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Economic Cooperation

Best Practices for Developing the Green Energy Smart Farm in the APEC Region

APEC Energy Working Group

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Executive Summary

In 2012, the APEC Leaders' Declaration unveiled that APEC energy security should be strengthened to develop cleaner energy sources for sustainable development. Recently, Energy Ministers at APEC Energy Ministerial Meeting (EMM11) in 2014 reaffirmed the UN's 2011 "Sustainable Energy for All" (SE4All) initiative (i.e., ensuring universal access to modern energy services, doubling the global rate of improvement in energy efficiency, and doubling the share of renewable energy in the global energy mix), and instructed the Energy Working Group (EWG) through the Expert Group on New and Renewable Energy Technologies (EGNRET) to develop the roadmap for the aspirational goal of doubling the share of renewables in the APEC energy mix. Later, the APEC Leaders have endorsed the Energy Ministers' aspirational goal to double the share of renewables including in power generation by 2030 in APEC's energy mix shown in 2014 APEC Leaders' Declaration. To attain this goal, the EGNRET will support R&D, innovation and commercialization of clean energy technologies and to promote practical cooperation on renewable technologies, equipment and services among member economies.

Currently in APEC's developing economies, most farms are located in the remote rural areas, and are difficult to connect the centralized power grid for access to the modern and clean energy. These farmers and their family rely on burning traditional biomass fuels directly for cooking, heating, studying, etc. breathing in toxic smoke. Only introducing the modern and clean energy can relieve them from the time-consuming drudgery to improve their living conditions. Thus, in order to cope with this difficult situation, deployment of the small-scale standalone distributed power system employed renewable energy with the appropriate financial mechanism can assist the farmers and their family in access to the modern and clean energy.

The objectives of this project are

(1) Assess and demonstrate the small-scale distributed renewable energy in the farms including solar PV and advanced biomass energy derived from the agricultural waste for the APEC region;

(2) Introduce the PV-ESCO (energy service company) model, a financial mechanism to provide the economic benefits to farmers directly in the APEC regions;

(3) Help APEC's developing economies to build up the green energy smart farms with access to the renewable energy, and also assist the farmers and their family in reducing the poverty.

The outputs of this project include

(1) Workshop: Two workshops of the best practice and experience exchange were conducted alongside a demonstration site visit to focus on the preliminary findings

in light of the desired outcomes. It offers an opportunity to assess the validity of the preliminary findings, and provide the check, peer reviews and consultations, and also receive the feedback for further revised actions.

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(2) Project Report: The final project report was produced highlighting the recommendations with suggested roadmap to develop the green energy smart farm with the small-scale standalone distributed renewable energy system, and the ESCO financial mechanism in the APEC region. The main contents of this report will include introduction to standalone distributed renewable energy system and installation, APEC legislative and policy framework, ESCO financial mechanism, research and technical development (RTD), challenges and barriers, deployment roadmap, recommendations, etc.

(3) Guidebook: A Guidebook will be published to provide all useful information and knowledge about building a green energy smart farm including the type and definition of renewable energy, constructing a small-scale standalone distributed renewable energy system, ESCO financial mechanism, APEC economies' legislative, policy framework, and incentives of renewable energy, etc.

(4) Demonstration Site: A small demonstration site (test base) will be established in an experimental farm in Chinese Taipei to conduct project experiments and show the best practice model for developing the green energy smart farm in the APEC region.

Currently renewable energy offers additional benefits over fossil fuels besides reducing pollution and carbon emissions. These decentralized power sources could potentially increase electrification rates cheaply in rural areas. The establishment of Green Energy Smart Farm could achieve the sustainable and efficient usage on agriculture resources and generate electricity for local needs. It could also provide new technologies and job opportunities for local new residents. Local women would be able to improve their income and living qualities by recycling agriculture waste and reducing the usage of chemical fertilizations. The improvement of local economic income could stable the society and enhance the protection of nature environment.

A robust legal framework must enable these projects to ensure that producers, whether self- generating or regional can supply electricity to users. Within APEC we see a wide variety of domestic strategies to develop both renewable energy and self-generation systems (micro-grids). Using data from the International Energy Agency (IEA) we surveyed: renewable energy generation, feed-in-tariff laws, and micro-grid laws in order to find successful examples of self-generation of renewable energy. In the survey we found economies fell into three categories: renewable and micro-grid laws, feed-in-tariff law only, and no supporting laws.

Most of APEC members do not have economy-wide power grid to cover all territory and some area are located in quite remote without effective installation of electricity equipment. A remote farm could provide sufficient agriculture waste and materials in four seasons. Those materials can be produced to biomass and using as energy resource to generate power for local needs. Burning biomass could reduce methane emission from agriculture sectors and address climate change. Using renewable energy is not favor in only one single source but exclude other options. A smart farm using green energy is encouraging the usage of various energy resources within its environment. The green energy concept also means the increasing energy resources to produce electricity but not simply replace the usage of conventional energy in remote area.

Adopted renewable energy is one of options to reduce emission of greenhouse gas from using fossil fuel, especially the economies taking commitment under the climate convention. The convention required its member states to produce domestic adaption policies to address impacts of climate change. The renewable energy regulations help the APEC members to achieve their reduction goal and assist the development of renewable energies. Therefore, the establishing of green energy smart farm shall starts from the analysis of renewable energy development regulations.

In addition, since the renewable energy gain the global interest, including solar photovoltaics (PV) energy. Many regions have potential to develop the solar power as future energy; the tropical economy has most potential due to longer duration of solar radiation. APEC members are including the regions in Southeast Asia such Indonesia; Malaysia; The Philippines; Singapore; Thailand; and Viet Nam. Basically, Southeast Asia region has similarity on geographic, economic growth, culture, and many sectors. However, each economy has different policy framework which is holding the consequential factor for developing renewable energy. In this report, the policy and statutory framework of Viet Nam, Thailand,

and Indonesia for developing solar power and other renewable energy, including biomass are explained. As the influence of the investment status, each has been analyzed by installing solar power for one-megawatt capacity. It has interpreted for their integrations from solar photovoltaics to agriculture, as knows as a smart farm.

In order to show the best practice model for developing the green energy smart farm in the APEC region, a small demonstration site (test base) was established in an experimental farm at Wuri District in Taichung City Chinese Taipei. Two systems including a 31 kW solar panel power generation system and a 10 kWe small-scale mobile downdraft biomass gasification-based power system were installed at the demonstration site. Currently it can provide 88,000 kWh of electricity per year, and receive USD 11,000 per year.

Moreover, after this project is completed, the established small demonstration site (test base) will be maintained to provide more researchers for conducting experiments and for follow-up actions, and to offer the site visits as a best practice model farm. Moreover, the site will also be maintained as an Environmental Education Venue according to Chinese Taipei's Environmental Education Act.

Finally, RETI, a new concept (Regulations, Economy, Technologies, and Integration) was proposed for developing the green energy smart farm.

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Chapter 1
Introduction

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Currently in APEC's developing economies, most farms are located in the remote rural areas, and are difficult to connect the centralized power grid for access to the modern and clean energy. These farmers and their family rely on burning traditional biomass fuels directly for cooking, heating, studying, etc. breathing in toxic smoke. Only introducing the modern and clean energy can relieve them from the time-consuming drudgery to improve their living conditions. Thus, in order to cope with this difficult situation, deployment of the small-scale standalone distributed power system employed renewable energy with the appropriate financial mechanism can assist the farmers and their family in access to the modern and clean energy.

Therefore, this project aims to demonstrate a best practical model for developing the green energy smart farm with the small-scale distributed renewable energy system. The objectives of this project are listed as follows:

(1) Assess and demonstrate the small-scale distributed renewable energy in the farms including solar PV and advanced biomass energy derived from the agricultural waste for the APEC region;

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Chapter 2

Legal Issues on Development of Green Energy Farm

2.1 Background

Renewable energy offers additional benefits over fossil fuels besides reducing pollution and carbon emissions. These decentralized power sources could potentially increase electrification rates cheaply in rural areas. The establishment of Green Energy Smart Farm could achieve the sustainable and efficient usage on agriculture resources and generate electricity for local needs. It could also provide new technologies and job opportunities for local new residents. Local women would be able to improve their income and living qualities by recycling agriculture waste and reducing the usage of chemical fertilizations. The improvement of local economic income could stable the society and enhance the protection of nature environment.

A robust legal framework must enable these projects to ensure that producers, whether self- generating or regional can supply electricity to users. Within APEC we see a wide variety of domestic strategies to develop both renewable energy and self-generation systems (micro-grids). Using data from the International Energy Agency (IEA) we surveyed: renewable energy generation, feed-in tariff laws, and micro-grid laws in order to find successful examples of self-generation of renewable energy. In the survey we found

APEC economies fell into three categories: renewable and micro-grid laws, feed-in tariff law only, and no supporting laws.

Most of APEC members do not have economy-wide power grid to cover all territory and some area are located in quite remote without effective installation of electricity equipment. A remote farm could provide sufficient agriculture waste and materials in four seasons. Those materials can be produced to biomass and using as energy resource to generate power for local needs. Burning biomass could reduce methane emission from agriculture sectors and address climate change. Using renewable energy is not favor in only one single source but exclude other options. A smart farm using green energy is encouraging the usage of various energy resources within its environment. The green energy concept also means the increasing energy resources to produce electricity but not simply replace the usage of conventional energy in remote area.

Adopted renewable energy is one of options to reduce emission of greenhouse gas from using fossil fuel, especially the economies taking commitment under the climate convention. The convention required its member states to produce domestic adaption policies to address impacts of climate change. The renewable energy regulations help the APEC members to achieve their reduction goal and assist the development of renewable energies. Therefore, the establishing of green energy smart farm shall starts from the analysis of renewable energy development regulations.

2.2 Feed in Tariffs in the APEC Region

Across the APEC region a diversity of renewable energy strategies, regulations, and electricity polices intermingle. Some of the largest users of renewable energy, like the United States lack a FIT at a domestic level. Others like New Zealand have different geographical conditions and policy indicatives that further developed renewable energy usage. However, in scanning across economies one can begin to see effective regulations in terms of developing both increased electrification and increased renewable energy development. The two tables below summarize current renewable energy usage starting with waste/biomass before moving on to solar, wind, and more.

The main focus of this research surveyed which economies had feed in tariffs (FITs) and micro-grid laws, and to what extent those policies accomplish their goals. As many laws came into force only several years ago, it may be difficult to determine their policy impact. Worth highlighting, only one IEA member, Japan, has a FIT. Eight members of APEC have FITs, and of those only two have both FITs and micro-grid laws. In Latin America only Chile and Colombia have a type of micro-grid supporting regulation. While Honduras with a FIT for only solar has seen dramatic increases in solar adoption, increasing solar production to more than 600 MW capacity between 2007 and 2013, a great achievement. Table 2.1 and Table 2.2 shows the electricity generated by biomass/waste and renewables in APEC Region in 2014.

Table 2.1 Electricity generated by biomass and waste in APEC Region in 2014 (GWh)

Economy	Municipal Waste	Industrial waste	Solid biofuels	Biogas	Liquid biofuels
Australia	0	0	1,876	1,635	0
Brunei Darussalam	0	0	0	0	0
Canada	265	0	4,118	972	0
Chile	0	0	5,873	41	0
China	0	12,956	44,437	0	0
Hong Kong, China	0	0	0	96	0
Indonesia	32	0	206	0	719
Japan	4830	1765	28,928	0	0
Korea	361	335	266	658	537
Malaysia	0	0	649	52	0
Mexico	0	77	1,189	164	0
New Zealand	0	0	389	245	0
Peru	0	0	1,211	80	0
The Philippines	66	0	130	0	0
Russia	0	3,071	32	0	0
Singapore	1,260	0	155	0	0
Chinese Taipei	3270	0	393	19	0
Thailand	317	0	7,672	551	0
USA	16,591	2,821	48,563	13,586	208
Viet Nam	0	0	59	0	0

Data source: IEA

Table 2.2 Electricity generated by renewable energy in APEC Region in 2014 (GWh)

Economy	Geothermal	Solar Thermal	Hydro	Solar PV	Tide/wave	Wind
Australia	1	4	18,421	4,854	0	10252
Brunei Darussalam	0	0	0	2	0	0
Canada	0	0	382,574	1,756	16	22,538
Chile*	0	0	19,445	2,550	0	2,252
China	125	34	1,064,337	29,195	8	156,078
Hong Kong, China	0	0	0	1	0	2
Indonesia	0	0	15,148	11	0	0
Japan	2,577	0	86,942	24,506	0	5,038
Korea	0	0	7,820	2,557	492	1146
Malaysia	0	0	13,388	227	0	0
Mexico	6,000	0	38,893	221	0	6426
New Zealand	7,258	0	24,336	16	0	2,214
Peru	0	66	22,199	0	0	206
The Philippines	10308	0	9,137	17	0	152
Russia	455	0	177,141	160	0	96
Singapore	0	0	0	36	0	0
Thailand	1	0	5,540	1,385	0	305
Chinese Taipei	0	0	7,439	552	0	1500
USA	18,710	2,688	281,527	21,915	0	183,892
Viet Nam	0	0	58,544	0	0	87

* Data in 2016. Data source: IEA

In the following sections, APEC member economies are grouped together based on their regulations (see Table 2.3). First group is listed by FIT and micro-grid laws, second is grouped by member economies with FITs, FIT alternatives, and lastly member economies with neither a FIT or renewable energy law.

Table 2.3 FIT adopted by the APEC Members

Economy	FIT	RPS	Auction	None	IEA Member	Micro-grid Law	Other
Brunei Darussalam				x			
Australia				x	✓		
Canada				x	✓		State FITs
Chile		✓	✓ Competitive for all technologies. No bias for renewable energies			✓	Carbon Tax
China	✓						7 Task Force of Emission Trading Scheme
Hong Kong, China				x			
Indonesia	✓					✓	
Japan	✓				✓		
Korea		✓			✓		FIT 2001-2008 & Emission Trading Scheme
Malaysia	✓					*	
Mexico			✓				Carbon Tax & Emission Trading Scheme
New Zealand				x	✓		Emission Trading Scheme
Peru			✓				
The Philippines	✓					*	
Russia			✓				
Singapore				x			
Chinese Taipei	✓						
Thailand	✓					✓	
US				x	✓		State FITs
Viet Nam	✓						

✓= Yes x = No * = Micro-grid support

2.3 Feed in Tariff and Micro-grid Law

In our survey we found only three economies with both a FIT and a micro-grid law: Indonesia and Thailand. Chile does have renewable energy support and a micro-gird law but does not have an actual domestic level FIT. Chile does however provide tax incentives for small distributed generation facilities and allows them to sell energy at spot market price or stabilized prices as well as allowing for self dispatch of electricity. However, Indonesia and Thailand stand out for having a specific FIT for small-scale renewable energy to increase both electrification and renewable energy usage.

2.3.1 Indonesia

Indonesia's Domestic Energy Plan in February 2014 (NEP14) sets a goal of changing the economies energy portfolio by 2025 to the following 30% coal, 22% oil, 23% renewable resources and 25% natural gas. Another part of the plan aims to achieve full electrification by 2020. Prior to this, there had already been a new policy from the Ministry of Energy and Mineral Resources "Ministerial Regulation No 04/2012 on Electricity Purchase from Small and Medium Scale Renewable Energy and Excess Power" that provides FIT (Table 2.4)for small scale (less than 10 MW) of biomass, hydropower, municipal solid waste, and landfill gas. In 2016, the Ministry set out rules for a solar-PV FIT but they did not make any special provisions based on size.[1]

[1] http://www.solarplaza.com/channels/markets/11591/new-government-decree-accelerate-indonesian-solar-market/

Table 2.4 Indonesia Domestic Energy Plan

Renewable source	Voltage	Feed-in tariff level in Rp/kWh	Territorial bonus (F)
Biomass	medium	975	Jawa and Bali Region: F = 1; Sumatera and Sulawesi Region: F = 1.2; Kalimantan, NTB and NTT Region: F = 1.3; Maluku and Papua Region: F = 1.5.
	low	1.325	
Hydropower	medium	656	
	low	1.004	
Municipal solid waste	medium	1.050	Jawa, Bali, and Sumatera region: F = 1; Kalimantan, Sulawesi, NTB and NTT regions: F = 1.2; Maluku and Papua region: F = 1.3.
	low	1.398	
Landfill gas	medium	850	
	low	1.198	

Source: IEA

2.3.2 Thailand

Thailand's FIT (Table 2.5) for covers Very Small Power Products (VSPP) which are less than 10 MW, and comes from the Ministry of Energy – Energy Policy and Planning Office. The covers small scale wind, hydropower, biogas (from cops), biogas (from waste), biomass, landfill methane capture, waste incineration (gasification). Southern provinces receive an additional premium of 0.50 baht on the tariff. All FITs last for 20 years except for landfill methane extract which only covers 10 years.

Like Indonesia and Thailand tries to incentive developing projects in southern provinces or areas that lack electricity resources. Both Thailand and Indonesia have separate FITs for tariffs, the main different between the two being a more nuanced support of various biomass or waste to energy generation sources.

Thailand's FIT for solar has a different rate for different capacities. The lowest 0-10kw has a fit of 6.96 BHT/kWh, with the largest 250 kW- 1MW reaching 6.16 BHT/kWh all projects cap at 200 MW of generation. The FIT for solar exceeds all other sources of energy except for small-scale incineration and wind. Within Thailand's plan community solar has a higher rate in the early years of plant operation. For the first three years community solar receives 9.75 BHT/kWh finally dropping to 4.5 BHT/kWh after 11 years. This helps to stabilize development in the beginning of community projects and spread electrification quickly.

While both Indonesia and Thailand have very different models of development, culture, and policy they have both chosen to go down a distributed electrification route providing specialized assistance to smaller producers as a domestic level policy. The remaining economies surveyed either did not have FITs, did not have effective renewable energy laws, lacked micro-grid support, or failed to provide any of the above regulations. Only economies with unique, well research or available policy information will be explored further below.

Table 2.5 Thailand’s FIT

<table>
<tr><th colspan="6">Feed-in Tariff levels in BAHT/kWh</th></tr>
<tr><th colspan="4"></th><th colspan="2">FIT Premium</th></tr>
<tr><th>Renewable Source</th><th>Capacity</th><th>Total calculated FIT</th><th>Period of support</th><th>For bioenergy (8 years)</th><th>Southern Provinces</th></tr>
<tr><td rowspan="3">Waste incineration</td><td>< 1MW</td><td>6.34</td><td rowspan="3">20 years</td><td rowspan="3">0.70</td><td rowspan="11">0.50</td></tr>
<tr><td>1MW – 3 MW</td><td>5.82</td></tr>
<tr><td>> 3 MW</td><td>5.08</td></tr>
<tr><td>Waste (landfill gas)</td><td></td><td>5.60</td><td>10 years</td><td>-</td></tr>
<tr><td rowspan="3">Biomass</td><td>< 1MW</td><td>5.34</td><td rowspan="7">20 years</td><td>0.50</td></tr>
<tr><td>1MW – 3 MW</td><td>4.82</td><td>0.40</td></tr>
<tr><td>> 3 MW</td><td>4.24</td><td>0.30</td></tr>
<tr><td>Biogas (from waste products)</td><td></td><td>3.76</td><td rowspan="2">0.50</td></tr>
<tr><td>Biogas (from energy crops)</td><td></td><td>5.34</td></tr>
<tr><td>Hydropower</td><td>< 200 kW</td><td>4.90</td><td>-</td></tr>
<tr><td>Wind</td><td></td><td>6.06</td><td>-</td></tr>
</table>

Source: IEA

2.3.3 China

China has FITs for multiple types of renewable energy and due to increasing funding into renewable energy has had to reduce the amount in recent years. However, different zones across China have different rates, The Domestic Development and Reform Commission (NDRC) has set a baseline on-grid power tariff at RMB 0.9, RMB 0.95 and RMB 1 per kwh according to the solar power resources and construction costs in different resources zones economy-wide with each tariff lasting a period of 20 years. Distributed solar power receives a standard subsidy of RMB 0.42 per kWh. For 2017, tariffs will drop to RMB 0.8, 0.88 and 0.98 per kWh respectively. While small-scale distributed solar does in effect count as a micro-grid, there are no explicit policies to develop them yet. There is however an exploratory demonstration project promoted by the Domestic Energy Administration.[2]

2.3.4 Japan

Since 2012 Japan has used a FIT to support the development of a number of renewable energy including: bioenergy, biomass for power, geothermal, hydropower, solar, offshore and onshore wind. Through these FIT policies Japan aims achieve 22-24% renewable electricity generation by 2030. An additional incentive, electricity providers must purchase renewable energy on a fixed-period contract at a fixed price. The cost of electricity is then divided across the economy as an equal surcharge. Electric companies must also pay a part of the cost, with purchase prices being reexamined and published every year.

Within this framework, small scale power providers receive larger purchase prices, but this does not match the same regulatory support as a specific micro-grid law. Solar power tariffs saw a decrease, dropping from 42 JPY/kWh in 2012 to 37 JPY/kWh in 2014 with a decrease to 31 JPY/kWh in 2016.[3]

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[2] https://www.iea.org/policiesandmeasures/pams/china/name-154596-en.php?s=dHlwZT1yZSZzdGF0dXM9T2s,&return=PG5hdiBpZD0iYnJlYWRjcnVtYiI-PGEgaHJlZj0iLyI-SG9tZTwvYT4gJnJhcXVvOyA8YSBocmVmPSIvcG9saWNpZXNhbmRtZWFzdXJlcy8iPlBvbGljaWVzIGFuZCBNZWFzdXJlczwvYT4gJnJhcXVvOyA8YSBocmVmPSIvcG9saWNpZXNhbmRtZWFzdXJlcy9yZW5ld2FibGVlbmVyZ3kvIj5SZW5ld2FibGUgRW5lcmd5PC9hPjwvbmF2Pg

[3] http://www.meti.go.jp/english/press/2016/0318_03.html

2.3.5 The Philippines

Since 2010, with both a FIT (Table 2.6) and a domestic level renewable energy act the Philippines has a strong foundation for further renewable energy development. Energy Regulatory Commission Decision Case No. 2011-006 RM set out guidelines requiring that electricity generated from renewable sources has a priority for grid connection, a priority purchase, and has a fixed tariff over a fixed period (not less than 12 years). To take advantage of these incentives power providers must first have a certificate of compliance from the Energy Regulatory Commission. The funding for the tariff system comes from a charge on electricity bills to all consumers, the fund itself is administered by the Domestic Grid Corporation of the Philippines, who then redistributes to renewable energy developers.

While no overarching micro-grid law exists, there are subsidies for off-grid power sources. These subside come from a combination of Missionary Electronification funds from Congress, private capital, multilateral aids or grants, and other development assistance funds. The subsides came in the form of direct cash incentives, but without the same clarity as other micro-grid laws they may run into impediments and challenges with funding sources.

Table 2.6 FIT in the Philippines

Renewable source	Period	Feed-in tariff rate in PhP/kWh	Degression rate	Installation targets in MW
Wind	20 years	8.53	0.5% after 2 years from affectivity of FIT	200
Biomass		6.63	0.5% after 2 years from affectivity of FIT	250
Solar		8.69	0.6% after 1 year from affectivity of FIT	500
Run-of-river hydropower		5.90	0.5% after 2 years from affectivity of FIT	250

Source: IEA

2.3.6 Malaysia

In 2011 Malaysian Renewable Energy Act formally established a FIT system that extends until 2030. Costs are passed on to consumers who must pay an additional 1% on top of their electricity bills. In a move to reduce pressure on lower income citizens, 75% of domestic electricity consumers who use less than 300kwh/month of electricity will be exempted from contributing to the renewable energy fund. The Sustainable Energy Development Authority (SEDA) of Malaysia manages a FIT dashboard on their website with updated information about FITs. They provide bonuses for using locally manufactured solar PV modules, inverters, or other installation structures. Like other economies they provide higher FIT rates for lower kWh production, projects less than 4lW receive 0.7 Rm per kWh, while projects above 24kW only receive 0.52 RM per kWh.

The FIT covers a range of solar projects from community, to individual, to small scale, other energies are also covered with different rates for biogas, biomass, small hydro, and geothermal. The current cumulative installed capacity of Solar PV currently reached

335.51 MW in 2015, an impressive accomplishment like the results seen in Honduras. No other form of renewable energy in Malaysia’s FIT scheme came close to the same impact. Biomass is the next largest only reached 80 MW under the same development policy.

Chapter 3

Policy and Economic Analysis of Renewable Energy for Smart Farms in the APEC Region

3.1 Introduction

Since the renewable energy gain the global interest, including solar photovoltaics (PV) energy. Many regions have potential to develop the solar power as future energy; the tropical economy has most potential due to longer duration of solar radiation. Asian-Pacific Economic Cooperation members are including the regions in Southeast Asia such Indonesia; Malaysia; The Philippines; Singapore; Thailand, and Viet Nam. Basically, Southeast Asia region has similarity on geographic, economic growth, culture, and many sectors. However, each economy has different policy framework which is holding the consequential factor for developing renewable energy.

This chapter will explain the policy and statutory framework of Viet Nam, Thailand, and Indonesia for developing solar power and other renewable energy, including biomass. As the influence of the investment status, each has been analyzed by installing solar power for one-megawatt capacity. It has interpreted for their integrations from solar photovoltaics to agriculture, as knows as a smart farm.

3.2 Policy Analysis of Renewable Energy for Smart Farms- Case Study I: Viet Nam

3.2.1 Introduction

The Government is an executive agency of the Domestic Assembly and is the highest administrative agency of Viet Nam. The Government is subjected to the mechanism of supervision by and reporting to the Domestic Assembly, the Standing Committee of the Domestic Assembly, and President. Government term is 5 years. The head of the Government is the Prime Minister; under whom are Deputy Prime Ministers, the Ministers and the Heads of ministerial-level agencies (International Atomic Energy Agency, 2012).

The Domestic Strategy on Energy Development to 2020 outlook to 2050 has made the following policies for domestic energy security, energy prices, investment policies for the development of new and renewable energy sources, biofuels, nuclear power, energy saving and efficient uses, and environmental protection policy.

The government of Viet Nam is supporting the development of renewable energy. This paper review will explain the most updated policy of grid-connected solar power and biomass power plant in Viet Nam. This paper served in order to understand of development mechanism, including tax, land, administration, and the requirement for establishing the solar power plant or biomass power plant in Viet Nam.

3.2.2 General Rules

The electricity buyer is the Viet Nam Electricity Group or an authorized member unit. Electricity sellers are organizations and individuals licensed to conduct electricity activities in the field of electricity generation from grid-connected solar power plants and off-grid biomass. The connection point is the location where the electricity seller's line connects to the electricity buyer's power system. Powerpoint is the point where power measurement and measurement equipment are agreed upon in the power purchase agreement in order to determine the electricity output sold by the electricity seller. The contract for the sale of electricity for the grid-connected projects and roof projects is the power purchase agreement issued by the Ministry of Industry and Trade as the basis for the application of electricity purchase transactions between electricity sellers and Power buyer. The electricity price of the FiT (Feed in Tariff) is the fixed price that the electricity buyer has to pay to the electricity seller.

For integrated photovoltaics: Organizations and individuals that have a solar roof project sell surplus electricity to the buyer. A solar power project is a project to produce electricity from solar panels that convert light energy into electricity. A solar roof project hereinafter referred to as a roof project is a solar power project installed on a roof or connected to a building and directly connected to a grid of the electricity purchaser.

Biomass energy used to produce electricity includes By-products, wastes in agricultural production, agroforestry processing and other crops that can be used as fuel for electricity production. Biomass power generation is a biomass power plant project that mainly uses biomass energy to produce electricity. A grid-connected biomass project is a biomass power plant project that is connected to the domestic grid to supply part or all of the electricity produced to the domestic grid. Off-grid biomass power project is a biomass power plant project to provide all power to households in the area, not connected to the domestic power grid. The sample power purchase agreement for grid-connected biomass projects is the power purchase agreement promulgated by the Ministry of Industry and Trade as the basis for the application of power purchase transactions generated from the grid connected electricity project between electricity seller and buyer. The avoided cost of the domestic electricity system is the cost of producing per kWh of the thermal power plant using imported coal in the domestic electricity system, which can be avoided if the buyer buys per kWh from a biomass power plant instead. The avoided cost tariffs for biomass electricity projects are the tariffs calculated according to the avoided costs of the domestic electricity system when 1 kWh of electricity generated from the biomass power plant is transmitted to the domestic power grid. Main categories of biomass power plant projects include boilers, turbines, generators, and substations. Heat-electricity co-generation is a biomass power generation project that produces both thermal and electric energy.

3.2.3 The Regulation Framework

The Development Planning

Planning for the development of solar power includes the planning of domestic solar power development, provincial planning of solar power development. The development plan for solar power is the basis for solar PV development, which is adjusted in line with the solar potential studies and assessments in each period. Solar power development planning applies only to grid-connected projects, not to rooftop solar power projects. Biomass power development planning is one of the contents of the plan for biomass energy development and use. Biomass energy development and utilization planning include planning for the development and use of domestic biomass energy, provincial biomass energy development, and utilization planning. The development and utilization of biomass as the basis for biomass energy development and utilization is being adjusted in line with the research and assessment of biomass energy potential in each period. Domestic biomass and or solar power resource development and utilization planning and provincial biomass energy development and utilization plan shall be prepared once for the period up to 2020 with a vision to 2030 and adjusted and supplemented when necessary. From the following planning phases, biomass power development planning is integrated into the Provincial Electricity Development Plan and Domestic Power Development Plan.

The Mechanism

Responsibility to buy electricity from solar power projects: a) the buyer is responsible for purchasing all the electricity generated from the solar power projects; priority is given to exploiting the full capacity and electricity generated by solar power projects for commercial operation; b) the purchase and sale of electricity shall be made through the solar power purchase agreement made under the sale and purchase contract model applicable to solar power projects issued by the Ministry of Industry and Trade; c) within 30 days after the electricity sellers have all the dossiers and written requests for electricity sale, the electricity buyers, and sellers shall sign electricity sale and purchase contracts according to regulations; d) The term of the power purchase agreement for solar power projects is 20 years from the date of commercial operation. After 20 years, the two parties can extend the contract period or sign a new contract in accordance with current law.

Responsibility to buy electricity from grid-connected biomass projects: a) the electricity buying side is responsible for purchasing all the electricity generated from the connected biomass power plants in the locality under their control; b) the sale and purchase of electricity shall be effected through electricity purchase and sale contracts made under the electricity sale contract model for grid-connected biomass projects promulgated by the Ministry of Industry and Trade; c) within 6 months after the investor of a biomass electricity project submits a written request for electricity sale, the electricity buyer must sign the electricity purchase and sale contract with the electricity seller according to regulations; d) the term of the power purchase agreement for biomass power generation projects is twenty years from the commercial operation date. After 20 years, the two sides can extend the contract period or sign a new contract in accordance with current law.

