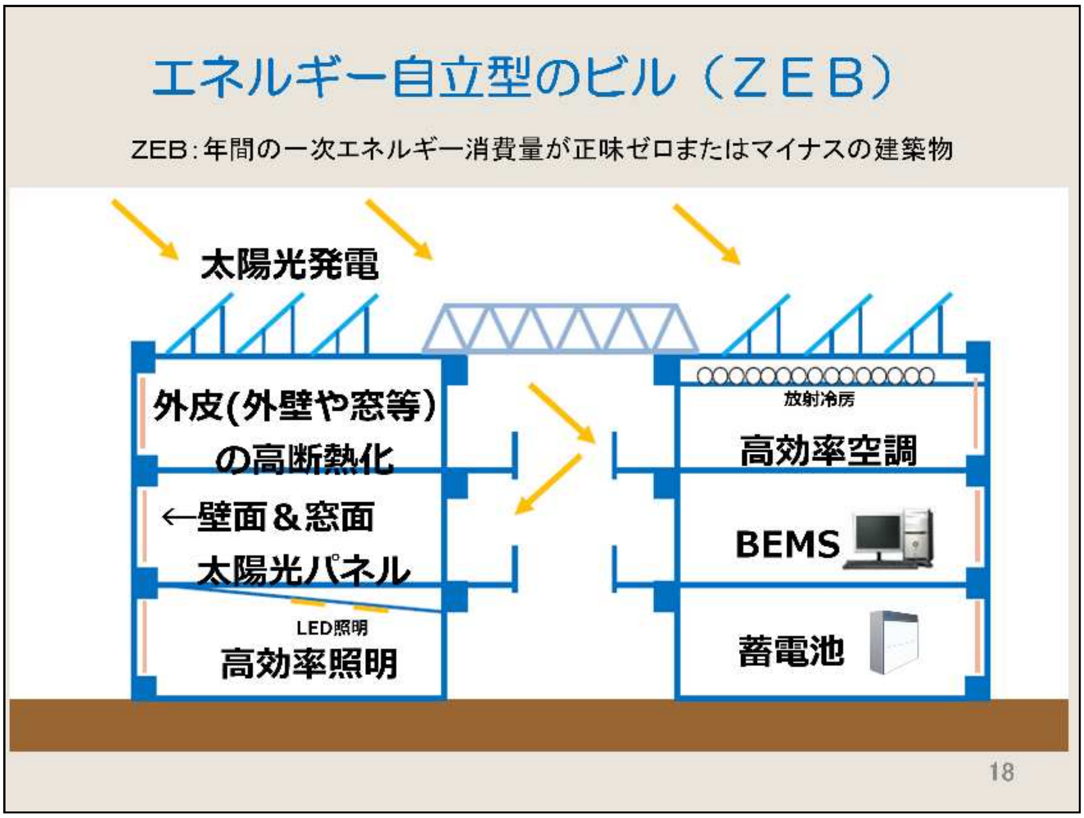
○日本では、いくつかの研究所や工場で、電気をたくさん使用する時間帯に、従業員が通勤で乗ってくるＥＶの電気を使い、帰宅する時間までにＥＶに充電するという仕組みが導入されています。



○今、日本では、太陽光発電で電気を作るとともに、
高断熱の壁や窓などで省エネ化をすすめることで、
エネルギー消費量がプラス、マイナスでゼロになる住宅、
ネット・ゼロ・エネルギー・ハウスの普及が進んできています。
国も神奈川県も、ＺＥＨ普及のために補助制度を実施しています。

○これは、神奈川県の藤沢市にある「藤沢サスティナブル・スマートタウン」です。

神奈川県は、この街のＺＥＨの整備を支援しています。



○住宅だけでなく、ビルについても、
エネルギー消費量がプラス、マイナスでゼロになるビル、
ネット・ゼロ・エネルギー・ビルの普及を進めるため、
国も神奈川県も補助制度を実施しています。

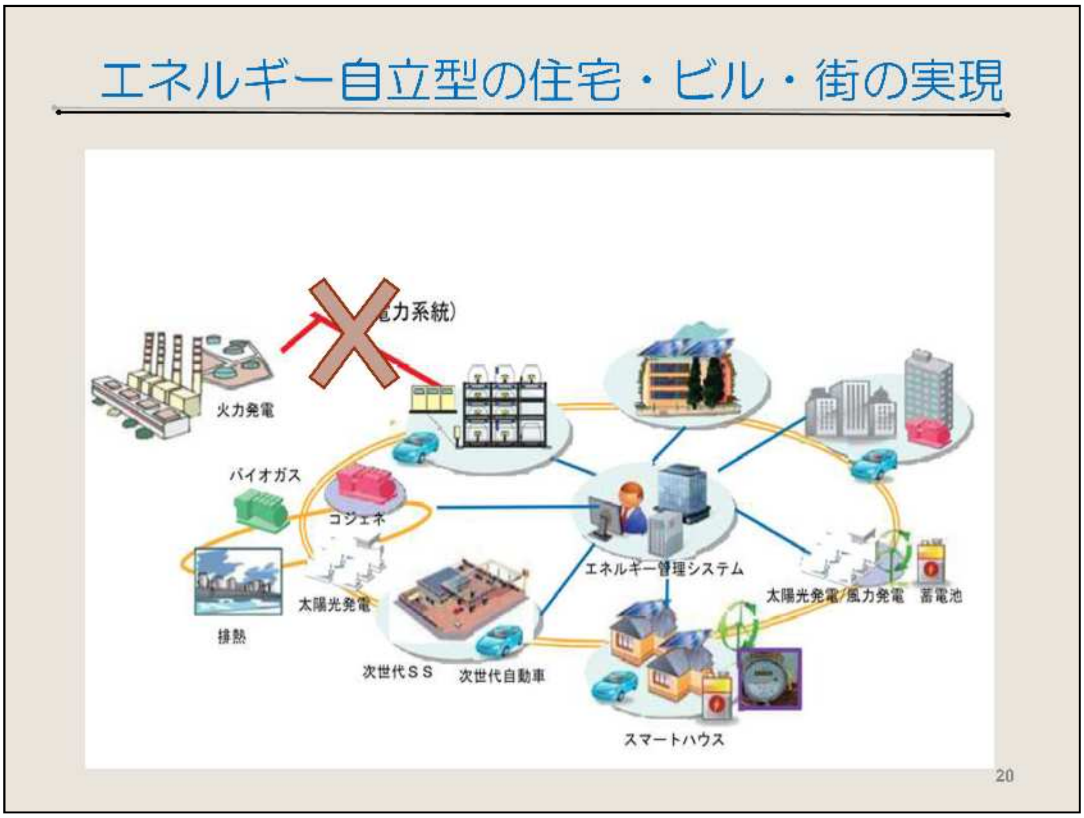
エネルギー自立型のビル（ＺＥＢ）

大成建設ＺＥＢ実証棟
（横浜市）

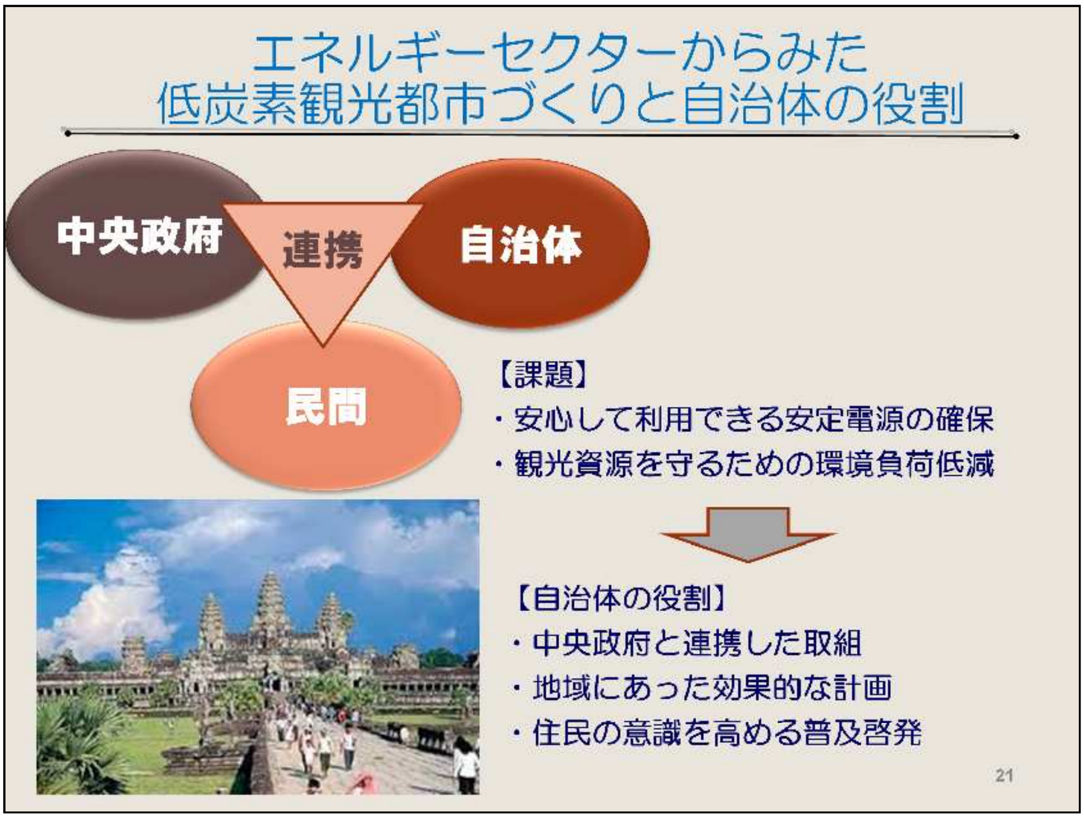
鈴廣蒲鉾本店本社
（小田原市）

19

○神奈川県に既に整備されているZEBとして
　明日、視察予定の横浜市内の大成建設の実証棟、
　小田原市内の鈴廣蒲鉾本社ビルがあります。



○神奈川県は、こうしたエネルギー自立型の住宅やビルを増やし、
太陽光発電や電気自動車などをうまく使って、
遠くの発電所から送られてくる電気に頼る集中型電源システムから、
電気を使う場所の近くで作る分散型電源システムへの転換を図り、
エネルギー自立型の街を実現させることを目指しています。



○さて、2020年に、日本で、東京オリンピック・パラリンピックが開催されます。

世界中から多くのお客様にいらしていただき、快適に過ごしていただくためには、災害などが起きても、停電などの心配がなく、　安心して利用できる電源の確保が必要です。また、同時に自然や歴史的な遺産を保全していくためには、大勢の観光客を受け入れても、環境に与える影響をできるだけ少なくしていくことが重要です。

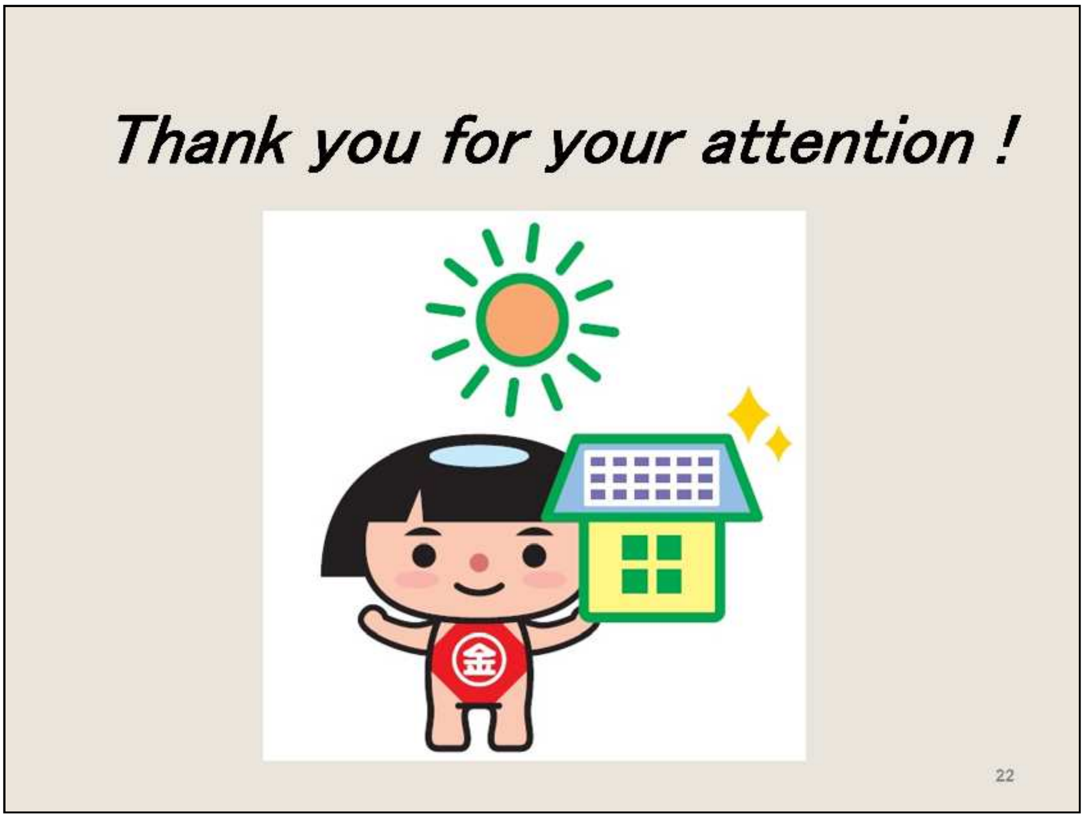
○私たち、自治体は、こうした課題解決に向けて

・中央政府と連携しながら、

・それぞれの地域にあった取組を

・住民の皆さんと一緒に進めていくために、努力しています。

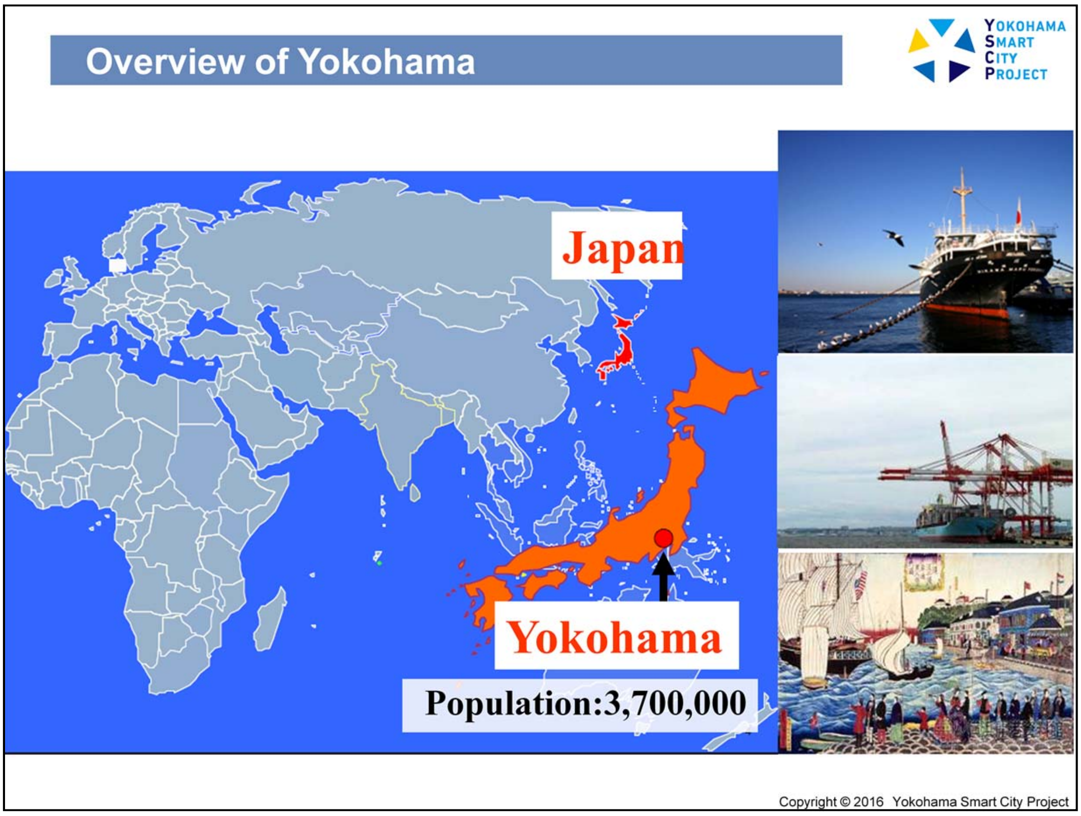
私たちの取組を、シェムリアップ州の低炭素観光都市づくりの参考にしていただけましたら光栄です。



○ご清聴ありがとうございました。

Hello, my name is ○○○, I'm a manager of Climate Change Policy Headquarters at Yokohama City. Thank you for inviting this seminar.

Today, I would like to explain our flagship project, the Yokohama Smart City Project.

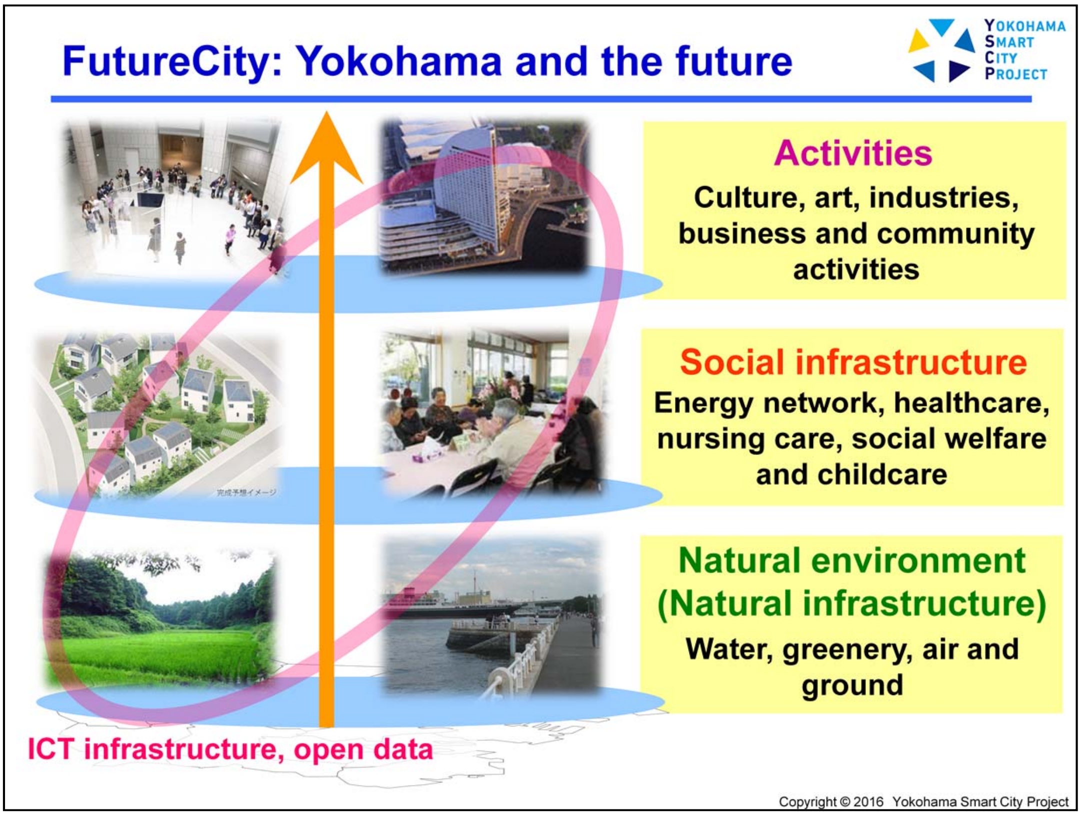


At first, I'm going to introduce the city of Yokohama.
Yokohama is located in the center of Japan islands.
Yokohama was opend as a international port in 1859.
At that time, there were few dozen houses.
But Yokohama is growing as the second largest municipality in Japan,
with a population of 3.7 million.

YOKOHAMA
SMART
CITY
PROJECT

1 Challenges That Yokohama Faces

We are currently faced with the several challenges, global warming, super-aging, and so on.