The Connection to Grid Power System

In order to connect solar power projects to the power system, the electricity seller is responsible for the investment, operation, and maintenance of the transmission line and transformer station (if any) from the powerhouse of the electricity seller to the point of connection with electricity grid of the buyer. The connection points shall be agreed upon by the electricity seller and the buyer according to the principle that the nearest connection points to the electricity grid are available from the electricity buyers, ensuring the electricity transmission capacity of the electricity seller, with the approval for power development plan. Where the connection point is different from that of the measuring device, the electricity seller shall bear the loss of power on the connecting line and the loss of the transformer of the plant. The Ministry of Industry and Trade specifies the method of calculating loss on the connection line.

In the case of connecting biomass power projects to the power system, regulating the operation of biomass power plants. The connection of biomass power projects to the domestic grid must be in line with the approved electricity development plannings. The connection points shall be agreed upon by the electricity seller and the electricity buyer in the principle that the electricity sellers shall have to invest in electricity transmission lines to the nearest domestic grid connection points according to the provincial electricity development plannings. Where the connection point to the domestic grid is not included in the electricity development master plan, the investor shall agree on the connection point with the distribution unit or the electricity transmission unit, which shall serve as a basis for supplementing the planning on electricity development to develop provincial-level electricity according to current regulations. Where the connection point is not agreed upon, the electricity seller shall have to submit it to the Ministry of Industry and Trade for consideration and decision. The Investors of biomass power projects shall be responsible for investment, operation, and maintenance of transmission lines and transformer stations (if any) from power plants of the electricity seller to the connection points under the connection agreement with electricity buyer. It also depends on the connection voltage level, the electricity-distributing units or electricity-transmitting units shall have to invest in power transmission lines from the point of connection to the domestic electricity grid according to the approved electricity development plannings and signed an agreement to connect with the investor of biomass power projects. After completion of investment and acceptance into commercial operation, the electricity system operator and the electricity market operator shall be responsible for mobilizing the biomass power plant in accordance with the principle of priority for full exploitation of transmission power and capacity in accordance with the supply capacity of biomass energy of the plant.

Land Incentives

Solar power projects, transmission lines and transformer stations for connection with power grids will have land use levy, land rents and water surface rents exempted or reduced, according to the current law provisions for projects in the field of investment incentives. Referring to planning approved by competent authorities, the provincial-level People's Committees shall create conditions for arranging land funds for the investors to carry out the projects on solar power. Compensation and support for ground clearance shall be implemented in accordance with the current land legislation.

Biomass electricity projects and transmission lines and transformer stations for connection with domestic power grids shall be entitled to exemption or reduction of land use levies and land rents according to the current law applicable to the projects in the field of investment incentives. Referring to the planning approved by competent authorities, the provincial-level People's Committees shall have to allocate sufficient land funds to implement biomass electricity projects. Compensation and support for ground clearance shall be implemented in accordance with the current land legislation.

Incentive on Investment Capital and Taxes

Mobilization of investment capital is organizations and individuals participating in the development of solar electricity projects are entitled to mobilize lawful capital from organizations and individuals inside and outside the economy for investment in the implementation of electricity projects. It is in accordance with the current law. Import tax is solar power projects are exempted from import duties on goods imported to create fixed assets for the project; comply with the current law on export tax and import tax on goods imported for production of projects being materials, supplies and semi-finished products which cannot be produced at home.

Mobilizing investment capital for biomass project: a) Investors may mobilize capital from domestic and foreign organizations and individuals for investment in the implementation of biomass electricity projects according to the current law provisions; b) Biomass electricity projects are entitled to investment credit preferences in accordance with the current law on investment credit and export credit of the government. The import tax for biomass projects are exempted from import tax on imported goods in order to create fixed assets for the projects; Imported goods are materials, supplies and semi-finished products which cannot be produced domestically and are imported to serve the production of the projects in accordance with current regulations on export tax and import tax. Enterprise income tax is the exemption and reduction of enterprise income tax for biomass projects shall be the same as for projects in the domains eligible for investment preferences under the current tax law. Enterprise income tax is the exemption and reduction of enterprise income tax for solar power projects shall be the same as for projects in the domains eligible for investment preferences under the current tax law.

Investment and Funding

The central budget or funding shall allocate funds for the performance of tasks in elaborating, evaluating, announcing and adjusting plannings for the domestic development of solar power. The budgets of the provinces and centrally-run cities shall allocate funds for the performance of tasks in elaborating, evaluating, announcing and adjusting local solar power development plannings. Encourage the mobilization of other lawful funding sources for the planning of solar power and biomass development. The investment in the construction of grid-connected projects must be in line with the electricity development plannings already approved by the competent agencies. The investment in the construction of solar power projects shall comply with the current law provisions on investment, construction, fire protection, environmental protection and other relevant regulations. Main equipment of solar power projects must meet technical standards of solar power; the electricity quality of the solar power project must meet the technical requirements on voltage, frequency, and other relevant requirements according to current regulations. Electricity sellers shall have to invest in and install electricity-measuring and counting devices; to organize the inspection, calibration and testing of electricity-measuring and counting equipment in strict accordance with the law on measurement. Organizations and individuals investing in the construction of solar power projects, which have the responsibility to install solar power equipment, must ensure the structural safety and work safety according to the current regulations. The investment in the construction of roof projects must meet the following requirements: a) Roofs or structures constructed with solar panels must bear the load and structure of the solar panels and associated accessories; b) To ensure the electricity safety regulations according to the provisions of law; c) Ensuring the preservation of the surrounding landscape and environment.

Funding for the Biomass explained by preparation, evaluation, approval, and publication of the plan for the development and use of biomass. The State shall allocate funds for the tasks of elaborating, evaluating, announcing and adjusting the planning on the development and use of biomass energy. In order to encourage the mobilization of other lawful funding sources for the elaboration of planning on the development and use of biomass energy, the investment in the construction of grid-connected biomass projects must be in line with the planning of the development and use of biomass energy and the electricity development plannings of all levels approved by the competent agencies. For biomass power plan which haven't signed on the list of domestic biomass development and utilization plans and the approved domestic electricity development plannings, the investors shall have to compile dossiers to propose the supplement to the planning and send them to the Ministry of Industry and Trade for appraisal, submit to the Prime Minister for consideration and decision. While the Plan for biomass development and utilization has not yet been approved, the investment in biomass power projects should be approved by the Prime Minister. The investment in the construction of biomass electricity projects shall comply with the provisions of the law on construction, fire protection, environmental protection and other relevant regulations. The investor shall elaborate a scheme on electricity prices and determine the total State budget support, then submit them to the Ministry of Industry and Trade for appraisal and report them to the Prime Minister for approval. The total amount of state budget support is extracted from Viet Nam Environment Protection Fund.

<u>Validation and Administration</u>

Photovoltaics agreement has involved Viet Nam Electricity Corporation (VEC) or authorized unit and electricity sellers or investor. VEC members responded to a) negotiate and sign electricity sale and purchase contracts with electricity sellers under the formulation and sale prices specified; b) calculate the electricity purchase cost of the solar power projects and inputting the input parameters in the annual electricity price scheme of the VEC, submitting to competent authorities for approval; c) prior to 31 January every year, the VEC reports to the Ministry of Industry and Trade the total installed capacity of the solar power projects as of 31 December of the previous year. Electricity sellers responsible to a) install a metering and counting meter in accordance with current regulations for measuring the electricity used for electricity payment; b) send a copy of the signed power purchase and sale contract to the Ministry of Industry and Trade at least 30 days from the date of signing for the grid-connected projects; c) comply with regulations on operation of the power system, regulations on power transmission system, electricity distribution system, metering system and related regulations issued by the Ministry of Industry and Trade.

Conditions for commencing the construction of biomass power plants investors are only allowed to commence the construction of grid-connected biomass power plants, there must also be: the investment certificate, the written approval of the buyer to buy electricity; a connection agreement with the Distributor or the Transmission Unit (for grid-connected biomass projects); comments on the design of a competent state agency in accordance with the law on management of investment in construction. Meanwhile the administration project progress report required: a) within 5 working days from the date of issuance of the investment certificate, the investor shall send a certified copy of the investment certificate to the Ministry of Industry and Trade for monitoring and management; b) during the construction of a biomass electricity project, before the 15th day of the first month of each quarter, the project leader shall have to report on the implementation of the project in the previous quarter and the plan for the subsequent quarter. Annually, before January 15, investors shall have to report on the implementation of the project in the previous year and the implementation plan of the following year, to the provincial-level People's Committees and the Ministry of Industry and Trade for management, monitoring and implementation to coordinate implementation with electricity buyers.

The Feed-in Tariff

For grid-connected solar power projects, the electricity buyer has the responsibility to purchase all the electricity generated from the grid-connected projects with the electricity purchase price at Viet Nam Dong (VND) 2,086/kWh (excluding value added tax, equivalent to 9.35 US cents/kWh, according to the central exchange rate of VND to USD, announced by the State Bank of Viet Nam on 10 April 10 2017, is VND 22,316 per USD). Electricity prices are adjusted by the exchange rate of VND/USD exchange rate. This electricity price applies only to grid-connected projects with 16% or greater solar module efficiency or 15% larger modules.

For electricity from grid-connected biomass projects, valid for heat-electricity co-generation projects, the buyer is responsible for purchasing all surplus power generated from biomass power heat-electricity co-generation projects with electricity prices at the delivery point of 1,220 VND/kWh (excluding value added tax, equivalent to 5.8 UScents/kWh) (Refer to Table 3.1).

The cost of purchasing electricity from solar power or biomass power projects shall be calculated and included in the input parameters in the annual electricity price scheme of the Viet Nam Electricity Corporation as approved by the competent authority. The currency based on the central exchange rate of VND against the USD announced by the

State Bank of Viet Nam on the last date of exchange rate announcement in the previous year, the Ministry of Industry and Commerce issues the FiT.

Table 3.1 The valid feed-in tariff of photovoltaics and biomass in Viet Nam

Type Power Plant	Feed in Tariff (VND/kWh)
Photovoltaics	2,086
Biomass	1,220

Source: Prime Minister (2014); Prime Minister (2017)

3.2.4 Interpretation and Conclusion

The government of Viet Nam initiated to promote the renewable energy implementation. The solar power and biomass have big potential to apply in Viet Nam as a tropical economy which has high solar isolation annually. Besides, Viet Nam is an agrarian economy which has the more capacity of raw material for biomass productions. The government offered the high rate of Feed-in tariff, it is supportive for financial payback investment to investor or developer. The administration and legislation haven't big obstacle, it simplifies the business entity to join the renewable energy business such photovoltaics and biomass in Viet Nam.

3.3 Policy Analysis of Renewable Energy for Smart Farms-Case Study II: Indonesia

3.3.1 Government Profile

Ministry of Energy and Natural Resources

Ministry of Energy and Natural Resources (MENR) is a cabinet of the government of Indonesia. Responsible as domestic policymakers and subordinate of President and Vice President of Republic Indonesia. In order to take economy responsibility of energy and natural resources management, since 1965 along with PT. Perusahaan Listrik Negara (PT. PLN) collaborate for domestic electricity distributions (Ministry of Energy and Natural Resources, 2017).

PT. PLN is Indonesia state-owned corporations for electricity transmission, distributions, and generations. The Company also develops and installs electricity infrastructure and equipment. Perusahaan Listrik Negara serves residential, commercial, and government sectors in Indonesia (Bloomberg, 2017).

Vision and Mission

The ministry of energy and natural resources collaborate with PT. PLN in order to face the challenge of domestic development and achievement. Government cabinet set up the Domestic Development Vision 2015-2019 is: "The realization of a sovereign, self-reliant Indonesia, and a personality based on mutual cooperation".

Along with domestic vision, the government put effort for domestic mission: 1) Realizing domestic security capable of maintaining regional sovereignty, sustaining economic independence by securing maritime resources, and reflecting the personality of Indonesia as an archipelagic economy; 2) Creating an advanced, sustainable, and democratic society based on the rule of law; 3) Realizing a free active foreign policy and strengthening identity as a maritime economy; 4) To realize the quality of human life of Indonesia is high, advanced, and prosperous; 5) Creating a competitive economy; 6) To realize

Indonesia as an independent, advanced, strong, and economy-based maritime state; 7) Creating a society of personality in culture (Ministry of Energy and Natural Resources, 2017).

Statutory Framework

Indonesia regulates the economy law certain forms of renewable energy. MEMR as domestic policymakers collaborates with PT. PLN as state-owned monopoly electricity company collaborates with the private sectors and shareholders in order to transmit, generates and distributes electricity. For example Regulation of Minister of Energy and Mineral Resources No. 12/2017 on the Utilization of Renewable Energy Resources for Electricity Supply (MEMR 12/2017). It regulates both the price at which electricity generated from these renewable energy sources is to be sold to the Indonesian State-owned power utility, PT PLN and also the manner in which PLN is entitled to procure electricity supply from a number of these renewable sources (Baker McKenzie, 2017).

3.3.2 General Rule of Energy Policy 2017 in Indonesia

PT. Perusahaan Listrik Negara (PT. PLN) states electricity company established by MEMR Reg. 23/ 1994 fundamental state rule as changing from public company become state share company. A business entity is state-owned enterprises, regional owned enterprises, a Private business entity incorporated Indonesian law, and cooperatives that seek in the field of electricity supply (Ministry of Energy and Natural Resources, 1994).

License for electricity supply business or IUPTL is Permission to conduct commercial power supply business incorporated Indonesian law. Commercial Operation Date (COD) is the start date of operation of PV power plant industry to distribute commercial electric power to PT. PLN network. The validation of COD is referred to purchasing agreement or called PJBL for 20 years period. Dirjen EBTKE is director general of new, renewable energy and energy conservation responsible for the formulation and implementation of policies in the field of supervision, control and fostering geothermal activities, bioenergy, various renewable energy, and energy conservation. Ministerial regulation commissioned PT. PLN to purchase power from PV power plant and biomass power plant industry managed by business entity either by direct appointment by PT. PLN or cooperation agreement by the business entity. The Feed in Tariff is fixed price on power purchase agreement which is calculated starting COD (Commercial Operation Date) agreement date. The transaction in Rupiah currency is by Jakarta Interbank Spot Dollar (JISDOR). (Ministry of Energy and Natural Resources, 2016a)

3.3.3 Policy of Photovoltaics 2017 in Indonesia

First, the consideration of Photovoltaics policy 2017 in Indonesia is that the domestic project of renewable energy implementation by photovoltaics technology encouragement for domestic electricity supply. Secondly, the government encourages the transparency and competitiveness power plant industry development for expediting the purchasing power from PV power plant industry by PT. PLN. Required the consideration of domestic standard of Photovoltaics application module, Quota capacity quoting mechanism, price fixing of Feed-in tariff by PT. PLN to PV power plant industry.

On the regulation sides, photovoltaics power plant industry called Pembangkit Listrik Tenaga Fotovoltaik or PLTFS is power plant industry which converting solar energy into electric power, directly interconnected to the PT. PLN network. Tingkat Komponen Dalam Negeri (TDKN) is a certification for the level scale of the domestic component as the scale of combination service and goods on PV modules constructions. It encouraging domestic product applied to the PV power plant industry should be domestic equipment, maintenance, and service. The constructions and equipment applied accentuate Indonesia domestic production by certification of Indonesia domestic standard or international standard. PV system which is in accordance with the provisions of ministerial regulations that carry out government affairs in the field of industry. Quota Capacity is maximum quota capacity of PV power plant industry offered to the PT. PLN for Feed in Tariff price fixing and project period determined. The power purchase agreement signed by PT. PLN and ministry inaugurated PV power plant manufacturer. The agreement including quota capacity and regional price fixing or Feed-in Tariff (described in Table 3.2). (Ministry of Energy and Natural Resources, 2016a)

On the other side, PV power plant business entity is obtained to register the cooperation with PT. PLN by 7 days registration period by requirement: (a) Company profile and resume; (b)Company administration; (c)State certified financial statement; (d) Tax assessable verification certificate; (e) Government letter for official company establishment; (f) Government letter for company investment profile. The registration followed by business entity administration verification, quota capacity request, quota capacity offer from PT. PLN to PV power plant industry, verification, and announcement. The requirement has to be submitted by online to PT.

Table 3.2 Quota capacity offer and price fixing of feed in tariff

No.	Region	Quota Capacity (MWp)	Feed in Tariff (cent USD/kWh)
1	Jakarta	150.0	14.5
2	West Java		
3	Banten		
4	Central Java and Yogyakarta		

5	East Java		
6	Bali	5.0	16.0
7	Lampung	5.0	15.0
8	South Sumatra, Jambi, and Bengkulu	10.0	15.0
9	Aceh	5.0	17.0
10	North Sumatra	25.0	16.0
11	West Sumatra	5.0	15.5
12	Riau and Riau Islands	4.0	17.0
13	Bangka-Belitung	5.0	17.0
14	West Kalimantan	5.0	17.0
15	South Kalimantan and Central Kalimantan	4.0	16.0
16	East Kalimantan and North Kalimantan	3.0	16.0
17	North Sulawesi, Central Sulawesi, and Gorontalo	5.0	17.0
18	South Sulawesi, South East Sulawesi, and West Sulawesi	5.0	16.0
19	West Nusa Tenggara	5.0	18.0
20	East Nusa Tenggara	3.5	23.0
21	Maluku and North Maluku	3.0	23.0
22	Papua and West Papua	2.5	25.0

Source: Ministry of Energy and Natural Resources (2016a)

PLN for Ministry of Energy verification was until announcement for agreement within 6 days. The quota capacity request will be determined by indicators: (a) Recapitulations of government certified for company financial statement; (b) The Photovoltaics module and inverter quality certificate; (c) Feasibility Study (referred to Table 3.3); (d) Interconnection study (referred to Table 3.4); (e)The quota capacity per region has been set on regulation; (f) If regional quota capacity (>100MW), per business entity, has maximum limit 20 MW supply; (g) If regional quota capacity (10 - 100 MW), per business entity, has maximum limit 20% supply of quota capacity per region; (h) If regional quota capacity (<10 MW), per business entity, has no maximum limit supply. (Ministry of Energy and Natural Resources, 2016a)

Table 3.3 Feasibility study analysis in Indonesia in 2017

Chapter	Indicator
1	Project Summary
2	Project Introductory and Background
3	Technology Descriptions, Analysis and Control System
4	The review of domestic Electricity project, analysis of Indonesia renewable energy and the policy, the renewable energy project feasibility and efficiency, incentive availability analysis.
5	Location profile and geographical identity preview
6	Geographical assessment and natural disaster risk analysis
7	Social and environment assessment
8	Engineering Technical Feasibility Analysis
9	Network Interconnection study
10	Energy yield analysis
11	Project plan report
12	Construction plan and analysis
13	Investment calculation; capital expenditures and administration
14	Financial assessment and payback period calculation
15	Risk Assessment Analysis
16	Operation and Maintenance
17	Decommissioning
18	Warranty service study

Source: Ministry of Energy and Natural Resources (2016a)

Regarding the quota capacity, it will be agreed and published in the domestic newspaper as an official announcement. If the calculations by PV power plant industry meet incompatibility with TDKN official verifier, PV power plant has punished by power purchase reduction. The basic calculation of reduction of electricity purchase price by pattern: (Ministry of Renewable Energy Industry, 2017b).

Table 3.4 Interconnection study in Indonesia in 2017

Purpose	The study of system continuity, the safety, and risk presupposition
Requirement	1. Capacity of PV power plant industry less than equal to 25% of peak daytime load capacity 2. Short Circuit Level (SCL) less than equal to 10% of maximum short-circuiting 3. Protection function requirement a. Maximum-minimum Voltage and Frequency b. Function of voltage sensing and time delay frequency c. Anti-islanding d. Detection of distribution network

	e. Transfer trip f. Manual interconnection breaker g. Surge withstand capability h. Parallelization equipment i. Reclose blocking j. Backup protection equipment 4. Prevention function of system interference requirement a. Setting voltage b. Response to abnormal voltage c. Response to abnormal frequency d. Synchronization e. Flicker f. Harmonics g. Power factor 5. Specific technological requirements of generating technologies a. Synchronous generator b. Induction generator c. International certification for inverter 6. During low load conditions and cloudy conditions a. Limiting the ramp of the inverter at a rate of 10% per minute of inverter capacity (start up, shut down, normal operation and restriction orders) except during solar radiation degradation b. Setting the restart time for double inverter at 15 seconds or over 7. Communication and metering requirements 8. Testing, certification, and commissioning 9. Additional requirement for system stability
Interconnection Scope	1. Interconnection Feasibility analysis 2. Impact distribution system analysis 3. Connection facility analysis

Source: Ministry of Energy and Natural Resources (2016a)

$$c = \frac{a-b}{a}; c \leq 1 \; or \; 100\% \; d' = d \times (1-c)$$

a : minimum percentage of TDKN by ministry regulations

b : percentage of TDKN by the ministry of energy official verifier

c : percentage of sanctions for the decline in the purchase price of

electricity

d : price fixing of purchase price agreement

d': price fixing of purchase price corrected calculation

PV power plant industry (<10MW) responsible for reaching COD within 12 months and 24 months for capacity >10MW, calculated since power supply business license published date. If there meet incompatibility, PV power plant industry responsible for receiving punishment: (Ministry of Energy and Natural Resources, 2016a)

a. Retardation ≤ 3 months, price reductions for 3%
b. Retardation 3 – 6 months, price reductions for 5%
c. Retardation 6 – 12 months, price reductions for 12%
d. Retardation > 48 months, subject to the sanction of business license revocation.

PV power plant responsible for reaching fulfillment of financing (financial close) by submitting the report by online to the ministry of energy no longer than 6 months start the agreement signed to date. The retardation submits subject to the sanction of business license revocation. PV power plant industry admitted co-operating with the ministry of energy responsible for submitting the report on the progress of development implementation every 3 months since the date of the agreement signed till COD period expiration date by online.

3.3.4 Policy of Biomass 2017 in Indonesia

The domestic project of new energy and renewable energy is implemented by biomass and biogas encouragement for domestic electricity supply. Regarding the regulations, the setting of fixed price of electric power purchases out of biomass power plant industry is by observation of biomass power plant electricity production capacity, network voltage PT. PLN and region of biomass power plant industry for factor F. The fixed-price (referred to Table 3.5) is the price includes all procurement costs, fixed-price without price negotiation and or escalation, and the price applicable to the agreement as per the date of the COD in PJBL. The biomass power plant business entity is obtained to register the cooperation with PT. PLN within 7 days by requirement: PT. PLN verified of company feasibility study which has substance biomass power plant industry development investment calculation and project period estimation, domestic standard verification of installation product, and study of financial ability. The application of business entity will be processed within 30 days. The PV power plant business entity is obtained to register the cooperation with PT. PLN.

Biomass power plant industry admitted co-operating with the ministry of energy responsible for submitting the report on the progress of development implementation every 6 months since the date of the agreement signed till COD period expiration date. Biomass power plant industry responsible for reaching fulfillment of financing or financial close by submitting the report to the ministry of energy no longer than 12 months start the agreement signed to date. The retardation submits subject to the sanction of business license revocation. Biomass power plant industry responsible for reaching COD within 36 months calculated since power supply business license published date. If there meet incompatibility, biomass power plant industry responsible for receiving punishment:

a. Retardation ≤ 3 months, price reductions for 3%
b. Retardation 3 – 6 months, price reductions for 5%
c. Retardation 6 – 12 months, price reductions for 12%
d. Retardation >48 months, subject to sanction of business license revocation

Excess-power purchase agreement is an agreement between registered biomass power plant industry and PT. PLN in order to procurement excess power from the power plant. The excess power agreement signed without specific terms, the registration by written application proposal to PT. PLN, Ministry of Energy and Dirjen EBTKE. The fixing price of excess power (referred to Table 3.6). (Ministry of Energy and Natural Resources, 2016b)

Transitional provisions are the biomass power plant industry registered before July 25th, 2016 responsible for updating the feed-in tariff as 85% from the price listed in Table 4 and 5. The registered biomass power plant should apply to the Dirjen EBTKE.

Table 3.5 Fixing price of biomass

No	Region	Feed in Tariff (cent USD/ kWh)				Factor F
		Capacity ≤20 MW		20 MW< Capacity≤50MW	Capacity>50 MW	
		Low Voltage	Medium-High voltage	High Voltage	High Voltage	
1.	Java	16,00 x F	13,50 x F	11,48 x F	10,80 x F	1,00
2.	Sumatra	16,00 x F	13,50 x F	11,48 x F	10,80 x F	1,15
3.	Sulawesi	16,00 x F	13,50 x F	11,48 x F	10,80 x F	1,25
4.	Kalimantan	16,00 x F	13,50 x F	11,48 x F	10,80 x F	1,30
5.	Bali, Bangka Belitung, and Lombok	16,00 x F	13,50 x F	11,48 x F	10,80 x F	1,50
6.	Riau Islands, Nusa Tenggara, and other islands	16,00 x F	13,50 x F	11,48 x F	10,80 x F	1,60
7.	Maluku and Papua	16,00 x F	13,50 x F	11,48 x F	10,80 x F	1,70

Source: Ministry of Energy and Natural Resources (2016b)

Table 3.6 Excess power procurement fixing price

No	Region	Feed in Tariff (cent USD/ kWh)			
		Capacity ≤20 MW		20 MW< Capacity≤50MW	Capacity>50 MW
		Low Voltage	Medium- High voltage	High Voltage	High Voltage
1.	Java	16,00	13,50	11,48	10,80
2.	Sumatra	16,00	13,50	11,48	10,80
3.	Sulawesi	16,00	13,50	11,48	10,80
4.	Kalimantan	16,00	13,50	11,48	10,80
5.	Bali, Bangka Belitung, and Lombok	16,00	13,50	11,48	10,80
6.	Riau Islands, Nusa Tenggara, and other islands	16,00	13,50	11,48	10,80
7.	Maluku and Papua	16,00	13,50	11,48	10,80

Source: Ministry of Energy and Natural Resources (2016b)

3.3.5 Indonesia Collaboration and Partnership

Domestic Renewable Energy Lab (NREL)

In support of the Millennium Challenge Corporation's Compact with the Indonesian government, NREL is working to identify renewable energy investment opportunities in selected Indonesian provinces. The objective is to alleviate poverty by enabling local economic development. NREL also supports activities related to USAID's Enhancing Capacity for Low Emission Development Strategies (EC-LEDS) program, aiming to strengthen Indonesian capacity in order to design and implement low carbon development strategies. (Domestic Renewable Energy Laboratory, 2015)

OPIC (Overseas Private Investment Corporation)

In 2010, the Overseas Private Investment Corporation (OPIC) updated its 1967 Investment Support Agreement between the United States and Indonesia by adding OPIC products such as direct loans, coinsurance, and reinsurance to the means of OPIC support which U.S. companies may use to invest in Indonesia.

Indonesia has joined the Multilateral Investment Guarantee Agency (MIGA). MIGA, a part of the World Bank Group, is an investment guarantee agency to insure investors and lenders against losses relating to currency transfer restrictions, expropriation, war and civil disturbance, and breach of contract (export.gov, 2017).

IRENA (International Renewable Energy Agency)

While reliance on domestic coal and imported petroleum products has grown, Indonesia has started adding more renewables to its energy mix. Indonesia has set out to achieve 23% renewable energy use by 2025, and 31% by 2050.

The benefits of such accelerated uptake would greatly outweigh the costs. Compared to current plans and policies, it would cut net energy system costs and avoid air pollution and carbon-dioxide emissions – enough to save up to USD 53 billion per year by 2030 in economic terms. This amounts to an estimated 1.7% of Indonesia's gross domestic product in 2030. (International Renewable Energy Agency, 2016)

ASEAN Centre for Energy

An organization based in Jakarta, Indonesia. The ASEAN Centre for Energy will accelerate the integration of energy strategies within ASEAN by providing relevant information state-of-the-art technology and expertise to ensure that over the long term, necessary energy development policies and programs are in harmony with the economic growth and the environmental sustainability of the region. (Open EI, 2016)

Asian Development Banks (ADB)

ADB operations in Indonesia continue to focus on strengthening energy security; extending the reach, reliability, and efficiency of the domestic electricity grid; and fostering greater use of clean energy. ADB assistance also aims to reduce poverty and food insecurity by improving agricultural and fishery productivity and competitiveness, fostering income diversification and improving the availability of water for agricultural use. ADB has approved $32.7 billion in sovereign and not- sovereign loans (excluding co-financing), and $894.02 million in technical assistance and grants for Indonesia (Asian Development Bank, 2017).

Private Sectors

International and Indonesian stakeholder such as BLUEJAY Energy, Huawei, JinKO Solar, SMBC, Solar Plaza, AKUA Energy, Munich RE, POWERDRILINDO and much more also participated in Indonesia renewable energy project.

Government and International Support

An international organization, institutions, NGOs, and ENGO collaborate with Indonesian Ministry of Energy and private sectors in order to investment, infrastructure and technology development for Indonesia green energy sustainability.

Bank

State-owned Bank, Foreign Exchange Banks, and Private Banks have programs for a loan in order of investment project. There are the list of top Indonesian bank by total assets: Bank Negara Indonesia, Bank Rakyat Indonesia, PT Bank Tabungan Negara (BTN), Bank Mandiri, Bank Central Asia (BCA), Bank CIMB Niaga, Bank Danamon, Bank Permata, Bank Panin, Bank Internasional Indonesia (BII), and many more.

3.3.5 Conclusions

Indonesia regulations governed by Ministry of Energy and Natural Resources which is the policymakers for domestic electricity and energy. In order to transmit, generate and distribute the domestic electricity, MEMR collaborates with PT. PLN as executor for whole economy electricity distributions.

Indonesia government encourages the renewable energy program by Feed in Tariff. The seduce price offered by MEMR regulations through PT. PLN, encourage stakeholder and investor local and international to develop renewable energy project in Indonesia.

The regulations and law proceed of Photovoltaics could refer to MEMR No. 19 the year 2016. Biomass regulation referred to MEMR No. 21 the year 2016.

3.4 Economic Feasibility of Renewable Energy for Smart Farms- Case Study I: Viet Nam

3.4.1 Introduction

Since the renewable energy, including solar energy, gain the global interest, it has an indispensable role for economies to meet the raise energy demand, as a result of the socioeconomic growth and environmental eco-green reconstructions. The present session of Viet Nam Geographic Information System shows the highest potential of Viet Nam concentrating solar power among Southeast Asia regions. The solar energy takes the huge potential for developing Viet Nam, including for agriculture integrations. This session explained the 2017 policy framework and the potential utilization through solar power development in Viet Nam. Turn into the 1 MW capacity investment analysis with the estimation of payback less than 5 years. It served the significant data as investor's information needed and guideline for investing the solar energy in Viet Nam. Finally, the financial analysis has been used for the case study of the smart farm with solar energy integrations in Viet Nam.

Viet Nam is low-middle income economy located in Southeast Asia with a population of over 90 million and a territory of more than 330,000 square kilometers. During the past 15 years, the domestic strong growth in the industrial and service sectors has majorly contributed to the economy's economy. The growth was particularly strong in the service sector, which recorded an average annual growth of 7.0%, followed by 6.3% in the industrial sector and 3.4% in the agricultural sector during 2005–2014. Thus, in 2014, the agriculture sector's contribution to GDP was only 17%, while the contribution of service sector was 44% and industrial sector was 39% (Asian Development Bank, 2015). The demand for electricity mostly goes to the industrial and agricultural sectors. By increasing the demand for electricity, Viet Nam has to develop more in the energy sector to balance the demand and supply of energy.

Geographically, Viet Nam has high annual solar isolation among the Asian economies. It is an advantage for Viet Nam in their efforts to develop a solar photovoltaics industry. Also in legal status, Ministry of Investment and Trading under Viet Nam government start to enhance the renewable energy integrations by encouraging investment, especially in terms of investment capital, tax, and land use rights. The Domestic Strategy on Energy Development to 2020 outlook to 2050 has made the following policies for domestic energy security, energy prices, investment policies for the development of new and renewable energy sources, biofuels, nuclear power, energy saving and efficient uses, and environmental protection policy.

3.4.2 Basic Theory

Firstly we implement the Cost-beneficial Analysis. For an investment of a project, the investor should understand about the current condition and hope to reap benefits in the future. Regarding the return on investment that must be considered is the result of changes made from the profit. Based on Frank Reilly and Keith C. Brown theory, period duration of investment is holding period. Then payback period of the investment called HPR (Holding Payback Period) by using formula these below (Andoko, 2016).

$$HPR = (End\ Value - Initial\ Value) / Initial\ Value$$

PR usually bigger or equal with 0, if the value bigger than 1 it is meant to have profit, as a flipside if lower than 1 or equal with 0 thus investor failed to reap the profit from the investment. For evaluation of the percentage yearly profit, thus HPR must be converted to annual HPY (Holding Period Yield)

$$HPY = HPR^{1/n}, \text{ which } n \text{ is total years of investment.}$$

Appropriate comparison between the total revenues in the future with overall spending in the present or in the future is important to note because there are differences in currency values calculated time period. This imbalance can be overcome by using time value of money concept. Based on this concept, the revenue and expenditure throughout the project are estimated to exist in the future is calculated by giving additional factor worth present value of the future, thus that it can be seen in now and can be compared with the present condition. Present worth factor used in calculating the value of investment projects can use the market interest rate or bank rate. The formula of present worth factor is $DF=1 / (1+r)^n$, which DF is Discount Factor, r is discounted level, and n is total years of investment.

Net Present Value (NPV)

Net Present Value (NPV) is a measurement of the profitability of an undertaking that is calculated by subtracting the present values of cash outflows (including initial cost) from the present values of cash inflows over a period of time. Incoming and outgoing cash flows can also be described as benefit and cost cash flows.

$$NPV = \sum_{t=1}^{T} \frac{Ct}{(1+t)^t} - Co$$

Ct : net cash inflow during the period *t*

Co : total initial investment costs

r : discount rate

t : number of time periods

Discounted Payback Period (DPP)

The discounted payback period is a capital budgeting procedure used to determine the profitability of a project. A discounted payback period gives the number of years it takes to break even from undertaking the initial expenditure, by discounting future cash flows and recognizing the time value of money. Good investment if the condition of DPP is lower than project period.

$$Discounted\ Cash\ Inflow = \frac{Actual\ Cash\ Inflow}{(1+i)^n}$$

i : the discount rate

n : the period to which the cash inflow relates

$$Discounted\ Payback\ Period = A + \frac{B}{C}$$

A : Last period with a negative discounted cumulative cash flow

B : Absolute value of discounted cumulative cash flow at the end of the period A

C : Discounted cash flow during the period after A.

<u>Benefit Cost Ratio</u>

A benefit-cost ratio (BCR) is an indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values.

Benefit cost ratio (BCR) takes into account the amount of monetary gain realized by performing a project versus the amount it costs to execute the project. The higher the BCR results in the better the investment. The general rule of thumb is that if the benefit is higher than the cost the project is a good investment.

$$BCR = \frac{PVB}{PVC} = \frac{\sum_{t=1}^{n} \frac{Bt}{(1+r)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+r)^t}}$$

PVB : present value of benefits

PVC : present value of cost

B_t : monetary value of benefits incurred during the period t

C_t : monetary value of cost incurred during the period t

r : discount rate

t : number of time period

Internal Rate of Return (IRR)

Internal Rate of Return is a rate of return used in capital budgeting to measure and compare the profitability of investments. It is also called the discounted cash flow rate of return (DCFROR) or the rate of return (ROR). In the context of savings and loans, the IRR is also called the effective interest rate. The term internal refers to the fact that its calculation does not incorporate environmental factors such as interest rate and inflation.

$$IRR = \sum_{t=1}^{n} \frac{(Bt - Ct)}{(1+r)^t} = 0$$

B_t : monetary value of benefits incurred during the period *t*

C_t : monetary value of cost incurred during the period *t*

r : discount rate

t : number of time periods

3.4.3 Methodology

Statutory Framework

The Government is an executive agency of the Domestic Assembly and is the highest administrative agency of Viet Nam subjected the Domestic Strategy on Energy Development to 2020 outlook to 2050 has made the following policies for domestic energy security, energy prices, investment policies for the development of new and renewable energy sources, biofuels, nuclear power, energy saving and efficient uses, and environmental protection policy.

The government supports mechanism for policy and regulatory by prioritizing investment, supporting individuals, organization, and business entity. Also applying various fiscal incentives within import tax, corporate income tax, land taxes and

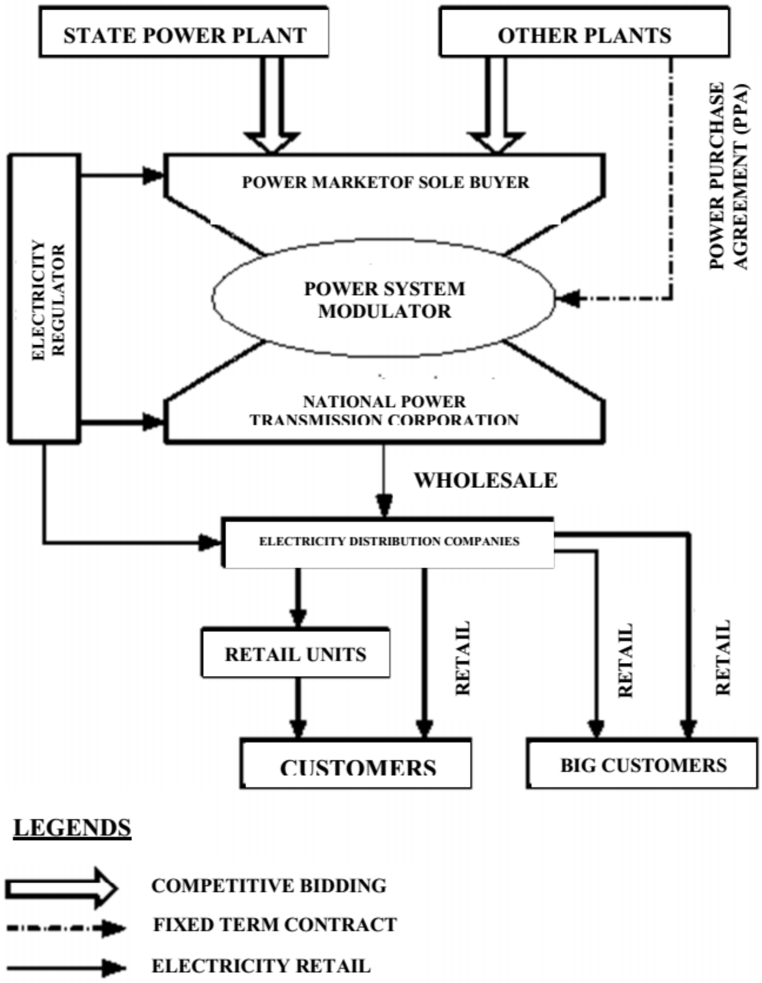
fees, depreciation policy, as well as credit incentives as specified in legislation, applicable to special preferential projects and preferential investment projects (Asia Pacific Economic Cooperation, 2016).

Renewable Energy Business Model

Since 2005, Viet Nam's electricity business model with the approval of the Prime Minister, has been in transition from "Monopoly power market" to the "competitive electricity market" with 3 respective levels: a) level 1 (2005 - 2014) period of competitive electricity generation market; b) level 2 (2015-2022) period of competitive electricity wholesale market; c) level 3 (after 2022) period of competitive electricity retail market. Since February 2012, the legal energy business model in Viet Nam following model (referred to Fig. 3.1).

Legal System Pricing

For grid-connected solar power projects, the electricity buyer has the responsibility to purchase all the electricity generated from the grid-connected projects with the electricity purchase price at Viet Nam Dong (VND) 2,086/kWh (excluding value added tax, equivalent to 9.35 US cents/kWh, according to the central exchange rate of VND to USD, announced by the State Bank of Viet Nam on April 10, 2017, is VND 22,316 per USD). Electricity prices are adjusted by the exchange rate of VND/USD exchange rate. This electricity price applies only to grid-connected projects with 16% or greater solar module efficiency or 15% larger modules (Prime Minister, 2017)



Source: Central Power Corporation (2011)

Fig 3.1 Diagram of legal energy business model in Viet Nam

Financial Analysis

There is some popular brand of solar PV module installed in Viet Nam: Red Sun solar; Viet VMicro JS, Mitsubishi, Viet Linh AST, IREX and much more. The price depending the quality and type of module installed, the average price around 3-5 USD/ Watt. Since the Viet Nam policy unregulated to install the local product, the initial cost of PV installation calculated as Thailand experiment calculation by 16 June 2017 the exchange rate to Vietnamese Dong, 1 THB = 668.14 (referred to Table 3.7). Installing Thailand product has beneficial for Viet Nam due to efficient cost land logistic due to Viet Nam and Thailand are neighbor economies. Meanwhile, the scale of labor in Thailand is higher than Viet Nam. By 2017, minimum daily labor wage for Thailand is 8.7 USD and Viet Nam for 4.64-5.23 USD (Department of Labor and Employment, 2017). The initial cost for PV installation calculated as 1 MW, by multiplication of VND 28,729.98 with 1,000,000 Watt and exchange to USD currency (1 VND= 0.000044 USD). It equal to 1,264,119.12 USD, excluded the Value Added Tax (VAT) and land lease cost.

The project period for 20 years as PPA specified agreement. The discount rate calculated as 1%. The revenue is calculated from multiplication FiT with hour's operations, VND 2,086 per kWh equal to USD 0.092; exchange rate by 2017, June 16th. Annual revenue: 0.092 x 1000 x 24 x 365 = USD 805, 920. The maintenance cost calculates start USD 12 per kWh by the second year of constructions which increasing 10% annually. The calculation referred to Table 3.8.

Table 3.7 The Initial cost of PV installation in Viet Nam

	Utility-scale PV systems >1 MW	Currency exchange
Cost Category	THB/Watt	VND/Watt
Module	25	16,698.56
Inverter	5	3,339.71
Electrical Equipment (racking, wiring etc.)	5	3,339.71
Installation Labor	5	3,339.71
Profit or Commission	4	2,671.77
Other (permitting, contracting, financing etc.)	2	1,335.89
Total	43	28,729.98

Source: International Energy Agency (2016)

Table 3.8 The financial analysis of 1 MW PV development in Viet Nam

Year	Investment Cost	Revenue	Annual Cash Flow	NPV of Annual Cash Flow	Cumulative NPV
2018	1,264,119	0	-1,264,119	0	-1,264,119
2019	12,000	0	-12,000	-11881.2	-1,276,000
2020	13,200	805, 920	792,720	777,100.3	-498,900
2021	14,520	805, 920	791,400	768,125	269,225
2022	15,972	805, 920	789,948	759,124.5	1,028,350
2023	17,569.2	805, 920	788,351	750,088.7	1,778,438
2024	19,326.1	805, 920	786,594	741,007	2,519,445
2025	21,258.7	805, 920	784,661	731,867.7	3,251,313
2026	23,384.6	805, 920	782,535	722,658.3	3,973,971
2027	25,723.1	805, 920	780,197	713,365.1	4,687,337
2028	28,295.4	805, 920	777,625	703,973.4	5,391,310
2029	31,125	805, 920	774,795	694,467.2	6,085,777
2030	34,237.4	805, 920	771,683	684,829.1	6,770,606
2031	37,661.1	805, 920	768,259	675,040.3	7,445,647
2032	41,427.3	805, 920	764,493	665,080.4	8,110,727
2033	45,570	805, 920	760,350	654,927.1	8,765,654
2034	50,127	805, 920	755,793	644,556.4	9,410,210
2035	55,139.7	805, 920	750,780	633,942	10,044,152
2036	60,653.6	805, 920	745,266	623,055.6	10,667,208
2037	66,719	805, 920	739,201	611,866.2	11,279,074
2038	73,390.9	805, 920	732,529	600,340.2	11,879,414

The calculation result of 1 MW PV power development in Viet Nam indicated as good and profitable investment. The payback period of USD 1,264,119 investment cost is three years since constructions. The investor has the possibility to make a profit on the third year for USD 269, 225 per year and by the end of the project, the profit calculated is USD 11,879,414.

Investment Incentives

Regarding the valid regulations and business opportunities, an investment capital for developing solar power industry is investors may mobilize capital from domestic or overseas organizations and individuals to invest in solar power projects. For import duty, solar power projects are exempted from import duty on goods imported to create fixed assets of the projects; components, materials and semi-finished products which are not available at home for the project's operation. In line with financial strategies considered factors are corporate income tax which is solar power projects will also enjoy the same corporate income tax exemption and reduction as projects in sectors receiving investment incentives according to the current regulations on taxation. For example, corporate income tax rate of 10% will be applied for 15 years, tax exemptions within four years and tax reduction by 50% in the next nine years (Massmann, 2017)

Implementation to Smart Farm

By 2017, Viet Nam has 17 % GDP come from agriculture sector and demanding 1 % of domestic energy demand (Asian Development Bank, 2015). The agriculture in Viet Nam still face a lack of technology, thus it decreasing the interest of local people to expanding their sector in agriculture. It is an opportunity since the Ministry of Industry and Trade (MOIT) is drafting specific regulations for solar power projects in Viet Nam. It plans to submit to the Prime Minister for approval by June 2016. The MOIT has proposed FiT as a support mechanism for solar PV farm and solar PV rooftop projects (Ministry of Industry and Trade, 2016). Viet Nam has a chance for enhancing their agriculture to be domestic strong growth sectors. By integrating the renewable energy especially solar power industry to farming, it becomes a good investment for farmers or investor for next 20 years.

3.4.5 Output

As a developing economy, Viet Nam is still facing a lot of challenge for developing renewable energy. As evaluated the regulations offered a low rate of Feed-in tariff, it has to decrease global interest to invest for Viet Nam PV. Compared with the neighbor economy, Indonesia, and Thailand, Viet Nam has the lowest FiT rate.

During the study of Viet Nam solar power, there is much information hasn't provided in English. Also some part it has provided not enough information, no complete survey or source of information on PV that investor or researcher may accede. Lack of information on solar power is an obstacle for an investor for access the investment status for Viet Nam. Investors seek the information to support their investment decision.

Since Viet Nam has a high rate of corruption among Southeast Asia economies, it might be a challenge for a legalization framework that affected to financial status reliability process. The statutory framework of renewable energy is under development, it might have updated the regulation annually. The investor has to ready with financial strategies to face the rule changes also additional cost such local tax, local authorization fee, illegal charges and many more issues.

In Southeast Asia, Viet Nam regulations set the Feed-in Tariff still category has a low rate, compared with economy neighbor such Thailand and Indonesia. Viet Nam policy hasn't drawn any difference between the capacity of the solar rooftop projects or solar farm, but the government sets the Feed-in tariff rate based on the electricity capacity generated. However, regarding world's solar map Viet Nam has the highest rate of sunshine through Asian economies. It is a huge possibility and potential to apply the solar photovoltaics for Viet Nam, especially to integrate solar energy to agriculture as smart farm.

The government of Viet Nam also expands their connections with global cooperation such USAID (United States Agency for International Development), TPP (Trans-Pacific Partnership), APEC (Asia-Pacific Economic Cooperation), and much more. Involved in worldwide meant Viet Nam open the foreign developer, investor, experts, and collaboration in order to develop the infrastructure, especially in green energy.

3.5 Economic Feasibility of Renewable Energy for Smart Farms- Case Study II: Thailand

3.5.1 Introduction

The statutory framework of renewable energy in Thailand shows as a supportive sign to promote the low carbon emission to agriculture. Thailand as the largest solar energy productions among Southeast Asia economies has potential as a top developer of solar energy technology in Asia. Since the regulations and strategic geographical of Thailand gain interest for an investor to develop the solar energy, it also gains the competition with land and capacity offer with the government. Nowadays, the possibility of new investor is come up with the idea for integrating solar energy to agriculture for electrifying the remote area which is in line with Thai government mission. This session analyzed the installment of solar power with one megawatt and ten-megawatt capacity; suitable for solar integrations for a farm in small, medium, or large scale.

Thailand is fourth-largest solar module production capacity in the world, following China, Japan, and Malaysia (IRENA, 2017). Potentially, Thailand with an area of 500,000 square kilometers is the 5th rank of world solar radiation level, the insolation is 18.2 MJ / m2 (5.0 - 6.5 kWh/m^2) per day (Andoko, 2016). In 2015, the final energy consumption increased by 4.0% annually. Meanwhile, the energy prices are in a downtrend due to the oversupply of oil, natural gas, and coal in the world market. The prices of Diesel, Gasoline, and Gasohol increased from the low level. (Ministry of Energy, 2016). Regional and Domestic economic situation which affect domestic energy consumption in Thailand such as Government's transportation infrastructure investment projects and the commencement of ASEAN Economic Community, AEC, in late 2015 (Pichalai, 2015) be consideration of Thailand government to update the domestic program called Power Development Plan 2015-2036 (PDP 2015). It focuses on (1) Energy Security: coping with the increasing power demand to correspond to Domestic Economic and Social Development Plan and taking into account fuel diversification (2) Economy: maintaining an appropriate cost of power generation for long-term economic competitiveness (3) Ecology: lessening carbon dioxide intensity of power generation (Ministry of Energy, 2015).

Thailand has a high growth rate interest in solar power, setting its goal toward The Alternative Energy Development Plan 2015-2036 MW (AEDP 2015). The overall renewable energy (RE) target to be achieved 30% share in final energy consumption by 2036, including RE shares in electricity, heat and fuel consumption. For electricity, 15-20 % of energy consumption shall be sourced from RE (Federal Ministry for Economic

Affairs and Energy, 2017). The plan aims to increase the use of solar energy with an installed capacity of 6,000 MW by 2036 (International Energy Agency, 2016).

3.5.2 Basic Theory

Firstly we implement the Cost-beneficial Analysis. For an investment of a project, the investor should understand about the current condition and hope to reap benefits in the future. Regarding the return on investment that must be considered is the result of changes made from the profit. Based on Frank Reilly and Keith C. Brown theory, period duration of investment is holding period. Then payback period of the investment called HPR (Holding Payback Period) by using formula these below (Andoko, 2016).

HPR = (End Value - Initial Value) / Initial Value

PR usually is bigger or equal with 0, if the value bigger than 1 it is meant to have profit, as a flipside if lower than 1 or equal with 0 thus investor failed to reap the profit from the investment. For evaluation of the percentage yearly profit, thus HPR must be converted to annual HPY (Holding Period Yield).

Annual HPY = HPR $^{1/n}$, which n is total years of investment

Appropriate comparison between the total revenues in the future with overall spending in the present or in the future is important to note because it is different in currency values calculated time period. This imbalance can be overcome by using time value of money concept. Based on this concept, the revenue and expenditure throughout the project are estimated to exist in the future is calculated by giving additional factor worth present value of the future, thus that it can be seen in now and can be compared with the present condition. Present worth factor used in calculating the value of investment projects can use the market interest rate or bank rate. The formula of present worth factor is DF=1 / $(1+r)^n$, which DF is Discount Factor, r is discounted level, and n is total years of investment.

Net Present Value (NPV)

Net Present Value (NPV) is a measurement of the profitability of an undertaking that is calculated by subtracting the present values of cash outflows (including initial cost) from the present values of cash inflows over a period of time. Incoming and outgoing cash flows can also be described as benefit and cost cash flows.

$$NPV = \sum_{t=1}^{T} \frac{Ct}{(1+t)^t} - Co$$

Ct : net cash inflow during the period *t*

Co : total initial investment costs

r : discount rate

t : number of time periods

Discounted Payback Period (DPP)

The discounted payback period is a capital budgeting procedure used to determine the profitability of a project. A discounted payback period gives the number of years it takes to break even from undertaking the initial expenditure, by discounting future cash flows and recognizing the time value of money. Good investment if the condition of DPP is lower than project period.

$$Discounted\ Cash\ Inflow = \frac{Actual\ Cash\ Inflow}{(1+i)^n}$$

i : the discount rate

n : the period to which the cash inflow relates

$$Discounted\ Payback\ Period = A + \frac{B}{C}$$

A : Last period with a negative discounted cumulative cash flow

B : Absolute value of discounted cumulative cash flow at the end of the period A

C : Discounted cash flow during the period after A.

<u>Benefit Cost Ratio</u>

A benefit-cost ratio (BCR) is an indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values.

Benefit cost ratio (BCR) takes into account the amount of monetary gain realized by performing a project versus the amount it costs to execute the project. The higher the BCR results in the better the investment. The general rule of thumb is that if the benefit is higher than the cost the project is a good investment.

$$BCR = \frac{PVB}{PVC} = \frac{\sum_{t=1}^{n} \frac{Bt}{(1+r)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+r)^t}}$$

PVB: present value of benefits

PVC: present value of cost

B_t : monetary value of benefits incurred during the period t

C_t : monetary value of cost incurred during the period t

r : discount rate

t : number of time period

Internal Rate of Return (IRR)

Internal Rate of Return is a rate of return used in capital budgeting to measure and compare the profitability of investments. It is also called the discounted cash flow rate of return (DCFROR) or the rate of return (ROR). In the context of savings and loans, the IRR is also called the effective interest rate. The term internal refers to the fact that its calculation does not incorporate environmental factors such as interest rate and inflation.

$$IRR = \sum_{t=1}^{n} \frac{(Bt - Ct)}{(1+r)^t} = 0$$

B_t : monetary value of benefits incurred during the period *t*

C_t : monetary value of cost incurred during the period *t*

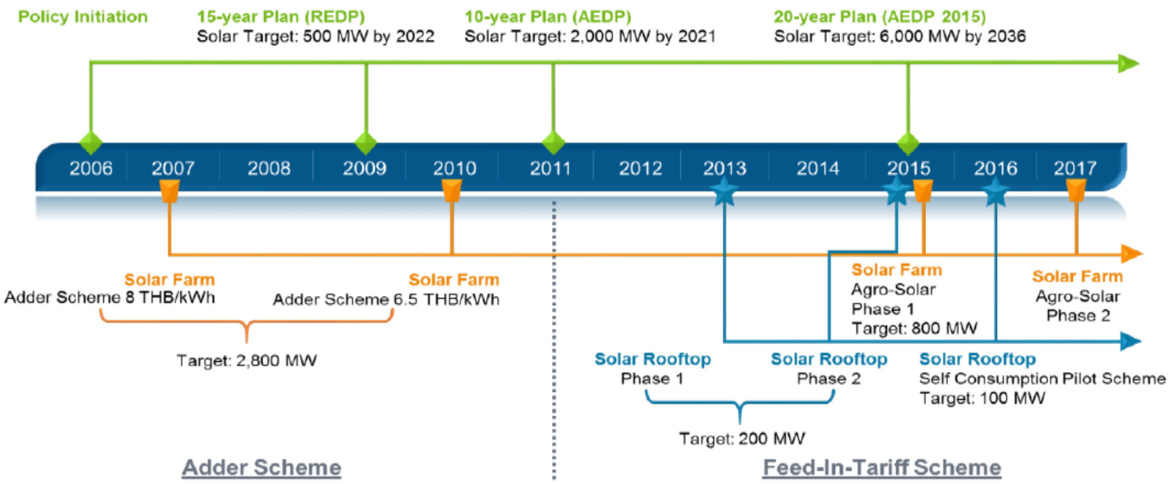
r : discount rate

t : number of time periods

3.5.3 Methodology

Policy Framework

The newest update statutory framework of Thailand policy of PV approved by Domestic Energy Policy Council are outlined in the Alternative Energy Development Plan 2015-2036 (AEDP 2015). Thailand Ministry of Energy targeted the achievement from 2.7 GW to 6 GW by 2036. (Referred to Fig. 3.2)



Source: Federal Ministry for Economic Affairs and Energy (2017)

Fig. 3.2 Thailand's solar PV policy target timeline

Power Purchase Agreements (PPA) may be entered into with EGAT, the PEA or the MEA. The Thai Government does not typically guarantee payments under PPAs. The allocation of risks in PPAs is well understood and is generally bankable by Thai and international banks that are active in the Thai power market (Davies and Lemin, 2016).

The PPA duration is 25 years starting the Scheduled Commercial Date Operation (SCOD) specified in PPA. It must be signed within 120 days from the date of notice from ERC. In case a PPA has already been signed but the project cannot dispatch power to the system, the SCOD can be postponed by sending a letter to the related distribution authority 30 days prior to the SCOD. The distribution authority will then consider extending the SCOD.

Realizing the potential is evaluated on 1% of possible installation in Thailand: 42,356 MW (Department of Alternative Energy Development and Efficiency, 2016); (Achawangkul, 2015). Thus, Domestic Reform Council (NRC) spoke in favor of a program called Rooftop PV Self-Consumption Pilot Scheme that aims at simplifying the installation of rooftop solar and allows all citizen to install such system and connect it to the power network. It related with all agencies (ERC, EPPO, DEDE, MEA, PEA) were involved in crafting the content of the scheme. The applicant shall be the roof owner or the third person holding a lease contract with the owner or be otherwise permitted by the owner to act on his behalf. The applicant can be an existing or new electricity user with MEA/PEA; those who have previously installed PV systems for self-consumption can apply the scheme.

Besides the solar rooftop, the Thailand government announced the "Governmental Agency and Agricultural Cooperatives Program" (Agro-Solar) with an overall target of 800 MW. This program aims at realizing solar farms with capacity up to 5 MW in the form of public-private partnerships (PPP) with the governmental sector or agricultural cooperatives as public partners. The eligible applicants must be either government agencies or agricultural cooperatives, which will function as project owner and PPA holder. The project owner can have project supporters through public-private partnerships (PPP). Project supporters must be companies registered in Thailand and each company is allowed to support more than one project but no more than 50 MW in total. The applicant categories: governmental agencies; universities regulated by the government; governmental organizations (excl. public organization and state enterprises); local administration units; agricultural cooperatives; land settlement cooperatives; fishing cooperatives

The government supports both the solar rooftop and Agro-Solar by Feed in Tariff as fix price (referred to Table 3.9). Solar Rooftop Phase 1 (2013) as the first solar PV rooftop

FiT policy for the economy was announced in 2013 with a target of 100 MW for commercial rooftops (10-1,000 kW) and 100 MW of residential (0-10 kW) rooftop systems (original document and unofficial GIZ translation). While the quota for commercial rooftop PV was reached quickly and the program was closed for further applications, only ~21 MW of PPAs were signed in the residential sector. The systems were originally meant to be commercially operated by the end of 2013, but many of the systems were not built on time and were delayed until 2014 and 2015 due to licensing reasons. Solar Rooftop Phase 2 (2015) as the residential sector received only ~21 MW of applications from the 100 MW quota. In August 2014 the NEPC announced to re-open the residential program calling it 'Solar rooftop phase 2' (original document and its amendment). The scheme allocated 78.63 MW to fulfill the 100 MW target in the residential sector, with no quota for the commercial sector and ERC officially announces the applications in February 2015 (Federal Ministry for Economic Affairs and Energy, 2017).

Table 3.9 Feed-in tariff for solar PV installations in Thailand

Category	Capacity	Type	Phase 1 FiT (THB/kWh)	Phase 2 FiT (THB/kWh)	SCOD
Rooftop Residential	≤ 10 kWh	House	6.96	6.85	June 2016
Rooftop commercial	10 - 250 ≤ kWh	Com.	6.55	6.40	June 2016
Rooftop commercial	250 - 1,000 kWh	Com.	6.16	6.01	June 2016
Agro-Solar Program	≤ 5 MWh	Agri. Coop.	5.66	4.12	2017
Large Scale	≤ 90 MWh	Pipe	5.66	4.12	June 2016

Source: Federal Ministry for Economic Affairs and Energy (2017)

System Pricing

Turnkey prices per watt of PV systems at various categories (referred to Table 3.10). The

PV system prices depend on the system size and type of installation, such as the rooftop system and the ground mounting system. In 2015, the PV rooftop price was in the range of 60 – 75 THB/Watt depending on the product's guarantee and after sale service contracts. However, the Utility-scale PV systems were in the range of 41-54 THB/W, mostly leaning on the warranty of the equipment or systems.

Table 3.10 The Cost breakdown of PV installations by domestic trend system price

	Residential PV System < 10 kW	Utility-scale PV systems >1 MW
Cost Category	THB/Watt	THB/Watt
Module	27.5	25
Inverter	12	5
Electrical Equipment (racking, wiring etc.)	11	5
Installation Labor	11	9
Profit or Commission	4	4
Other (permitting, contracting, financing etc.)	2	2
Total	67.5	47

Source: International Energy Agency (2016)

Financial Analysis

The financial parameters set for two major types of photovoltaics (PV) applications: PV rooftop system (less or equal 1 MW) and Utility-scale PV systems (1 to 90 MW). Firstly, the cost of PV rooftop system is installed without land lease cost. The cost of 1 MW capacity shall be THB 67,500,000 which equal to USD 1,981,216. (1 THB= USD 0.029). The maintenance cost shall be 12-15 USD per kWh which calculates as average equal to 13 USD per kWh (Referred to Table 3.11).

The project period for 25 years as PPA specified agreement. The discount rate calculated as 1%. The revenue is calculated from multiplication FiT with hour's operations (THB 6.16 or equal to USD 0.181). Annual revenue: 0.181 x 1000 x 24 x 365= USD 1,585,560. The maintenance cost calculates start USD 13 per kWh by the second year of constructions which increasing 10% annually. Basically, the investment indicated the payback period on year-3 after installation and year-4 has profit USD 1,069,874. (Refereed to Table 3.12).

Secondly, as the calculation for Utility-scale PV systems, imagery for 10 MW capacity, the initial cost shall be THB 470,000,000 which equal to USD 13,791,083. The maintenance shall be 13 USD per kWh (referred to Table 4). The utility-scale PV system required land lease cost additional. For 10 MW installation required a minimum 10 hectares which equal to 62.5 Rai (Thailand standard measurement for land). The price of land is depending on the locations and infrastructure. In the north part of Thailand is most expensive land price, in Chiang Rai province, the average is THB 100,000,000 per rai (DoingBusinessThailand.com, 2014).

The discount rate calculated as 1%. The revenue is calculated from multiplication FiT with hour's operations (THB 5.66 or equal to USD 0.166). Annual revenue: 0.166 x 10,000 x 24 x 365= USD 14,541,600. The maintenance cost calculates start USD 13 per kWh by the second year of constructions which increasing 10% annually.