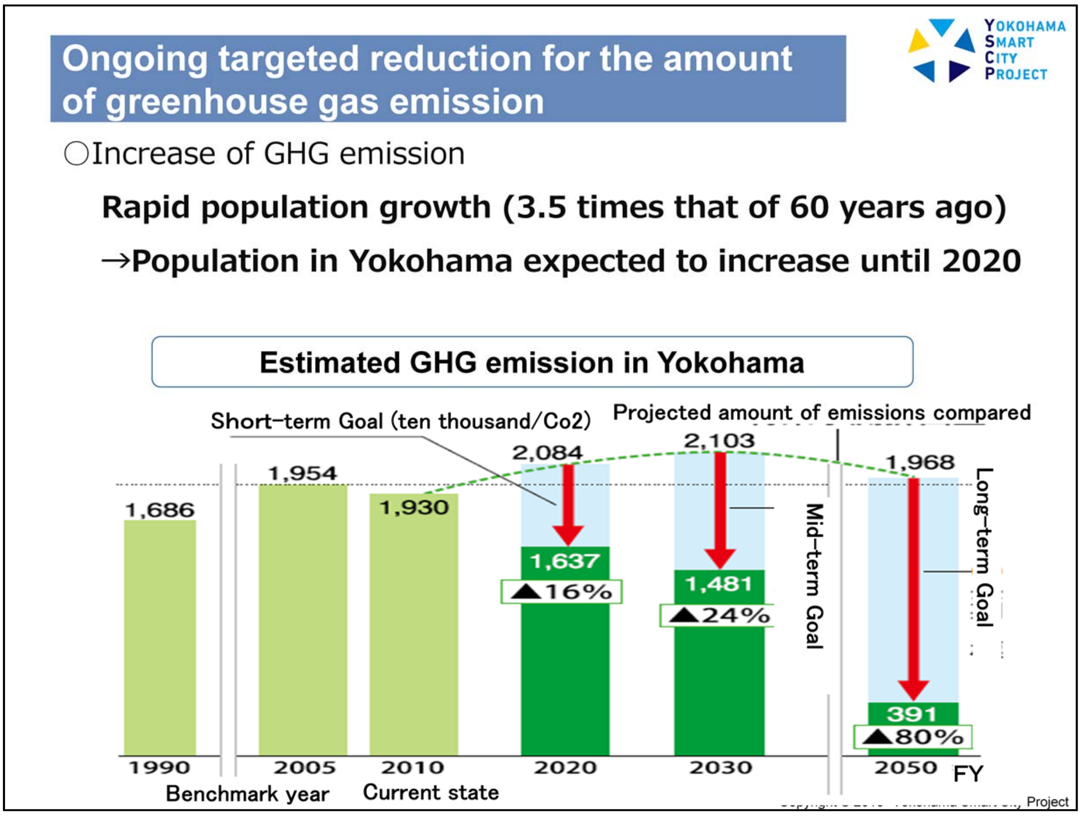


To solve these issues in a comprehensive manner, we promote the future initiatives by three areas.

First, at the very bottom is the natural infrastructure layer.
The second layer is man-made social infrastructure.
The third is visible, daily social activities.

Working together with citizens, local businesses, municipality,

We called these initiatives “Future City Yokohama" .



To mention about global warming, if we don't make the counterplan, Green House Gas emission will increase as growing the population.

In Japan, birth rate becomes low and elderly people are increasing.

But Yokohama's population is forecast to increase until 2020. The green dotted line is the forecasted CO2 emissions if we do not make counterplan to reduce CO2 emissions.

In 2020, the amount of CO2 emission will be 20.84 million tons.

In 2030, the amount of CO2 emission will be 21.03 million tons.

So, we make the climate change policy action plan.

(Not read)

On this plan, we set the amount of CO2 emission in 2005, as a standard amount.

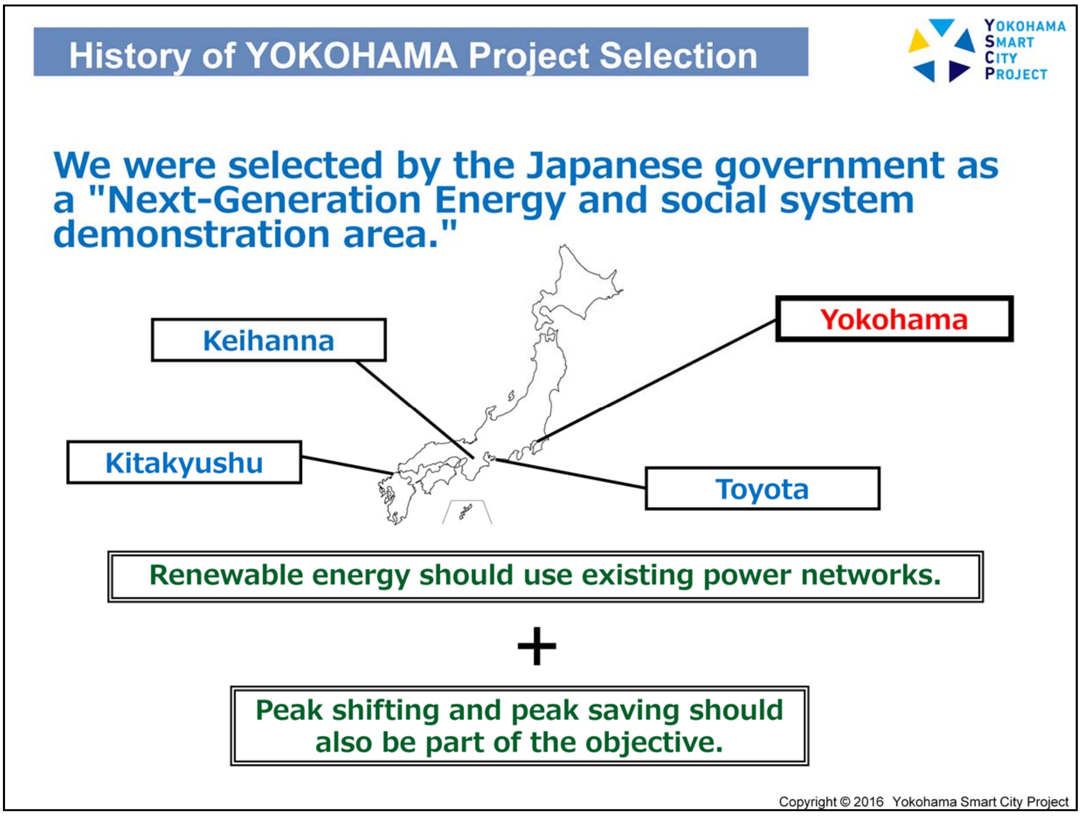
In 2020, we are going to reduce the 16% of CO2 emission amounts in 2005.

In 2030, we are going to reduce the 24% of CO2 emission amounts in 2005.

2. About YSCP
(Yokohama smart city project)

Now, I introduce the specific efforts about climate change policy, Yokohama Smart City Project.

Yokohama Smart City Project is being conducted as one major project.



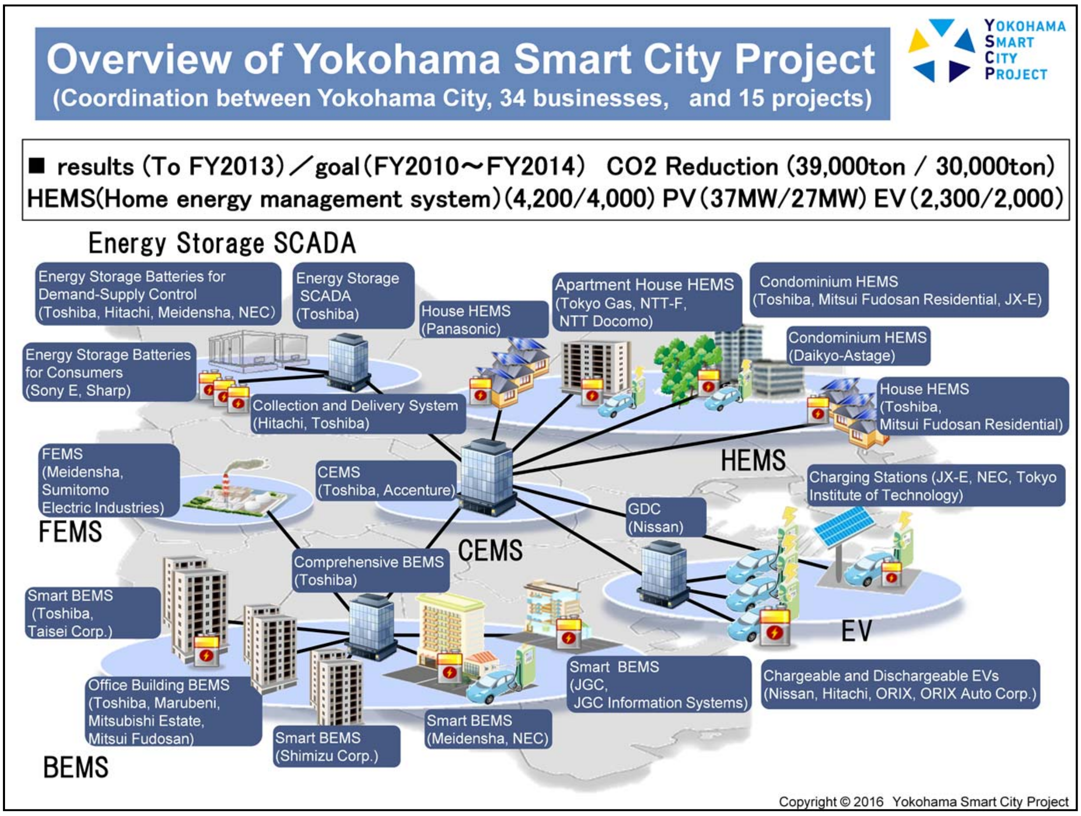
In 2010, Yokohama Smart City Project was selected by the Ministry of Economy, Trade and Industry.

As one project of Next-Generation Energy Infrastructure and Social Systems Demonstration Areas.
The initial theme was to spread renewable energy and stabilize the systems.

But, after the Great East Japan Earthquake march eleventh 2011,

It became increasingly important to distribute, decentralize the energy system, and power-saving, as disaster measures.

For this reason, we incorporated items such as cutting peak electricity into the demonstration project.



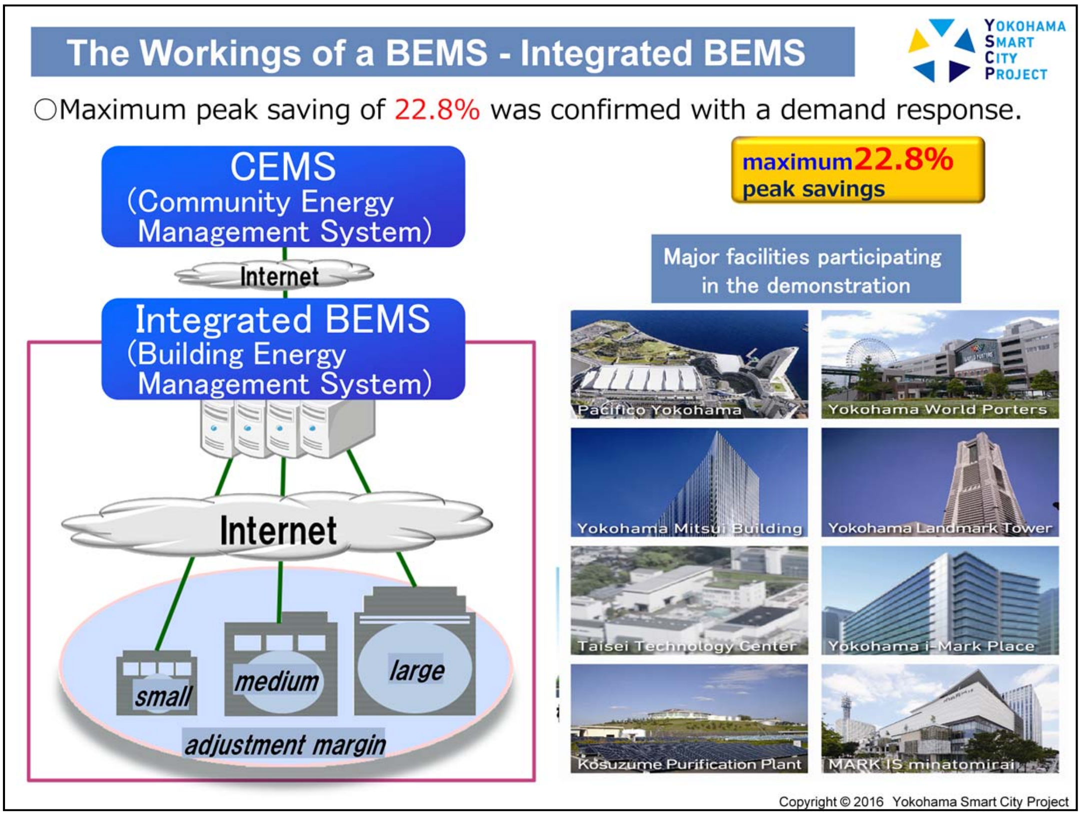
This picture is the overview of the energy management of this project.

The feature is a large-scale demonstration in existing urban areas.
From 2010 to 2014, we developed and tested a variety of technology.

HEMS, Electric Vehicles for households, BEMS for buildings, FEMS for factories and SCADA gathering small storage batteries, which were linked with CEMS for community-wide energy management.
We reached our target a year ahead of schedule, introducing HEMS into around 4,200 households, 37 megawatts of solar panels and 2,300 electric vehicles.

The amount of CO_2 reduction was 39,000 tons.

The CO_2 reduction ratio was 29%



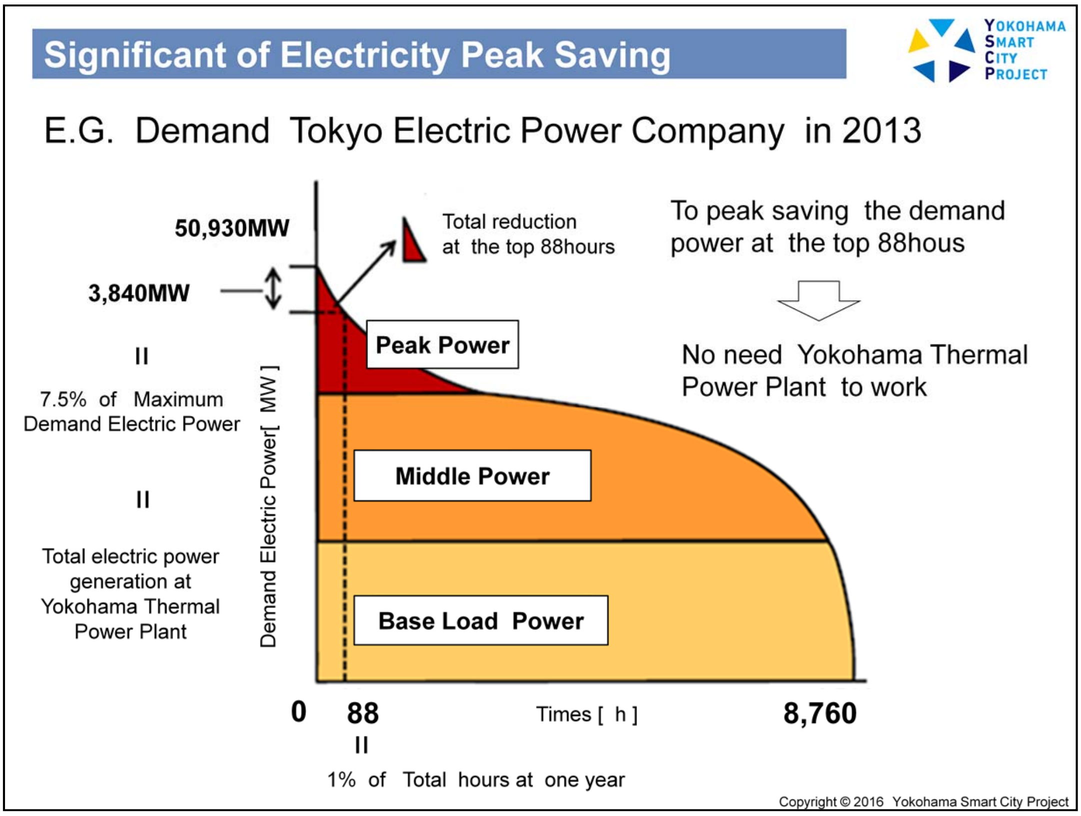
In regard to demonstration, I explain only about BEMS.

Because my presentation time is limited, I omit HEMS, PV, EV.

In the BEMS demonstration testing, we introduced a system that manages multiple BEMS as a group.

It called integrated BEMS, to manage buildings with varying characteristics, such as large office buildings, commercial buildings and water purification plants as a group.

It carried out the demand response demonstration aimed at cutting electricity peaks.
For the results, we achieved a maximum peak saving of 22.8% by demand response.



Then, I explain the importance of peak saving.

This graph is the electricity distribution for a year, demanded Tokyo Electric Power Company in 2013.

Horizontal axis is time scale, vertical axis is demand electric power.

Between 0 and 88hours, the demand electricity is 3,840MW.

It is almost equal the total power generation at Yokohama Thermal Power Plant.

If we reduce the consumption at the top 88 hours, it is not necessary to work the thermal power plant to cover peak electricity.

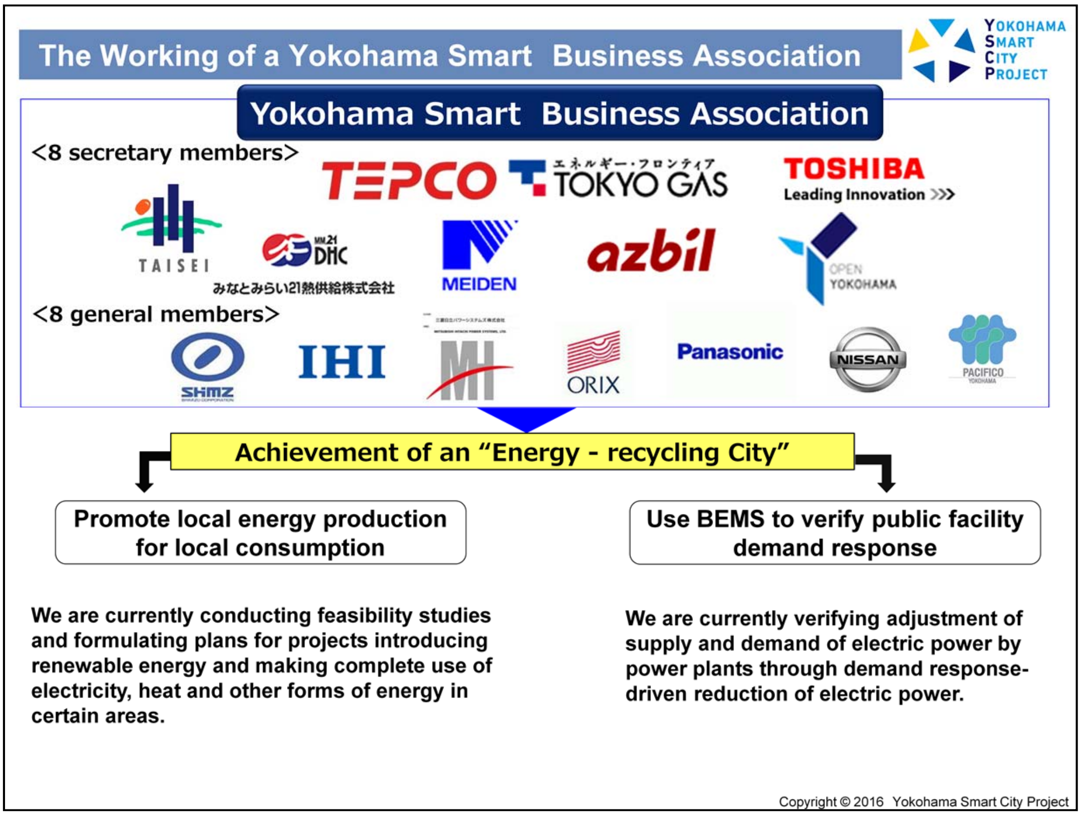
So, we think it is useful to reduce CO_2 exhausts.

That’s why we promote peak saving by demand response.

3. From Verification of YSCP to Implementation

Thus far, I explained the demonstration of YSCP.