Table 3.11 Results of financial analysis of PV rooftop system for 1 MW installation in Thailand (in USD)

Year	Investment Cost	Revenue	Annual Cash Flow	NPV of Annual Cash	Cumulative NPV

				Flow	
2018	1,981,216	0	-1,981,216	0	-1,981,216
2019	13,000	0	-13,000	-12871.3	-1,994,087
2020	14,300	1,585,560	1,571,260	1,540,300	-453,787
2021	15,730	1,585,560	1,569,830	1,523,662	1,069,874
2022	17,303	1,585,560	1,568,257	1,507,064	2,576,938
2023	19,033.3	1,585,560	1,566,527	1,490,496	4,067,435
2024	20,936.63	1,585,560	1,564,623	1,473,946	5,541,381
2025	23,030.29	1,585,560	1,562,530	1,457,400	6,998,780
2026	25,333.32	1,585,560	1,560,227	1,440,843	8,439,624
2027	27,866.65	1,585,560	1,557,693	1,424,261	9,863,885
2028	30,653.32	1,585,560	1,554,907	1,407,637	11,271,521
2029	33,718.65	1,585,560	1,551,841	1,390,952	12,662,474
2030	37,090.52	1,585,560	1,548,469	1,374,188	14,036,662
2031	40,799.57	1,585,560	1,544,760	1,357,323	15,393,985
2032	44,879.53	1,585,560	1,540,680	1,340,335	16,734,320
2033	49,367.48	1,585,560	1,536,193	1,323,199	18,057,518
2034	54,304.23	1,585,560	1,531,256	1,305,887	19,363,406
2035	59,734.65	1,585,560	1,525,825	1,288,373	20,651,778
2036	65,708.11	1,585,560	1,519,852	1,270,622	21,922,401
2037	72,278.93	1,585,560	1,513,281	1,252,603	23,175,004
2038	79,506.82	1,585,560	1,506,053	1,234,278	24,409,282
2039	87,457.5	1,585,560	1,498,103	1,498,103	25,907,384
2040	96,203.25	1,585,560	1,489,357	1,489,357	27,396,741
2041	105,823.6	1,585,560	1,479,736	1,479,736	28,876,477
2042	116,405.9	1,585,560	1,469,154	1,469,154	30,345,631
2043	128,046.5	1,585,560	1,457,513	1,457,513	31,803,145

The result of financial calculation of utility-scale PV system for 10 MW capacity installations has payback period year-4 and by year-5 indicated profit USD 13,709,195 which indicates health and profitable investment. As 25 project term, the calculation evaluated by 1 % discount rate which might increase on next year calculations by risk, environmental, bank and loan changing possibility.

Table 3.12 Results of financial analysis of utility-scale PV Systems for 10 MW installation in Thailand (in USD)

Year	Investment Cost	Revenue	Annual Cash Flow	NPV of Annual Cash Flow	Cumulative NPV
2018	13,791,083	0	-13,791,083	0	-13,791,083
2019	130,000	0	-130,000	-128,713	-13,919,796
2020	143,000	0	-143,000	-140,182	-14,059,978
2021	157,300	14,541,600	14,384,300	13,961,260	-98,718
2022	173,030	14,541,600	14,368,570	13,807,913	13,709,195
2023	190,333	14,541,600	14,351,267	13,654,738	27,363,933
2024	209,366.3	14,541,600	14,332,234	13,501,612	40,865,546
2025	230,302.93	14,541,600	14,311,297	13,348,405	54,213,951
2026	253,333.223	14,541,600	14,288,267	13,194,975	67,408,925
2027	278,666.5453	14,541,600	14,262,933	13,041,168	80,450,093
2028	306,533.1998	14,541,600	14,235,067	12,886,820	93,336,914
2029	337,186.5198	14,541,600	14,204,413	12,731,753	106,068,666
2030	370,905.1718	14,541,600	14,170,695	12,575,772	118,644,439
2031	407,995.689	14,541,600	14,133,604	12,418,670	131,063,108
2032	448,795.2579	14,541,600	14,092,805	12,260,218	143,323,326
2033	493,674.7837	14,541,600	14,047,925	12,100,173	155,423,499
2034	543,042.262	14,541,600	13,998,558	11,938,268	167,361,767
2035	597,346.4882	14,541,600	13,944,254	11,774,214	179,135,981
2036	657,081.137	14,541,600	13,884,519	11,607,698	190,743,679
2037	722,789.2508	14,541,600	13,818,811	11,438,381	202,182,060
2038	795,068.1758	14,541,600	13,746,532	11,265,894	213,447,954
2039	874,574.9934	14,541,600	13,667,025	13,667,025	227,114,979
2040	962,032.4928	14,541,600	13,579,568	13,579,568	240,694,547
2041	1,058,235.742	14,541,600	13,483,364	13,483,364	254,177,911
2042	1,164,059.316	14,541,600	13,377,541	13,377,541	267,555,452
2043	1,280,465.248	14,541,600	13,261,135	13,261,135	280,816,587

Both financial calculations indicated health and profitable investment status. The revenue might increase by the regulation update. The investment cost calculated basic constructions and maintenance assumption without additional cost such insurance, tax, local retribution and others fees. The company is able to reap profit less than 5 years, indicate the investment under health financial. It might have a big possibility of bank determination in the case of loan or investment cooperation.

3.5.4 Discussion

Thailand, a strategic region in Southeast Asia, is a solar PV industry distributions and supportive regulations from the government of Thailand. Starting in 2017, phase after policy update and regulation or Thailand second solar gold rush 2017. The opportunities to participate in Thailand Solar industry as the Thai Energy Policy and Planning Office (EPPO) has announced new solar development plans for 2017, which open up several opportunities for foreign investors to participate. The year 2017 will see the realization of the delayed 518 MW Agro-Solar phase 2 tranche at a feed-in tariff rate of THB 5.66 per kWh over 25 years. These projects will still require the cooperation with governmental agencies and agricultural cooperatives, which is far from being free and easy. Phase 2 caught public attention by a petition filed by 2,000 agriculture cooperatives to stop and drop embarrassing formalities of a public tender for a lucky draw decision by the government's agency EPPO. At least the chances for a swift drive forward reach nearly zero. The successfully awarded 67 projects under the Agro-Solar phase 1 solar farm program with a combined capacity of 281 MW is on the market and some of them still open for a participation or joint venture.

Thailand's energy policymakers started to provide the private sector with better access to the state solar rooftop program in an attempt to promote the use of solar power. The program is now allowing private companies to apply for solar rooftop development licenses. Currently, companies are still barred from selling power back to utilities. Households and factories may be allowed to sell electricity from solar rooftops to the domestic power grid starting September 2017 (Praktikantin, 2017).

3.5.5 Conclusions

Thailand has a strategic location for developing the solar energy into commercial, including the rooftop and or solar farm. Since the regulations gain the interest of investors by the high rate of feed-in tariff, it is a chance for the new business entity for solar energy. However, the competition going to be tougher, the investor might think to integrate to agriculture sectors in Thailand. The agriculture holds big portions of GDP growth of Thailand. It meant if solar power integrates to agriculture, is in line with government mission in order to improve the socioeconomic and economic growth based on technology and infrastructure. Finally, it has analyzed for one megawatt and ten-megawatt capacity installations in Thailand. Both investments including maintenance for twenty-five years indicated the health and profitable investment.

3.6 Economic Feasibility of Renewable Energy for Smart Farms- Case Study III: Indonesia

3.6.1 Introduction

While the electricity demand increased at around 6% each year, Indonesia is predicted to increase by up to 3% in the following years. Nowadays, Indonesia energy is still depending on fossil fuel and oil for generating more than 158.64 terawatt hours (TWh). However, by 2016 Indonesia still have more than 12 million households have no electricity access. As a massive tropical economy located in the equator, Indonesia has higher solar isolation rate. It is a potential to be world largest solar power manufacturer. Indonesia also easily becomes the world biggest solar power installer for rural and islands electrification. Indonesia is known as a largest agrarian economy which most GDP come from agriculture sectors. In order to improve the domestic economic growth and development, Indonesia has an opportunity to integrate the solar power to agriculture sectors as a smart farm. To promote the renewable energy especially solar photovoltaics, the government set up the regulations by increasing feed-in tariff rate. It increases the foreign and local investor interest to develop the solar power in Indonesia. The solar power investment in Indonesia indicates the health and profitable financial status. Indonesia is an APEC member and actives in the international interest of supporting the renewable energy. Indonesia holds the world strategic opportunities for promoting rural electrification and their integration as a smart farm.

3.6.2 Background

Indonesia is the largest economy in Southeast Asia in term of energy consumptions. The demand for energy increases rapidly with increasing the populations. Electricity demand has grown at an average of 7.1 % per year since the end of the 2000s from 134.6 TWh in 2009 to 202.8 TWh in 2015 (Gandolphe, 2017). In the end of 2014, the capacity of power system Indonesia is 53.528,10 MW that consists PLN's Power Plan 38.314,23 MW and Non-PLN 17.213,87 MW (Directorate General of Electricity, 2016). By 2014 study of consumption electricity in Indonesia is 199 TWh and productions are 228 TWh. The productions of electricity currently are 94% non-renewable energy source such fossil fuel, gas, and coal (see Table 3.13) (United States Agency for International Development, 2016).

Indonesia has electricity source potential from solar around 89.600 GW (United States Agency for International Development, 2016). If only 1 % of potential has installed, the potential revenue could be USD 129,920,000 per hour operations. The estimation calculated by multiplication with USD 14.5 cent as lowest Feed in Tariff of Photovoltaics 2017 in Jakarta region (Ministry of Energy and Natural Resources, 2016).

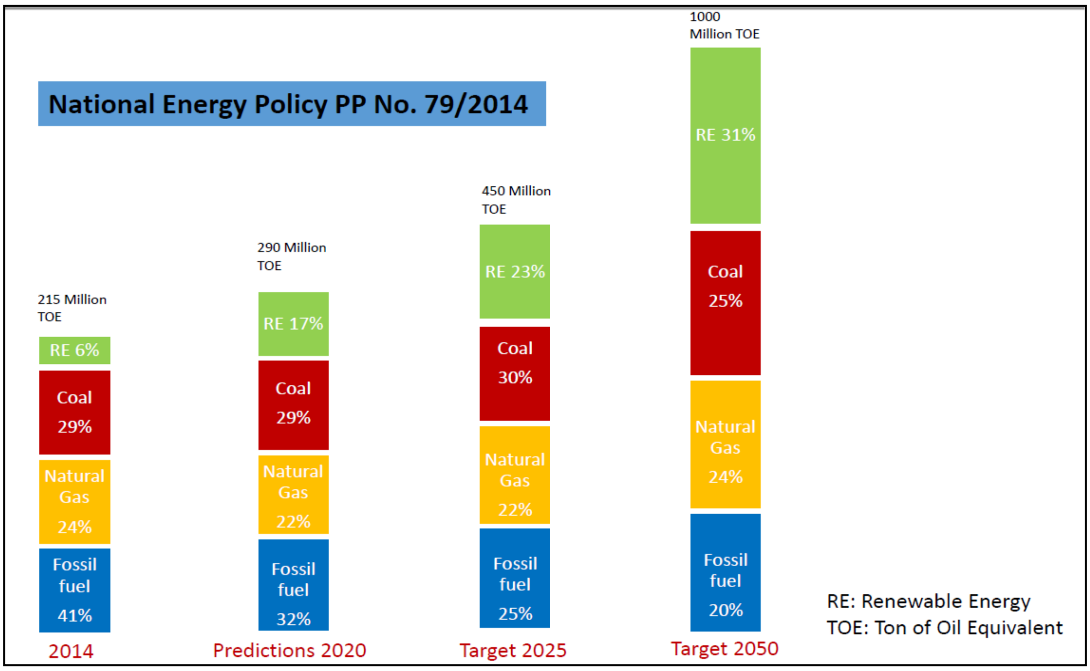
Table 3.13 Electricity source from renewable energy in Indonesia in 2014

NO	Renewable Energy Source	Potential	Installed Capacity
1	Hydro	75.000 MW	5.250 MW
2	Geothermal	29.475 MW	1.403,50 MW
3	Biomass	32.000 MW	1.740,40 MW
4	Solar	89.600 GW (4,80 kWh/m2/day)	71,02 MW
5	Wind and Hybrid	3 – 6 m/s	3,07 MW
6	Ocean Wave	61 GW	0,01 MW
7	Uranium	3.000 MW	30,00 MW

Source: Hutapea (2016)

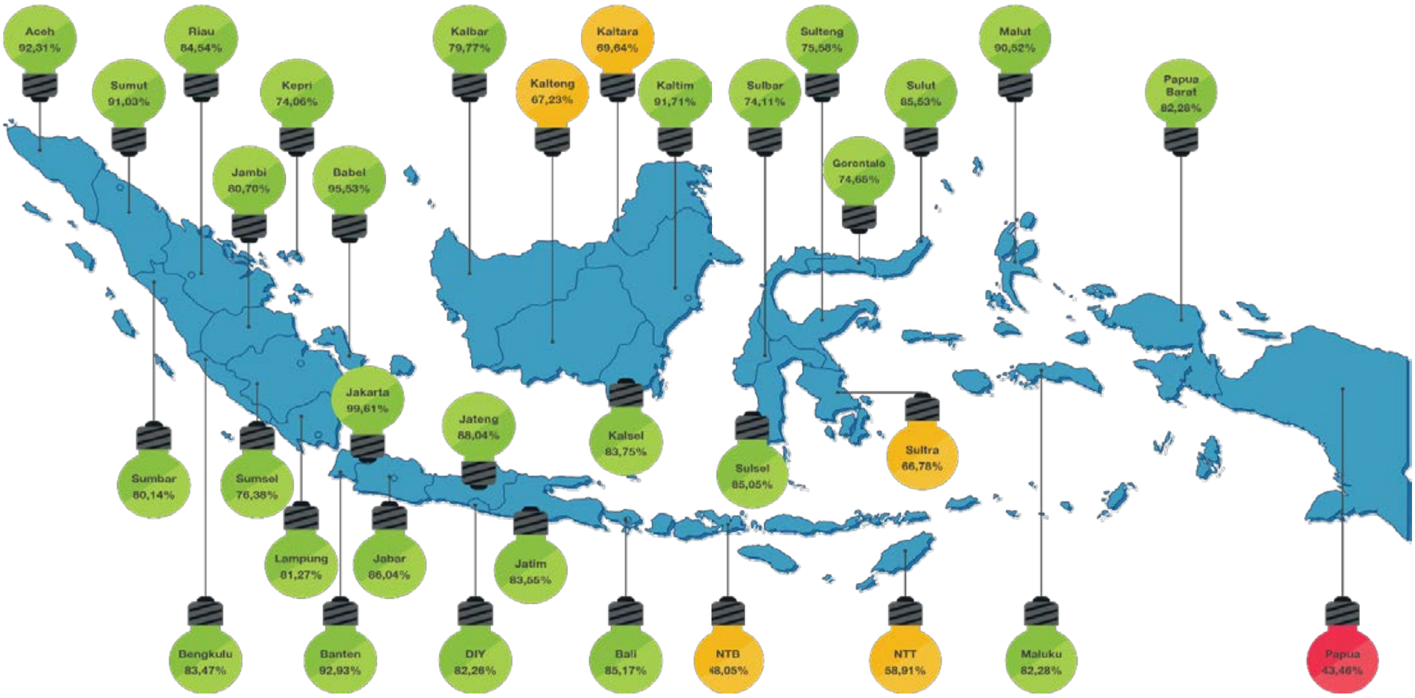
Regarding the domestic renewable energy target, Indonesia government targeted of 23% renewable energy implementation in 2025 and 31% in 2050 (Referred to Fig. 3.3) (Ministry of Energy and Natural Resources, 2014).

Indonesia Energy Minister set up the regulations for encouraging photovoltaics technology as one of alternative energy for the Indonesian power. By 2016, 293,532 households still have no access to electricity especially located in remote area. The cabinet government targeted the development of 20 provinces in Eastern Indonesian rural area within 2017-2019 (Liputan 6, 2017).



Source: Ministry of Energy and Natural Resources (2014)

Fig. 3.3 The development of energy source regarding Domestic Energy Policy in Indonesia



Source: Directorate General of Electricity (2015).

Fig. 3.4 Electricity distributions in Indonesia

Indonesia Ratio Electrifications of Indonesia by 2014 with average 84.35 % (Ministry of Energy and Natural Resources, 2015). The domestic ratio electrification by 2014 is 85 %, regarding the domestic ministry of energy and natural resources No. 79 the year 2014 (MEMR 79/2014). The government set up the target to reach 100% ratio electrification in 2020 (referred to Fig. 3.4). Indonesia has the unequal infrastructure in each region; government set up different Feed-in Tariff by regional. Table 3.14 shows the quota capacity and Feed-in tariff for 22 regions in Indonesia (Ministry of Energy and Natural Resources, 2016).

Table 3.14 Quota capacity and regional feed-in tariff in Indonesia

No.	Region	Quota Capacity (MWp)	Feed-in Tariff (cent USD/kWh)
1	Jakarta	150.0	14.5
2	West Java		
3	Banten		
4	Central Java and Yogyakarta		
5	East Java		
6	Bali	5.0	16.0
7	Lampung	5.0	15.0
8	South Sumatra, Jambi, and Bengkulu	10.0	15.0
9	Aceh	5.0	17.0
10	North Sumatra	25.0	16.0
11	West Sumatra	5.0	15.5
12	Riau and Riau Islands	4.0	17.0
13	Bangka-Belitung	5.0	17.0
14	West Kalimantan	5.0	17.0
15	South Kalimantan and Central Kalimantan	4.0	16.0
16	East Kalimantan and North Kalimantan	3.0	16.0
17	North Sulawesi, Central Sulawesi, and Gorontalo	5.0	17.0
18	South Sulawesi, South East Sulawesi, and West Sulawesi	5.0	16.0
19	West Nusa Tenggara	5.0	18.0
20	East Nusa Tenggara	3.5	23.0
21	Maluku and North Maluku	3.0	23.0
22	Papua and West Papua	2.5	25.0

Source: Ministry of Energy and Natural Resources (2016)

3.6.3 Basic Theory

Firstly we implement the Cost-beneficial Analysis. For an investment of a project, the investor should understand about the current condition and hope to reap benefits in the future. Regarding the return on investment that must be considered is the result of changes made from the profit. Based on Frank Reilly and Keith C. Brown theory, period duration of investment is holding period. Then payback period of the investment called HPR (Holding Payback Period) by using formula these below (Andoko, 2016).

$$HPR = (\text{End Value} - \text{Initial Value}) / \text{Initial Value}$$

PR usually bigger or equal with 0, if the value bigger than 1 it is meant to have profit, as a flipside if lower than 1 or equal with 0 thus investor failed to reap the profit from the investment. For evaluation of the percentage yearly profit, thus HPR must be converted to annual HPY (Holding Period Yield).

Annual HPY = $HPR^{1/n}$, which n is total years of investment.

Appropriate comparison between the total revenues in the future with overall spending in the present or in the future is important to note because there are differences in currency values calculated time period. This imbalance can be overcome by using time value of money concept. Based on this concept, the revenue and expenditure throughout the project are estimated to exist in the future is calculated by giving additional factor worth present value of the future, thus that it can be seen in now and can be compared with the present condition. Present worth factor used in calculating the value of investment projects can use the market interest rate or bank rate. The formula of present worth factor is $DF=1 / (1+r)^{n}$, which DF is Discount Factor, r is discounted level, and n is total years of investment.

Net Present Value (NPV)

Net Present Value (NPV) is a measurement of the profitability of an undertaking that is calculated by subtracting the present values of cash outflows (including initial cost) from the present values of cash inflows over a period of time. Incoming and outgoing cash flows can also be described as benefit and cost cash flows.

$$NPV = \sum_{t=1}^{T} \frac{Ct}{(1+t)^t} - Co$$

Ct : net cash inflow during the period t

Co : total initial investment costs

r : discount rate

t : number of time periods

Discounted Payback Period (DPP)

The discounted payback period is a capital budgeting procedure used to determine the profitability of a project. A discounted payback period gives the number of years it takes to break even from undertaking the initial expenditure, by discounting future cash flows and recognizing the time value of money. Good investment if the condition of DPP is lower than project period.

$$Discounted\ Cash\ Inflow = \frac{Actual\ Cash\ Inflow}{(1+i)^n}$$

i : the discount rate

n : the period to which the cash inflow relates

$$Discounted\ Payback\ Period = A + \frac{B}{C}$$

A : Last period with a negative discounted cumulative cash flow

B : Absolute value of discounted cumulative cash flow at the end of the period A

C : Discounted cash flow during the period after A.

Benefit Cost Ratio

A benefit-cost ratio (BCR) is an indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values.

Benefit cost ratio (BCR) takes into account the amount of monetary gain realized by performing a project versus the amount it costs to execute the project. The higher the BCR results in the better the investment. The general rule of thumb is that if the benefit is higher than the cost the project is a good investment.

$$BCR = \frac{PVB}{PVC} = \frac{\sum_{t=1}^{n} \frac{Bt}{(1+r)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+r)^t}}$$

PVB: present value of benefits

PVC: present value of cost

B_t : monetary value of benefits incurred during the period t

C_t : monetary value of cost incurred during the period t

r : discount rate

t : number of time period

Internal Rate of Return (IRR)

Internal Rate of Return is a rate of return used in capital budgeting to measure and compare the profitability of investments. It is also called the discounted cash flow rate of return (DCFROR) or the rate of return (ROR). In the context of savings and loans, the IRR is also called the effective interest rate. The term internal refers to the fact that its calculation does not incorporate environmental factors such as interest rate and inflation.

$$IRR = \sum_{t=1}^{n} \frac{(Bt - Ct)}{(1+r)^t} = 0$$

B_t = monetary value of benefits incurred during the period t

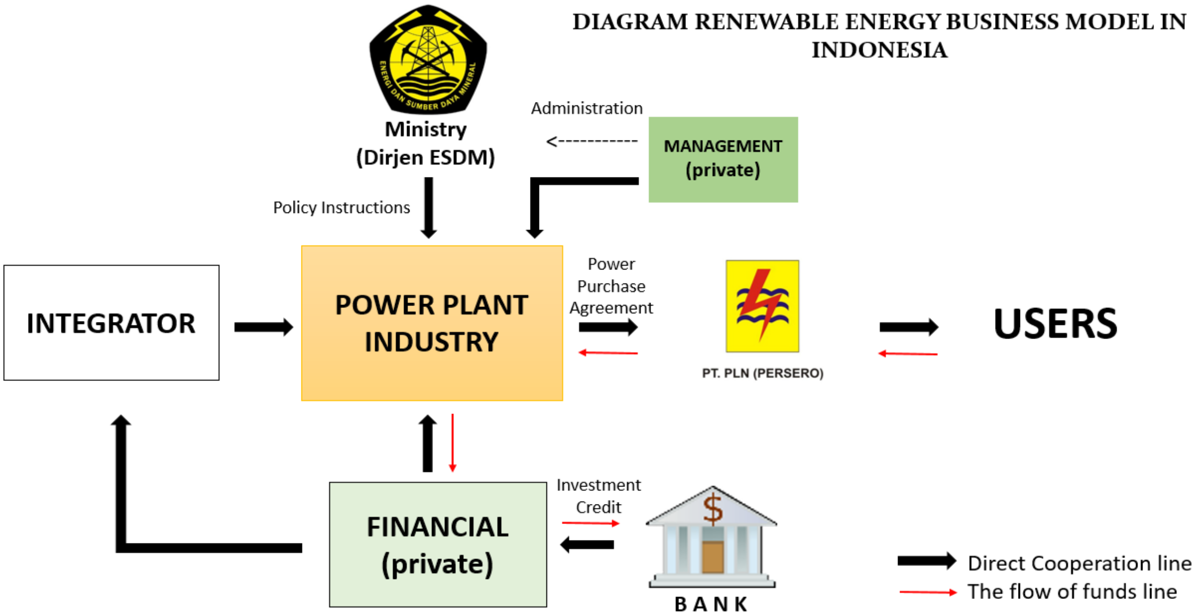
C_t= monetary value of cost incurred during the period t

r= discount rate

t = number of time periods

3.6.4 Methodology

We established Photovoltaics Power Plant Industry Business Model. First, about Indonesia Electricity Business Model, Renewable energy development in Indonesia depends much with government policy. In Indonesia, electricity market has monopolized by ministry by PT. PLN. Since the beginning, PT. PLN always collaborates with stakeholder or private power plant industry in order of electricity purchasing (See Fig. 3.5).



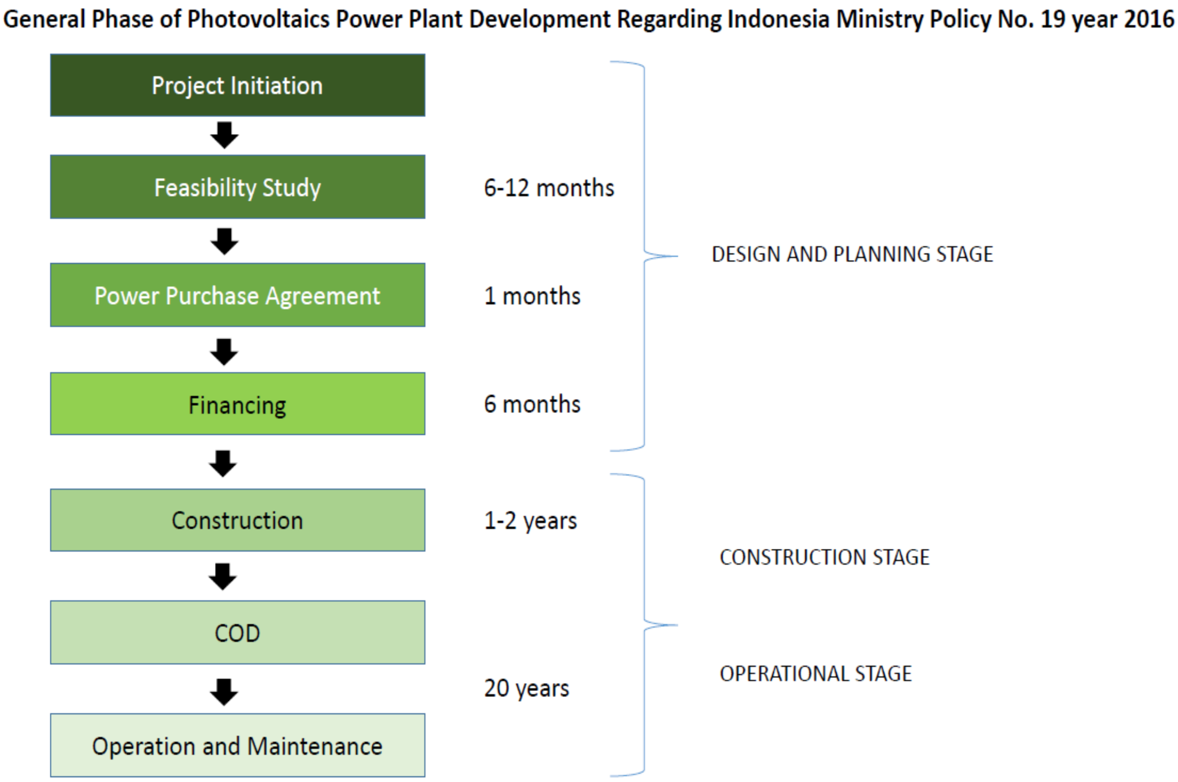
Source: Study from Indonesia Institute of Science (2014)

Fig. 3.5 The diagram of energy business cycle regarding the legitimate law in Indonesia

Regarding MEMR policy about photovoltaics power plant industry, called MEMR regulations No. 19 the year 2016 (MEMR 19/2016), photovoltaic power plant industry project start by project initiation phase for specifying the company rule, CSR, vision, and mission. It would take time depending the company performance. Then feasibility study of photovoltaics power plant basically took half until a year. Meanwhile, the company is ready for submitting the document and requirement to the PT.PLN for PJBL or Power Purchase Agreement. Based on policy, the PT. PLN will process the PJBL within 30 days.

The financing phase is the responsibility of power plant industry to financial closing report to PT. PLN within 6 months period. Then continue to the constructions of the company. The company should meet the complete constructions for capacity 1-10 MW is 1 year and 2 years for capacity more than 10 MW. The Commercial Date of Operation (COD) is the date of operation of PV power plant industry to distribute commercial electric power to

PT. PLN network. The validation of COD is referred to purchasing agreement or called PJBL for 20 years. Then during the operation for 20 years contract, it required maintenance and operations which planned on first project initiation (See Fig. 3.6).



Source: Study from MEMR 19/2016

Fig. 3.6 General phase of photovoltaics power plant development in Indonesia

Location for 30 cities as representative of 33 provinces in Indonesia and monthly solar radiation data (in kWh/m^2) as the input are given as polygon format in GIS environment in Indonesia (See Table 3.15).

Table 3.15 Monthly geographical and solar isolation in Indonesia

City	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Aceh	4.76	4.91	4.94	4.88	4.84	4.68	4.58	4.62	4.56	4.32	4.19	4.74
Medan	4.65	4.77	4.83	4.6	4.42	4.34	4.22	4.38	4.38	4.23	4.09	4.37
Padang	4.89	4.82	4.82	4.93	4.94	4.87	4.94	4.78	4.69	4.57	4.54	4.34
Riau	5.41	5.85	6.06	5.54	4.87	5.02	5.21	5.15	4.75	4.39	3.99	4.63
Jambi	4.85	4.86	4.88	4.69	4.69	4.61	4.71	4.88	4.85	4.59	4.18	4.64
Palembang	4.57	4.57	4.78	4.66	4.73	4.49	4.79	4.8	4.6	4.46	4.39	4.47
Bengkulu	4.54	4.69	4.69	4.71	4.7	4.73	4.83	5.24	5.13	4.8	4.47	4.52
Lampung	4.64	4.77	4.94	4.85	4.92	4.87	5.06	5.12	5	4.67	4.48	4.43
Belitung	4.74	4.79	4.69	4.42	4.37	4.75	5.18	5.14	4.84	4.54	4.46	4.44
Jakarta	4.57	4.65	4.85	4.95	4.96	5	5.07	5.21	5.42	5.4	4.84	4.74
Bandung	4.57	4.75	4.87	4.95	5.02	4.97	5.17	5.35	5.11	4.77	4.7	4.96
Semarang	4.85	5.04	5.14	5.15	5.21	5.59	6.1	6.64	6.21	5.05	4.9	5.15
Yogyakarta	4.37	4.72	4.8	4.65	4.52	4.56	4.93	5.4	5.61	5.13	4.98	4.52
Surabaya	4.64	4.84	4.9	4.81	4.64	4.71	5.24	5.81	5.83	5.03	4.85	4.79
Banten	4.74	4.96	4.94	4.77	4.88	4.98	5.43	5.77	5.52	4.88	4.8	4.95
Bali	5.21	5.5	5.64	5.14	5	5.29	5.84	6.11	6.1	5.55	5.29	4.9
Lombok	4.99	5.29	5.46	5.04	5.05	5.33	5.82	6.16	6.19	5.66	5.4	4.67
Kupang	5.56	5.96	6.37	5.78	5.96	5.88	6.7	7.16	7.54	7.41	6.68	4.6
Pontianak	5.17	5.17	5.11	5.08	5.03	4.98	5.31	5.3	5.2	4.99	4.85	5.27
Palangkaraya	4.97	4.92	4.86	4.81	4.8	4.77	5.01	4.96	4.95	4.7	4.64	5.01
Banjarmasin	5.04	5.05	5.03	4.92	4.84	4.88	5.29	5.51	5.27	4.66	4.75	4.77
Samarinda	4.66	4.88	4.99	4.98	4.89	4.76	4.76	4.87	4.92	5.04	4.8	4.42
Manado	5.61	5.77	6.04	6.24	6	5.65	5.87	6.53	6.61	6.19	5.69	5.59
Palu	5.24	5.34	5.43	5.28	5.46	5.2	5.7	5.84	5.6	5.22	4.98	5.67
Makassar	5.3	5.47	5.74	5.99	5.96	5.92	6.41	6.74	6.65	5.51	4.92	5.36
Kendari	4.64	4.8	4.66	4.63	4.44	4.27	4.69	6.05	6.3	5.46	4.8	5.61
Gorontalo	5.26	5.38	5.43	5.31	5.1	5.15	5.48	5.6	5.42	5.13	5	4.7
Ambon	5.52	5.57	5.49	5.37	5.17	5.16	5.3	6	6.02	6.25	6.2	6.04
Ternate	5.73	6	6.08	5.73	5.36	5.4	6.04	6.32	6.23	6	5.75	5.14
Jayapura	4.95	5	4.97	4.9	4.8	4.76	4.89	4.99	5	4.93	4.87	4.57

Source: Rumbayan (2012)

Regarding the Ministry of Renewable Energy Industry Regulation No 04/M.IND/PER/2/2017 about TDKN (Tingkat Komponen Dalam Negeri) for photovoltaics power plant industry development, and in order to encourage the local industry in service and goods, TDKN is the percentage measurement of local products applied. The standard percentages of photovoltaics materials applied are referred to Table 3.16.

Table 3.16 Local content requirements for solar plants

No.	Component	Elucidation	Value (%)
1	Solar Panel		40.50
2	Inverter and Solar Charge Controller		13,50
3	Racking		10.80
4	Electrical spare part		±7
5	Service	Constructions, installation, logistic	10

Source: Ministry of Renewable Energy Industry (2017).

The pattern of TDKN Final Evaluation Price (FEP) is shown as follows (Ministry of Renewable Energy Industry, 2017):

FEP goods : (100% / (100% + Pg)) x Og

FEP services : (100% / (100% + Ps)) x Os

where

Og = Offer price of goods

Os = Offer price of services

Pg = Preferences of goods

Ps = Preferences of services

The development of Photovoltaics power plant industry required long-term land usage. The development cost of power plant around USD 2.500.000 – USD 3.000.000 per MWp except for land lease cost. Regarding Bloomberg New Energy Finance the photovoltaics panel cost USD 0.46 per Wp for 1st tier categories. The cost of the inverter is around USD 0.06 - USD 0.08 per Wp. The maintenance cost is USD 12 - USD 15 per kWp. Table 3.17 shows the calculation of new installation of photovoltaics investment.

Table 3.17 Investment for 1 MW installation

Cost Item	USD/W	USD/MW
Developer Cost	0.15	150,000
Engineering	0.50	500,000
Permitting	0.09	90,000
Site Preparation	0.10	100,000
Panel Procurement	0.85	850,000
Inverter	0.30	300,000
Installation	0.30	300,000
Electrical Installation Tools	0.45	450,000
Commissioning	0.05	50,000
Total	2.79	2,790,000

Source: United States Agency for International Development (2016)

In order to check the financial due diligence, basically the requirement for credit or loan investment: 1) Initial investment cost and maintenance cost financial report; 2) Operational assumption, operation efficiency minimum 80%; 3) State certified business license; 4) Cash flow schedule; 5) Financing close report ; 6) Tax and retribution report ; 7) Financial report on profit, liquidity, and solvency (Poillot, 2017) .

Bank Central Asia has well reputed as a top private bank of Indonesia. Experienced more than 60 years for investing in a business entity in Indonesia, by April 2017, the loan interest for USD 2,500,000-3,000,000 platform is 11.75 % for 84 months period (Poillot, 2017).

The Indonesia Ministry of Finance Regulation No. 21/PMK.011/2010 about Tax Facility and Customs for Utilization of Renewable Energy Activity, provides the following deductions in income tax, Value-added Tax (VAT), import duty, and tax, which may be available for renewables developers:1) income tax facility; 2) net income deduction of 30% of total investment, for 6 years, 5% for each year; 3) accelerated amortization and depreciation; 4)Income Tax for dividend paid to foreign taxpayers charged at 10% or Fit in Tariff, based on avoidance of double tax agreement; 4) financial compensation for losses incurred for more than 5 years, but not exceeding 10 years; 5) exemption of income tax for import of machinery and equipment; 6) VAT facility: exemption from VAT on import of taxable goods such as machinery and equipment; 7) import duty facilities for import of machinery and capital goods for power plant industries (Davies and Lemin, 2016).

3.6.5 Output

We set the parameters to conduct the cost-benefit analysis. The cost of photovoltaics installment is added by usage of land. For 1 MW electricity production by solar panel required 1 hectare. The land price in Indonesia depends on the locations, for agriculture usage average USD 5,000-9,500 per hectare. The imagery the land cost USD 7,000. The initial cost should be USD 2,790,000 (See Table 3.17) and the addition of USD 7,000 equal to USD 2,797,000.

The revenue assumption is an average of 22 regional FiT= USD 16.9 cent/kWh or USD 0.17. By calculating 0.17 x 1000 x 24 hours x 365 = USD 1,489,200. Discount rate equals to 1%. And Maintenance is USD 0.13 per kWh, increase 10% yearly.

The calculation (referred to Table 3.18) is calculated by initial cost and maintenance cost for 20 years. The revenue could start since PPA phases (see Fig. 3.6). It required 2 years of constructions, checking, and COD agreement. The revenue could get after second year.

Table 3.18 Results of economic analysis of photovoltaics power plant industry in Indonesia

Year	Investment Cost	Revenue	Annual Cash Flow	NPV of Annual Cash Flow	Cumulative NPV
2018	2,797,000	0	-2,797,000	-2,797,000	-2,797,000
2019	13,000	0	-13,000	-12,871.3	-2,809,871
2020	14,300	0	-14,300	-14,018.2	-2,823,890
2021	15,730	1,489,200	1,473,470	1,430,135	-1,393,754
2022	17,303	1,489,200	1,471,897	1,414,464	20,710
2023	19,033.3	1,489,200	1,470,167	1,398,813	1,419,523
2024	20,936.63	1,489,200	1,468,263	1,383,171	2,802,694
2025	23,030.29	1,489,200	1,466,170	1,367,523	4,170,217
2026	25,333.32	1,489,200	1,463,867	1,351,856	5,522,073
2027	27,866.65	1,489,200	1,461,333	1,336,155	6,858,228
2028	30,653.32	1,489,200	1,458,547	1,320,403	8,178,632
2029	33,718.65	1,489,200	1,455,481	1,304,582	9,483,214
2030	37,090.52	1,489,200	1,452,109	1,288,673	10,771,887
2031	40,799.57	1,489,200	1,448,400	1,272,655	12,044,543
2032	44,879.53	1,489,200	1,444,320	1,256,505	13,301,048
2033	49,367.48	1,489,200	1,439,833	1,240,199	14,541,247
2034	54,304.23	1,489,200	1,434,896	1,223,710	15,764,957
2035	59,734.65	1,489,200	1,429,465	1,207,008	16,971,965
2036	65,708.11	1,489,200	1,423,492	1,190,064	18,162,029
2037	72,278.93	1,489,200	1,416,921	1,172,842	19,334,871
2038	79,506.82	1,489,200	1,409,693	1,155,306	20,490,177

The payback period is on year-4. The revenue might increase by the regulation update. The investment cost calculated basic constructions and maintenance assumption without additional cost such insurance, tax, local retribution and others fees. The company is able to reap profit less than 5 years, indicate the investment under health financial. It might have a big possibility of bank determination in the case of loan or investment cooperation.

3.6.6 Discussion

<u>Sharia Finance to Green Industry Business in Indonesia</u>

As largest Muslim population economy, Indonesia has influenced by Muslim regulations in every life sector including finance and business. The Indonesian government is eager to turn Indonesia into a major global hub for Islamic banking as this would deepen the economy's financial markets, hence making the economy less vulnerable to the negative effects of global economic turmoil (Indonesia-Investment, 2015).

Along with the increasing of Sharia banking in Indonesia is shown in Table 3.19. For renewable energy, business investment should determine in financial sustainability. The indicator that power plant industry required is how the financial flow by changing from conventional to Sharia banking.

Islamic banking in Indonesia has also had difficulty to expand due to weak government management (a lack of ministerial-level coordination), an uncertain legal environment and the lack of highly qualified human capital, innovation, and creativity in the economy.

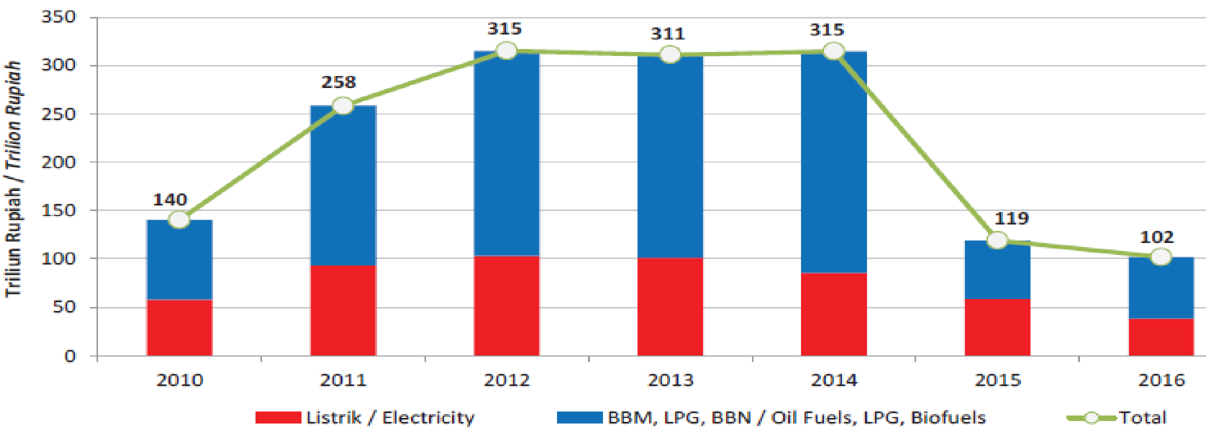
Table 3.19 Islamic banking assets in Indonesia (in trillion IDR)

Year	2010	2011	2012	2013	2014
Islamic Commercial Banks & Islamic Business Units	975	145.5	195.0	242.3	272.3
Islamic Rural Banks	2.7	3.5	4.7	5.8	6.6
Total Assets	100.3	149.0	199.7	248.1	278.9

Source: Indonesia-Investment (2015)

Government Electricity Subsidy

The Indonesia electricity development during 2009-2014 is Susilo Bambang Yudhoyono presidential by increasing subsidy regulation for energy. Then starting 2015, during Indonesia President Joko Widodo presidential decreasing the subsidy of energy and electricity in order to reduce the domestic debt program. Along with decrease the government subsidy, the price of electricity increase and charged to electricity users. It will affect the government policy about Feed in Tariff. If FIT higher, the power plant industry investment could be healthier. It is the opportunities for power plant industry development during Joko Widodo presidential (referred to Fig. 3.7).



Source: Sugiyono (2016)

Fig. 3.7 Energy subsidy development for 2010-2016

3.6.7 Case Study

The Samarinda local authorized in irrigation division started the project of solar powered automatic irrigation door, knows as P2A-SIHMEK. By 2016, it has been installed more than 100 units all over the farm in Samarinda city. The project started by regional government for funding and training support. The system is integration from a solar panel with the hand-made machine, it enabled for operating the time to open the irrigations door. The machine is able to control the irrigation automatically by manual setting time. This case is reaped the great success as smart farm innovator in Samarinda City and another city in East Kalimantan, Indonesia.

In another location, there invented the solar energy based for automatic water pumping. As an island in East Nusa Tenggara province called Sabu Island. The local government supports the solar energy implementation to their agriculture for efficient and smart farmers programs. The automatic water pumping system powered by photovoltaics panels and controlled automatically by soil humidity sensor. This invention gains the domestic interest and becomes Indonesian role-model as smart farm city.

3.6.8 Conclusions

Indonesia has highest electricity demand among Southeast Asia regions due to populations and the wide area. By 2016, more than 50% energy sources from oil and fossil fuel. It seems Indonesia as big contributors for world's carbon emission and pollutions. However, the government started to support the renewable energy (RE) implementation in Indonesia by set up the regulations for RE business entity development. Supported by strategic location and huge land area, Indonesia has good potential to install RE such solar energy.

The ministry of energy Indonesia targeted to apply 31% RE in 2050 by consideration of low carbon emission, infrastructure, socioeconomic growth and economic development. Currently, the local institutions collaborate with regional government in order to improve the rural development. Mostly remote area based on agriculture development. Therefore, many cases supporting the rural area development by integrating the good potential such solar energy for agriculture are known as a smart farm.

The solar power in Indonesia regulated as a high rate of feed-in tariff. It is a supportive rule from the government to interact more local and foreign investor in order to develop more solar energy in Indonesia. Finally, as calculated by one megawatt (MW) for 20 years development, an investor be able to reap the profit less than 5 years with payback period in the fourth year. The case of 1 MW capacity is possible to integrate into farm or remote area based on agriculture in line with the government mission of micro and macro-finance, socioeconomic growth, and rural development.

3.7 Conclusions and Recommendations

Viet Nam, Thailand, and Indonesia policy framework for solar energy has been evaluated. As a part of the policy to promote socioeconomic growth, economic development, including the rural area among Asian Pacific Economic Cooperation (APEC) region to develop the economic by a build up the green energy smart farm with access to the renewable energy. The effort of integrating the technology to farm is an effort to assist the farmers and their family in reducing the poverty.

As the result of economics analysis for the investment in different region cases, it summarized as the differences of policy framework will affect the financial or investment status. In the case of Thailand and Indonesia, both have higher feed-in tariff rate. Although the initial cost of Thailand and Indonesia calculated higher than Viet Nam, the payback period analyzed as same less than five years. It meant the investment analysis for Viet Nam, Thailand, and Indonesia has indicated as health and profitable investment.

The three region summarized have good potential solar source and the supportive government regulations. They hold the significant factors for developing the solar energy in regions. Since the solar energy has gained the interest of local and foreign investors and limited capacity offer from local authorized, it becomes a tougher competition of the electricity purchase in an area. The new business entity or investor still has a chance for developing the solar panel through integrate to agriculture. Most regions in Southeast Asia are dependent on their GDP growth from the agriculture sector. Therefore, the agriculture integrations with solar energy are line with economic and socioeconomic growth in economies. APEC programs of green energy through smart farm implementation analogous with government mission for domestic growth, global vision for eco-green energy, and impacted to fight the poverty and backwardness of area among APEC regions.

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Chapter 4

Establishing a Small Smart Farm Demonstration Site

4.1 Introduction

In order to show the best practice model for developing the green energy smart farm in the APEC region, a small demonstration site (test base) was established in an experimental farm in Chinese Taipei. The site is an experimental animal farm located at Wuri District in Taichung City shown in Fig. 4.1. The total area is about 7.330 ha.

Fig. 4.1 Demonstration site at National Chung Hsing University in Chinese Taipei

This task is to integrate advanced energy conversion technologies, and build a smart green farm for the next generation. Therefore, the objectives are to build a modular system and reach the ultimate goal to transfer and copy the techniques to export them to the APEC region. To achieve the objective, there are three key research themes to be covered, which run separately at the initial stages, after verification of individual function, and then integrate one another to build a self-efficient green farm at last.

The business model includes the high-value orchid, poultry, livestock, green power generation and application. Green waste recycle and reuse are also included to establish a new model, smart green farm, of next generation as an example and an advertisement.

The three major research themes are:

1. Using green power and the design of cultivating place to cultivate high-valued orchid in a green powered greenhouse making orchids grow steadily and healthily. This cultivation depends on bio-sourced solid carbon with less carbon dioxide from item 3. And the cultivation of inedible plants can use livestock's excrement with heavy metal or sulfide from item 2 under the condition that the benefit of environment improves;

2. Sunshine farms and the establishment of coops can improve the environment so that livestock will have the better ability to grow, develop and breed and the possibility of disease will be significantly avoided. The setting of solar panel increases the utility rate of green power, and reach to the goal of energy conservation and carbon reduction. Its environmental attribution can provide the excrement of livestock to item 1 and item 2;

3. Designing a waste energy system of the mobile energy supply system can treat the waste from orchid cultivation, such as water moss and grass, and, after gasification, transfer to heat-electricity and bio-sourced solid carbon. The waste pots and styrofoam from orchid cultivation also can generate electricity through burning, so as the excrement of livestock from sunshine farm and coops, which provide to item 1 and item 3.

In summary, the biomass power and bio-sourced solid carbon produced by the green farm is recycled to the farm for re-usage, along with the solar power generated, creating a next generation eco-friendly farm. This task combines the three developmental themes mentioned above, which effectively reduces the power consumed, uses renewable energy, and builds a green environment, creating a next-generation smart green farm integrated system, an innovative business model, and industrial efficiency. The innovative development strategy for making APEC more competitive in the new generation framing industry has been fulfilled and preliminarily verified.

This task focuses on the characteristic of National Chung Hsing University which is natural agriculture and animal husbandry resource and the teaching extension research service to the environment. It combined the current energy efficient and energy saving, low carbon emission, strategy of renewable energy and sustainable use of the demonstration system, construct the green farming pasture innovation business model, achieve the second generation of the future industrial benefits. Overall, the aim of the task concerns about green energy agriculture and animal husbandry demonstration program, using the existing green orchid cultivation field, sunshine pasture and chicken coop and the mobility of farmland waste energy of thermoelectric conversion, integrated it and plan the most wisdom green intelligent farm of the modular system.

In Chinese Taipei, the most competitive agriculture industry is the orchid industry, especially butterfly orchid. The orchid that is suitable to grow in Chinese Taipei, it has a characteristic of high-temperature cultivation (25-30^{o}C), which is assorted with the climate of Chinese Taipei which is subtropical climate. However, orchid becomes commodity that must be open the stalk flowering stage from the low temperature to high temperature, due to this, the summer cooling and winter heating of the orchid greenhouse become the largest energy demand of the project. So, this study is using butterfly orchid greenhouse as the main subject and the concept of the ecological green energy of the energy use and improvement assessment of the orchid butterfly greenhouse. The key point of the work including the improvement of the greenhouse energy saving mode, verification and application, improvement of the greenhouse structure and equipment, hot pump and other temperature control equipment. Besides that, improving the commercial varieties of the orchid and flowering physiological properties test and the physiological cumulative index of the crop for energy saving products is also studied.

Besides the orchid cultivation site, this site also includes pasture poultry houses, chicken coop, dairy processing factory and slaughterhouses. In addition, “negative pressure” chicken coop is built to prevent the avian flu problem. It is using the Tunnel ventilation and curtains to regulate the temperature of the coop to ensure that the all of the chickens are healthy and to reduce the possibility of chicken get infected by influenza virus. The basic structure of the pasture and the chicken coop is using the energy of the wise sunshine ranch and chicken coop in order to achieve the reduction of the carbon, animal welfare and the economic benefits of the “small but beautiful” modular farmhouse.

Therefore, the task has to consider about the erection of small renewable energy power generation system, small regional renewable energy decentralized power generation system and intelligent energy management system.

4.2 Small-scale Renewable Energy Power Generation System

The application is to set up a solar panel to power up the power generation system. Because of the campus is located in the city, it is no suitable to install the larger fans. So, the school ranch and the chicken coop will have the priority by using the solar energy and the small biogas heat source are the main planning of the renewable energy system. Currently, the most common solar panel in the market is the single crystal and polycrystalline due to their stability of the power generation. According to the research, the efficiency of the photoelectric conversion will become the highest, if the solar panel to maintain the angle of 25 degrees with the sun. If more than this angle, the sun is reflected half and reduced power generation efficiency. Normally, the solar panel is fixed at a certain angle (see Fig. 4.2), regardless the length of the sunshine and the movement of the sun, the fixed panel can only have 2.5 to 3 hours of power generation. From the current technology, the solar panel can be combined with the recovery system, i.e. the automation tracked solar energy system (Fig. 4.3), so that the solar panel can continue to maintain the effective angle (that is, within 25 degrees). This high photoelectric conversion is efficiency and it can achieve the electricity when there has the sunshine.

Fig. 4.2 Fixed solar panel system

Fig. 4.3 Automation tracked solar energy system

At this stage, the system can be divided into power-based system (to track GPS) and non-electric-type system, the former can be mentioned. The solar panel is about 30 ~ 45% of the power generation efficiency, the non-electric-type system can enhance the power generation efficiency of the solar panels around 50%. In addition, the advantage of the non-electric-type system is not just enhance the efficiency of the solar panel, but the clean and maintenance also easier than the traditional solar panel. This kind of panel is made by artificial clean, dry and simple and easy to leave the water, so even the panel embroidery or the motor is soaked, it will not cause any roof leakage.

According to the current construction situation of the ranching, chicken coop, dairy processing factory and the slaughterhouses, the roof is stable and it is suitable for carrying a solar panel. Therefore, the project will consider both general solar type and chase solar type and consider the following two options for building a solar panel, to choose one of the following:

Set up Your Own Solar Panel

The procedure includes purchasing the solar panel with a better recovery efficiency, agreeing with the manufacturers about the maintenance fees of the solar panel and signing a purchase contract with Taipower Electric Power Company. This task is planning to contribute to the construction of solar panels and it has more flexible research space, including the installation of the energy monitoring system, transmission and distribution system, and the free extraction of electricity information and without any privacy issues.

Cooperating with energy service companies (ESCO) with solar panel leasing

California in the US was the birthplace of the solar leasing industry. A resident who lived in California will be leased to the roof panel to the solar panel manufacturers to set up the solar panels and do not have to bear the installation cost for the solar panel. Besides that, they don’t have to bear the risk of the maintenance and damages of the solar panel. If the solar panel output power is higher than the home electricity, the residents can earn part of the electricity spread, to the solar panel industry, households and the environment are beneficial a win-win situation. There are some related industrial rises in Chinese Taipei, for example Kaohsiung Municipal Government in 101 planning public roof rental, and relax regulations so that the roof volume of 100% can be installed the solar panels. Leasing solar panels will sign a 10-year contract with the manufacturers to ensure the maintenance of the solar panels and signed a 20 years power purchase contract with the Taipower Electric Power Company to ensure the acquisition of clean energy.

In the future, the energy generated by the solar panel can be directly connected to the cattle house, chicken coop and the processing factory. If there is any surplus, you can consider to sell it back to the Chinese Taipei Electric Power Company system. The site has been installed DC-AC converter so that electricity can be used immediately to reduce the efficiency of energy transmission and conversion damage. The power consumption equipment in the branch of the school including cattle house of the milking machine, grass and fan; barn, chicken coop air conditioning, and lighting equipment. The actual operation of the energy-consuming equipment is as follows: the chopper in the barn was started for an hour sooner or later. The milking machine was started 2 hours a day, not all day, and there were three fans in the negative pressure house. It was running for 8 hours a day and belonged to a long period of continuous electricity. Other than that, the animal husbandry in the school is planning to build the electric farm, in response to avian flu on the traditional slaughter may be a threat. All of these is the solar or biogas heat source system that can be used directly in the future.

4.3 Smart Energy Management System

This task is considering to install the smart meters in the pasture. Besides the measurement of the general use of the electricity of the barn and the chicken house, it also monitors the solar panel generated by the total power, the deployment of solar power supply. In the second implementation of the project, the first year has been completed with the energy service manufacturers. They have completed the 31 kWe solar panel. Besides solar panel continued to build, it also adding the consumption of poultry and livestock statistics, the third year is the actual test of sun ranch and chicken coop operation, and with other projects integrated with each other.

4.4 Energy Conversion Technology of Mobile Farmland Waste

The task is to build up a 10 kWe small-scale mobile downdraft biomass gasification-based power system using the poultry and livestock output of agricultural and animal husbandry waste for energy recovery to demonstrate the use of electricity for the rangeland and also the production of the hot air, it can use the greenhouse facilities. On the other hand, the agricultural and animal husbandry waste will be converted into bio- charcoal waste and it will return to the soil to stimulate the plant growth to achieve the zero-waste Green farm sustainable development goals.

The maximum output power of this small-scale mobile downdraft biomass gasification-based power system is 10 kWe. The system includes the downdraft gasifier, heat exchanger, syngas filter, generator, and mobile bearing chassis as shown in Fig. 4.4. The gasifier was constructed of 6 mm SUS310 stainless steel covered with ceramic fiber to limit heat loss. The gasifier is 100 cm in height and 30 cm in diameter.

Fig. 4.4 10 kWe small-scale mobile downdraft biomass gasification-based power system

When the gasification power generation system is operating, the biomass is fed into the gasifier. After gasification of biomass, the syngas leaves the gasifier and passes through the heat exchanger. In addition, the heat exchanger can also adjust its pipelines, so that the preheated air can be introduced into the plant greenhouse. After through the heat exchange, the syngas passes through a filter to remove the dust and tar of the syngas, and it enters the generator for the power generation. Moreover, the developing of the biochar analysis work of the soil greenhouse gas emission in the laboratory has to prepare the biochar. Apart of the biochar is from the gasification system and the other part is the direct use of agricultural and animal husbandry waste preparation.

4.5 The Integrated Smart Green Energy Farming Ranch System with Innovative Business Models

Green agriculture and animal husbandry business module has a solid market potential. It is not only contained the concept of ecological farming but also to achieve energy saving and carbon reduction effect. The highlight of the Green agriculture and animal husbandry business module including (1) Negative pressure poultry house can reduce the risk of chicken get infected with avian influenza virus and reduce the risk getting infection; (2) Animal husbandry provides the outside supply chain, it combined with solar energy, biomass energy, and another renewable energy system. This not only save the disposable fees (orchid cultivation of organic waste, cattle flocks of organic excreta, the slaughter of organic waste, etc.), but also the energy is available for the production chain. The production of the renewable energy will need the energy-intensive organic waste converted to valuable green gold; (3) Green agriculture and animal husbandry business module can sign a renewable energy purchase contract with Chinese Taipei Electric Power

Company. (4) Green agriculture and animal husbandry business module have the benefits of energy saving and carbon reduction of the environmental, reduce a number of organic waste emissions, orchid cultivation and absorption of carbon dioxide are beneficial to environmental protection. At the end, there will be an assessment which is related to the benefits and analysis of relevant information to collect cost-effective information on the various units in the Green agriculture and animal husbandry business module, including: (1) The actual consumption of the electricity of barn, house, slaughterhouse, as the baseline (Base Line); (2) The production status of the roof-type solar panels; (3) The data of the egg production rate of the chickens; (4) The amount of organic excreta in livestock and the amount of organic excreta in the slaughterhouse; (5) Biomass thermoelectric conversion efficiency theory data, etc., to facilitate the participant test (Participant Cost Test, PCT).

4.6 The Smart Green Farm Experiments and Verification

4.6.1 Sunshine Ranch and Chicken Coop

The solar panels were built to generate the electricity on the rooftop using the existing Uzbek Ranch, including a barn, eleven negative pressure chicken coop and the construction of the slaughterhouse and dairy processing plants and other buildings. The building design as shown in Fig 4.5 for the barn and the barn roof solar panel building map. The other power supply in Fig 4.6 is for the negative pressure chicken coop.

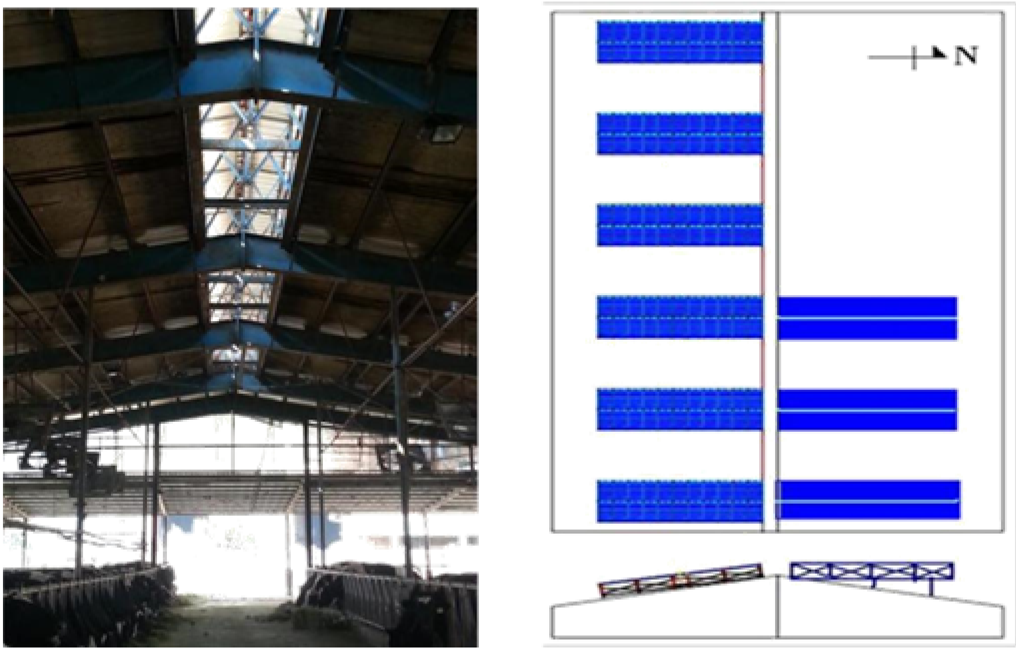

Fig 4.5 Cattle and barn roof solar panels construction

Fig 4.6 Cattle house (L) and negative pressure chicken coop (R)

Solar plant power generation information will also be visualized by the cloud server monitoring system. It was built by two-way, synchronous, interactive point of the information read and collect gradually by completed the intelligent of the green campus. Fig. 4.7 shows the cloud electronic control system architecture.