From now I explain about the implementation of YSCP.



Since April 2015, we established the association to achieve an energy recycling city.

It named Yokohama Smart Business Association, with 15 representative Japanese companies including Toshiba, TEPCO, Tokyo Gas, and Taisei Corporation, have joined with Yokohama to promote the project.

We conduct two efforts, mainly.

One is to promote local energy production for local consumption.

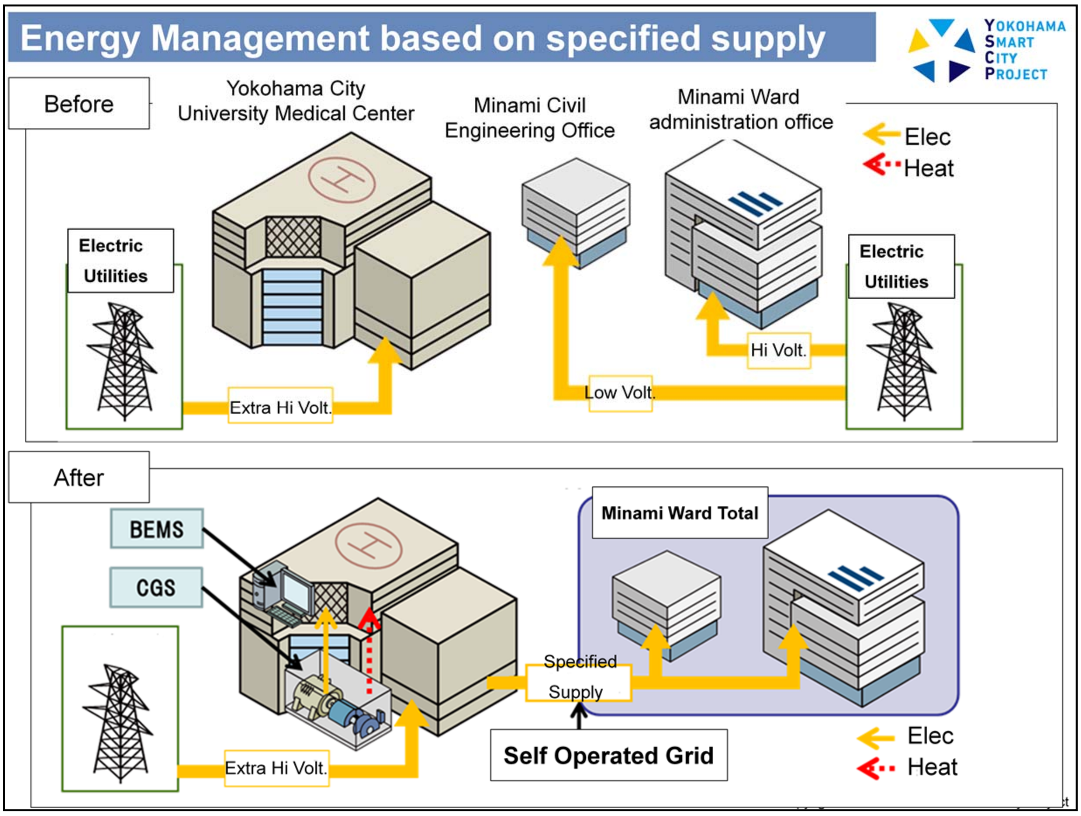
We are moving forward with the conducting of feasibility studies and the formulation of plans for projects to be implemented next fiscal year and beyond.

The other is to use BEMS to verify public facility by demand response.

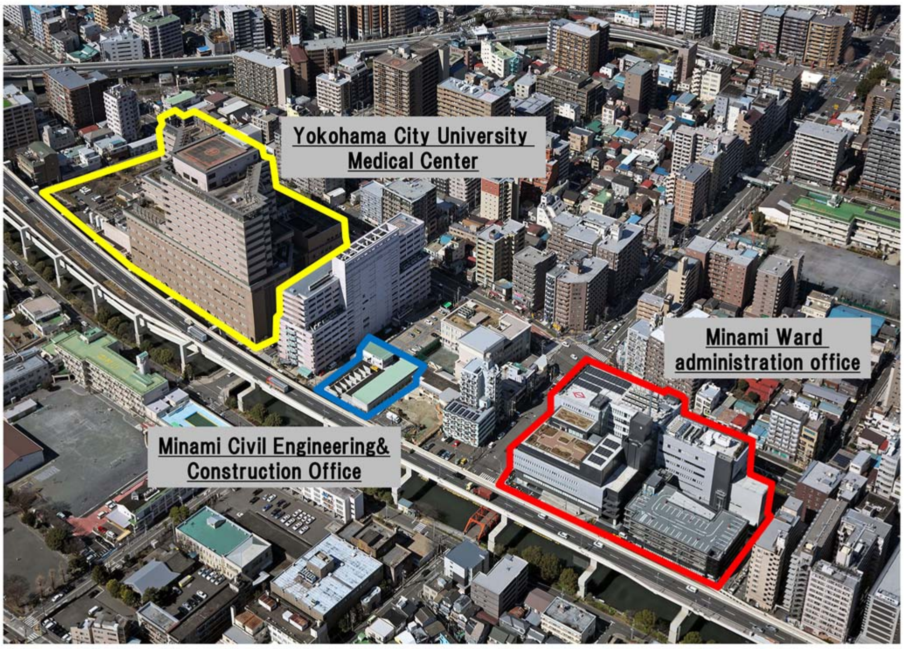
It is thought that the social environment surrounding energy will change in the future, for example with the forecast liberalization of electricity and gas retailing.

We will be working through public-private partnerships to construct business models.

And we utilize technology and expertise gleaned the demonstration, such as optimization energy use throughout consolidating the amounts of customer power saved.


Energy Management based on specified supply
YOKOHAMA SMART CITY PROJECT
Before
Yokohama City University Medical Center
Minami Civil Engineering Office
Minami Ward administration office
Elec
Heat
Electric Utilities
Electric Utilities
Hi Volt.
Low Volt.
Extra Hi Volt.
After
BEMS
CGS
Minami Ward Total
Specified Supply
Self Operated Grid
Extra Hi Volt.
Elec
Heat

energy management based on specified supply

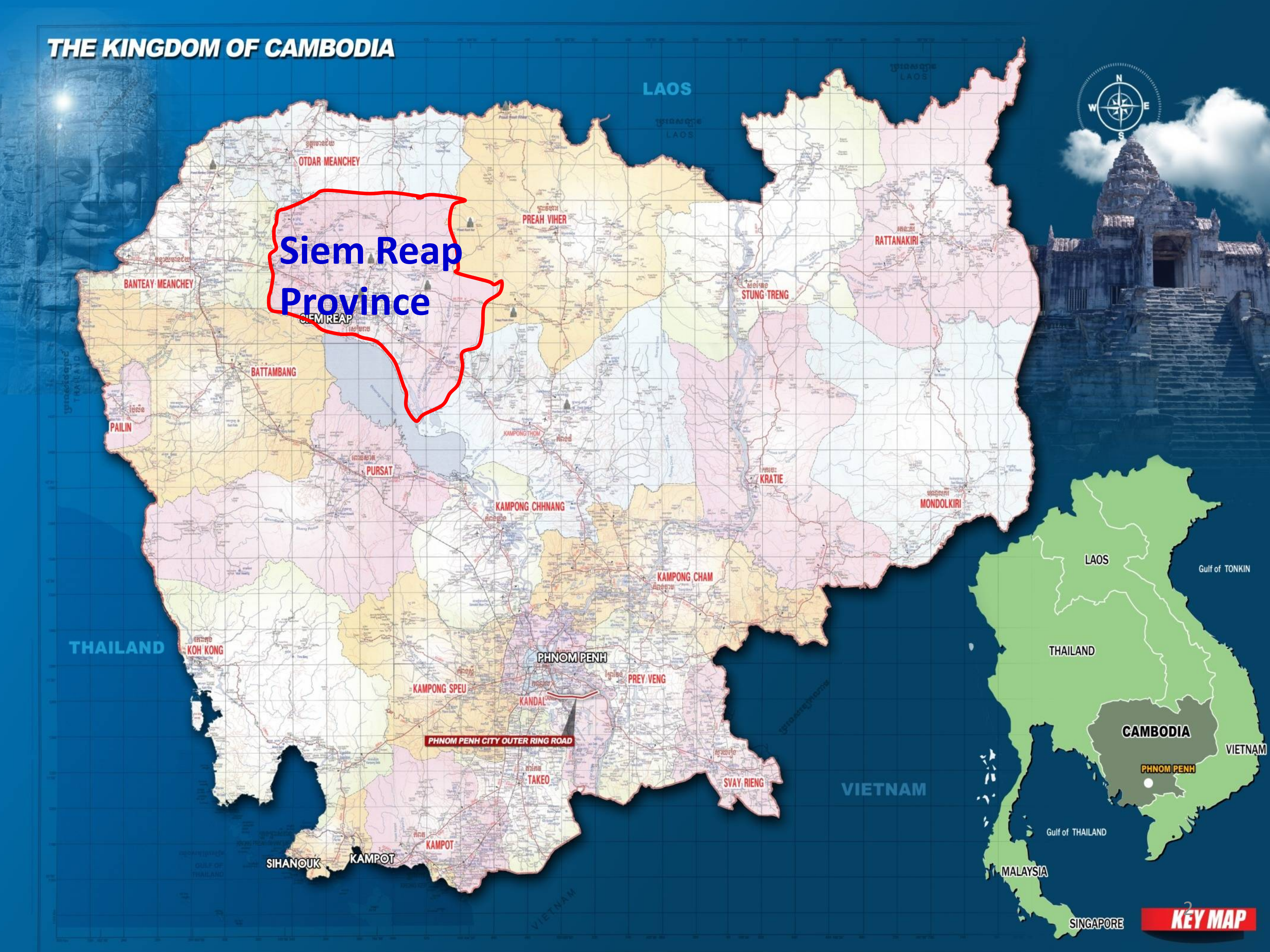


Workshop on Joint Crediting Mechanism (JCM) City-to-City Collaboration Projects

Siem Reap City
Siem Reap Province

Presented by Mr. Ung Sophean,
Director of Inter-Sectoral Division,
Siem Reap Provincial Administration
Kingdom of Cambodia

20 October 2016
Kitakyushu, Japan


THE KINGDOM OF CAMBODIA
Siem Reap Province
LAOS
OTDAR MEANCHEY
PREAH VIHER
RATTANAKIRI
STUNG TRENG
BANTEAY MEANCHEY
SIEM REAP
BATTAMBANG
PAILIN
PURSAT
KAMPONG THOM
KRATIE
MONDOLKIRI
KAMPONG CHHNANG
KAMPONG CHAM
THAILAND
KOH KONG
PHNOM PENH
PREY VENG
KAMPONG SPEU
KANDAL
PHNOM PENH CITY OUTER RING ROAD
TAKEO
SVAY RIENG
VIETNAM
KAMPOT
SIHANOUK
LAOS
Gulf of TONKIN
THAILAND
CAMBODIA
VIETNAM
PHNOM PENH
Gulf of THAILAND
MALAYSIA
SINGAPORE
KEY MAP

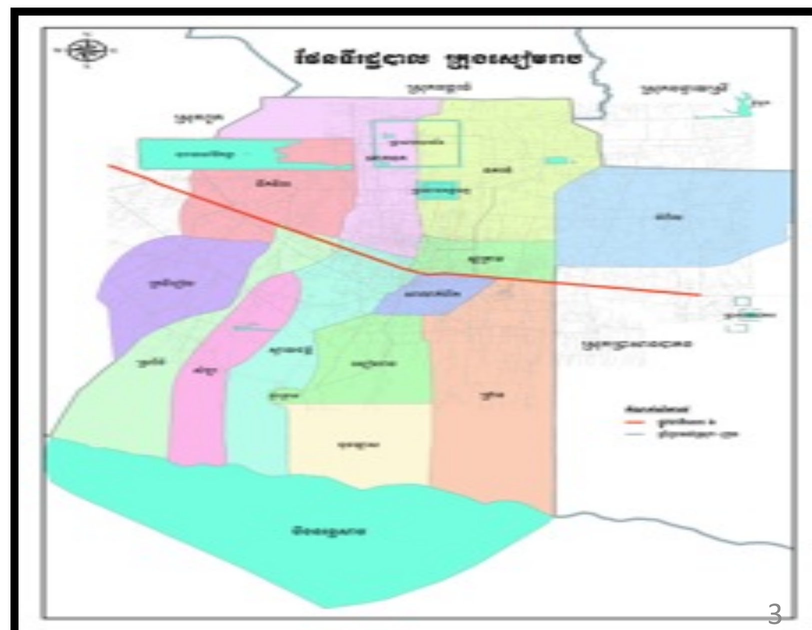
I-Brief Outline

Siem Reap Province

- Land area: 10,299.43 Km2
- 1 City (Siem Reap City))
- 11 Districts
- 100 Communes/Sangkats
- 922 Villages
- Population: 995,057 (Female: 504,596)
- Main Industries:
  - Agriculture (80%)
  - Service and others (20%)
- Angkor Wat (world heritage)
  Tourists: 3,019,280 (2015)
  (International: 1,105,680)

Siem Reap City

- Land area: 472.73 Km2
- 13 Sangkats:
- 108 Villages
- Population: 256,018 (Female:131,528)
- Households 50,824
- Family size: 5



II. low-carbon policies/strategies/action plans in Siem Reap city

1. City Overall Visions

- Town of Water
- **Town of Green**
- Town of Culture and Education
- Town of Tourism Assets

2. City Development Plan

- Environmental development plan (Priority Plan)
- Introduction of Environmental public transport in the Angkor Archeology Park (AAP): Battery Car / Electric bus, Traditional transport (Horse cart, Elephant ,.)

3. Public Awareness Raising Mechanism

- Environmental Campaign/Environmental Day
- Training/workshops
- Banners (Public)

4. Waste Management

Recycling and Reusing Activities

Animal Feeding

Plastic Battle Reproduction

Composting

III. Expectation to the JCM City-to-City Collaboration Project

1. Process of sustainable development
2. City overall visions for Low-Carbon policy, strategy and action plan
3. Lesson learn and reality of low-carbon implementation process
4. Legal procedure for low-carbon
5. Local participation and collaboration process
6. Roles and responsibilities of local government.

IV. Roles of Siem Reap Administration for Low-Carbon Implementation Policy

1. Support city development plan implementation
2. Provide capacity development and human resources
3. Strengthening roles and responsibility of city administration on low-carbon policy/strategy and action plan
4. Provide technical support
5. Cooperated with development partners for low-carbon project implementation
6. Improve local participation and understanding on environmental protection process

V. Difficulties/Barriers in Implementation

1. Lack of legal and institutional arrangements
2. Lack of human resources at local administration
3. Lack understating on environmental issues and protection
4. Lack of financial support from government on environment protection process
5. Lack of participation from development actors (civil societies and development partners)
6. Disadvantage of development process


Thank You for Your Consideration

C2CC with Siem Reap and Kanagawa

Tomonori KIMURA
CEO
Asian Gateway Corporation

October, 2016

3-7-2, KANDANISHI CHO, CHIYODA-KU, TOKYO

PUBLISHED OCTOBER 2016
WWW.ASIANGATEWAY.CO.JP

PPP Scheme

PPP approach like Bilateral Cooperation with Siem Reap and Kanagawa (Nov. 2015)

PPP Scheme

G2G	• National Strategic Development Plan • Government Aid Policy • JCM(Joint Crediting Mechanism)
LG2LG	• City to City Collaboration • EV Tourism and Renewable Energy
B2B	• International Consortium for JCM • Business Partnership with Asian Gateway • Consulting and Trading for Sustainable Energy

PPP: Public-Private Partnership

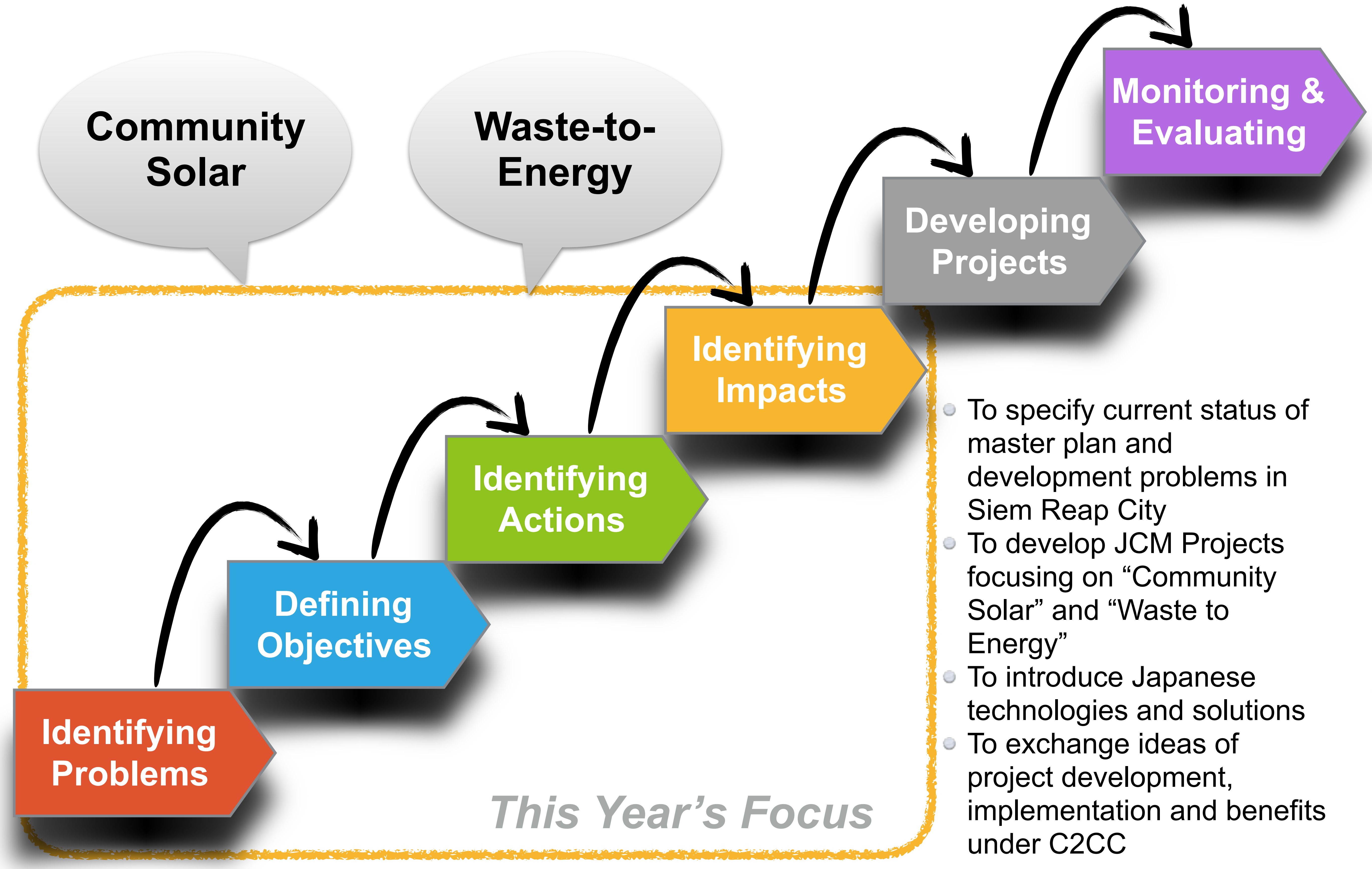
C2C Cooperation with Siem Reap and Kanagawa

Objectives

- Creating low-carbon tourism city (Green 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