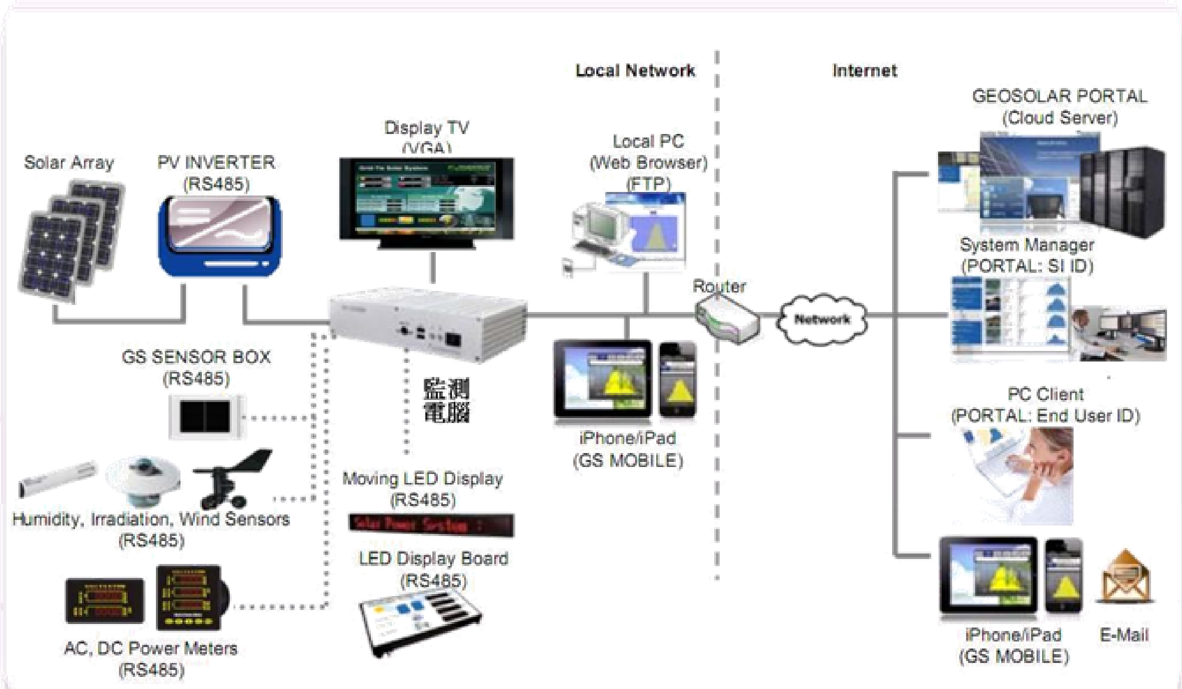

Fig. 4.7 Cloud electronic control system structure diagram

4.6.2 Farmland Waste Energy and Thermoelectric Conversion Technology

Due to the mobility, the 10 kWe small-scale mobile downdraft biomass gasification-based power system was for generation experiments using farmland waste.

4.7 Results and Discussion

First is to complete the design of the blue garden green greenhouse cultivation and using the existing orchids to produce greenhouse experiments. The specific results of the completion include:

1. The improvement of the new greenhouse and existing greenhouse. The new greenhouse as shown in Fig 4.8.
2. The completion greenhouse energy saving model can be applied to different orchid and other crops.

3. To establish a structure that is related to the use of energy in the greenhouse, covering the materials and equipment which is related to energy-saving needs of the relevant information.
4. To complete the establishment of crop production that is required for the important information on physiological information, and with the accumulation of physiological principles for energy-saving operations.

Fig. 4.8 The greenhouse

The second work is the farmland waste energy and energy conversion technology from 10 kWe small-scale mobile downdraft biomass gasification-based power system. Normally 7 kg woody waste or 12 kg cow manure can generate 1 kWh of electricity.

The third work is for the sun ranch and chicken coop with PV system. The completed construction of solar panels is shown in Fig. 4.9, and the data efficiency of the collection, and the cloud system monitoring is shown in Fig. 4.10.

Fig. 4.9 The completed construction of solar panels

Fig. 4.10 The real-time state diagram system

According to the 31 kW solar panel power generation system and the 10 kWe small-scale mobile downdraft biomass gasification-based power system, the supply of pasture orchard power required, the annual can send 90,000 kWh to produce 0.562 kg of carbon dioxide per kilowatt, Minus 50,580 kg of carbon dioxide emissions.

For solar panel power generation (31 kWe), the daytime solar panel power supply is 25 kW × 250 days /year × 0.8 (efficiency) × 8 hours = 40,000 kWh/year. It is around USD 0.125/ kWh, and it could receive a total of USD 5,000/ year.

For 10 kWe small-scale mobile downdraft biomass gasification-based power system to supply the pasture orchard power required, the production capacity was calculated as follows: 10 kW × 300 days / year × 0.8 (efficiency) × 20 hours = 48,000 kWh/year. It is around 0.125/ kWh, and it could receive a total of USD 6,000/ year.

4.8 Conclusions

In order to show the best practice model for developing the green energy smart farm in the APEC region, a small demonstration site (test base) was established in an experimental farm at Wuri District in Taichung City Chinese Taipei. Two systems including a 31 kW solar panel power generation system and a 10 kWe small-scale mobile downdraft biomass gasification-based power system were installed at the demonstration site. Currently it can provide 88,000 kWh of electricity per year, and receive USD 11,000 per year.

Moreover, after this project is completed, the established small demonstration site (test base) will be maintained to provide more researchers for conducting experiments and for follow-up actions, and to offer the site visits as a best practice model farm. Moreover, the site will also be maintained as an Environmental Education Venue according to Chinese Taipei's Environmental Education Act.

Chapter 5
Project Workshops

5.1 Introduction

The objectives of this project are to assess and demonstrate the small-scale distributed renewable energy in the farms including solar PV and advanced biomass energy derived from the agricultural waste for the APEC region; introduce the PV-ESCO (energy service company) model, a financial mechanism to provide the economic benefits to farmers directly in the APEC regions; and help APEC's developing economies to build up the green energy smart farms with access to the renewable energy, and also assist the farmers and their family in reducing the poverty. Therefore, the Workshops were conducted to focus on the preliminary findings in light of the desired outcomes. It offered an opportunity to assess the validity of the preliminary findings, and provide the check, peer reviews and consultations, and also receive the feedback for further revised actions.

The first project workshop of the best practice and experience exchange for developing the green energy smart farm has been conducted alongside a demonstration site visit to focus on the preliminary findings in light of the desired outcomes. This workshop was held in conjunction with an EGNRET 46 meeting on 12-13 April, 2016 in Taichung, Chinese Taipei. More than half APEC economies' representatives and the domestic academia, government officers, industrial stakeholders participate the workshop. The workshop can be divided into two parts, including (1) Policy Instruments and Measurements, and (2) Case Studies. For the Policy Instruments and Measurements Session, the legal issues on development of green energy farm, PV-ESCO mechanism, and barriers for developing green energy were delivered. For the Case Studies Session, the smart DC power opportunity for community and farm in Thailand, the distributed biomass gasification power system in Indonesia, micro generators for agricultural usage in Chinese Taipei, and the advanced two-stage biogas production technology application in Chinese Taipei were presented at the workshop. The demonstration site for the project, the Next Generation Green Farm at National Chung Hsing University in Chinese Taipei was also introduced. A concept called RETI (regulations, economy, technologies, and integration) was proposed for the next action.

The 2nd project workshop of the best practice and experience exchange for developing the green energy smart farm has been conducted alongside a demonstration site visit to focus on the preliminary findings in light of the desired outcomes. This workshop was held in conjunction with an EGNRET 47 meeting on 10-13 October, 2016 in Jakarta, Indonesia. A total of 47 participants including APEC economies' EGNRET representatives, and the domestic academia, government officers, and industrial stakeholders attended the workshop. The workshop can be divided into two parts, including (1) Policy Instruments and Measurements, and (2) Case Studies. For the Policy Instruments and Measurements Session, the legal issues on development of green energy farm, PV-ESCO mechanism, and barriers for developing green energy were delivered. For the Case Studies Session, the smart DC power opportunity for community and farm in Thailand, the distributed biomass gasification power system in Indonesia, micro generators for agricultural usage in Chinese Taipei, and the advanced two-stage biogas production technology application in Chinese Taipei were presented at the workshop. The demonstration site for the project, the Next Generation Green Farm at National Chung Hsing University in Chinese Taipei was introduced. Moreover, a new model called social enterprise was also introduced for sustainable development of a green smart farm. A concept called RETI (regulations, economy, technologies, and integration) was proposed for the next action.

The workshops offered an opportunity to assess the validity of the preliminary findings, and provide the check, peer reviews and consultations, and also receive the feedback for further revised actions.

5.2 First Workshop

5.2.1 Work plan for the APEC Project on Developing the Green Energy Smart Farm in the APEC Region

Keng-Tung Wu, National Chung Hsing University, Chinese Taipei

There is global interest in increasing the renewable energy implementation as future energy. Energy Ministers at APEC Energy Ministerial Meeting (EMM11) in 2014 reaffirmed the UN’s 2011 “Sustainable Energy for All” (SE4All) initiative (i.e., ensuring universal access to modern energy services, doubling the global rate of improvement in energy efficiency, and doubling the share of renewable energy in the global energy mix by 2030.

Figure out that most farms in APEC's developing economies are located in the remote rural areas, and are difficult to connect the centralized power grid for access to the modern and clean energy. These farmers and their family rely on burning traditional biomass fuels directly for cooking, heating, studying, etc. breathing in toxic smoke. The possible action is introducing the modern and clean energy in order to relieve them from the time-consuming drudgery to improve their living conditions.

The workshop targeted to demonstrate a best practice model for developing the green energy smart farm in small-scale distributed renewable energy system. In order to develop society economies by developing the green energy smart farm, focused on promoting renewable energy, energy efficient, energy security, and energy resiliency including the development of low carbon technology and alternative energy sources. Through this workshop, APEC set the example of international practices of smart farm though for sustainability of regulation, technology, economic, and integrations for development.

The objective of work-plan for the APEC project on developing the green energy smart farm in the APEC region following: 1) assess and demonstrate the small-scale distributed renewable energy in the farm including solar PV and advanced biomass energy derived from the agricultural waste for the APEC region; 2) introduce the PV-ESCO (energy service company) model, a financial mechanism to provide the economic benefits to farmers directly in the APEC regions; 3) figure out to help APEC's developing economies to build up the green energy smart farms with access to the renewable energy; 4) assist the farmers and their family in reducing the poverty.

As the outcome of the project has done by the workshop, demonstration site, guidebook, and final report. The demonstration site established on an experimental farm at National

Chung Hsing University in Chinese Taipei to conduct project experiments and show the best practice model for developing the green energy smart farm in the APEC region. The guidebook will be published to provide all useful information and knowledge about building a green energy smart farm including the type and definition of renewable energy; constructing a small-scale standalone distributed renewable energy system; ESCO financial mechanism; APEC economies' legislative, policy framework; incentives for renewable energy. The Guidebook will be uploaded to the APEC EGNRET's website, and also be delivered to the farmers who request support to build up a green energy smart farm. The final project report will be produced highlighting the recommendations with suggested roadmap to develop the green energy smart farm with the small-scale standalone distributed renewable energy system, and the ESCO financial mechanism in the APEC region.

Involved the three economies, Chinese Taipei, Thailand, and Indonesia and delegated by nine experts representing APEC economies attending the first workshop in Taichung, Chinese Taipei and the second workshop in Jakarta, Indonesia. The expert speakers addressed various topics related to renewable energy including global projections for renewable energy, projections and consequences through APEC region, system integration and flexibility issues, renewable energy for buildings, and green technologies for the smart farm.

5.2.2 The Legal Issues on Development of Green Energy Farm

William Yiyuan Su, National Chung Hsing University, Taichung, Chinese Taipei

The remote area mostly has no serious environmental destructions. It happened because of less human operations due to the lack of logistic and technology. Behind it all, energy in a rural area is one significant backwardness of infrastructure sluggish reason. Facing the sustainability energy issues nowadays, which related to renewable energy and smart energy. The rich of natural resources having most possibility to solve this issues. The remote area which is still having much agricultural land and natural resources become a global interest of building the green energy independence system for supporting worldwide subject about smart energy farm.

Regarding Articles 3, Renewable Energy Development Act (2009) about the legal framework for independent power producer, the definition of renewable energy is energy generated by direct use or treatment of domestic general waste and general industry waste. It is relatively to biomass which is energy generated from direct use or treatment of vegetation, marsh gas and domestic organic waste. The statutory framework supporting self-use renewable energy; identified as capacity equal or less than 500 kW with efficient installation construction, operation, supervision, registration, and management are subject to diversifying supply, fair use, freedom of choice the power provider (Electricity Act., Chinese Taipei). Construction means design, supervision, installation, operation, renovation, inspection and maintenance. Parallel connection and wholesale purchasing shall be applicable.

As evaluating the law regarding the biomass application, there are some restrictions on sitting and constructions. The building restrictions concern about the height, noise pollutions, aesthetics, and safety reason for operations and the environment. Besides, it shall be concern about permitting for land incentives usage for agriculture, recreational, scenic, and development interest. In line with Renewable Energy Development Act (2009) Articles 15 explained the location of the power plant for combustion-based biomass energy shall be restricted to the industrial area, while this regulation does not apply to power generation from methane; marsh gas burning type have no involved in the law legal development. The transmission access opened for the remote site which required the high-level distribution access fee. It shall concerning of the rights and obligations for transmission access dispute. For utility interconnections, the purpose should aware about the determination of grid-disconnected system or grid-connected system. The grid-connected system has evaluated as inconsistent access and unclear utility interconnection requirement. It is considered for the additional financial requirement for liability insurance, inspections, permitting, metering and or standby charge fee.

The legal law and policy are taking the significant role in the order of development the energy producer. There any considerable factors of legalization and legal responsibility which might influence to financial strategies. The competition law emerges for wholesale purchasing agreement, power purchase agreement, and fair trade agreement. The fair-use action explained referred to principles regulatory on Electricity Act. Art. 14 of Executive Yuan, Chinese Taipei for restrict business activity by mutual understanding, jointly determining the price, technology, products, and facility. The fair trade regulations of Chinese Taipei regulated in Fair Trade Commission No. 102192 in 2013.

5.2.3 Smart DC Power Opportunity for Community and Farm

Worajit Setthapun, Chiang Mai Rajabhat University, Chiang Mai, Thailand

Chiang Mai Rajabhat University (CMRU) initiated to conduct a project of Asian Development Institute for Community Economy and Technology (adiCET) as a green energy research center. Located in Chiang Mai World Green City, CMRU, adiCET concerned about energy conservation, energy efficient, and renewable energy concept integration to social economic and technology. Chiang Mai World Green City is the main project to develop a green community, which composes of an academic institution, renewable energy research center, climate change protection office, and eco-product business center which is under international organization support such APEC, ASEAN, and AREC. Chiang Mai World Green City is also the first model community in the world that is integrated with nature, uses renewable energy, green technology and strives to be fully sustainable. CMWC is situated in 500 rai of the Saluang-Keele Campus, Chiang Mai Rajabhat University, Mae Rim, Chiang Mai. Chiang Mai World Green City or adiCET currently has project related community outreach, focus on renewable and sustainable energy such as PV stand-alone, PV bus-stop, 700 kW solar farming, PV rooftop, biogas fix-dome, wood-biomass gasifier, smart DC Home, low carbon agriculture management, organic farming, recycle waste plastic road, wind power, wind water pumping, biochar integrations, biogas grid-connected by renewable material and tissue culture lab for smart agriculture. As a green Institute for the development of the local community, adiCET provide the real living community park, build the passive design house which implementing the energy efficient building concept and using reuse material for constructions. It also supports the local people in order to save energy from air conditioner usage; mentioned Chiang Mai as the tropical region has sun isolation for a whole year. Therefore in some project, there is integrated with PV rooftop for a self-independence electricity provider. AdiCET also providing the learning center for people to experience the sustainable way of living such experiment on traditional way to convert manure into cooking gas. In some part of speech, adiCET invited students, researcher, and expert to experience as intern or research trip project in the order to contributing to integrate the idea through renewable energy application for the local community.

In conclusion, adiCET on the line is developing green energy smart farm by sufficiency economy and green technologies for renewable energy and energy efficiency system, integrating with community resources and waste management, implementing green energy for the community. Nowadays, based on water sources designing PV Water Pump System (DC/AC - Fix/Mobile) for optimizing the water usage. Meanwhile, adiCET moving forward for community capacity building which updated by the hybrid system; PV technology, wind, hydro, biomass generator and much more. However, it still required the interdisciplinary expert for Create awareness, correct information, demonstrate best practices.

5.2.4 Application of Renewable Energy in Agriculture Farm: Chinese Taipei's Experience

Chung-Hsien Chen, Chair, APEC EGNRET, Section Chief, Bureau of Energy, Chinese Taipei

Bureau of Energy in Chinese Taipei emphasized the renewable energy project of Chinese Taipei in 2030. By the end of 2014, the data shown installed capacity of renewable energy in Chinese Taipei has 4,074 MW. The target of renewable energy in 2030 is generating

17.25 GW capacity by the composition of solar photovoltaics, biomass, hydro-power, wind turbines power, and geothermal. The Renewable Energy Development Act 2009 as Chinese Taipei statutory framework for promulgated renewable energy underlined the development target, grid connection and power purchasing, obligations demonstration grants, Feed-in Tariff (FiT) rates, land-use requirements, and fund establishment.

In order of financial mechanisms for promoting renewable energy, especially photovoltaics in Chinese Taipei, there has a legal framework by Feed-in Tariff (FiT) and PV ESCO. Firstly, the FiT regulated as a core strategy in Renewable Energy Development Act 2009. A committee is formed to decide the calculation formula and feed-in tariffs. Tariffs and formula should be reviewed annually, referring to technical advancement, cost variation, and goal achievement status. Currently, only Solar PV tariff rates are set on the date when generating equipment installations are completed. Other technologies have tariff rates set on the Power Purchasing Agreement (PPA) signing date which is tariffs applied for 20 years. BOE announces PV capacity quota every year. PV systems ≥ 100 kW are subject to a bidding procedure to decide tariffs. Developers proposing higher discount rates receive the priority to get the quota. By 2016 regulations, the FiT announced average 14.3628 up to 19.9425 US ¢/kWh depending the capacity installed. Secondly, Bureau of Energy announced PV ESCO as green financing for the investment as providing financing support. ESCO model plays an important role in Chinese Taipei PV installation. PV-ESCO assists in installations for all buildings including solar community, public roof, solar farm, solar terminal, solar factory, solar rail, solar MRT, solar campus and much more. By applying system warranty and after-sales service also reimburse loan principal and interest. During the renting period, the site provider gets the rent. The ownership of system after the rent expiring should be discussed by the PV ESCO and the site provider.

By this system, PV installed capacity increase from 48% (2012), 63% (2013), and up to 80% (2014).

Chinese Taipei has installed 1,115 MW at the end of 2015, spread in the area of Solar Vegetable Farm, Pingtung and Kaohsiung, Solar Mushroom Farm, Changhua, Solar Pig Farm, Yunlin, Solar Goat Barn, Yunlin, Solar Chicken Farm, Changhua, Solar Goose Farm, Yunlin and many farms spread over Chinese Taipei islands. An example showcase of Hanbao Livestock Farm, Changhua County has 40 ha with capital 360 million NTD have biogas production 4,400 m^3/d capacity, solar power 963.5 kW, wind power 9 kW. Hanbao Livestock Farm is role-model for community smart farm as best practices for green energy in Chinese Taipei.

As concluding remarks, the promulgation of Renewable Energy Development Act and related regulations has paved the way for a sustainable long-term development of PV in Chinese Taipei. Various incentives have been issued to encourage the investment in PV in Chinese Taipei. The development of PV is expected to be prosperous in Chinese Taipei. In line though Chinese Taipei will devote itself to the continuous growth of PV and other REs, and welcomes the international cooperation to foster the development of PV together in the global society.

5.2.5 The Barrier to Install PV and Biogas Systems in the Remote Rural Areas of the Developing Economics

Chien-Ming Kao, Agriculture Mission Fellowship, Chinese Taipei

Agriculture Mission Fellowship is Chinese Taipei non-profit organization who work in agricultural for human development and rural development. During the presentation and sharing about their experience while they have to install photovoltaics and biogas system in several places.

Zomba is a city in southern Malawi, in the Shire Highlands. It is the administrative capital of Zomba District. The remote places with unemployment rate up to 37% and facing the issues among low-wage job and inflation. By October 2015, the minimum daily wage of Zomba district announced as USD 1.3 (by currency USD 1= MWK 530). It categorized as low-income countries among African regions. The other social issues in Zomba is about security which society haven't balanced between rights and obligations. Relatively with low-income issues, they began to start the issues of poverty and poor which the conditions lack energy and food. Thus, Agriculture Mission Fellowship have a project regarding PV installation by maximizing solar potential in Zomba. However, mentioned the issues among Zomba is human resources and education, which most people have no eligible skill. Thus the barrier to installing PV system in Zomba is about human resources which influence much in their development of new technology.

In a different case of remote area issues, this case located in Myanmar which facing similar conditions with Zomba. But Myanmar is agrarian economy and has richer natural resources. It is an opportunities to integrate the technology such biogas system. Currently, the Agriculture Mission Fellowship research the Myanmar system about digester system among their biogas productions. Since still using the traditional way to produce energy from agriculture waste, it has inefficient production of heat for kitchen implementation. The availability of human resources and materials since being barriers among Myanmar development in a biogas system. However, Myanmar has a society to develop their system as integration to smart farm by the installation of biogas instead of using LPG for cooking and also electricity. Nowadays, they start to have biogas generator to produce the electricity from biogas system by agriculture waste materials. In their organization, they started with 40 peoples to develop their area. It is an effort for developing the remote area in order to develop their economics and life quality.

5.2.6 Next Generation Green Farm at National Chung Hsing University

Samer M-C Wu and Keng-Tung Wu, National Chung Hsing University, Chinese Taipei

This aims of this presentation are designed to evaluate the economic benefits of smart energy-saving systems in the green campus. So, in order to achieve this objective, we use Wurih Livestock Research Campus of National Chung Hsing University as an empirical case. Besides that, this research campus has an orchid cultivation greenhouse, cow and chicken raising houses with solar power generation system of the roof, and utilized the waste for thermoelectric energy conversion portable facilities and all of these independent systems were tightly integrated into a Smart Energy Cloud Management System for optional efficiency.

The solar power system structure installed by solar panels, breaker, solar power connector, inverter, switchboard and public grid. The monocrystalline solar panel absorbs the solar cells from the sunlight (approximately <25 degrees) then it will pass it to the breaker. After the breaker, it will pass to the solar power connector, an inverter as changes DC to AC line, and switchboard and will end it at the public grid. So, the power is passing from direct power to alternating power. Basically, explained there are 3 different of model types for the electrical characteristic which is MM60-6RT-260, MM60-6RT-265, and MM60-6RT-270. The most efficient model is MM60-6RT-260. The module efficiency is about 15.98% which each solar module maximum output is 260 watts. There are three installation types of integrated solar cell. The first one is the Tracking sunlight with electricity power (1.56kW), second is Tracking sunlight with air pressure actuator (4.68kW) and the third one is the Fixed type on the roof (47.96 kW). After summing up all the solar power, the total solar power is equal 54.2 kW. Based on experiments done, the concluding remarks as the tracking type power generation is more efficient than the fixed one. In the order from the most efficient solar cell to the normal solar cell is a track with electricity goes to track without electricity to fixed-type. For this installation experiments, all of the systems applied remote-control system with internet-monitoring and controlling, integrated with Accumulated Power Record which is able to record daily, monthly and annual electricity usage. It is relatively able to monitor the efficiency DC to AC inverter operation.

The other part explained as Green Energy Smart Farm Operate Sustainable Development Mode which integrates the waste from cattle and chicken raising houses to operate the orchid cultivation. By applied 10 kW Small-scale Mobile Downdraft Gasification System for agricultural waste, it procced the material from cattle and chicken raising house, especially cow manure with capability 12 kg cow manure for 1 kWh electricity productions. The other resource electricity, integrate by solar photovoltaics technology and connected with inverter and generator for generating orchid cultivation greenhouse temperature control. The system is controlled and monitored by remote system on internet access.

5.2.7 Distributed Biomass Gasification Power System in Indonesia

Sudjono Kosasih, PT. Prima Gasifikasi Indonesia, Energi Baru Group, Jakarta, Indonesia

By the end of 2016, Indonesia has thousands of islands rich in natural resources and agriculture land. However, they still face a lack of electricity because of backwardness of technology and human resources. The possibility of generating the electricity to island area in Indonesia is small-scale gasification which identified as quick transmission, simplifies maintenance, and high efficient in small land requirement. The small gasification average below 3 MW capacity has supported the carbon negative cycle, green energy with biochar as a by-product. Biochar has a valuable price in the market for soil nutrient stimulant.

Calliandra calothyrsus or popular as red Calliandra is the tropical multi-purpose tree for fuelwood; identified as a fast-growing tree, high-calorie wood, and easy-maintenance plantation. The green energy smart farm cycle applied in Indonesia begin by energy farm of Calliandra calothyrsus plantation, then go through to biomass gasification technology for generating electricity for villagers and local community household. Red Calliandra has many advantages on other product such leaves for cattle and goat feedstock, the flower can be used for bee productions, and high-fiber wood for paper productions. The case of power plant development in Tj. Batu, Riau Islands, Indonesia installed biomass gasification by PEAKO-STEP Hong Kong technology provider for 1.1 MW capacity to the local grid. Since August 2015, has signed power purchase agreement with state-owned electricity authority for USD 0.14/kWh.

PT. Prima Gasifikasi Indonesia though the line of developing renewable power plant industry in Indonesia facing a lot of challenge. Establishing power plant in an isolated area has many obstacles of logistic for constructions and raw materials also lack skillful human resources for engineer and machine operator. There are many obligations for the law and legalization or state administration for Indonesia government authority. Moreover, since renewable energy industry in Indonesia is categorized fresh business, the bank or local investor calculated the REs project have a high risk of financial. Thus, financial or investment still become a significant problem for establishing REs project in Indonesia.

The development of biomass power plant in Indonesia, PT. Prima Gasifikasi Indonesia takes charged of infrastructure and developing the rural area. Start on green energy cycle concept for generating the electricity support the environmental for negative carbon emission also enhancing local as job creation and opportunities for improving their microfinance. The succeed case of development conduct by PT. Prima Gasifikasi Indonesia interacts global interest of rural development by biomass gasifier and the implementation of Calliandra calothyrsus as agroforestry fuelwood for improving local community in economic and environmental.

5.2.8 Micro turbine Generator: Solution For Biogas Application in Agriculture

Stephen Hsia, Power & Energy Group, AIDC

Turbine is a rotary engine that converts the energy of a moving stream of water, steam, or gas into mechanical energy. While Micro-turbine is an advanced gas turbine engine used for electrical power generation. Capstone MicroTurbine® System is a trademark of Capstone Turbine Corporation. The radial compressor is made of steel and titanium material. High speed and quality. It has a 4:1 compression ration which is considered as a high-efficiency design. Radial turbine is made of nickel-based high-temperature cast alloys, with high tip speeds and high-efficiency single stage.

There are several advantages of the use of microturbine. Every single turbine is made from the finest and strongest material of the industry. It guarantees a long life on the engine that is going to be installed. Each of the turbines presented before is capable of bringing low emissions. According to the material, preventing the high maintenance. The fuel on the turbines will be flexible, different kind of brands can be used. It doesn't have any vibration at all and with a scalable (200kw per module).

Biogas power generation from small to big type is typical biogas power plant which most common biogas power plant start from the manure (animals waste) and then is stored in a big container known as the digester. Then PVC tubes are connected to a blower where the gas is sent to the H_2S Scrubber and then taken to a biomass compressor. Once the gas is into the compressor it is transported to the micro-turbine and finally is converted into energy. Meanwhile, biogas quality has requirement for minimum composition of CH_4 >

55%; H_2S< 300ppm; O_2< 1.5%; H_2< 0.5% with biogas pressure > 50 mBar for rated load in condition dry and dew point in 5 °C.

AIDC has experiment of 2MW biogas power plant conduct in KKSL as the palm oil milling company located in Sitiwan, Perak, Malaysia. The milling capability for FFB (Fresh Fruit Bunch) is 100 ton per hour. The total POME is about 1200 tons per day. The biogas from the two digesters is about 48000 cubic meter per day, which is enough for feeding the generators more than 3 MW. KKSL biogas power plant is designed for three sets of CR1000 micro turbines. The first two CR1000s was procured, commissioned and feed in grid and plant load respectively. The contract for the third unit is under processing right now due to the success of feed-in electrical production more than expected. KKSL biogas power plant is designed for three sets of CR1000 micro turbines. The first two CR1000s was procured, commissioned and feed in grid and plant load respectively. The contract for the third unit is under processing right now due to the success of feed-in electrical production more than expected.

The other projects and products of AIDC has done are following: a) H_2S Scrubber System by bio-desulfurization and biogas-clean concept with H_2S Concentration < 50 ppm could be applied 2000 cubic meter per hour; b) big digester in palm industries with Two Sets of Lagoon Type Digesters with 2100 m^3/hr total; c) Screw biogas compressor, identified as screw type biogas compressor, VFD, ATX certified with outlet pressure 5.9 bar(g) and maximum flow is 840 Nm^3/hr while Inlet Pressure is 50mBar ~100mBar; d) C1000 MicroTurbine has International standard with rating for 1000 kW, the fuel consumption is 550 m^3/hr(CH_4=60%) and fuel inlet:5.3bar(g), CH_4>40%

The system of AIDC project and products has a simple, modular, robust, and reliable concept. With less maintenance meant to have high efficiency and effective for operations while it has minimum downtime and high availability. The products are suitable and excellent for grid-connected application with the less environmental burden.

5.2.9 Autonomous Power Generation by advanced Two-stage Biogas Production Technology and Building an Entrepreneurial Networking for Green Farm

Chen-Yeon Chu, Feng-Chia University, Chinese Taipei

SymBioGas reviewed as green energy revolution for smart farms is the next masterpiece in order to stop all those problems that are affecting our planet. The choice is on our hands to keep suffering from all the contamination or to change for a better world for our future generation. Among all the great ideas of green energy for smart farms are two important technology that will help each of us to decrease the pollution in our world. Autonomous power generation by advanced two-stage biogas production technology and building an entrepreneurial networking for the green farm will be a good start to developing green energy.

As the core technology is the advanced research of HyMeTek experimentation, found innovative hydrogenases and methanogenesis technology. The main source for that technology is located in different places. The main source is the waste from farms, factories, and restaurants.

The Concepts of Blue symbiosis and Benefit (3B Green Farm). BioGas Reactor is the representation of the farms; there are several sources that have been contaminating our environment, but within the next years that won't be a problem anymore. It is because those sources that have been contaminating our planet will be the idea that will save us from burning petroleum and another kind of resources that harm our mother earth. A win-win situation will occur and the general waste won't be seen as a garbage or a problem to our environment. Also, this kind of technology will help us to get profit from it and at the same time helping the environment.

As the case study is Thirteenth Five-year China Plan or known as China will be the largest economy of biomass consumer. China is considered as the economy that is growing drastically not only in population but also as one of the biggest economic potential in the world. Besides being one of the growing economies, it has been contaminated because of the high amount of factories that release CO_2 causing a big problem for the environment. Nowadays, companies along with the government are trying to reduce the CO2 emission by bringing green energy. Several projects have been set up in different places in China. Those projects have been accepted positively and that is the reason why more companies are interested in making a change. According to Domestic Development and Reform Commission, during the year 2015 China's generator approached 13 million kW and by 2020 will increase to more than half. In other words, 6.5 trillion RMB in biofuels generator was sold in market during five years.

The general waste from farms, factories, and kitchen are being gathered to be able to exploit it instead of throwing them away. As a result, 100 million Ha land will produce 200 million ton standard coal by biofuels. It means a 38 billion RMB marketing will be generated in electricity. The experts predict that Biomass energy will reach the top of economic development in recent 2 years.

However, there have several problems in China such air and water pollutions have become a very serious problem. Research and Development Corporation (RAND Corporation) described in a research report that in past 10 years, the cost of environmental pollution occupied about 10% GDP. At 2014, the GDP was 63 trillion and it's 10% was 6.3 trillion/year.

For BioH2 technology evolution at Feng Chia University, the greatest inventions take years to develop. That is the case of the $BioH_2$ technology at FCU. From 1998 till now, professors, scientist, and students have been working hard to get this project to become true. At first, it was hard facing difficulties and people to believe in the project. Now that the project has been successful, FCU would like to expand it in order to reduce the CO_2 emission and let more people know the importance of using the BioH2 instead of a gas that is from petroleum or any kind of sources that produce CO_2 emission. Bellow, you could see a picture that explains the process of $BioH_2$ technology. In 2006-2015, the research groups of Canada, UK, Singapore, Korea, Malaysia, Russia and other economies have pointed out that FCU is the first record in biohydrogen production rate in the world (15 m3 H2/m3-h).

During presentation also explained the potential feedstock for biomass which following corn cob, agriculture waste (rice straw), forestry waste as wood chip, cassava residue, Jatropha residue, food waste, organic wastewater, sugary waste-water (Coca, Pepsi etc., in Chinese Taipei such as pineapple residue, palm oil mill effluent, and waste paper. It depends on the location in order to the availability of materials from local agriculture productions.

For the international trends of gaseous bioenergy technology, according to the EBA website in 2013, there was 15,000 in Europe of biogas and 280 plants in Europe in the same year of biomethane gas. Nowadays, are considered the most popular technology in the biomass energy system. Biogas requires of a biogas purification technology meanwhile biomethane gas requires a biological hydrogen purification technology and it recovers 25% of more energy. The two-stage energy recovery technology is always more than one stage of 8-43%.

For evaluated the framework with APEC connectivity platform, the biggest picture of the $BioH_2$ technology is to be accepted by all the APEC regions and then the rest of the economies. Several professors and representative of Feng Chia University have been spreading the greatest news such as Thailand (KKU), China (Tsing Hua University), Chinese Taipei, Mexico (Lipata, UNAM), Indonesia (LIPI) and Viet Nam (UOS-HCMC). As eco-village recommendation, HyMeTek is trying to implement a new idea to all the farmers by collecting all the farm waste in order to set up more new gas station in the area of Taichung. Also, that will bring a reduction of the contamination that the farm waste was bringing to all the people around the area.

For Green farm ecosystem by two-stage biogas production technology, HyMeTek is partnering with CHEN Engine which is a manufacturer of the engine for vehicles. The main idea is to create a new kind of engine where BioH2 can be used. CHEN Engine is located in more than 56 countries and that will bring to HyMeTek a change to reach those markets along with CHEN Engine. GOV./World bank, NGO/Investors will be the negotiator to make this project successful. BioH2 will bring affordable prices to Communities in receiving affordable and reliable electricity (and income from the utility in case of co-ownership). Partial ownership granted in exchange for labor and resource stewardship –putting a value on ecosystem services. Also, agricultural production will increase with a great economic growth to the agricultural sector.

5.3 2nd Workshop

5.3.1 The Legal Issues on Development of Green Energy Farm

William Yiyuan Su, National Chung Hsing University, Taichung, Chinese Taipei

The remote area mostly has no serious environmental destructions. It happened because of less human operations due to the lack of logistic and technology. Behind it all, energy in a rural area is one significant backwardness of infrastructure sluggish reason. Facing the sustainability energy issues nowadays, which related to renewable energy and smart energy. The rich of natural resources having most possibility to solve this issues. The remote area which is still having much agricultural land and natural resources become a global interest of building the green energy independence system for supporting worldwide subject about smart energy farm.

This project will follow all the laws and regulations according to the economy that is going to be established such as energy law, renewable energy law, waste management and recycling laws, and agriculture regulations. The rural areas of the developing economies of APEC have been surviving all their lives without electricity. Farmers of remote areas wish to have electricity. The problem is that the transmission or distribution access fee will be high because of the distance where the power sources are located. It might need tons of wires and electrical pole to reach a remote area. Furthermore, the person in charge or technician of remote areas will charge extra fees because of the inspections, the insurance of the risk that he or she will take on going to those places. Public transportation isn't that common and rows are not in good conditions. It will take days to fix a problem from the grid connection. Electricity can be settled in the rural area, but the problem is that most of the families are not going to be able to afford the cost of it.

Each APEC member has their own regulation, and it is important to know the regulations of the economies that this project will be applied. There has analyzed two APEC's economies as a case study.

For Viet Nam Energy, in 2010 the government of Viet Nam set up a law for the economical and efficient use of energy. In other words, all those people who surpass a number of watts given by the government are going to pay a fine. Moreover, according to the Viet Namese government energy includes fuel, electric, and thermal energy directly attained or attained through the processing of renewable or unrenewable resources. Unrenewable energy resources include coal, coal gas, petroleum oil, nature gas, uranium ores, and other unrenewable resources. Renewable energy resources include water power, wind power, sunlight, geothermal, biofuel and other renewable energy. Meanwhile, in 2005 the Electricity Regulator Authority of Viet Nam (ERAV) sat up the Decision No. 258/2005/QD-TTg. It is also known as Electricity law which allows the use of wind power, biofuel, and biodiesel, exclude the biomass. On the same year, there was sat another law that is for the Environment Protection. In the article 3 waste will be allowed for renewable energy which can be substances in the solid, liquid or gaseous form discharged from pollution, business, services, daily life or other activities.

For Indonesia energy, in 2007 and 2009 the government of Indonesia sat a law on energy. It states that energy will be produced from either directly or indirectly source of energy, through conversion or transformation process. Also, energy resources are natural resources that can be utilized, both as energy sources and as energy. On the same years, the government claimed that renewable energy source is an energy source which is produced from the sustainable energy resources if managed well: among others earth heat, Bioenergy, sun ray, water flow, and waterfall, as well as the movement and difference of sea layer temperature. Meanwhile, in 2008, the government of Indonesia got the law of waste management. On the first article state that waste is the remains of human daily activities and/or naturally processed in the solid form. On the third article state, there should be followed by these principles: responsibility, sustainability, profitability, justice, awareness, togetherness, safety, security, economic value. Article 4 stated that waste should be used as an energy source.

The legal law and policy are taking the significant role in the order of development the energy producer. There any considerable factors of legalization and legal responsibility which might influence to financial strategies. The competition law emerges for wholesale purchasing agreement, power purchase agreement, and fair trade agreement. The fair-use action explained referred to principles regulatory on Electricity Act. Art. 14 of Chinese Taipei's Executive Yuan for restrict business activity by mutual understanding, jointly determining the price, technology, products, and facility.

5.3.2 Economic Issues for Developing Green Energy Smart Farm

John Chou, FECO Group, Chinese Taipei

The emission of severe CO_2 to the atmosphere, the release of different kind of chemicals, the destruction of forests and the killing of animals on the danger to extinct are some of the causes why we are getting several changes on the climate. Meanwhile, humans are still increasingly from nowadays existed more than 7 billion populations. The best solution to solve this problem will be in cooperating together and let the green energy to be the main one instead of the conventional one. Renewable energy for electricity additions over the next five years will top 700 gigawatts (GW). They will account for almost two-thirds of net additions to global power capacity which is the amount of new capacity added, minus scheduled retirements of existing power plants. Non-hydro sources such as the wind and solar photovoltaic panels (solar PV) will represent nearly half of the total global power capacity increase.

The Renewable Energy Development Act 2009 as Chinese Taipei statutory framework for promulgated renewable energy underlined the development target, grid connection and power purchasing, obligations demonstration grants, Feed-in Tariff (FiT) rates, land-use requirements, and fund establishment. Through that act, several Chinese Taipei firms have been changing the old conventional way of getting energy to renewable energy. There are many cases of Chinese Taipei for the implementation of green energy for conventional way such power plant company with PV installation for 953 kWp capacity, car factory with 64.68 kWp, and cosmetic company for 367 kWp also power plant in Central of

Chinese Taipei for 0.5 MW capacity installed. The regulation through Renewable Energy Act 2009 regulated the Feed-in Tariff varied from 4.7521 up to 6.6721 NTD per kilowatt hour. The price depending the capacity installed and type of renewable energy power plant. As shown in the table during the presentation, the FiT in Chinese Taipei has been reducing from 2010 to 2017.

Small-scale Hybrid Renewable Energy Systems (HRES) is the production of energy by means of small-scale generation systems, near the place where it will be consumed. This is usually done by using renewable sources such wind power, biogas, hybrid, solar photovoltaics and much more. The integration to wind-spot as many economies has been installed to produce electricity. The velocity of the wind, the size of the turbine and the spot where the wind spot is located are the key elements in the HRES. There are more PVs users than SWT because of the fewer suppliers. These are the features that a 3.5 kW WINDSPOT offers the high-quality manufacturing with exclusive technology, patented in major world markets, best performance, low noise levels and reliability, certified by the most prestigious technical institutions in the world, as one key product integration in order to promote HRES, the installation done in 40 countries with more than 1000 cases which tested in multiple applications such residential, Industrial, water pump systems, mining, farms, telecommunication tower and much more. In another implementation for HRES, there are wind power and photovoltaics technology which are haven't relative to the competition. In Hybrid Systems wind will produce more than the sun in months where there are less solar radiation and vice versa. Hybrid systems will provide an optional use of the renewable source. Solar energy and wind power analyzed as supporting the advantage and disadvantage. For example, while wind energy has the high initial cost, the solar energy has cheaper to install. There are much integrations of wind power done by

FECO Group, Chinese Taipei such in Chang Gung Memorial Hospital, American Taipei School for rooftop installation, Chocony Electronics in North of Taipei, Chi Jin Wind Park in Kaohsiung city, and Pig Farm in Taoyuan.

Chinese Taipei is a great example for all those other APEC's economies that haven't be able to use more green energy rather conventional. All the industries that had turned to green energy in China Taipei are getting great results and have gained relative success as world's important suppliers. Chinese Taipei's new government compromised on the next stage to allocate a more renewable resource and to be more focused to further facilitate green energy industries. The enlarging or creating of overseas and domestic markets for green energy is one of the key strategies for the success of green energy industries.

5.3.3 Application of Renewable Energy in Agriculture Farm: Chinese Taipei's Experience

Chung-Hsien Chen, Chair, APEC EGNRET, Section Chief, Bureau of Energy, Chinese Taipei

Bureau of Energy in Chinese Taipei emphasized the renewable energy project of Chinese Taipei in 2030. By the end of 2014, the data shown installed capacity of renewable energy in Chinese Taipei has 4,074 MW. The target of renewable energy in 2030 is generating 17.25 GW capacity by the composition of solar photovoltaics, biomass, hydro-power, wind turbines power, and geothermal. The Renewable Energy Development Act 2009 as Chinese Taipei statutory framework for promulgated renewable energy underlined the development target, grid connection and power purchasing, obligations demonstration grants, Feed-in Tariff (FiT) rates, land-use requirements, and fund establishment.

In order of financial mechanisms for promoting renewable energy, especially photovoltaics in Chinese Taipei, there has a legal framework by Feed-in Tariff (FiT) and PV ESCO. Firstly, the FiT regulated as a core strategy in Renewable Energy Development Act 2009. A committee is formed to decide the calculation formula and feed-in tariffs. Tariffs and formula should be reviewed annually, referring to technical advancement, cost variation, and goal achievement status. Currently, only Solar PV tariff rates are set on the date when generating equipment installations are completed. Other technologies have tariff rates set on the Power Purchasing Agreement (PPA) signing date which is tariffs applied for 20 years. BOE announces PV capacity quota every year. PV systems ≥ 100 kW are subject to a bidding procedure to decide tariffs. Developers proposing higher discount rates receive the priority to get the quota. By 2016 regulations, the FiT announced average 14.3628 up to 19.9425 US ¢/kWh depending the capacity installed. Secondly, Bureau of Energy announced PV ESCO as green financing for the investment as providing financing support. ESCO model plays an important role in Chinese Taipei PV installation. PV-ESCO assists in installations for all buildings including solar community, public roof, solar farm, solar terminal, solar factory, solar rail, solar MRT, solar campus and much more. By applying system warranty and after-sales service also reimburse loan principal and interest. During the renting period, the site provider gets the rent. The ownership of system after the rent expiring should be discussed by the PV ESCO and the site provider. By this system, PV installed capacity increase from 48% (2012), 63% (2013), and up to 80% (2014).

Chinese Taipei has installed 1,115 MW at the end of 2015, spread in the area of Solar Vegetable Farm, Pingtung and Kaohsiung, Solar Mushroom Farm, Changhua, Solar Pig Farm, Yunlin, Solar Goat Barn, Yunlin, Solar Chicken Farm, Changhua, Solar Goose

Farm, Yunlin and many farms spread over Chinese Taipei islands. An example showcase of Hanbao Livestock Farm, Changhua County has 40 ha with capital 360 million NTD have biogas production 4,400 m^3/d capacity, solar power 963.5 kW, wind power 9 kW. Hanbao Livestock Farm is role-model for community smart farm as best practices for green energy in Chinese Taipei.

As concluding remarks, the promulgation of Renewable Energy Development Act and related regulations has paved the way for a sustainable long-term development of PV in Chinese Taipei. Various incentives have been issued to encourage the investment in PV in Chinese Taipei. The development of PV is expected to be prosperous in Chinese Taipei. In line though Chinese Taipei will devote itself to the continuous growth of PV and other REs, and welcomes the international cooperation to foster the development of PV together in the global society.

5.3.4 Social Enterprise – A Challenge of Green Smart Farm

Keller Wang, Research Institute of Social Enterprise (RISE), Feng-Chia University

Chinese Taipei

Paris Agreement under the United Nations Framework Convention on Climate Change It is of vital importance to be all united in order to defeat climate change. By 2016, only 58.82 % of global GHG emission has achieved. The achievement might increase if more parties get involved. If global have any action from now the global greenhouse gas emission will increase from 52 Gt CO_2e/year in 2016 to 102 Gt CO_2e/year in 2050. However, if global take actions and start to work for a solution the global greenhouse gas emission will drop from 52 Gt CO_2e/year in 2016 to 37 Gt CO_2e/year in 2050 and will continue dropping.

Green energy is a good financial investment for market change. The vertical chart shown on presentation states that clean energy dropped in 2013 to -8% and then back up in 2014 to 16%.   According to Bloomberg New Energy Finance, "Global investment in clean energy fell to the lowest in more than three years as demand for new renewable energy sources slumped in China, Japan, and Europe. Third-quarter spending was $42.4 billion, down 43 percent from the same period last year and the lowest since the $41.8 billion reported in the first quarter of 2013."

The following is an example of sustainability problem on energy poverty and social innovation. It is unacceptable that in the 21st century nearly 1.6 billion people still have no access to electricity. Electricity has been the main allies for us in order to make our technologies better and be able to work more efficient than years ago. The quality of life of those people will improve if electricity reaches them and their economy will boost because they will have more time to work on their farms or for the students to have more time to study or learn new things on the internet. Secondly, social innovation for remote areas should have the change to have a different kind of projects where education about new technologies and sanitation should be included. If the community has a better education, they are going to be able to understand easily the importance of renewable energy. For them will be something new and might take time, if they are not educated in advance about the purpose of green energy smart farming.

The smart agriculture integrations for social enterprise are the solutions idea for those issues. A good leader should be selected in order to be the one to make the change for the community and find the solution when the problems are difficult to solve. Being a leader is someone who can govern, operate an enterprise and create resilient community in an inclusive economic way. It might not that hard to find a good leader, but the hardest part is to make all the community agree about a topic or an idea. Such as a green and smart farm can be complicated to let everyone agreed. Most of the community are already used to the old way of farming and most of the time the elders don't want to follow what the young generation is trying to do. That kind of situation always happens in remote areas where the elders are the one who have the last words. Energy supply is connected to the social enterprise where social and environment needs and wants in order to make the project successful. Smart farm needs intermediary social enterprise as the pillar for smart farm which is supported by the following: a) political negotiation, it was planned to make the utility Indonesia state electricity company, knows as PLN a fully independent and financially viable company but due to legal disputes such a decision has not been taken; b) social issue engagement, around 20% of the population representing 50 million people does not have access to electricity; c)technology education, lack of specialist know-how and a basic lack of awareness of the available potential have been the main reasons for sluggish progress in the past; d) financial funding in Indonesia has failed to meet this demand growth with adequate system investments; e) business marketing sectors of current case, the gasoline market has been opened for private players; e) human resources empowerment by government programs consolidated individual assistance, community empowerment, and SMEs; f) community solidarity for grid expansion is least-cost up to distances of around 16 km, where biomass isolated grids become lower-cost; g) network learning in Indonesian official statistics do not cover the traditional use of biomass as energy; h) impact diffusion of lack for the technical maturity or sustainable operation and service models that are necessary for large-scale dissemination.

5.3.5 Smart DC Power Opportunity for Community and Farm

Worajit Setthapun, Chiang Mai Rajabhat University, Chiang Mai, Thailand

Chiang Mai Rajabhat University (CMRU) initiated to conduct a project of Asian Development Institute for Community Economy and Technology (adiCET) as green energy research center. Located in Chiang Mai World Green City, CMRU which concerned about energy conservation, energy efficient, and renewable energy concept integration to social economic and technology. Chiang Mai World Green City is the main project to develop a green community, which composes of an academic institution, renewable energy research center, climate change protection office, and eco-product business center which is under international organization support such APEC, ASEAN, and AREC. Chiang Mai World Green City is also the first model community in the world that is integrated with nature, uses renewable energy, green technology and strives to be fully sustainable.CMWC is situated in 500 rai of the Saluang-Keele Campus, Chiang Mai Rajabhat University, Mae Rim, Chiang Mai.

Chiang Mai World Green City or adiCET currently has project related community outreach, focus on renewable and sustainable energy such as PV stand-alone, PV bus-stop, 700 kW solar farming, PV rooftop, biogas fix-dome, wood-biomass gasifier, smart DC Home, low carbon agriculture management, organic farming, recycle waste plastic road, wind power, wind water pumping, biochar integrations, biogas grid-connected by renewable material and tissue culture lab for smart agriculture.

As a green Institute for the development of the local community, adiCET provide the real living community park, build the passive design house which implementing the energy efficient building concept and using reuse material for constructions. It also supports the local people in order to save energy from air conditioner usage; mentioned Chiang Mai as the tropical region has sun isolation for a whole year. Therefore in some project, there is integrated with PV rooftop for a self-independence electricity provider. AdiCET also providing the learning center for people to experience the sustainable way of living such experiment on traditional way to proceed manure to be cooking gas. In some part of speech, adiCET inviting students, researcher, and expert to experience as intern or research trip project in the order to contributing to integrate the idea through renewable energy application for the local community.

In conclusion, adiCET on the line for developing green energy smart farm by sufficiency economy and green technologies for renewable energy and energy efficiency system, integrating with community resources and waste management, implementing green energy for the community. Nowadays, based on water sources designing PV Water Pump System (DC/AC - Fix/Mobile) for optimizing the water usage. Meanwhile, adiCET moving forward for community capacity building which updated by the hybrid system; PV technology, wind, hydro, biomass generator and much more. However, it still required the interdisciplinary expert for Create awareness, correct information, demonstrate best practices.

5.3.6 Distributed Biomass Gasification Power System in Indonesia

Sudjono Kosasih, PT. Prima Gasifikasi Indonesia, Energi Baru Group, Jakarta, Indonesia

By the end of 2016, Indonesia has thousands of islands rich in natural resources and agriculture land. However, they still face a lack of electricity because of backwardness of technology and human resources. The possibility of generating the electricity to island area in Indonesia is small-scale gasification which identified as quick transmission, simplifies maintenance, and highly efficiency in small land requirement. The small gasification average below 3 MW capacity has supported the carbon negative cycle, green energy with biochar as a by-product. Biochar has a valuable price in the market for soil nutrient stimulant.

Calliandra calothyrsus or popular as red Calliandra is the tropical multi-purpose tree for fuelwood; identified as a fast-growing tree, high-calorie wood, and easy-maintenance plantation. The green energy smart farm cycle applied in Indonesia begin by energy farm of Calliandra calothyrsus plantation, then go through to biomass gasification technology for generating electricity for villagers and local community household. Red Calliandra has many advantages on other product such leaves for cattle and goat feedstock, the flower can be used for bee productions, and high-fiber wood for paper productions. The case of power plant development in Tj. Batu, Riau Islands, Indonesia installed biomass gasification by PEAKO-STEP Hong Kong technology provider for 1.1 MW capacity to the local grid. Since August 2015, has signed power purchase agreement with state-owned electricity authority for USD 0.14/kWh.

PT. Prima Gasifikasi Indonesia though the line of developing renewable power plant industry in Indonesia facing a lot of challenge. Establishing power plant in an isolated area has many obstacles of logistic for constructions and raw materials also lack skillful human resources for engineer and machine operator. There are many obligations for the law and legalization or state administration for Indonesia government authority. Moreover, since renewable energy industry in Indonesia is categorized fresh business, the bank or local investor calculated the REs project have a high risk of financial. Thus, financial or investment still become a significant problem for establishing REs project in Indonesia.

The development of biomass power plant in Indonesia, PT. Prima Gasifikasi Indonesia takes charged of infrastructure and developing the rural area. Start on green energy cycle concept for generating the electricity support the environmental for negative carbon emission also enhancing local as job creation and opportunities for improving their microfinance. The succeed case of development conduct by PT. Prima Gasifikasi Indonesia interacts global interest of rural development by biomass gasifier and the implementation of Calliandra calothyrsus as agroforestry fuelwood for improving local community in economic and environmental.

5.3.7 Applying Biogas Technology for Green Energy Smart Farm

Chen-Yeon Chu; Chiu-Yue Lin; Eniya Listiani Dewi; Joni Prasetyo; Mahyudin Abdul Rachman; Zulaicha Dwi Hastuti, Feng-Chia University, Chinese Taipei

Organic waste is a big problem in most of the APEC regions. There is a high amount of organic wastes that farmers don't even know what to do with them. All those wastes have been bringing a lot of diseases, and respiratory problems to all the people that live around the area. Most of the people around the area are getting sick because of the pollution of the air caused by burning agro-industry organic wastes and water pollution caused by discharging high organic content wastewaters without port-treatment.

As the International trends of gaseous bioenergy technology, according to the EBA website in 2013, there was 15,000 in Europe of biogas and 280 plants in Europe in the same year of Biomethane gas. Nowadays, are considered the most popular technology in the biomass energy system. Biogas requires of a biogas purification technology meanwhile Biomethane gas requires a biological hydrogen purification technology and it recovers 25% of more energy. The two-stage energy recovery technology is always more than one stage of 8-43%.

The Feng Chia University (FCU) has a project with core technology is Innovative Hydro-genesis & Methane-genesis Technology (HyMeTek). In order to make our product successful FCU need to have the main ingredient which is the organic wastes from farmers, industries, and restaurants. Once we gather the main ingredient we get the hydro-genesis and methane-genesis technology. Later on, we wait for the fermentation producing the H_2 technology. Feng Chia University has successfully constructed benchmark model in 2006-2015, the research groups of Canada, UK, Singapore, Korea, Malaysia, Russia and other economies have pointed out that FCU is the first record in bio-hydrogen production rate in the world. (15 m^3 H_2/m^3-h)

The R&D&D stage for BioH_2 application demonstration is a gas station and the products for EV car integrated. The world's first Bio-H_2 gas station is launched. This is the first gas obtain from wastewater and food waste that can be able to make a car run. It is one of the greatest inventions of this century because it will help to reduce the general waste from the farms and industries. Allowing more spaces and giving a clean environment to the future generations. FCU and the economy, in general, feel proud of his invention which is going to place China Taipei as one of the leading products in the market. The main idea is to have a Bio-H2 gas station in different places of the world. Meanwhile, the biggest source of bio-hydrogen is Indonesia as the biggest crude palm oil (CPO) producer in the world with an existing of 8.5 million ha and with a potential for the future of 47 million ha. Since 2001, Indonesia increasing rapidly the productions of palm oil until 2015 Indonesia has produced palm oil more than 30 million tons annually. As huge palm oil producer, Indonesia also facing the problem of waste as palm shell waste. This case study could solve by the application of biomass technology. It means the agriculture waste as resources of biomass. Integration from palm waste to electricity and energy in Indonesia has many benefits as the environmental and economical business, a constant collection of biomass through whole the year in the huge land with skillful human resources.

HyMeTek Applications in food industry waste water can be established a cost-effective large-scale pilot plant. They could get all the waste from the farmers or local industries. Also, the price could be low or just for the transportation. HyMeTek has established the key technology of design and SOP instructions.

HyMeTek will be the partner with the CHEN Engine. The engine is patented and protected in 56 countries worldwide and that motor will be suitable for the gas that is developed by HyMeTek. The cost will be much cheaper than the other engine that is in the market and with double horsepower. Only the engine without the Bio-H2 gas, produce a 60% reduction of pollution of traditional engines. In other words, by having the gas implemented into the engine the emission will be less. CHEN Engine is considered the smallest and the long lasting engine in the world with a duration of lifetime of 20 years and the 40% of the size, less than the common engine with fewer parts, simpler assembling, and easier maintenance. The only duel-application engine for gaseous fuels and liquid fuels are both applicable. All gaseous fuels including gas, hydrogen, methane, and others or liquid fuels such gasoline, diesel, ethanol, and bio-fuel could be used as long as ignitable.

In addition, Feng Chia University has collaborated with Agency for the Assessment and Application of Technology (BPPT) as a body representative of Deputy Minister of Research and Technology of Indonesia with manufacturers work for renewable energy technology. Industry-academic Joint Project between FCU and BPPT, Indonesia for building 1 m^3 Mobile BioH_2 Production system by POME is constructing in Indonesia. Another collaboration conducted by Feng Chia University is APEC Research Center for

Bio-hydrogen Technology, Feng Chia University, Chinese Taipei by Prof. CY Lin and Dr. Andrew Chu for Bio-gaseous refueling station technology with the potential investor GIAA, Group, Chinese Taipei by President Ku and Mr. Yang for system integration and mass production process design and CHEN ENGINE CO., LTD, Chinese Taipei by President Chen as Green Vehicle Production Center also Dr. William Su as policymaker.

5.3.8 Micro Turbine Generators for Agricultural Usage

Jinn-Shing Su, Aerospace Industrial Development Corporation, Chinese Taipei

Experienced more than 50 years, AIDC is a major Asian supplier in the global aerospace industry. As depicted in the timeline, AIDC was established in the 1960s and began with a core business in military aviation which included; helicopter, Trainer, Fighter jet, and Engine. Later under the Ministry of Domestic Defense, AIDC developed full capability to start a program from clean-sheet design, manufacturing, qualification testing, production, and delivery and total fleet Management services for the Indigenous Defense Fighter (IDF). Which provided further experience, established our foundation and know-how for the further commercial market development. In 1996 following the restructuring under the Ministry of Economic Affairs AIDC expanded into the global commercial aerospace market by focusing upon partnering with world renown airframe and engine manufacturers. AIDC achieved privatization in August 2014 which enabled the company to become more flexible in its operation and financing in meeting demands. This year, AIDC has added new programs with GE and the upgrades for Advance Trainer, and the Airbus SA program.

AIDC consists of 4 major facilities located in Taichung, Sha Lu and Kang-Shan with a total area of 313.82 acres. The current location lies in Taichung complex, which contains the Headquarters building, as well as the Engineering, Aircraft Parts Fabrication, and Avionics Assembly & Testing buildings. The Sha Lu complex is away from Taichung complex around 30 minutes, which contains facilities for Avionics & Flight Control Engineering office and most important the Aircraft Assy. & Testing. The neighboring Chinese Taipei Advanced Composite Center (TACC) is set up for the composite manufacturing process. AIDC has also launched the next phase of the capacity expansion investment plan. Later on in the presentation, there will be details about the new facilities. The Kang-Shan complex located in southern Chinese Taipei specializes in Engine Parts Fabrication, assembly, and testing.

The core business portfolio includes the upgrade services and maintenance in domestic defense segment, and also a complete range of products and services in design, manufacturing system integration and assembly for commercial aviation and engine program. The company's sales growth recorded as steady growth projects a solid foundation and future stability. From the year 2012, AIDC had received 140 million USD in annual revenue over the past 4 years, which is a nearly 20% increase.

The AIDC Engineering System (AES) as another innovated technical support would be our web-based Engineering System. This system integrates all engineering and production activities, as well as the ISO requirement, from the stage of product design to delivery and maintenance. For example, once a change notice is released, evaluation and adjustment through CATIA Data Manager (CDM), Product Data Management (PDM), Enterprise Resource Planning (ERP), are all incorporated in this single collaboration system, so that all cross-functional teams such as Fabrication or Procurement can access the system in zero-latency and examine the impact on schedule, cost, and material. This Integration System is crucial for the company to perform precise and effective program management.

Turbine is a rotary engine that converts the energy of a moving stream of water, steam, or gas into mechanical energy. While Micro-turbine is an advanced gas turbine engine used for electrical power generation. Capstone MicroTurbine® System is a trademark of Capstone Turbine Corporation. The radial compressor is made of steel and titanium material. High speed and quality. It has a 4:1 compression ration which is considered as a high-efficiency design. Radial turbine is made of nickel-based high-temperature cast alloys, with high tip speeds and high-efficiency single stage.

There are several advantages of the use of microturbine. Every single turbine is made from the finest and strongest material of the industry. It guarantees a long life on the engine that is going to be installed. Each of the turbines presented before is capable of bringing low emissions. According to the material, preventing the high maintenance. The fuel on the turbines will be flexible, different kind of brands can be used. It doesn't have any vibration at all and with a scalable (200kw per module).

Biogas power generation from small to big type is typical biogas power plant which most common biogas power plant start from the manure (animals waste) and then is stored in a big container known as the digester. Then PVC tubes are connected to a blower where the gas is sent to the H_2S Scrubber and then taken to a biomass compressor. Once the gas is into the compressor it is transported to the micro-turbine and finally is converted into energy. Meanwhile, biogas quality has requirement for minimum composition of CH_4 >

55%; H_2S< 300ppm; O_2< 1.5%; H_2< 0.5% with biogas pressure > 50 mBar for rated load in condition dry and dew point in 5 °C.