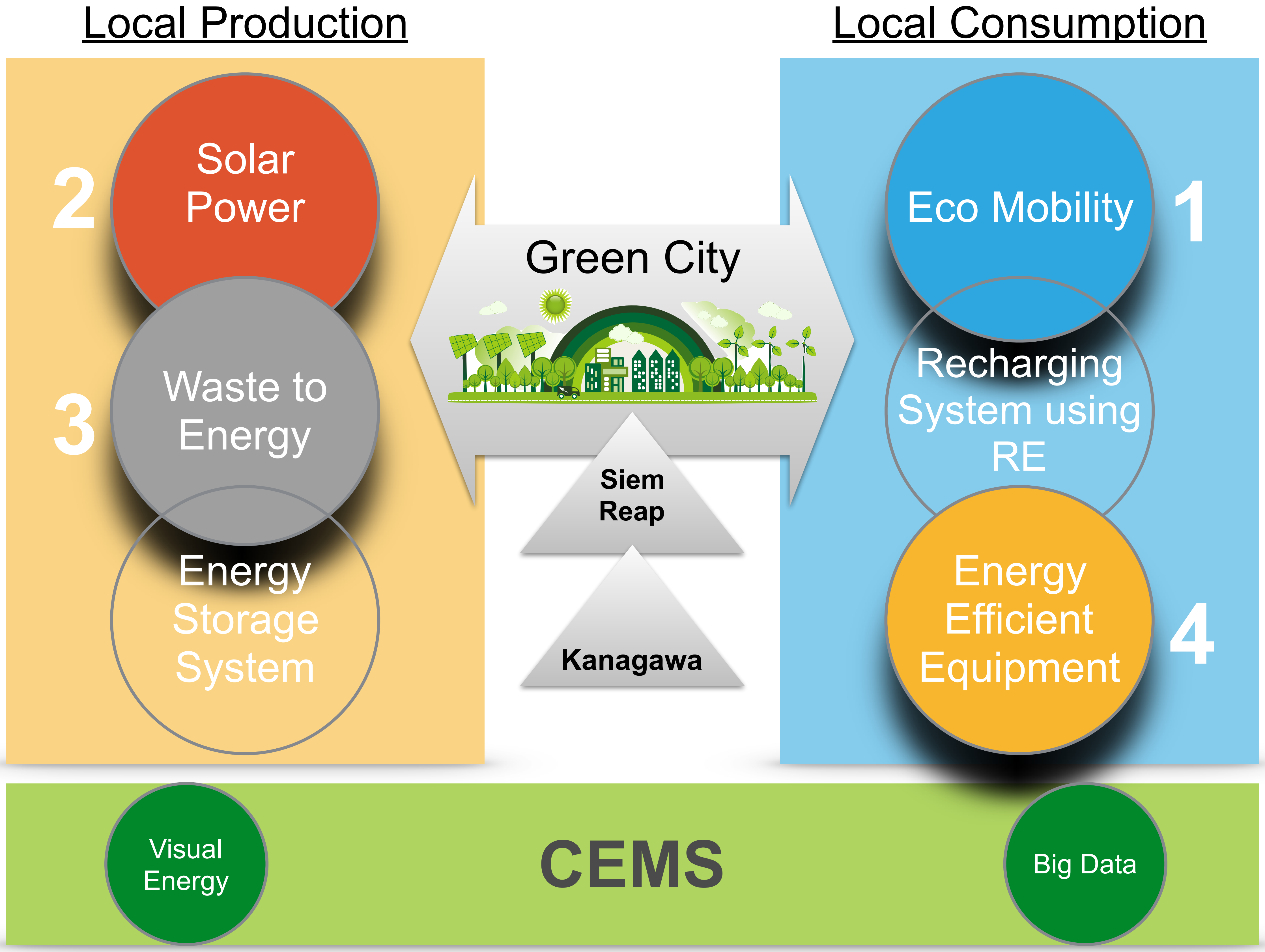
Strategical Steps for C2C Cooperation in 2016

Strategical Steps for C2C Cooperation in 2016



- To specify current status of master plan and development problems in Siem Reap City
- To develop JCM Projects focusing on "Community Solar" and "Waste to Energy"
- To introduce Japanese technologies and solutions
- To exchange ideas of project development, implementation and benefits under C2CC

Vision: Local Production for Local Consumption



C2C Cooperation: City-to-City Cooperation
CEMS: Community Energy Management System

Strategic Steps for C2CC

As is October 2016

Identifying Problems	Kickoff Meeting for Visioning and Concept Understandings	Strategic Planning	Long List Made, Prioritizing and Short List Made	Contact Made and Hearing
Defining Objectives	Discussion Documents Made	Meetings with Prospects and Investors	Site Survey	Secured Requirements
Identifying Actions	Preparation for Proposal	Preparation for Establishment of AG Cambodia	Fundraising	Now Proposal Finalized
Identifying Impacts	Specified Requirements	Finalizing Proposal	Term & Conditions Negotiated	Contracting MOU

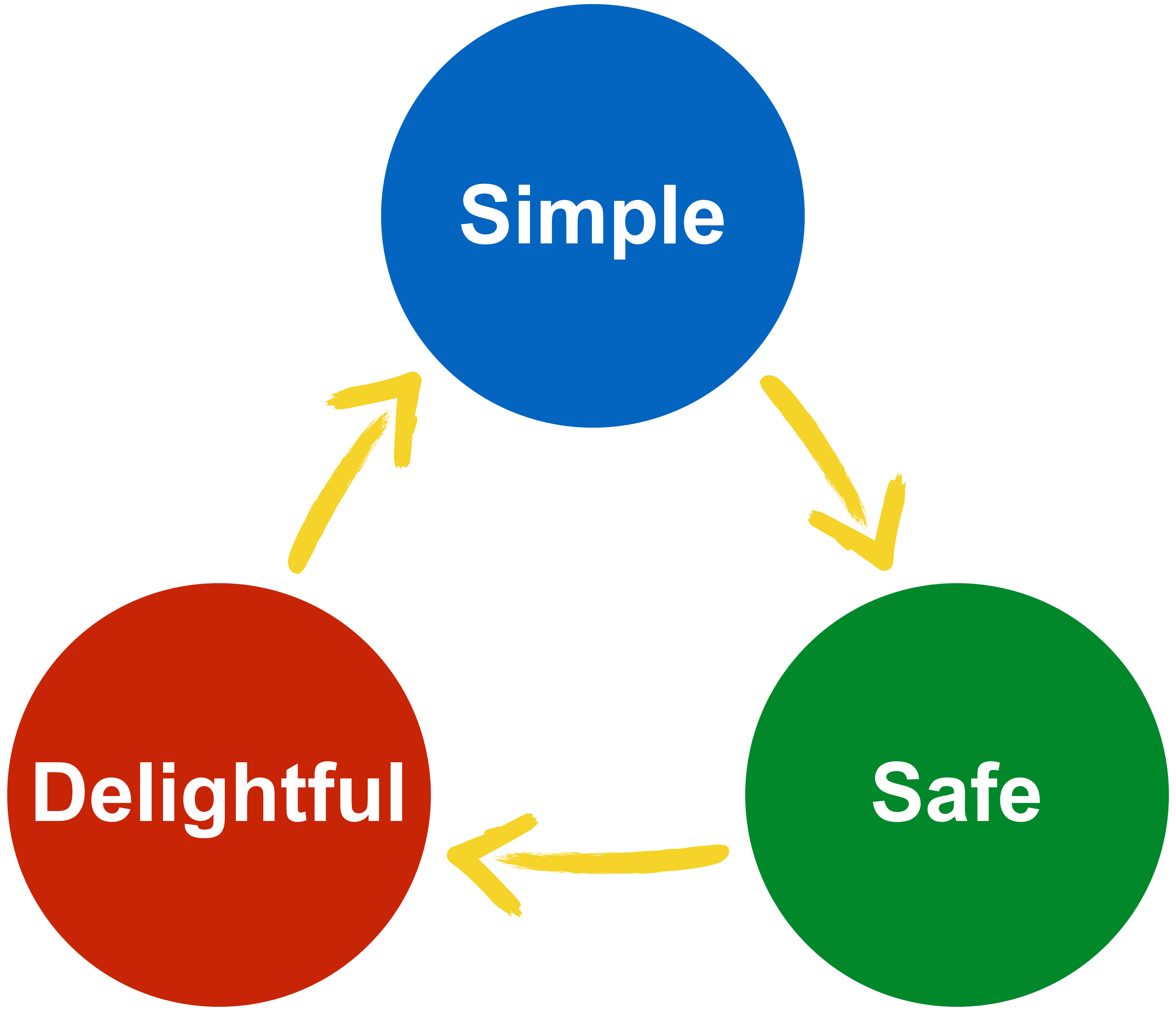
FS Formation for C2CC

C2C Cooperation: City-to-City Cooperation
JDI: Japan Development Institute
OECC: Overseas Environmental Cooperation Center Japan
FS: Feasibility Study
MOEJ/C: Ministry of Environment, Japan/Cambodia

EDC: Electricity De Cambodia
MME: Ministry of Mine and Energy
EAC: Electricity Authority Cambodia
GAEA: Garbage Collection of skill in the art

e-Mobility in Siem Reap

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

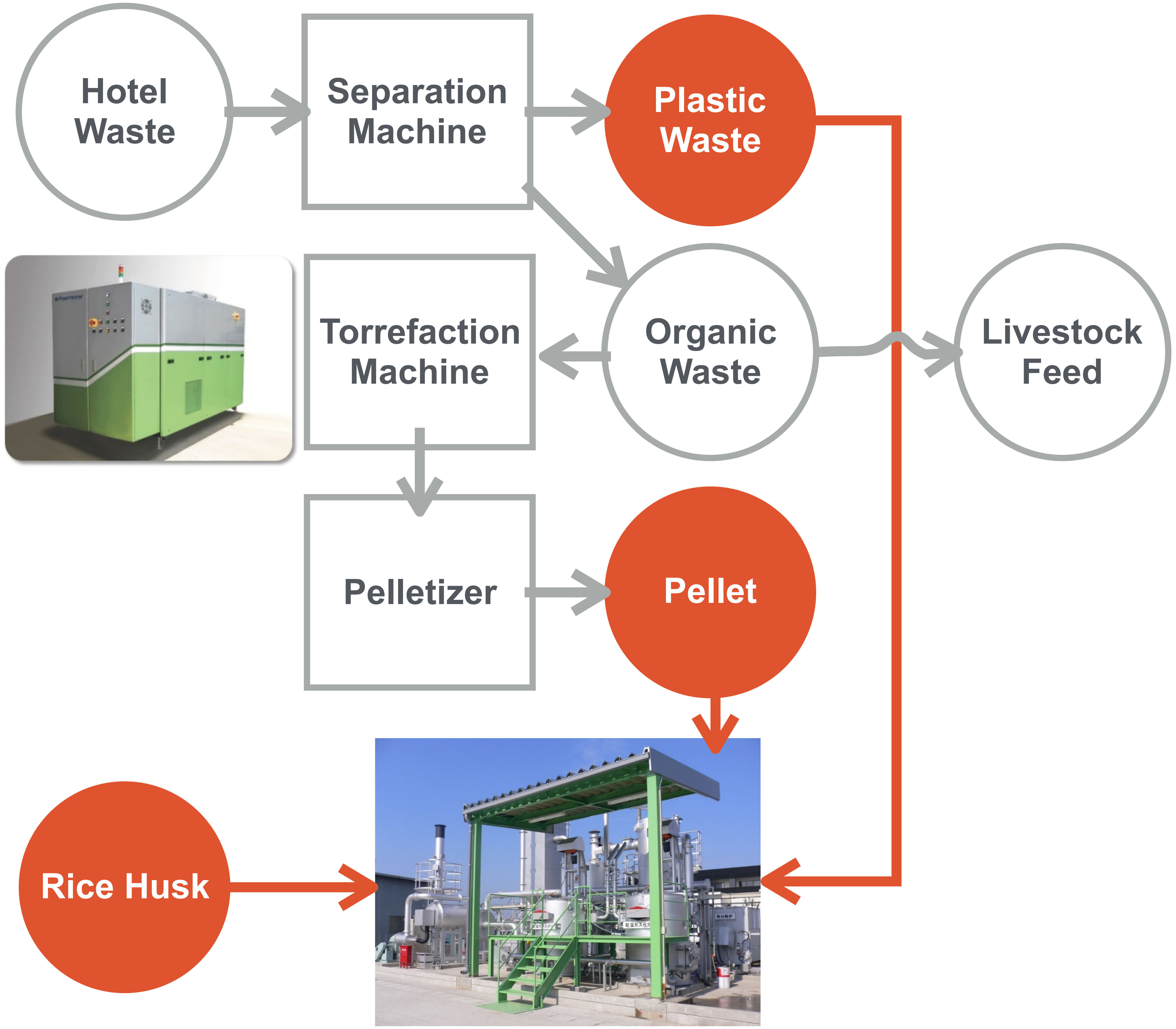


Rooftop Solar Energy in Siem Reap

- Community Solar with rooftop solar energy at five stars hotels and public facilities.
- Encourage self-consumption first and enable to sell excess power.

Aim	Target Group	Target
• Reduce day-peak of electricity • Reduce loss in electricity grid • Lead to self-sufficient power consumption society • Job and business creation	• Area-based • Electricity consumption-based • Electricity user type	• Country peak load • Area Electricity profile
Investment	**Power purchasing model**	**Incentive Measures**
• Self investment • Investment with loan • Leasing	• Feed-in Tariff • Retail price • Net Metering	• Subsidy (Partly) • Tax incentive • Non-tax incentive • Soft loan (ex, IDA (International Development Association))

Waste to Energy in Siem Reap



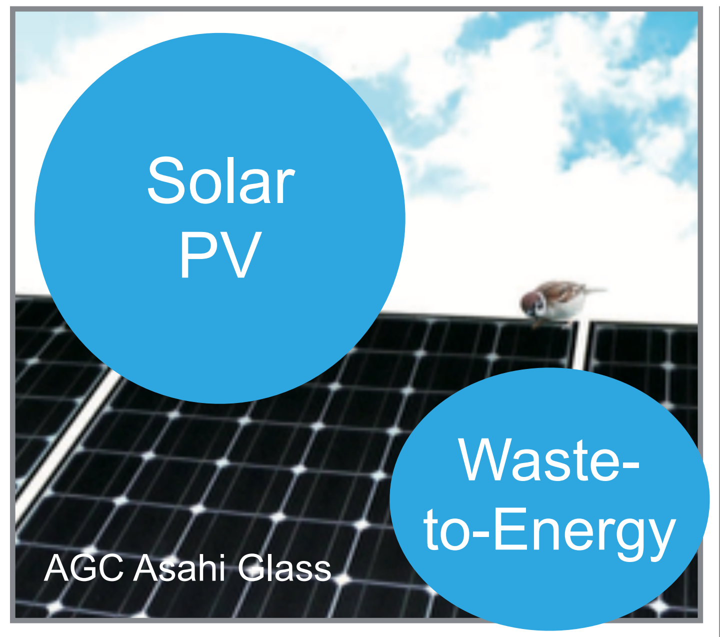
Biomass Power Generation System

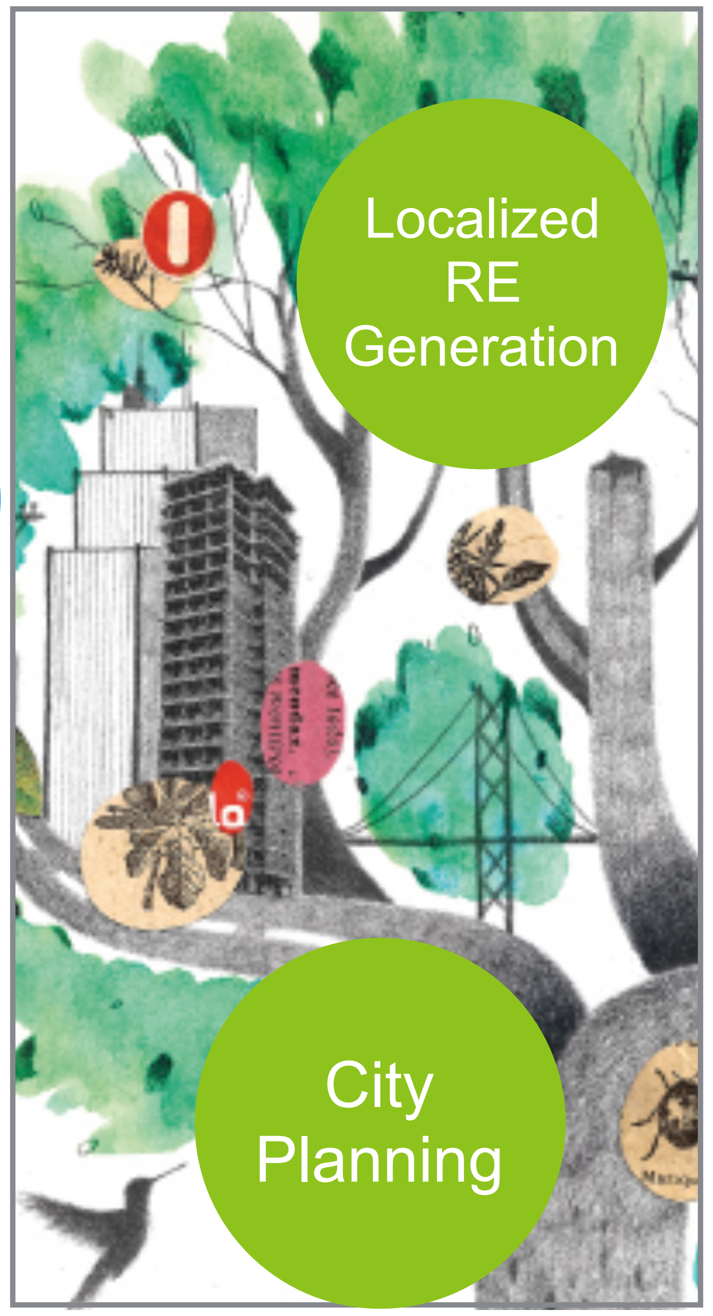
ZEB in Siem Reap

- Zero Energy Building for 5 stars hotels based on RE/EE.
- New Project in 2017

Functions X Infrastructure X Behavior

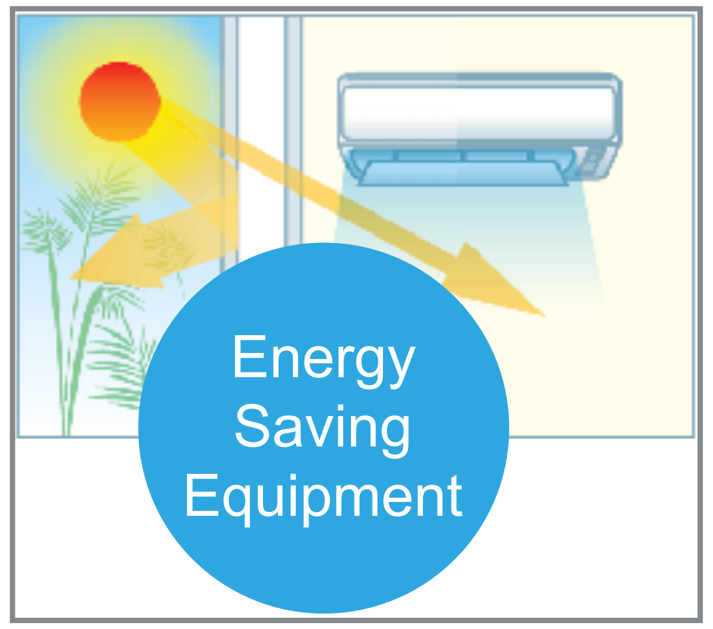
Renewable Energy(RE)





- Decentralization by Rooftop Solar Energy in city
- Electrification
- Reliable and Affordable

Energy Efficiency & Conservation

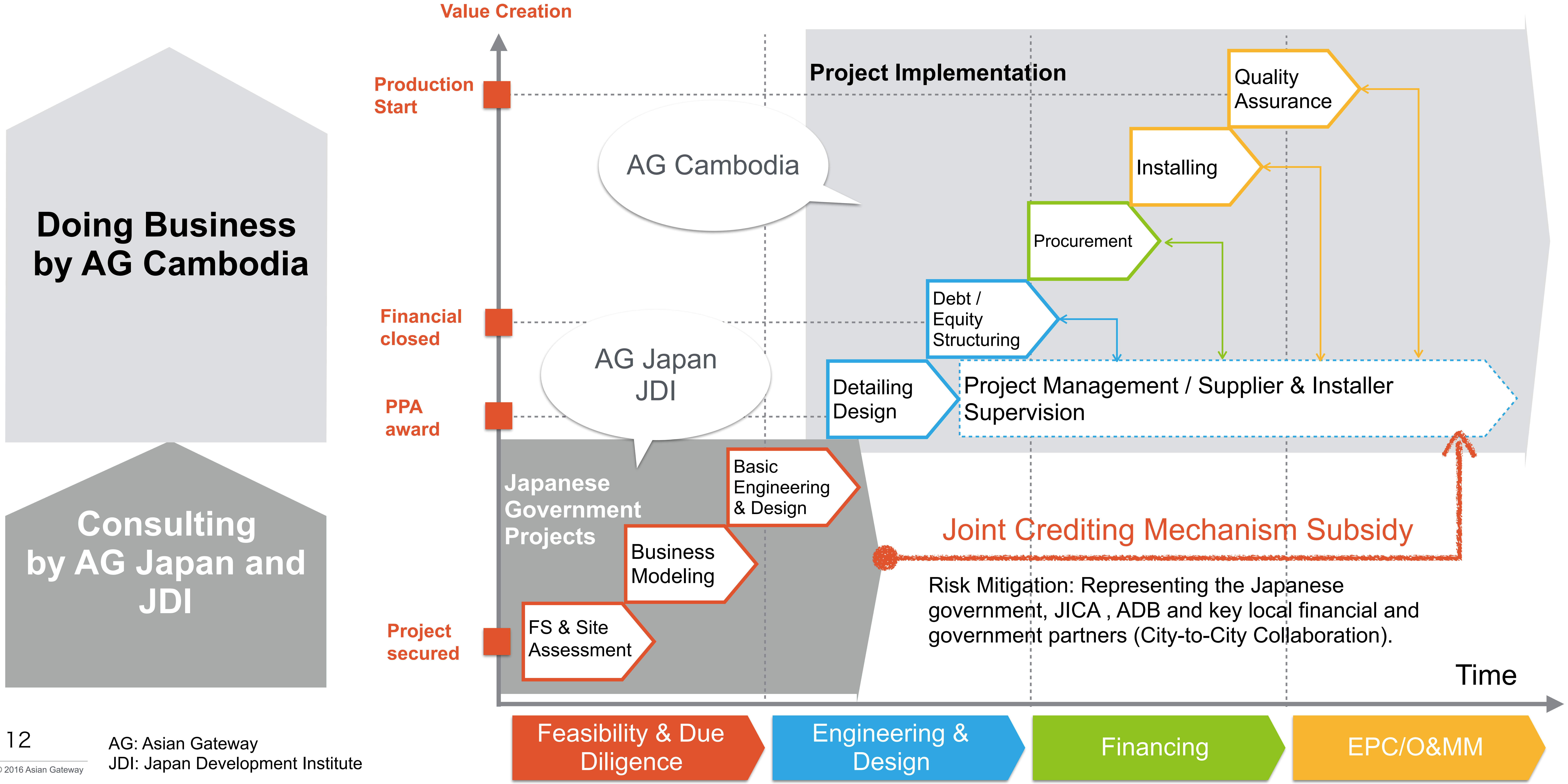


- Efficient Applications
- Integration of architecture and energy saving equipments

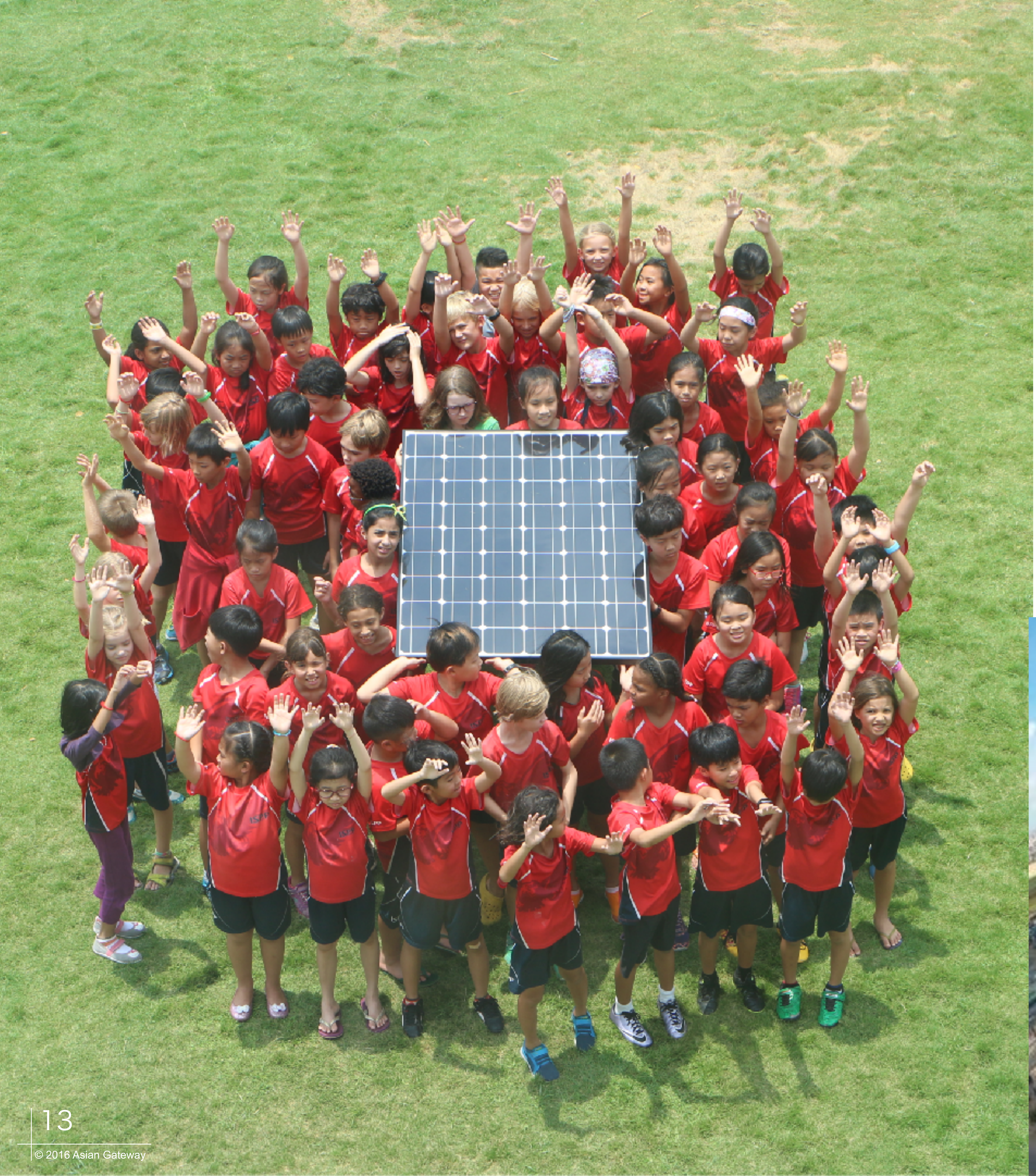
Eco Village controlled by APSARA Authority

- The Run Ta-Ek village Development project, which encompasses 1,012 hectares of land 33 kilometers outside Siem Reap town, was set up by the Apsara Authority, which administers the Angkor temple complex, in an effort to limit the amount of housing within the temple park and along the Siem Reap River.

AG Japan and AG Cambodia



AG: Asian Gateway
JDI: Japan Development Institute



ISPP (International School of Phnom Penh)

- 5.4ha of land
- 200kW + 800kW (Max. 1MW)
- 830 students
- The first GEC JCM Project in Cambodia Solar Market

Target Domain by Cambodia Sun Power

Cambodia AsianGateway

Integrated Solar Energy and Sunshine Power aiming to Local Production for Local Consumption

Food

Synergy

Energy

IoT

IoT: Internet of Things

THANK YOU! FOR YOUR ATTENTION

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

Cambodia AsianGateway

2017.1.19

非公開セミナー：都市間連携に基づくJCM 案件形成可能性調査の進捗報告及び活用が想定される資金支援スキーム

日時：　2017 年 1 月 23 日（月）、09:00-11:00 （受付：08：30-）
場所：　TKP 新橋カンファレンスセンター 3 階 ホール 3A
主催：　環境省
共催：　（公財）地球環境戦略研究機関（IGES）
言語：　日英同時通訳

アジェンダ：

09:00-09:05　主催者挨拶 （会場：3階ホール3A）
水谷 好洋 （環境省 地球環境局 国際連携課 国際協力室長）

09:05-09:10　会場移動（グループ B のみ）

09:10-10:10　第Ⅰ部：案件報告会（60 分）

グループ A （会場：3階ホール3A）	グループ B （会場：4階ルーム4A）
－ カンボジア・シェムリアップ市（2） アジアゲートウェイ（株） 代表取締役社長 木村 友則	－ インドネシア・バタム市（4） 日本工営（株） 環境・水資源事業部-環境技術部 齋藤 哲也
－ インドネシア・バリ州（1） JFE エンジニアリング（株） 都市環境本部 海外事業部 統括スタッフ 樋口 真司	－ ミャンマー・ヤンゴン市（2） 日本工営（株） 環境事業部 環境技術部 副参事 清水 幸代
－ ミャンマー・エーヤワーディ管区（2） （株）三菱総合研究所 環境・エネルギー事業本部 主席研究員 小島 浩司	－ タイ・バンコク都（1） 横浜港埠頭（株） 事業営業部 事業営業課長 尾崎 克行
－ タイ・ラヨン県（2） （株）エックス都市研究所 代表取締役会長兼 CEO 大野 眞里 （株）NTT データ経営研究所 社会・環境戦略コンサルティングユニット シニアコンサルタント 山川 まりあ／網代 睦	－ モンゴル・ウランバートル市（3） （一社）海外環境強力センター 次長／主席研究員 西村 真琴
－ カンボジア・プノンペン都（2） ㈱日建設計シビル エンジニアリング部門 環境計画部 計画主管 藤尾 健太 （株）NTT データ経営研究所 シニアコンサルタント 山川 まりあ／網代 睦	括弧内の数字は調査案件数。1 案件あたり発表時間は 5 分を想定。 （例：バタム 4 案件×5 分＝20 分） 各グループには各都市で行われている調査案件の関係者が参加。
－ ベトナム・ハイフォン市（1） （株）NTT データ経営研究所 シニアコンサルタント 山川 まりあ／網代 睦	
- マレーシア・イスカンダル開発区（1） （株）NTT データ経営研究所 シニアコンサルタント 山川 まりあ／網代 睦	

10:10-10:30　休憩（20 分）

10:30-11:00　第Ⅱ部：資金支援スキームの概要説明（各発表＋質疑応答 10 分）（会場：3階ホール3A）

① 設備補助事業
坂内 修 （（公財）地球環境センター 東京事務所 事業第一グループ 総括主任）

② JCM 日本基金（JFJCM）
手島 裕明 （アジア開発銀行 持続可能な開発・気候変動局 気候変動・災害リスク管理課 環境専門官）

③ 緑の気候基金（GCF）
丸山 出 （三菱 UFJ モルガン・スタンレー証券㈱ クリーン・エネルギー・ファイナンス部 コンサルタント）

（11:00-　昼食） （会場：1階ホール1A）

- ✓ 希望者は第Ⅱ部発表者との個別面談
- ✓ パネルディスカッション登壇者の打合せ

2017.1.19

公開セミナー：アジアにおける低炭素社会実現のための都市間連携セミナー

日時：　2017 年 1 月 23 日（月）、14:00-17:00 （受付 13：30-）
場所：　イイノホール＆カンファレンスセンター　4 階 Room B
主催：　環境省
共催：　（公財）地球環境戦略研究機関（IGES）
言語：　日英同時通訳

アジェンダ：

14:00-14:10	主催者挨拶（10 分） 梶原　成元 （環境省 地球環境審議官）
14:10-15:00	第Ⅰ部　アジアの都市の低炭素化を推進する支援スキームと事例の紹介 ①　都市間連携を活用したアジアの都市の低炭素化を進める取組（15 分） 佐井　祐介 （環境省 地球環境局 国際連携課 国際協力室 環境専門調査員） ②　設備補助事業（10 分） 坂内　修 （（公財）地球環境センター 東京事務所 事業第一グループ 総括主任） ③　JCM 日本基金（10 分） 手島　裕明 （アジア開発銀行 持続可能な開発・気候変動局 気候変動・災害リスク管理課 環境専門官） ④　緑の気候基金（GCF）（10 分） 丸山　出 （三菱 UFJ モルガン・スタンレー証券㈱ クリーン・エネルギー・ファイナンス部 コンサルタント） 質疑応答（5 分）
15:00-15:45	第Ⅱ部　都市間連携事業の参加都市による取組事例紹介 ①　インドネシア国バリ州における廃棄物発電事業（10 分） 大島　健太郎 （東京二十三区清掃一部事務組合 清掃事業国際協力室 清掃事業国際協力課 清掃事業国際協力係 主任） ②　タイ国における JCM を活用した港湾の低炭素・スマート化支援調査事業（10 分） 奥野雅量 （横浜市 国際局 国際協力課 国際技術協力担当課長） 鈴木明広 （横浜市 港湾局 賑わい振興課長） ③　エーヤワディの低炭素化に向けた JCM 案件形成調査事業（10 分） アウン・ミン・ナイン （ミャンマー国エーヤワディ管区 開発局長） 宍戸　亮 （福島市 環境部 環境課長） ④　ハイフォン市・低炭素化促進事業（10 分） グエン・トルン・ヒウ （ベトナム国ハイフォン市 外務局 副局長） 質疑応答（5 分）
15:45-16:00	休憩（15 分）
16:00-17:00	第Ⅲ部　パネルディスカッション（60 分） モデレーター： 水谷　好洋 （環境省 地球環境局 国際連携課 国際協力室長） パネリスト： 天野　一　（神奈川県 産業労働局 産業部 エネルギー課長） 浦崎　真　（北海道 総合政策部 国際局 国際課 プロモーショングループ 主幹） 大橋　武郎（札幌市 経済観光局 国際経済戦略室 経済戦略推進課 戦略推進担当係長） 深堀　孝博（川崎市 経済労働局 国際経済推進室 課長補佐） 園　順一　（北九州市 環境局 環境国際戦略部 環境国際戦略課 アジア低炭素化センター 特区プロジェクト担当課長） ソフェン・ウング （カンボジア国シェムリアップ州政府 地区共通課長） バツク・ボロルトヤ （モンゴル国ウランバートル市 自然環境局 自然環境資源部長） ポンピロドム・パニット （タイ国ラヨン県行政機構 県環境科学官）

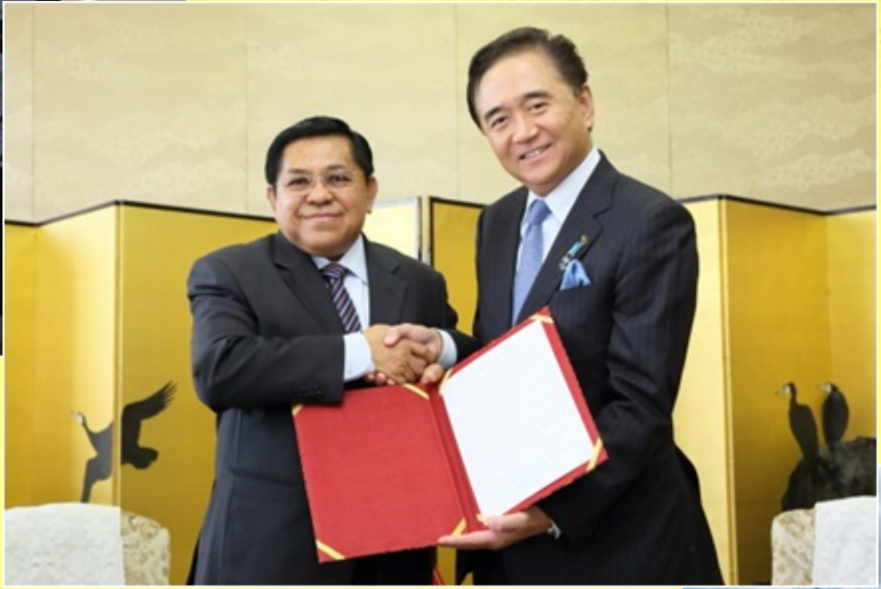
① カンボジア・シェムリアップ州における都市間連携によるJCM案件形成可能性調査事業 神奈川県／シェムリアップ州 （5分）
② モンゴル・ウランバートル市における都市間連携による JCM 案件形勢可能性調査事業 北海道／札幌市 （5分）
③ ミャンマー・ヤンゴン市における都市間連携による JCM 案件形成可能性調査事業川崎市（5分）
④ タイ・ラヨン県における都市間連携によるJCM案件形成可能性調査事業 北九州市 （5分）

＜発表・討議のポイント＞
・自治体の政策におけるJCM案件形成調査の位置づけ
・今年度の案件形成調査の活動を振り返って見えてきたこと
・都市間連携の意義、自治体にとってのメリット、課題と対応策

17:00 閉会挨拶
水谷 好洋 （環境省 地球環境局 国際連携課 国際協力室長）

18:00-19:30 歓迎レセプション
会場：ロッシニ（ROSSiNi）（東京都千代田区内幸町 2 丁目 2-2 富国生命ビル1階）

カンボジア・シェムリアップ州と 神奈川県の取組について



神奈川県産業労働局産業部エネルギー課

取組のきっかけ

ＪＣＭ大規模案件形成可能性調査の一環で 2014年11月に訪日研修受入⇒その後、支援要請あり

本県のエネルギー施策について解説

シェムリアップ州の抱える課題

- 急速な都市化
- 輸入電力に依存
- ディーゼル発電によるバックアップ

- 世界遺産等登録と観光客の急増
- ユネスコからの保全の要請（酸性雨対策等）

低炭素観光都市づくりが急務

かながわスマートエネルギー計画

策定の経緯

平成25年７月に制定した「神奈川県再生可能エネルギーの導入等の促進に関する条例」に基づき、エネルギー政策に関する基本的な計画として策定

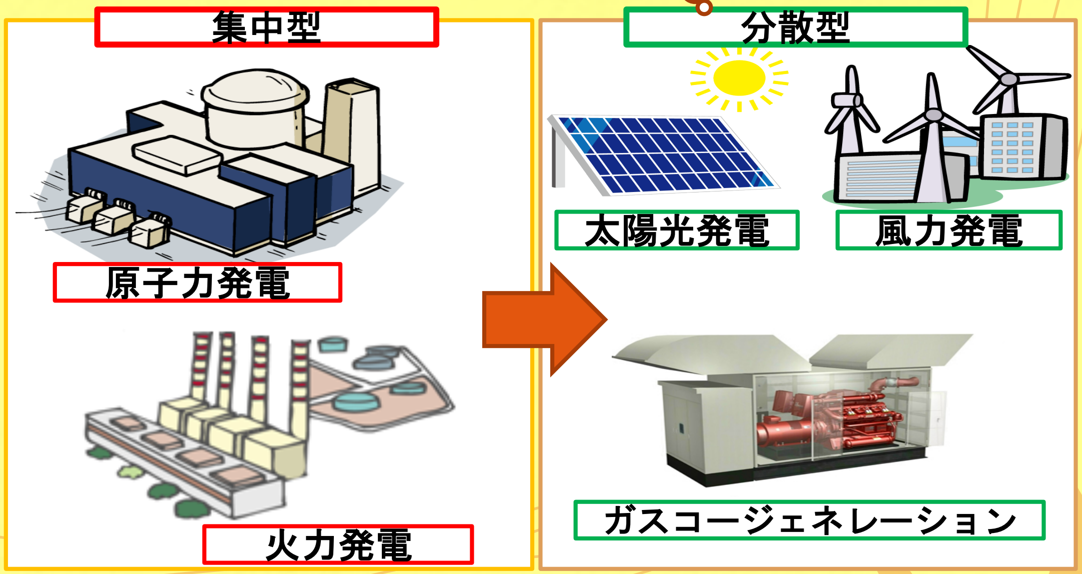
３つの原則

○ 原子力に過度に依存しない
○ 環境に配慮する
○ 地産地消を推進する

本県の取組がシェムリアップ州の課題解決に役立つのではないか・・・

5つの基本政策

○再生可能エネルギー等の導入加速化
○安定した分散型電源の導入拡大
○情報通信技術(ICT)を活用した省エネ･節電の取組促進
○地域の特性を活かしたスマートコミュニティの形成
○エネルギー産業の育成と振興



出典：日本原子力発電株式会社、大阪ガス株式会社

今年度の主な取組

①コミュニティ型太陽光発電

企業現地調査

訪日研修（視察）

②有機系廃棄物と籾殻を利用したバイオマス発電

企業現地調査

訪日研修（視察）

本調査事業の全体像

シェムリアップ州 ⇔ MOU締結 ⇔ **神奈川県**

シェムリアップ州のニーズ

- 交通課題
- 環境課題
- 貧困層課題

課題

解決

「屋根貸し」による

太陽光発電事業の事例紹介等

低炭素観光都市づくり

インフラ輸出事業

- 公立高校の「屋根貸し」を利用した
  コミュニティ型太陽光発電事業
  - 自家消費型で案件化を実現
- 有機系廃棄物と籾殻を利用した
  バイオマス発電事業
  - 設置場所が確定し、籾殻収集調査が終了

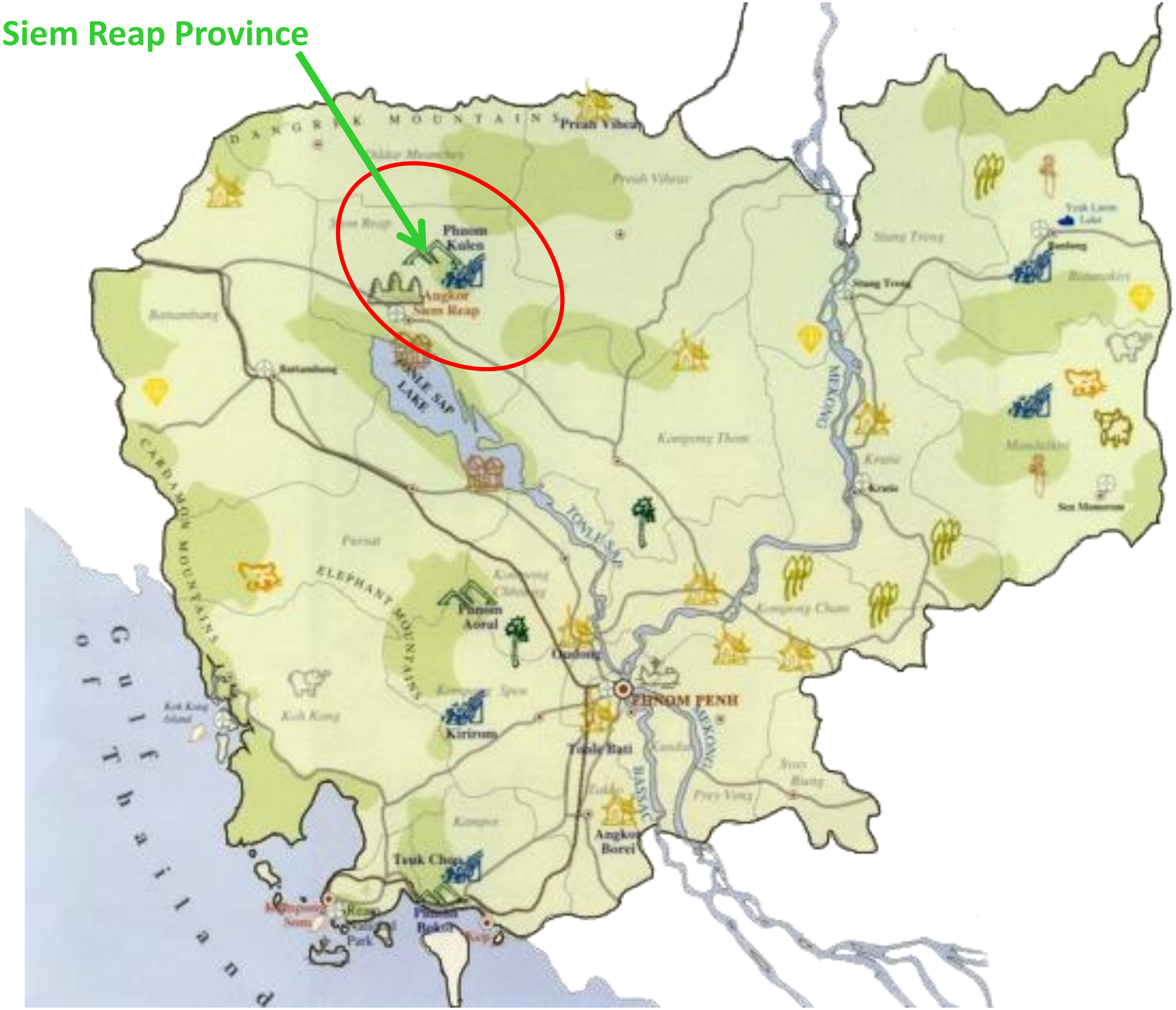
Seminar of Joint Crediting Mechanism (JCM) City-to-City Collaboration Projects

Siem Reap Province Cambodia

By Mr. Ung Sophean
Director of Inter-Sectorial Affairs

January 23, 2017
Tokyo, Japan

Siem Reap Province



Overview of the Province

- Total area of the province 10.299km ^{2}
- Population : 1.042.286 people
  - Female: 526,784)
  - 18 years old up: 712,658 (Female 415,079).
- Family : 206,385 families
- Population density : 101,2 People/km^2
- Population Increase : 3%

Overview of Siem Reap City

- Land area: 472.73 Km2
- 13 Sangkats:
- 108 Villages
- Population: 256,018 (Female:131,528)
- Households 50,824
- Family size: 5
- Tourists: 3.5 Millions

low-Carbon Policies/strategies/action Plans in Siem Reap City

1. City Overall Visions

- Town of Water
- **Town of Green**
- Town of Culture and Education
- Town of Tourism Assets

2. City Development Plan

- Environmental development plan (Priority Plan)
- Introduction of Environmental public transport in the Angkor Archeology Park (AAP): Battery Car / Electric bus, Traditional transport (Horse cart, Elephant ,.)

3. Public Awareness Raising Mechanism

- Environmental Campaign/Environmental Day
- Training/workshops
- Banners (Public)

Roles of Siem Reap Provincial Administration for Low-Carbon Implementation Policy

1. Support city development plan implementation
2. Provide capacity development and human resources
3. Strengthening roles and responsibility of city administration on low-carbon policy/strategy and action plan (Transfer from National administration to City administration)
4. Provide technical support to city administration (National/Provincial Administration)
5. Cooperated with development partners/private sector for low-carbon projects implementation
6. Improve local participations and understanding on environmental protection process (Environmental Campaign/Environmental Day, Training/workshops, Banners for public)

Waste Management

Recycling and Reusing Activities

Animal Feeding

Plastic Battle Reproduction

Composting

Waste Separation Management Project

Siem Reap City

Private Company

Electric Tourists Transportation

Private Companies Investment

← **Asian Gateway**

Request to the JCM City-to-City Collaboration Project

1. Develop City overall visions for Low-Carbon policy, strategy, guideline and action plan (National and Sub-national)
2. Implementation of low-carbon projects for sustainable development
3. Strengthening Roles and responsibilities of local government and local people .


Thank You for Your Consideration

Feasibility Study for C2CC-JCM 2016 in Siem Reap

Tomonori KIMURA
CEO
Asian Gateway Corporation

January 23, 2017

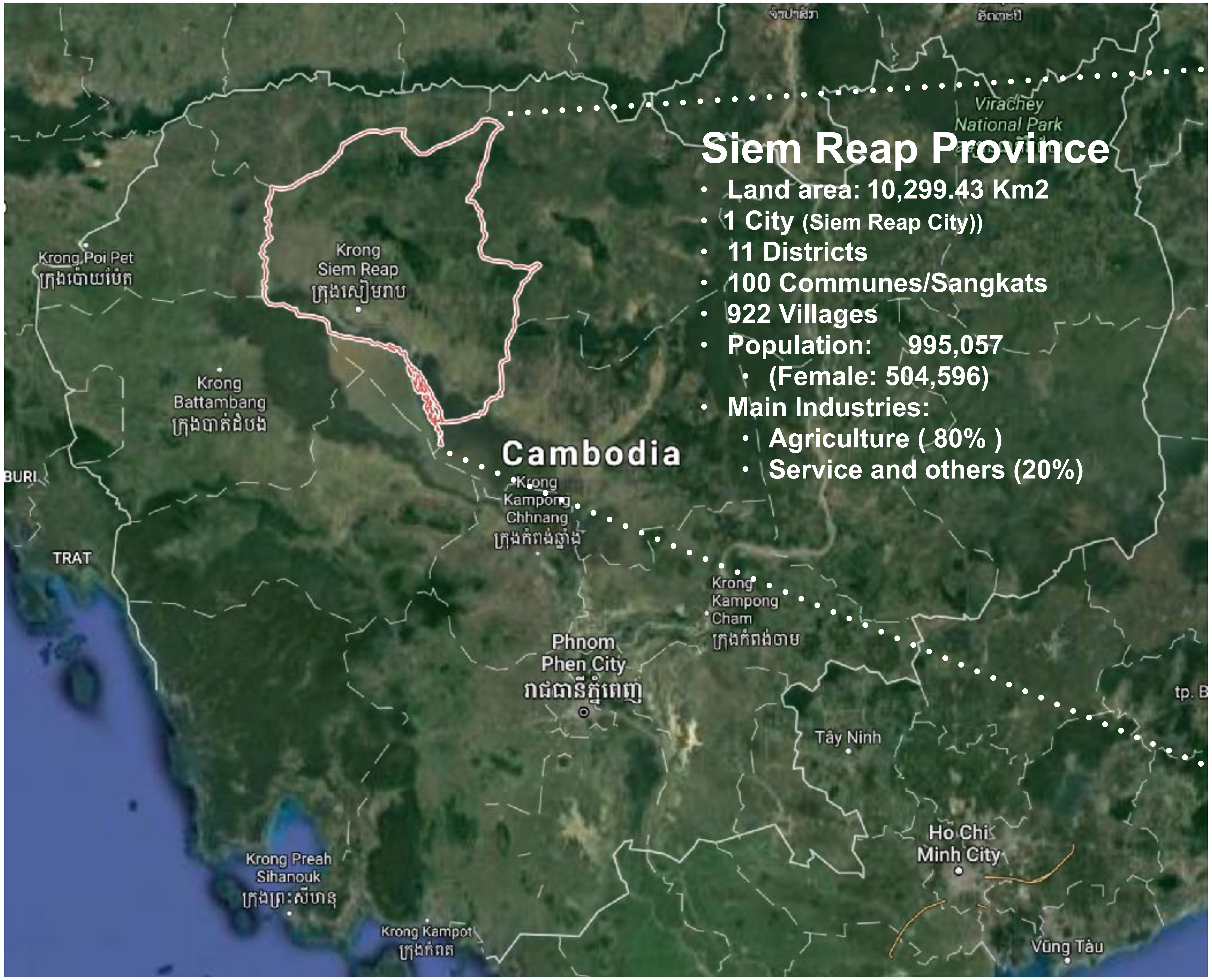
AsianGateway

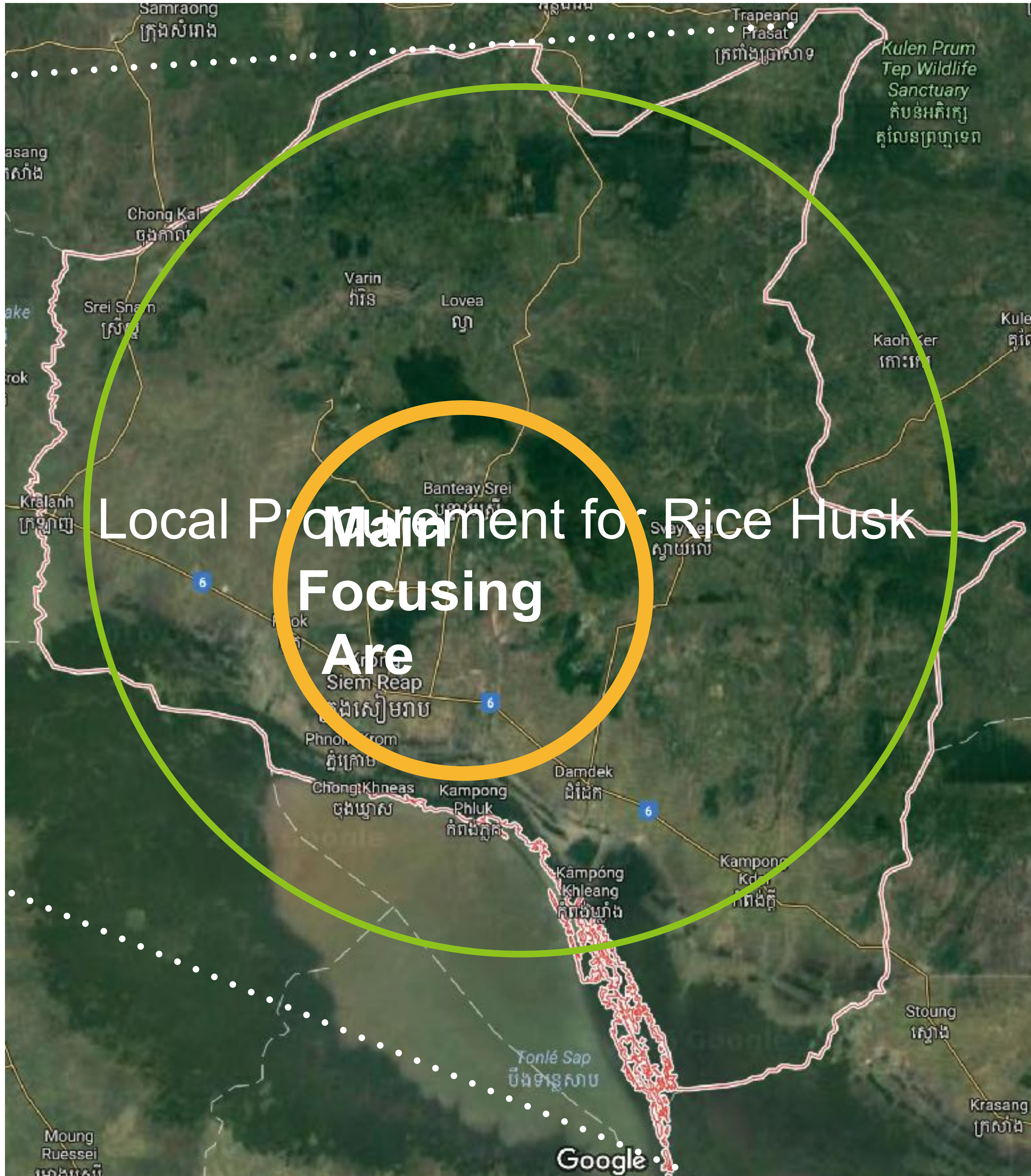
3-7-2, KANDANISHI CHO, CHIYODA-KU, TOKYO

PUBLISHED JANUARY 2017
WWW.ASIANGATEWAY.CO.JP

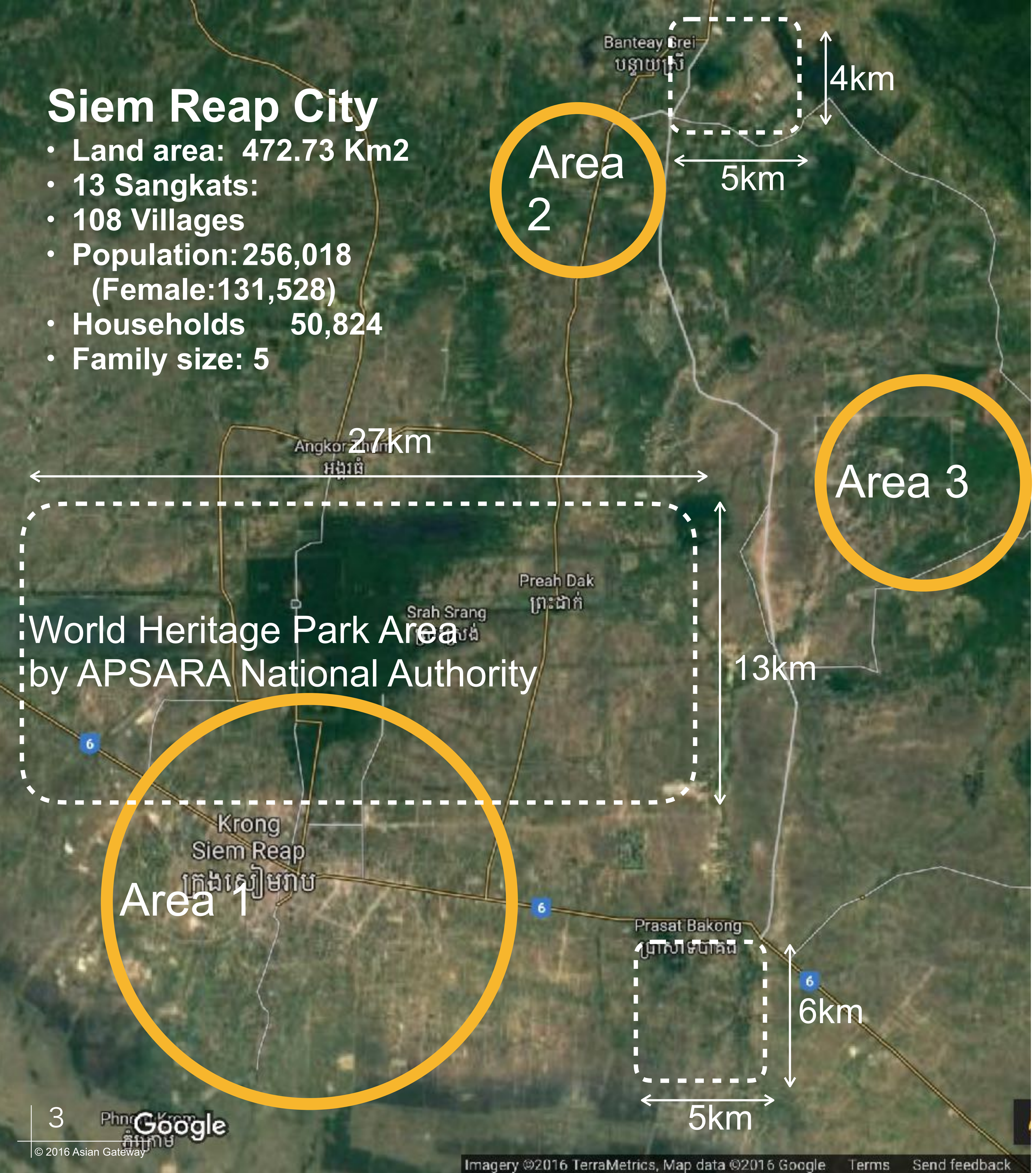
C2CC-JCM: City to City Cooperation-Joint Crediting Mechanism

Our project site in Sime Reap Province





Close up for our main focusing area and projects



Area 1

- Downtown of Siem Reap City
- Rooftop Solar Implementation with Self-Sufficient and Off-Grid with turnkey provider
- Electric Mobility for Para Transit and Logistics

Area 2

- 30ha Land nearby Banteay Srey Temple
- Forest Resort Development as a showcase of Smart City with FCC (Foreign Correspondents Club)

Area 3

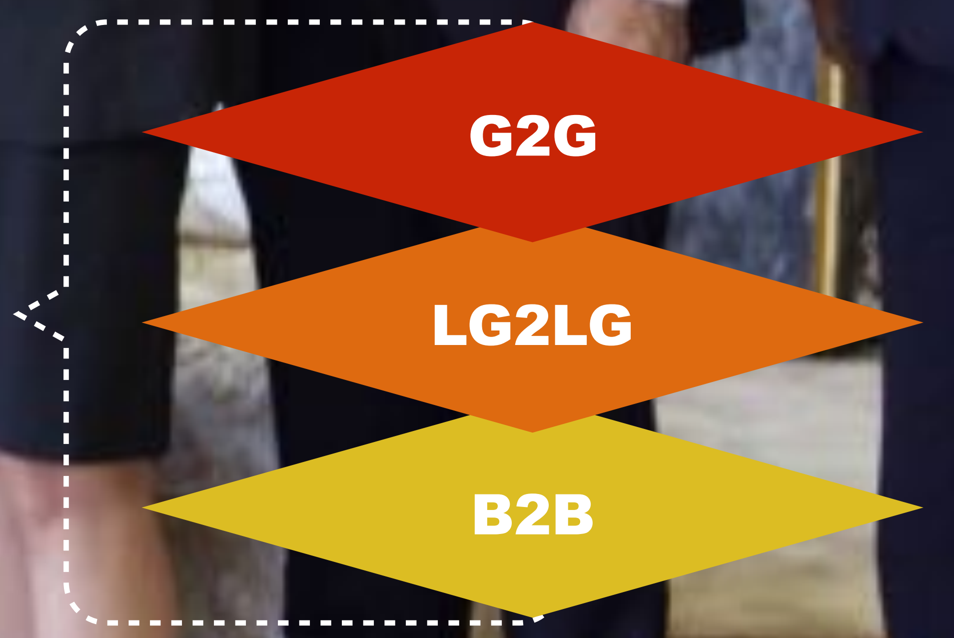
- Eco Village (1,000ha) managed by APSARA National Authority nearby Phnom Bok
- Solar Energy and Biomass Power Plant Development for Hydroponics with SOMA Group

PPP Scheme with C2CC

AsianGateway

C2CC-JCM 2016

PPP approach like Bilateral Cooperation with Siem Reap and Kanagawa (Nov. 2015)



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

- City to City Collaboration
- EV Tourism and Renewable Energy
- International Consortium for JCM
- Business Partnership with Asian Gateway
- Consulting and Trading for Sustainable Energy

PPP: Public-Private Partnership

C2CC-JCM FS: City to City Cooperation-Joint Crediting Mechanism Feasibly Study

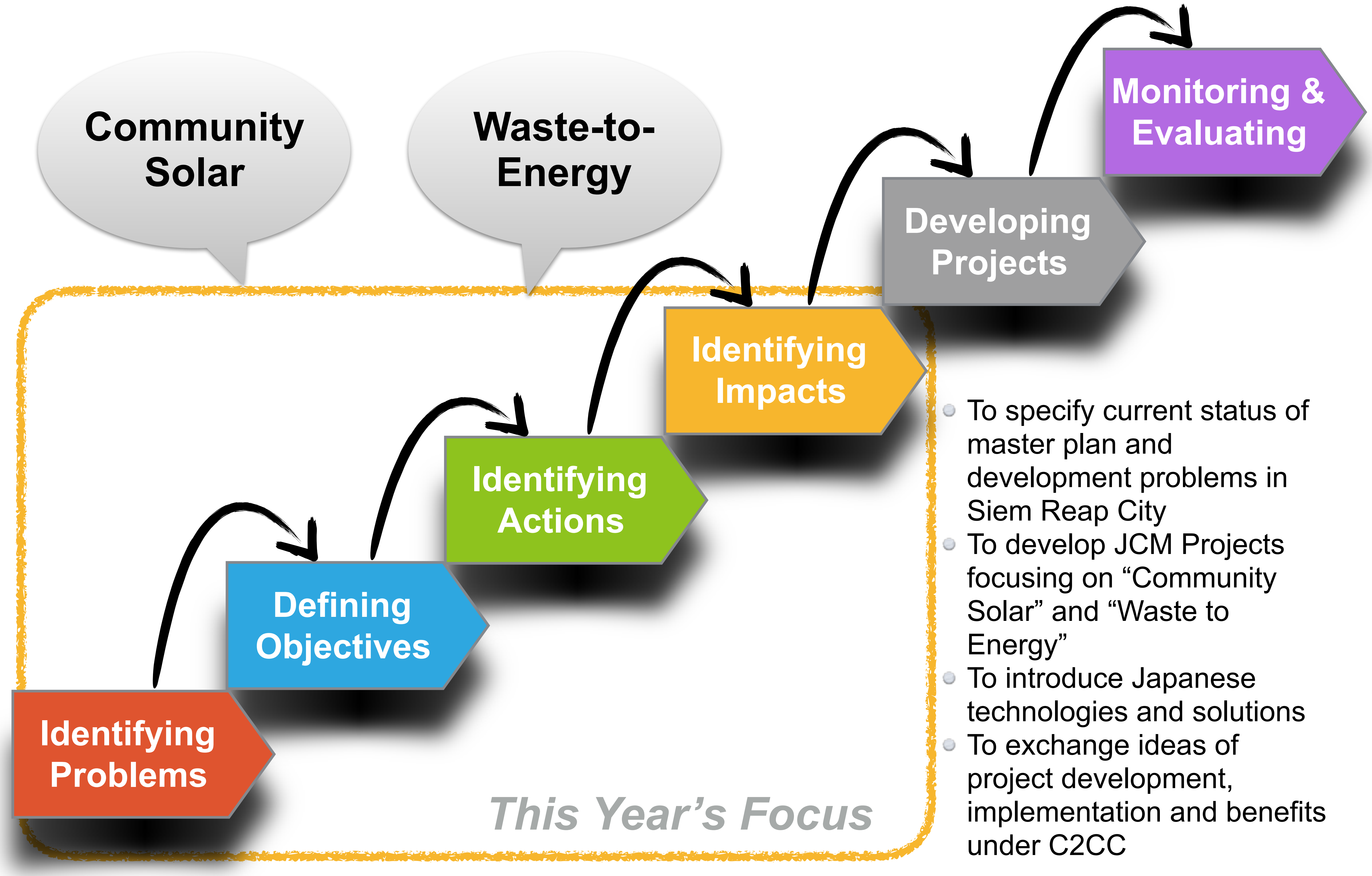
C2CC with Siem Reap and Kanagawa

Objectives

- Creating low-carbon tourism city (Green 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

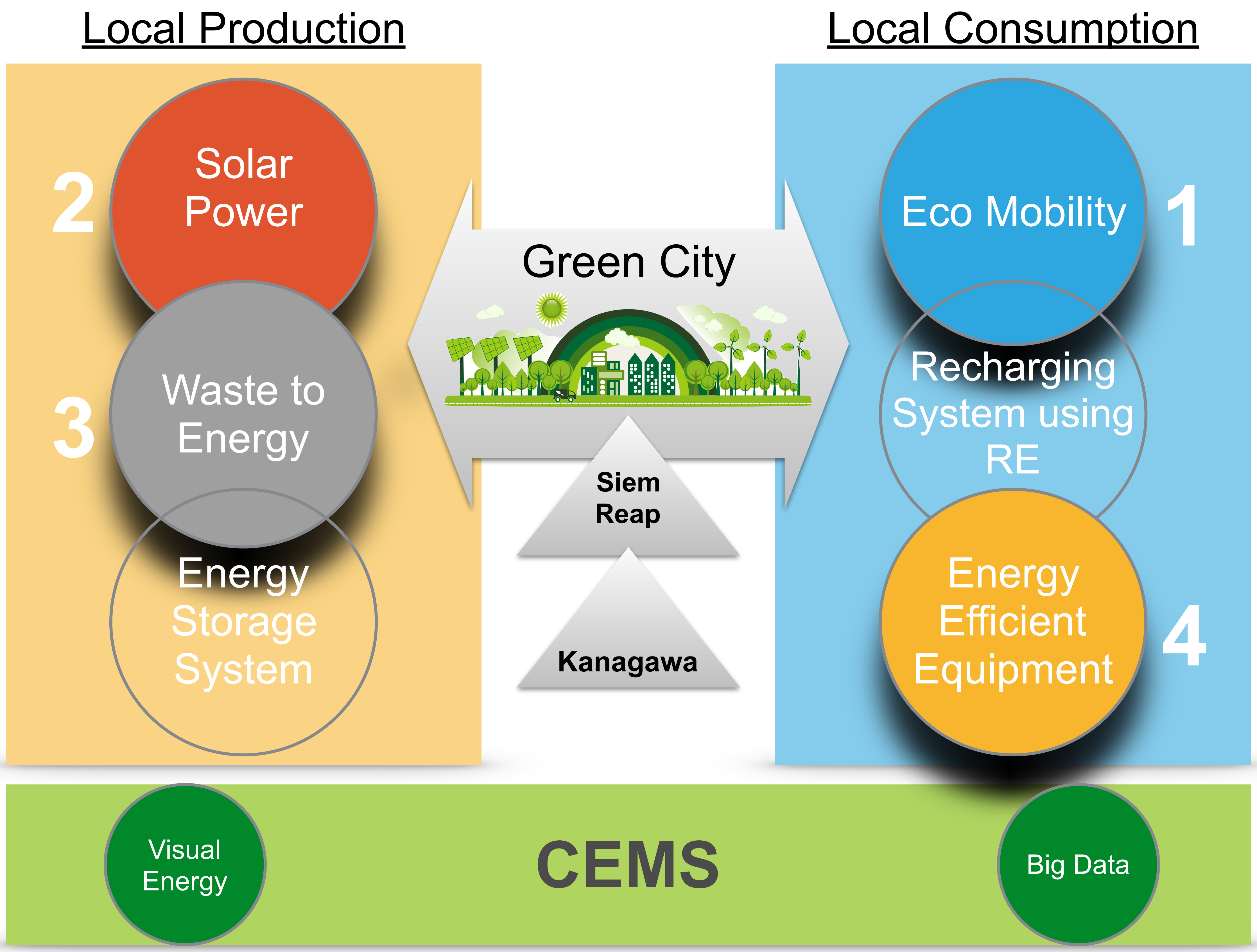
Strategical Steps for C2CC in 2016

Strategical Steps for C2C Cooperation in 2016



- To specify current status of master plan and development problems in Siem Reap City
- To develop JCM Projects focusing on "Community Solar" and "Waste to Energy"
- To introduce Japanese technologies and solutions
- To exchange ideas of project development, implementation and benefits under C2CC

Vision: Local Production for Local Consumption



C2C Cooperation: City-to-City Cooperation
CEMS: Community Energy Management System

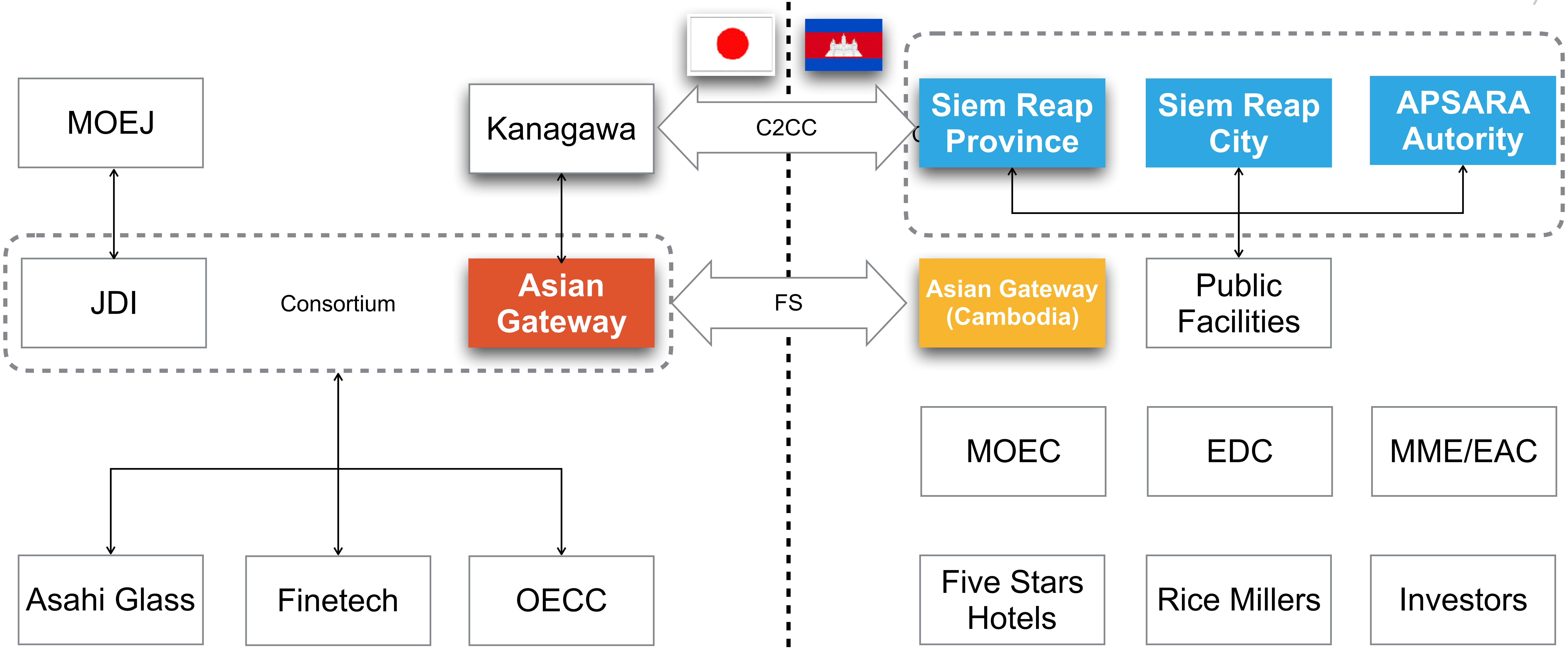
Strategic Steps for C2CC

AsianGateway

Identifying Problems	Kickoff Meeting for Visioning and Concept Understandings	Strategic Planning	Long List Made, Prioritizing and Short List Made	Contact Made and Hearing
Defining Objectives	Discussion Documents Made	Meetings with Prospects and Investors	Site Survey	Secured Requirements
Identifying Actions	Preparation for Proposal	Fundraising	Preparation for Establishment of AG Cambodia	Proposal Finalized
Identifying Impacts	Specified Requirements	Finalizing Proposal for JCM and Prospects	Term & Conditions Negotiated with Prospects	Contracting MOU

As is January 2017

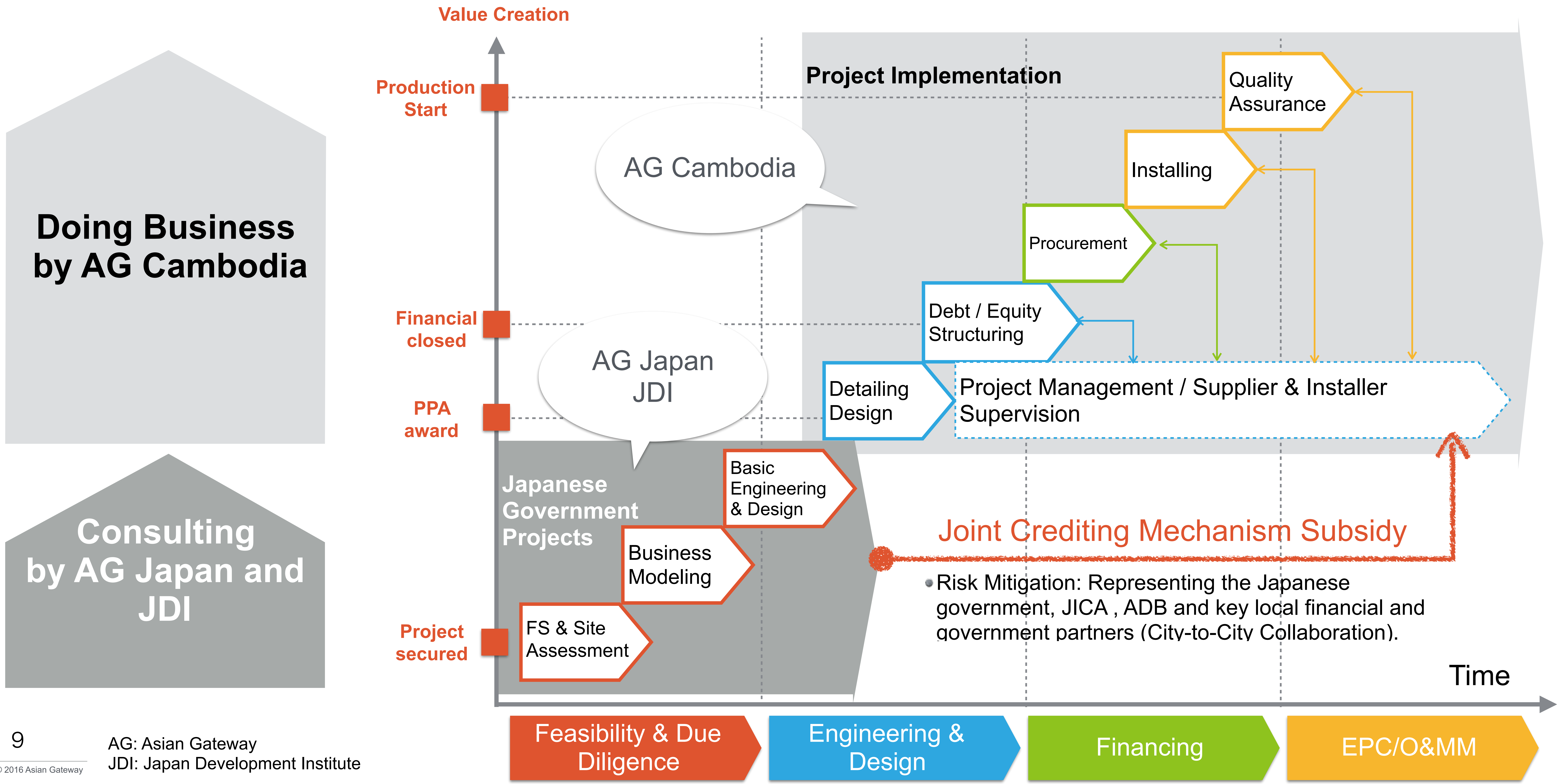
FS Formation for C2CC



C2C Cooperation: City-to-City Cooperation
JDI: Japan Development Institute
OECC: Overseas Environmental Cooperation Center Japan
FS: Feasibility Study
MOEJ/C: Ministry of Environment, Japan/Cambodia

EDC: Electricity De Cambodia
MME: Ministry of Mine and Energy
EAC: Electricity Authority Cambodia
GAEA: Garbage Collection of skill in the art

AG Japan and AG Cambodia



AG: Asian Gateway
JDI: Japan Development Institute

Rooftop Solar Implementation with Self-Sufficient and Off-Grid

AsianGateway

Area 1

AsianGateway Cambodia

Rooftop Solar Implementation by SPV with AGC

Asian Gateway (Cambodia) Co., Ltd. is establishing SPV (Special Purpose Vehicle) to provide Solar energy hotel with PPA (power purchase agreement). There is no permission to connect solar energy to national grid controlled by EDC.

Renewable Energy

- Solar Energy
  - Rooftop
  - Ground Mounted
  - Floating
- Solar Financing
  - Joint Crediting Mechanism (JCM)
  - Solar Leasing
  - Fundraising Service
- Biomass Power Generation
  - Waste to Energy
  - Torrefaction
  - Pellet Exporting and Plelletization

Rooftop Solar Energy in Siem Reap

- Community Solar with rooftop solar energy at five stars hotels.
- Encourage self-consumption first and enable to sell excess power.

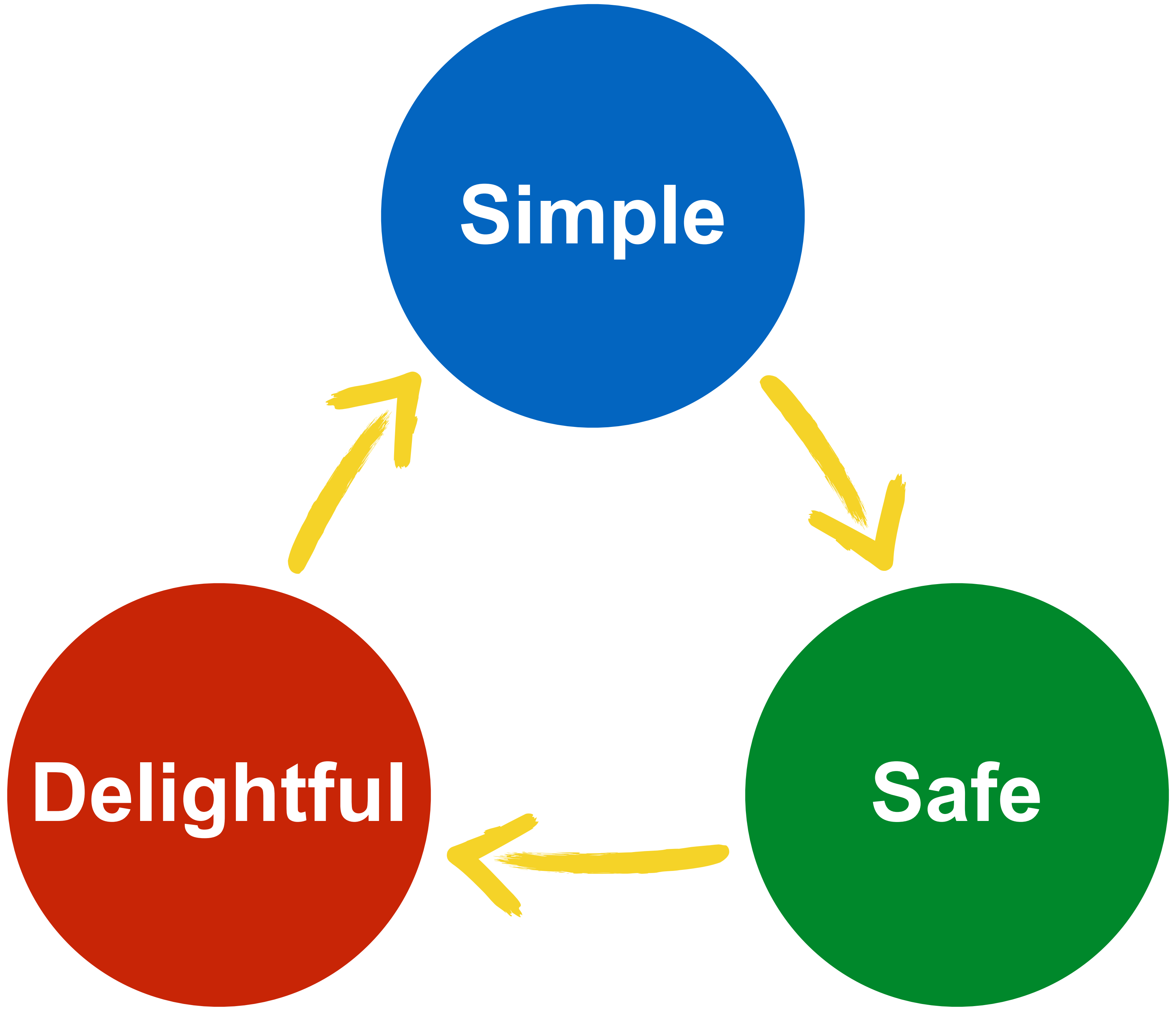
Aim	Target Group	Target
• Reduce day-peak of electricity • Reduce loss in electricity grid • Lead to self-sufficient power consumption society • Job and business creation	• Area-based • Electricity consumption-based • Electricity user type	• Country peak load • Area Electricity profile
Investment	**Power purchasing model**	**Incentive Measures**
• Self investment • Investment with loan • Leasing	• Feed-in Tariff • Retail price • Net Metering	• Subsidy (Partly) • Tax incentive • Non-tax incentive • Soft loan (ex, IDA (International Development Association))

PPA based SPV with Hotels

- Turnkey Provider is main EPC with majority investment for initial equity of SPV.
- SPV provides the solar electricity with affordable price including operation and maintenance service to hotel.
- SPV also provides energy efficiency equipment to hotel.

e-Mobility in Siem Reap

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



Special Experience Just For You!

Forest Resort Development with FCC

Area 2

FCC Hotels & Restaurants

From our very first days in Phnom Penh and in Siem Reap, FCC has been the meeting place for intrepid adventurers, locals and visitors, from around the world. FCC brings together spirited people where, in colonial settings perfect for conversation, good food and drink have always been the order of the day. And, where sharing information and telling of stories both big and small, myths have been born.

Key facts and objectives

AsianGateway

- Creating a fully energy neutral eco-resort and development
- Creating the most integrated resort for nature lovers
- Becoming a show case for sustainable tourism development

Basic Concept for Forest Resort

AsianGateway

- Net-Zero Energy Resort
- Exclusive Luxurious Healing Space during long stays inside Angkor Forest

net zero asia

Eco Village

Our targeted land (2ha)

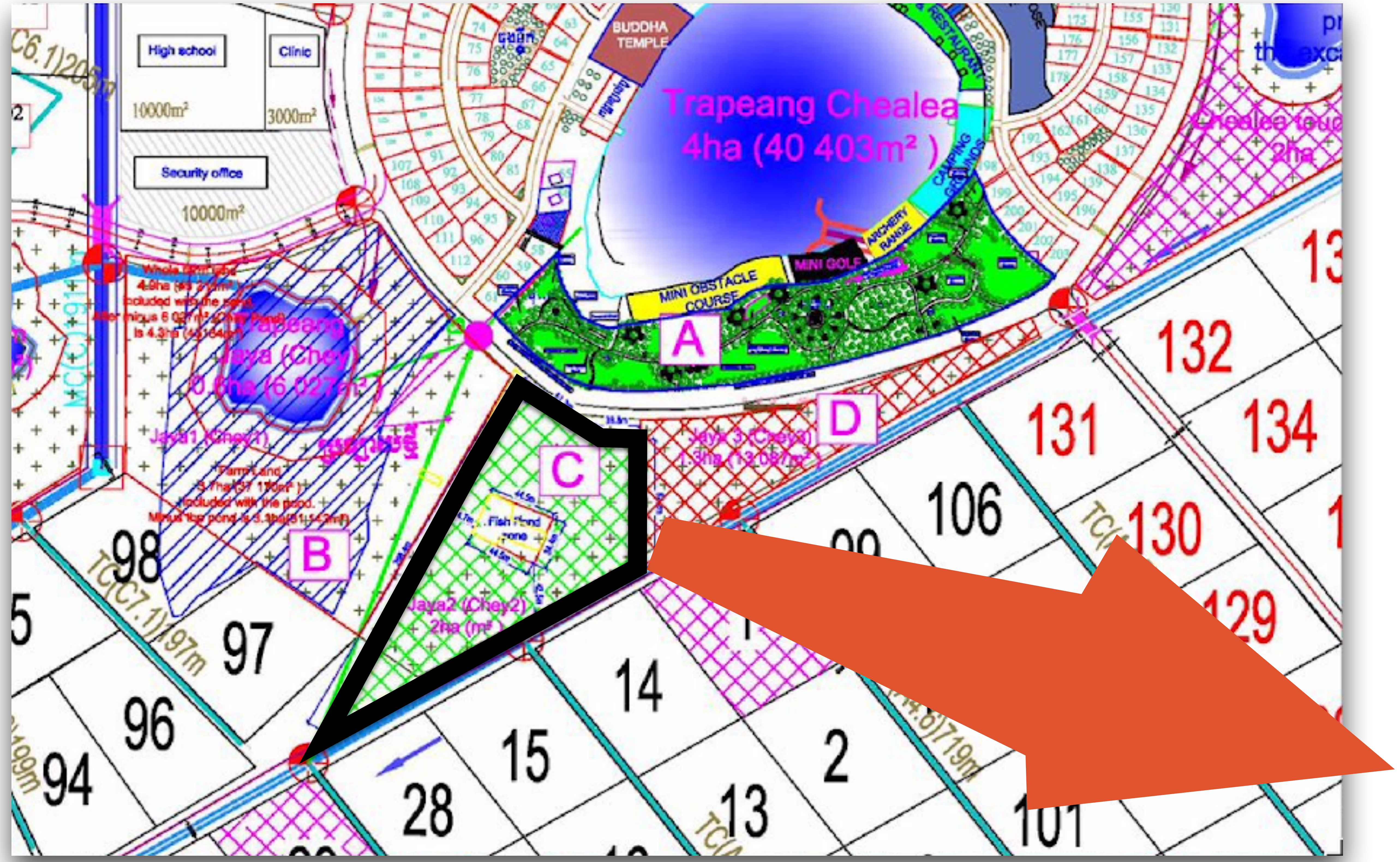
Area 3

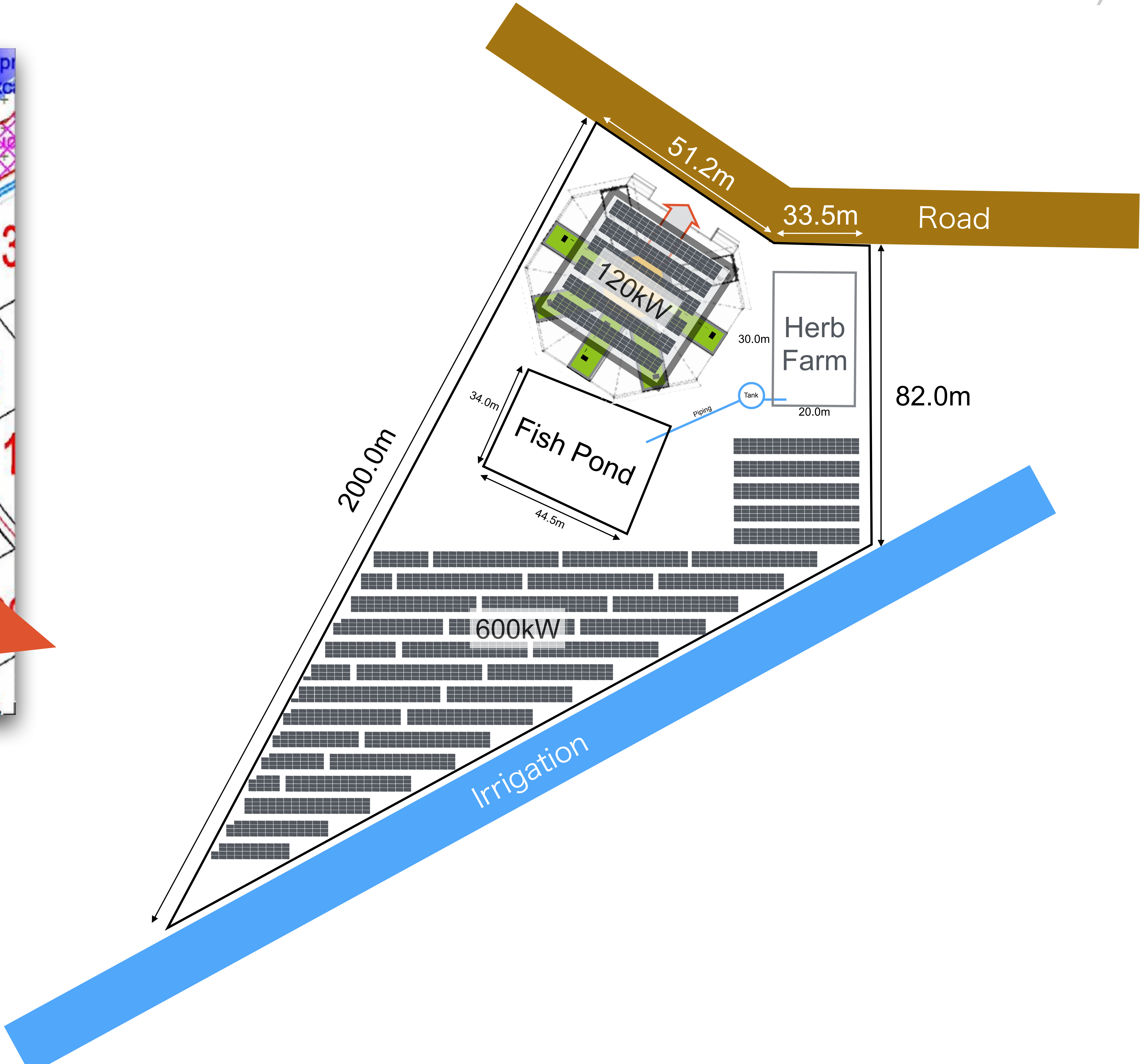
AsianGateway Cambodia

Food and Agribusiness led by Asian Gateway (Cambodia) with APSARA National Authority

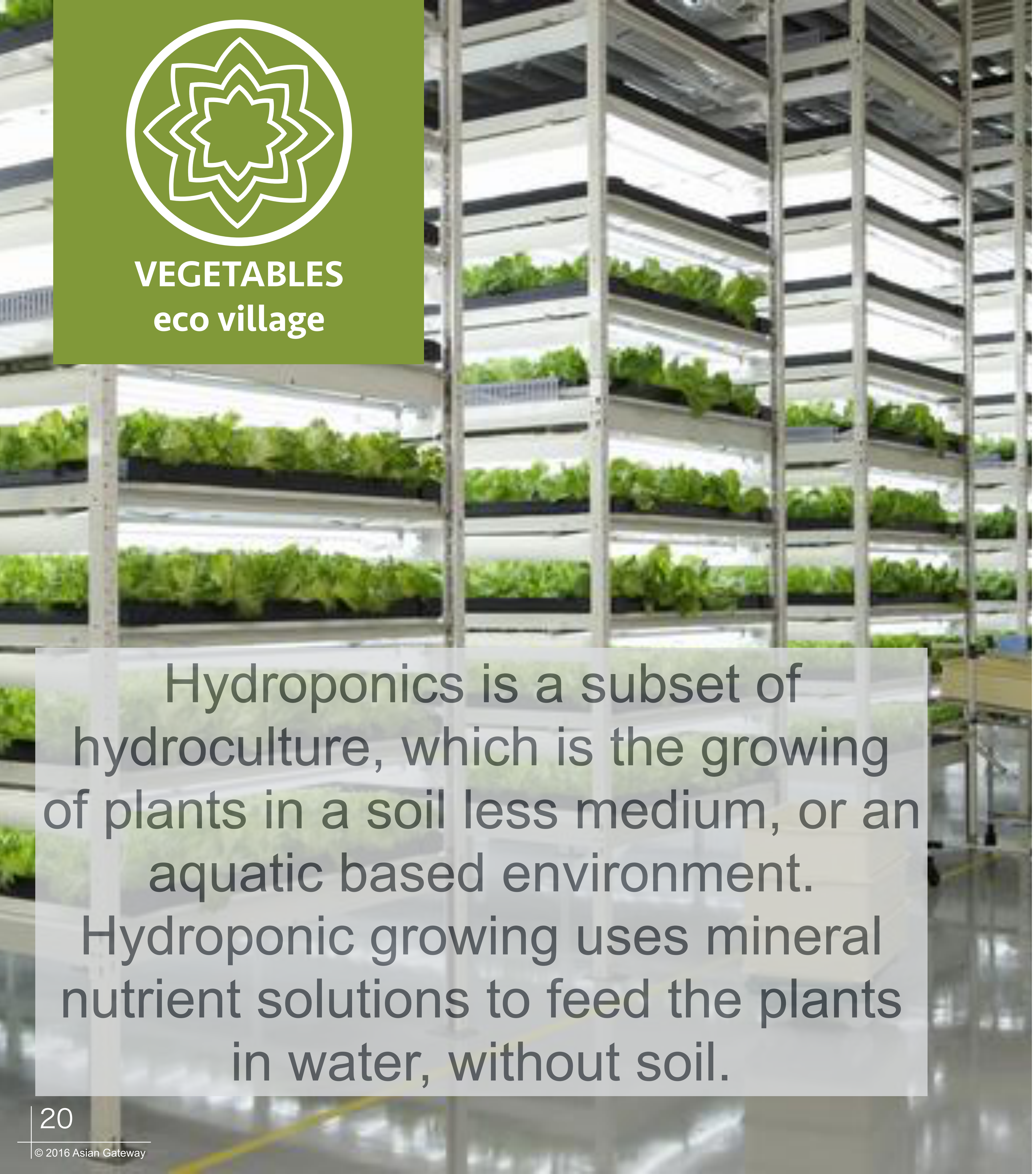
Asian Gateway (Cambodia) is developing new agribusiness using LED based Hydroponics using Biomass Power and Solar Power with Energy Efficiency equipment.

Project Site: Run Ta Ek EcoVillage





- 2ha land for our project
- Solar Farm
- Hydroponics Farm



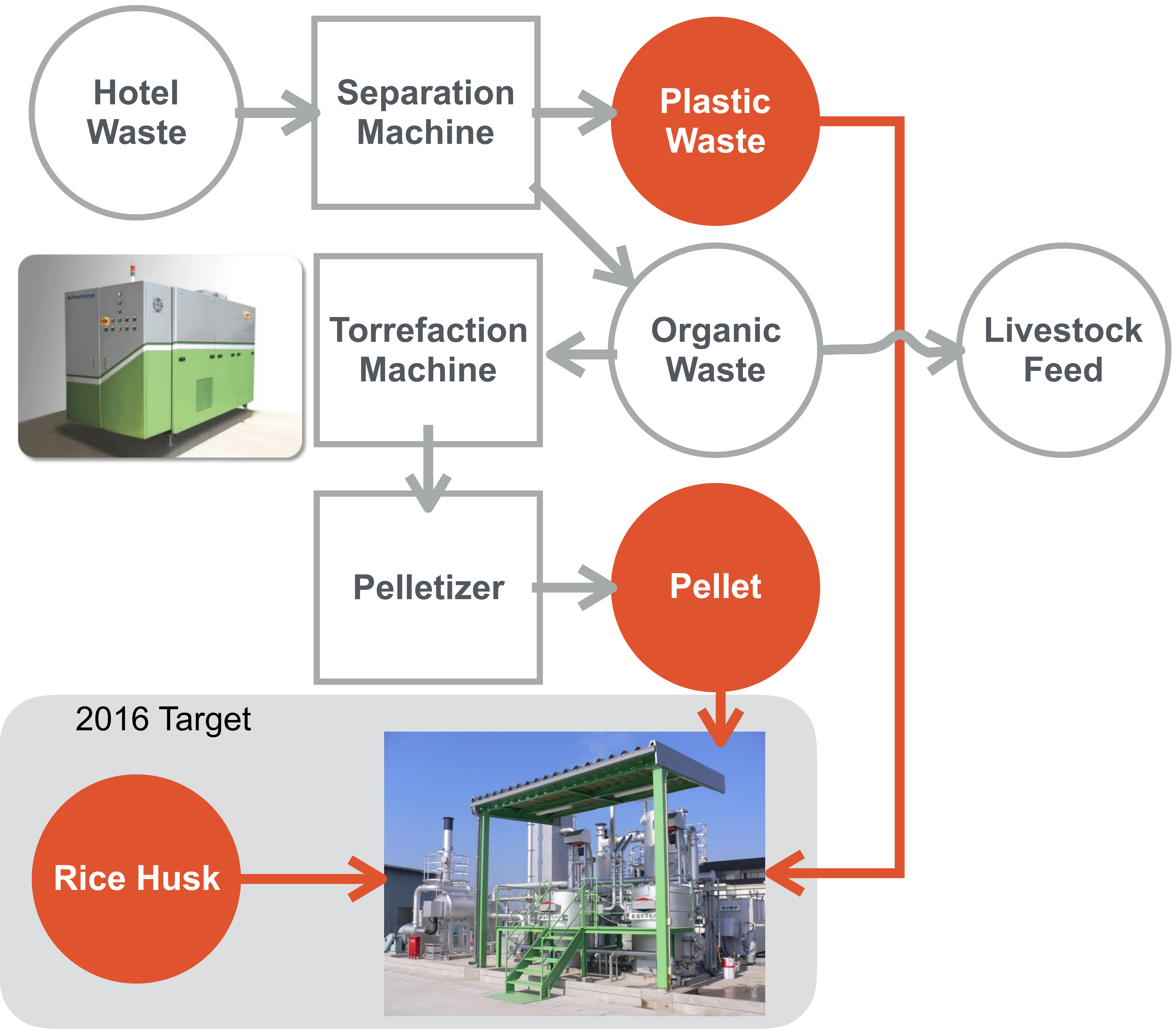
Hydroponics

AsianGateway

- Automatic cultivation with traceability
- Using Biomass Power and PV power electricity and energy efficiency equipment
- Cultivate, harvest and sell in the store
- Cultivate at central farm, and deliver to the restaurant
- Agriculture in REDA (Run Ta EK EcoVillage Development Area)

PV: Photovoltaic

Biomass Power Plant



Biomass Power Generation System

PPA based SPV in Eco Village

- Turnkey Provider is main EPC with majority investment for initial equity of SPV.
- SPV provides the solar electricity and biomass power with affordable price including operation and maintenance service to the off-taker.
- SPV also provides energy efficiency equipment to the off-taker.

THANK YOU! FOR YOUR ATTENTION

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

AsianGateway