AIDC has experiment of 2MW biogas power plant conduct in KKSL as the palm oil milling company located in Sitiwan, Perak, Malaysia. The milling capability for FFB (Fresh Fruit Bunch) is 100 ton per hour. The total POME is about 1200 tons per day. The biogas from the two digesters is about 48000 cubic meter per day, which is enough for feeding the generators more than 3 MW. KKSL biogas power plant is designed for three sets of CR1000 micro turbines. The first two CR1000s was procured, commissioned and feed in grid and plant load respectively. The contract for the third unit is under processing right now due to the success of feed-in electrical production more than expected. KKSL biogas power plant is designed for three sets of CR1000 micro turbines. The first two CR1000s was procured, commissioned and feed in grid and plant load respectively. The contract for the third unit is under processing right now due to the success of feed-in electrical production more than expected.

The other projects and products of AIDC has done are following: a) H_2S Scrubber System by bio-desulfurization and biogas-clean concept with H_2S Concentration < 50 ppm could be applied 2000 cubic meter per hour; b) big digester in palm industries with Two Sets of Lagoon Type Digesters with 2100 m^3/hr total; c) Screw biogas compressor, identified as screw type biogas compressor, VFD, ATX certified with outlet pressure 5.9 bar(g) and maximum flow is 840 Nm^3/hr while Inlet Pressure is 50mBar ~100mBar; d) C1000 MicroTurbine has international standard with rating for 1000 kW, the fuel consumption is 550 m^3/hr(CH_4=60%) and fuel inlet:5.3bar(g), CH_4>40%

The system of AIDC project and products has a simple, modular, robust, and reliable concept. With less maintenance meant to have high efficiency and effective for operations while it has minimum downtime and high availability. The products are suitable and excellent for grid-connected application with the less environmental burden.

5.3.9 Biomass Potential as Raw Material for Renewable Fuel

Joni Prasetyo, Badan Pengkajian dan Penerapan Teknologi, Indonesia

Badan Pengkajian dan Penerapan Teknologi (Agency for the Assessment and Application of Technology, AAAT) has 5 roles which are intermediation, Tech. clearing house, assessment, and technology audit and technology solution. Through all those 5 roles the AAAT needs to find a new innovation that is going to be beneficial for everyone. Technology services need to offer the best solutions to make the new innovation much better. The technology service will offer surveys, tech ref. tech audio, pilot project, and recommendation. Innovation and technology service is connected to the value proposition of three aspects Tech. state of the art, industrial competitiveness and sovereign economy and at the end appears domestic welfare.

Biomass in Indonesia has high potential due to rich of natural resources and agricultural area. The terminology of biomass identified by livestock waste, food processing waste, municipal waste, oil production biomass, sewage sludge. The most common material in Indonesia is municipal waste which is pulp paper or depending on the conditional of raw material. Energy is recovered either through biochemical & thermochemical conversion. The other common biomass materials in Indonesia as the agrarian economy is woody residues, woody biomass, sugar, and starch producing crops, herbaceous biomass, and non-edible parts of farming crops. As the efficient renewable resources for the power plant, only Biomass can be utilized for both power and fuel.

From palm oil industry, palm oil & the waste has a potential raw material for strategic future fuel. Regarding Renewable Fuel Developed by BPPT (AAAT), the potency of palm in Indonesia is as biggest CPO producer in the world (32 million ton/year), Palm Oil Mill Effluent, (POME) and possible to integrate as solid waste. The first thing is to get the renewable resources that can be a liquid waste and then the Bio-H_2 help to disintegrate the organism of the general waste and then Bio-hyphae and also the biogas is made by liquid wasted and then the biogas transforms to Bio-CNG. Finally, transform into electricity. Another way, it will be the crude palm oil (CPO) it has a long process but even though it is the longer it is the most commonly use. In addition, neutral carbon cycle for biomass; sunlight is required during the process then the fruits from the palm oil are taken. Next, all the seeds have to be gathered to obtain the extraction and the pyrolysis of the crude plant oil. After that, the oil is refining and the result will be green petroleum. Finally, it is stored in containers to be able to be used as a fuel.

Currently, there are many applications of Pure Plant Oil (PPO) to substitute fossil fuel at state-owned power plant company. By the background of High-Speed Diesel (HSD), consumption at industry and power plant is in average 12.5 million kiloliter per year. The potential of palm oil production is 32 million ton/year and as mandatory for biofuel or renewable fuel. The solution is PPO substitution for HSD on Power Plant of Diesel (PLTD) & Gas (PLTG) and the price of PPO shall less than in order to potential Saving and clean emission. The possible implementation following: a) step 1 (PLTD) evaluated as good performance up to blending 60% PPO and 40% HSD; b) Step 2 (PLTG) evaluated as good performance up to blending 20% PPO and 80 % HSD.

Assessment and Application of Technology pilot project for biogas power plant 0.5 MW capacity are using POME concept, divided by two subjects: a) subject 1 for design engineering, installation operation and maintenance for biogas power plant; b) Subject II for technology innovation and performance improvement for biogas power plant.

5.3.10 APEC Policy Partnership on Food Security: Climate Smart Agriculture

Matthew Tan, Co-Chair, WG1 Singapore Representative (Private Sector),

Policy Partnership on Food Security, APEC

There are several cases about food issues. For all those food industries that care about their consumers will take years to develop a product that is suitable for human consumption. However, there are some businesses that don´t care much about food safety causing the illness or even death to their consumers. Those businesses have been getting used to getting a higher profit by using the lowest quality and the cheapest raw materials for their products. Through all those issues local governments established laws for food safety. All those businesses that don´t follow the rules are going to be punished by fine or prison.

APEC regions had several problems in regulating food safety, but in 2011 the Policy on Food Security (PPFS) was established with the purpose to secure the region from hazardous products.

The PPFS has been gaining positive answer on the food security. There are still some that don´t want to follow the law, but by the time it will become better. The APEC PPFS have given a solid foundation for agriculture, aquaculture, fishery, food exchange and cooperation under various multilateral and bilateral frameworks. The APEC populations feel more secure about what they are eating and enjoy all the dishes that they like without any fear.

Another important fact is that Asia-Pacific accounts for half of the world's cereal production and over 40% of its trade volume, production growth depends on expanding cultivable areas and continue enjoying favorable weather conditions. Moreover, APEC members account for over 80 percent of global aquaculture production and more than 65 percent of the world's capture fisheries. The great news is that aquaculture is growing year by year and the APEC comprises 9 of the 10 fish producers in the world.

In order to maintain APEC PPFS successfully, new ideas and partners have been joining the cause. For example in the case of NTU APEC Centre for Sustainable Development in Agriculture and Fishery Sectors was set up in Singapore to support the initiative of PPFS WG1.

In some APEC regions are some ongoing project about PPFS. Most of the projects involve private sectors. Currently, APEC has a total of 9 ongoing projects and 2 in the discussion. The projects are a focus on technology and for clean and renewable energy related.

The population is growing and at the same time, we are lacking space to build or even grow our own products. Now it is the time to find a solution to growing our own products.

There are a lot of new inventions that can help civilization to survive. One of the initiatives is inland vegetable farming which consists in the indoor farming. It allows the farmer to control the temperature of the crops through greenhouses. Also, it expected that is going to increase in the next years bringing new opportunities and ideas. That is called Climate Smart Agriculture Initiative.

Some climate-smart greenhouse fundamental ideas were conducted. Currently, there are many factors that affect farmers to get an outstanding production on their crops. Greenhouse gases are trapping more heat in the Earth's atmosphere causing average temperatures to rise all over the world. Temperatures have risen during the last 30 years, and 2001 to 2010 was the warmest decade ever recorded. Leading to a reduction in the amount of water available for irrigation, high temperature and the lack of water for irrigation are the causes why farmers are having a difficult time to get their crops to survive.

The hardest time is the one that leads us to find a solution to the problems. That is what happened during this period of time, we are desperate to control or defeat global warming. As a result, many greenhouses & nurseries (for seedling) are negatively impacted.

Regarding solar energy distribution, as seen on the above graph nearly 50% comprehends the visible spectrum of visible light which might be used as part of the photosynthetic process of the plants. Plants intercept and diffuse the sunlight, however, only the wavelengths between 400-700 nm are part of the photosynthetic active radiation (PAR). Only 50 % of the incident radiation is employed by the plant to produce photosynthesis (Varlet-Gancher et al, 1993). Wavelengths between 380-510 nm are the most energetic from an ecophysiological point of view, as it represents a stronger absorption of chlorophyll Wavelengths below 360 nm are considered as ultraviolet, and even below 260 nm can have germicide effect. Also is important to notice in the distribution the percentage of the light reflected as it could potentially account for part of the lost energy. From the intercepted solar energy only about 5% is converted into carbohydrates.

High temperatures let us develop new ideas such as the development of an anti-thermal coating for greenhouse and indoor nursery use. This technique will mitigate the rising temperature in Green House that is decimating young seedlings. Also, it will help with the Reduction in energy usage – Energy used in Green House for cooling purposes. In other words, the owner of that technology is going to be able to control the temperature of the greenhouses according to the crop that is planted in. Out there are several types of technologies that are helpful to stop global warming. A lot of people complain about the prices to install them, but in a long run, it will be the inexpensive and sustainable approach. There explained the testing that the anti-thermal coating for greenhouses is scientifically tested. The SHGC is expressed as a dimensionless number from 0 to 1. A high coefficient signifies high heat gain, while a low coefficient means low heat gain. The development of an anti-thermal coating for greenhouse and indoor nursery has a heat reduction by 90% with a light transmission of 80%. The average reduction is about 8 degree Celsius. It gives an ambient temperature. This kind of system isn't only for crops. Also, it is the use of Indoor Aquaculture Hatchery & temperate species grow-out Aquaculture farm.

The integration to climate smart irrigation, the lack of water is a big issue for the development of agriculture. Nowadays, we are facing this kind of problem because of the global warming. There is a new technique that will stop this kind of problems such the Development of Soil Moisturizer for sustained release of water for Agriculture Irrigation. The development of soil moisturizer will allow water to get attracted to the roots and the soil will get wet easily. The plant is going to receive all the right amount of water and the right amount of moisture. Also, the plant is going to grow healthy and production will increase. The high temperatures also produce high bulk density on the soil letting the water drain faster, but with the development of soil, moisturizer will reduce the drain. This technique is inexpensive and sustainable to approach.

At this period of time, we don't have to waste money nor water. The climate smart irrigation system will allow us to save water up to 50% to 80%. Manpower is important for agriculture, but this system will allow the farmer to have a saving of 300% on manpower. At the end, the farm will increase in yield as much as 30%.

For use of renewable energy for climate-smart farming with growing population, we are taking all the farming fields for the constructions of new buildings. The growth of solar energy power generation is growing in huge scale which requires a vast amount of land. Ironically and very often, the land below the solar array has no economic benefit which becomes a growing dilemma for many policymakers. This scenario represents a clear opportunity and possible optimal solution where clean energy production and farming can co-exist under the same plot of land. Crops such as lettuce, mushrooms, chilies, and melon are suitable for this type of Sheltered Greenhouse.

Possible doubling of yield on the same plot of land, solar array design allows for good light transmission while lowering shading effects given by semi-pitch on which the panels will be set up while aiding adequate ventilation in order to procure optimal climate management. Translucent panel arrangement allows optimal sunlight to go through in order to integrate light diffusion inside.

Increasing efficiency of current PV System by overcoming inherent problem faced by solar farms globally. The booming demand for solar PV referred to Bloomberg report shows that SOLAR will provide almost half of the global energy requirement by 2030 (Reference: "2030" Market Outlook", Bloomberg New Energy Finance (2014)). German report shows that SOLAR will undergo substantial growth and be the major energy source in the world by 2100 (Reference: "The World in Transition: Turning Energy Systems towards Sustainability (Summary for Policymakers)," German Advisory Council on Global Change, Berlin 2003). In the last years, solar PV has been getting a lot of popularity around the world because of the great sustainability and durability. For example in U.S. solar power has been increasing from 2005 and it hasn't been able to stop. Also, there are popular companies in U.S. that have been using PV for their local use such as Walmart which is the higher consumer of PV followed by Costco. In 2013, Germany is the country that is leading the chart of the most use of PV and the last one is U.S. However, in both economies the use of PV is increasing. Meanwhile, woes of Current Solar Farms, the solar panels (Silicon-based) suffers from an inherent degradation problem which has plagued all existing solar cell and panel manufacturers since its inception. Many if not all solar farms are not able to meet their output projections leading to much unhappiness with their shareholders.

Light Induced Degradation (LID) is solar modules typically degrade around 3-6% within the first year of use and will peak around 20% - 25% degradation in their lifetime. It is widely understood that Light Induced Degradation (LID) due to the formation of Boron-Oxygen (BO) defects in the silicon solar cell, is the main culprit for this degradation. As advanced hydrogenation difference, the normal solar panels have a duration of 20 years of use with an efficiency of 20%. Meanwhile, treated panels have a duration of 20 years of use as well, but with an efficiency less than 3%.

5.4 Conclusions

RETI, a developing concept was proposed (Regulations, Economy, Technologies, and Integration) for developing the green energy smart farm. The workshop offered an opportunity to assess the validity of the preliminary findings, and provide the check, peer reviews and consultations, and also receive the feedback for further revised actions.

Chapter 6

Social Entrepreneurship Matters

6.1 The Social Problem: Solving through Smart Farming?

6.1.1 Social problem around food and farming

According IFAD 2015 report in State of Food Insecurity of the World, there is no "one-size-fits-all" solution for tackling hunger and food insecurity. Interventions must be tailored to conditions, including food availability and access, as well as longer-term development prospects. Inclusive growth provides opportunities for those with meager assets and skills, and improves the livelihoods and incomes of the poor, especially in agriculture. It is therefore among the most effective tools for fighting hunger and food insecurity, and for attaining sustainable progress. Enhancing the productivity through smart technology and production innovation held by smallholder family farmers through community economic integration and well-functioning markets are essential elements of inclusive growth.

Technology innovation and community integration should therefore directly lead to social protection, economic equality and ecological resilience which then contribute to hunger reduction and environment sustainability. Proactive detecting the sustainability problems through social and environmental thinking and institutional design, i.e. social entrepreneurship, for creating "win-win" situations is more than importance. For example, institutional purchasing through cash-for-work programs from local farmers to supply school meals will allow communities to buy locally produced food and support the disadvantaged families at vulnerable regions. That is, progress in the fight against food insecurity, natural damage and social injustice by resources reallocation requires coordinated and complementary responses from all stakeholders including the social designer of smart devices.

Norman *et al.*[4] explore the socio-economic dimension of farming. The combination of production processes (crop, livestock and off-farm activities) is the farming system. A farmer household by decision making faces biophysical and socio-economic elements. The biophysical elements determine the physical potential and constraints on livestock, tree and crop enterprises, etc... The socio-economic elements include exogenous and endogenous factors. Exogenous factors are those of political, economic social and technological (PEST) conditions. Normally they are institutional, including intangible social structures, norms and beliefs, and tangible services related to extension, credit institutes, input distribution systems, markets and land tenure. They could be non-institutional factors like population density, location, infrastructure or equipment. Endogenous ones are those available and more or less controllable factors by small farmer household, including land, labor and capital. All these factors of stakeholders are variables of smart farming. They cause social problems when technology interference changes the social-economic ecosystem and re-structuralize the welfare context of the farming system.

[4] Norman, D.W., Simmons, E.B. and Hays, H.M. 1982. Farming Systems in the Nigerian Savanna: Research and Strategies for Development. Westview Press, Boulder, USA. 275 p.

One of the social problems causes is new power group during technology application. They are traders, money lenders who benefit from new investment and business and often lack the responsibility of traditional patron-client relationships. The traditional farming systems of communal and reciprocal labor are being replaced by capitalized labor market in cash by the job or by the day[5]. For example the navetane system, strongly associated with the cultivation of cash crop groundnuts in Gambia and Senegal, is becoming increasingly monetized. Without social thinking and environmental literature, entrepreneurship through smart technology becomes next problem of re-industrialization paradoxically.

Social problems are embedded in rural relationships. Traditional power structures still influence village life. Village leaders as ones of the most important stakeholders should be involved in the introduction of agricultural change. It is important to make sure, however, that inequalities within a village are not increased by newly-attained economic power in technology change. Unless government makes explicit efforts, common property resources are likely to deteriorate and not be managed for the benefit of the community as a whole[6]. Community action, control, and regulation need to be increasingly emphasized in strategies to protect common property resources including grazing land, woodlots, wildlife, water and in controlling degradation and erosion[7].

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[5] Unité d'évaluation. 1978. Evaluation de l'opération arachide et cultures vivrières: étude agroéconomique de 32 exploitations agricoles en zone OACV. Institut d'economie rurale, Bamako, Mali.

[6] Jodha, N.S. 1986. Research and technology for dry farming in India: some issues for the future strategy. Indian Journal of Agricultural Economics. 4.

[7] FAO. 1993. Key Aspects of Strategies for the Sustainable Development of Drylands. FAO, Rome. 69 p.

6.1.2 Social problem as "biggest issue" of smart farm

The main challenge of a smart farm is to increase the productivity of agriculture in a sustainable manner, that is, to fulfill a holistic goal of triple-bottom lines. A smart farming system should tackle the problems of business, environment and social issues as a whole, and try to bring these values activities into a sustainable business model that is accessible to the farmers and their stakeholders of a community. The needs of small-scale farms in diverse ecosystems are to create realistic opportunities for their development where the potential productivity seems to be low, where the people are relatively excluded and disadvantaged and where climate change may have its most adverse consequences. The challenges of a smart farming systems include:[8]

- How to improve social welfare and personal livelihoods in the rural sector and enhance multiplier effects of agriculture?
- How to empower marginalized stakeholders to sustain the diversity of agriculture and food systems, including their cultural dimensions?
- How to maintain and enhance environmental and cultural services while increasing sustainable productivity and diversity of food, fiber and biofuel production?
- How to manage effectively the collaborative generation of knowledge among increasingly heterogeneous contributors and the flow of information among diverse public and private AKST organizational arrangements?
- How to link the outputs from marginalized, rain fed lands into local, domestic and global markets?

These concerns can be characterized by sustainability objectives which legitimize the values of smart farming. Though the five concerns highlighted the problems of smart

[8] IAASTD Executive Summary of the Synthesis Report (April 2008), p. 4-6

farming in two-ways, i.e., outside-in and inside-out, the problems pave one way of problem-solving: holistic thinking/action. That is, the farmers and their outside world need an intermediary function to bridge innovative solutions which should target the community problems of insiders and outsiders at the same time. These problems must be categorized and innovatively dealt in three levels: micro-farmer (individual, family and household), meso-network (friends, NPOs, enterprise) and macro-condition (market, government and ecosystem). Since a smart farming system is embedded in these problem contexts, it should not just work smart but also think smarter proactively. For tackling the problems in the associations between and within levels and dimensions, a smart-farming system will not smart work without collaborating with a smarter intermediary function. There are enough problems by smart-farming in an excluded, remote and disadvantaged area. Social Innovation seems to be a necessary alternative of collaboration with technological innovation. The definition of social Innovation incorporates not only technological but also social context oriented conceptual and procedural dimensions. The social innovation bears one ounce more -- problem-solving for sake of global sustainability.

6.1.3 How difficult could smart farming keep smart for social innovation?

Smart farming of social entrepreneurship can't be smart enough without considering the stakeholders' behavior. Acceptance and use of technology is dominantly determined by users' intentions which are conditioned through their social attributes, habits, hedonic and price awareness[9]. Behavior change is therefore the most desirable outcome to indicate the

[9] Viswanath Venkatesh, James Y. L. Thong, Xin Xu (2012): Consumer Acceptance and Use of Information technology: Extending The Unified Theory of Acceptance and Use of Technology MIS Quarterly Vol. 36 No. 1 pp. 157-178/March 2012

performance[10] of technological application. A very interesting case is SAFA tool[11]. This tool helps the small scale farmer to indicate their problems and performance just when they are able and willing to use it. Because both tangible and intangible cost/expectancy counts[12], it could be a very tiny psychological complex in the local cultural setting which fatally damages a project. Besides, stakeholder's position and benefit will interfere with each other[13] whose impacts could be embedded in any network node of the business ecosystem. Ledgerwood emphasizes how market, government and nonprofit sector forces have fostered an institutional context that reinforces the importance of global strategic environmental management for both small and large corporations.[14]

Agro-cultural problem must be spotted under climate change. For example: For Karan Fries and Karan Swiss cows, the comfort zone for the maximum milk yield is 7 and 25 degree Celsius respectively, and the milk yield per day decreased with increase in temperature and humidity[15]. But risk management of climate change depends on stakeholder involvement. Local participatory attitude, plan and action are necessary. Action research is acknowledged worldwide as a powerful form of learning. It is used in

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[10] Sundbo, J. (2008), Innovation and Involvement in Services, in Fuglsang, L. (ed.), Innovation and the Creative Process, Cheltenham (Edward Elgar)

[11] FAO (2014): Sustainability Assessment of Food and Agriculture Systems, Tool User Manual Version 2.2.40.

[12] SCHIFFMAN L. G. AND KANUK L. L. (1994), Consumer Behavior, 5th Edition, Englewood Cliffs: Prentice-Hall.

[13] Jeffrey S. Harrison and Andrew C. Wicks (2013): Stakeholder Theory, Value, and Firm Performance. Business Ethics Quarterly 23:1 .

[14] Grant Ledgerwood ed. (1997): Greening the Boardroom, Corporate Governance and Business Sustainability. Sheffield, Greenleaf.

[15] Shinde et al. 1992: In Earthworm culture and castings, Links: Ecosyn.us/ecosity/links/My links pages/earthworm 011. htm.

educational settings across the professions: in industry, hospitals, local government, and other workplaces.[16] But, diffusion of knowledge through social learning normally not exists physiologically.[17] Social entrepreneur are short of fundamental bio-energy knowledge, especially the female and small farmers who must be educated[18]. Moreover, the experts in different academic circles usually can't cooperate with each other under same vision[19]. By the way, most technologic-academic people can't be transformed in entrepreneurial spirit[20].

The farmers themselves as human resources play therefore the most important role of technique learning. Social entrepreneurs and their mobile learning guarantee the technology smart working.[21] Since social enterprise offers intermediary necessary experience[22], political and legal entities must create a friendly business ecosystem for start-ups by technological application for sake of innovative thinking and action[23]. That

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[16] McNiff, J., Lomax, P. and Whitehead, J. (1996) You and Your Action Research Project. London, Routledge.

[17] Toms, M., Morris, N., & Foley, P. (1994) Characteristics of visual interference with visuospatial working memory British Journal of Psychology 85, 131-144

[18] Omkar Joshi et al. (2013): Landowner knowledge and willingness to supply woody biomass for wood-based bioenergy: Sample selection approach. Journal of Forest Economics. Volume 19, Issue 2, April 2013, Pages 97-109.

[19] Bøllingtoft A, Müller S, Ulhøi JP, Snow CC (2012) Collaborative innovation communities: role of the shared services provider. In: Bøllingtoft A, Donaldson L, Huber G, Håkonsson DD, Snow CC (eds) Collaborative communities of firms: purpose, process, and design. Springer, New York, pp 89–104/

[20] Hayter, C. S. (2011). What Drives an Academic Entrepreneur? New York, New York,

U.S.A.: The New York Academy of Sciences.

[21] Kukulska-Hulme, A. (2007): Mobile Usability in Educational Context: What have we learnt? The Interdomestic Review of Research in Open and Distance Learning. 8(2)1-16.

[22] Archana Singh (2007): The Process of Social Value Creation: A Multiple-Case Study on Social Entrepreneurship in India. Springer press.

[23] Bailin, S. and Siegel, H. (2002). Critical thinking. In Blake, N. et al., eds. (2003). The Blackwell guide to the philosophy of education. Oxford, UK: Blackwell Publishing

Innovation must be transformed in competitive venture investment[24] if green energy market and producing cost is evaluated[25]. We need more experience and data from all stakeholders for entrepreneurial plan.

6.2Smart Farming: Sustainable without Social Entrepreneurship?

6.2.1 Problems of technology by social entrepreneurship

"Smart Farming represents the application of modern Information and Communication Technologies (ICT) into agriculture, leading to what can be called a Third Green Revolution. Smart Farming applications do not target only large, conventional farming exploitations, but could also be new levers to boost other common or growing trends in agricultural exploitations, such as family farming (small or complex spaces, specific cultures and/or cattle, preservation of high quality or particular varieties,…). Smart Farming can also provide great benefits in terms of environmental issues, for example, through more efficient use of water, or optimisation of treatments and inputs."[26]

A real smart farm is therefore implemented in the guidelines of sustainability: "Good Governance, Environmental Integrity, Economic Resilience and Social Well Being which in turn divide up into 21 themes and 58 subthemes with associated explicit sustainability

[24] N.M.P. Boken (2015): Sustainable venture capital – catalyst for sustainable start-up success? Journal of Cleaner Production. Volume 108, Part A, 1 December 2015, Pages 647-658

[25] Anna C. Ferreira et al. (2014): Technical-economic evaluation of a cogeneration technology considering carbon emission savings. Interdomestic Journal of Sustainable Energy Planning and Management. Vol. 0: 33-46.

[26] https://www.smart-akis.com/index.php/network/what-is-smart-farming/

objectives. With this holistic interpretation of the major sustainability themes, the SAFA guidelines provide an overarching common sustainability language and framework for the food and agriculture sector. For the first time it is possible to assess the sustainability of farms and agriculture in a standardized, transparent and comparable manner."[27]

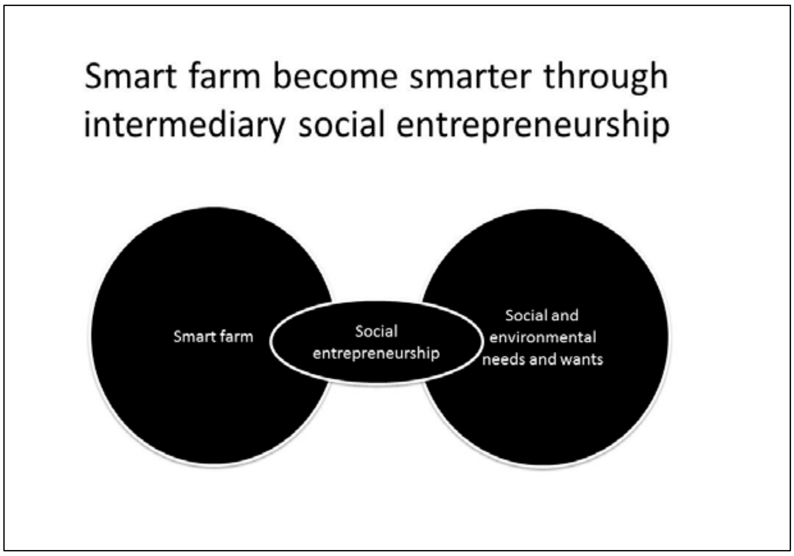


Fig 6.1 social entrepreneurship as an intermediary entity for bridging smart farm and sustainability problems

Social entrepreneurship is thus "irreplaceable", functions as intermediary body for problem-solving of sustainability which technology alone can't afford. A typical case is fair-trade. "Food security, free trade and sustainability are a triangle of factors that correlated with each other — one can't be excluded from the other. The world's current food production is actually sufficient to feed 7 billion people, but protectionism is a major problem affecting the availability and affordability of food. The barriers to open trade

[27] SAFA-Dimensions and themes (FAO 2013)

prevent goods from moving freely from one place of surplus to another facing shortage."[28] While government programs and fortified products can help food security, farms are ultimately the backbone of the industry.

Provided that supply chains are ready, small-scale farmers are not automatically empowered by smart technology. About 90 percent of the world's farms are small and found in rural areas. Most of them are poor and food insecure with limited access to markets and services. These smaller farmers need not by asking them to merge into a big firm, but to help them increase productivity through service support, education and entrepreneurship of best practices. "If you get production of smallholders up, you can raise their income and allow them to reinvest in the farm…these smallholders can be part of a solution (to food security) in some parts of the world".[29]

"Agritech" of smart farm including farm management software is defined as technology used to enhance farming systems and agricultural production. But business is business. Agriculture is a risky business economically, politically and environmentally. As technology plays a bigger role in agriculture and as governments start to relax private investment regulations investors could see better returns from their investments.[30] They neglect also the risks in the business ecosystem. Investments in a start-up support small-scale dairy farmers by providing smart milk collection and other services.

6.2.2 Social innovation and social enterprise for problem-solving of smart farming

[28] ETCNBC.com (2017): This fundamental global problem touches everything from farming to technology. Tuesday, 18 Apr 2017 | 8:59 PM.

[29] Ibid.

[30] Ibid.

Social innovation as “A novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals.”[31] A social enterprise is thus “an organization that applies commercial strategies to maximize improvements in human and environmental well-being—this may include maximizing social impact alongside profits for external shareholders.” “Social enterprises can be structured as a for-profit or non-profit, and may take the form (depending in which country the entity exists and the legal forms available) of a co-operative, mutual organization, a disregarded entity.”[32] “In the United States, "social enterprise" is also distinct from "social entrepreneurship", which broadly encompasses such diverse players as B Corp companies, socially responsible investors, "for-benefit" ventures, Fourth Sector organizations, CSR efforts by major corporations, "social innovators" and others. All these types of entities grapple with social needs in a variety of ways, but unless they directly address social needs through their products or services or the numbers of disadvantaged people they employ, they do not qualify as social enterprises.”[33] A typical agricultural social enterprise is a fair-trade based company. Fairtrade Labelling Organizations International (FLO) sets standards for fair pricing, humane labor conditions, direct trade, democratic and transparent organizations, community development, and environmental sustainability.

[31] James A. Phills Jr., Kriss Deiglmeier, & Dale T. Miller, 2006Rediscovering social Innovation. Stanford Social Innovation Review 2008 fall.

[32] "What is a Disregarded Entity – Disregarded Entity Definition". Biztaxlaw.about.com. 13 July 2013.

[33] https://en.wikipedia.org/wiki/Social_enterprise

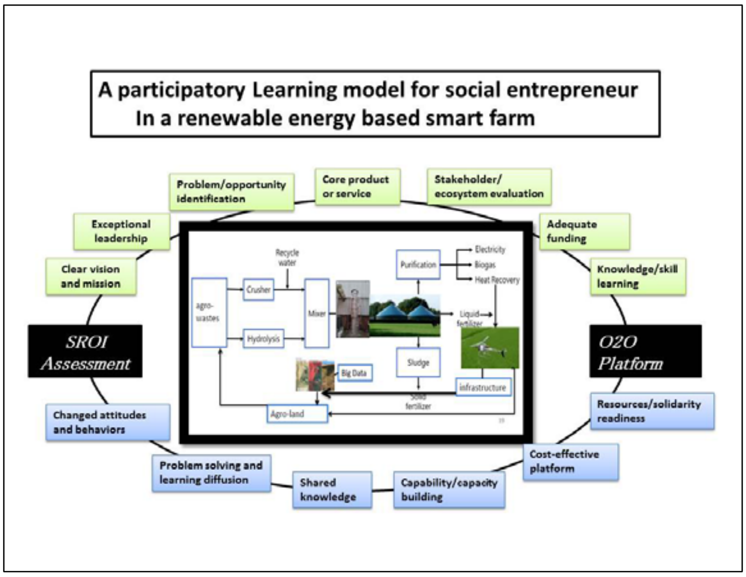


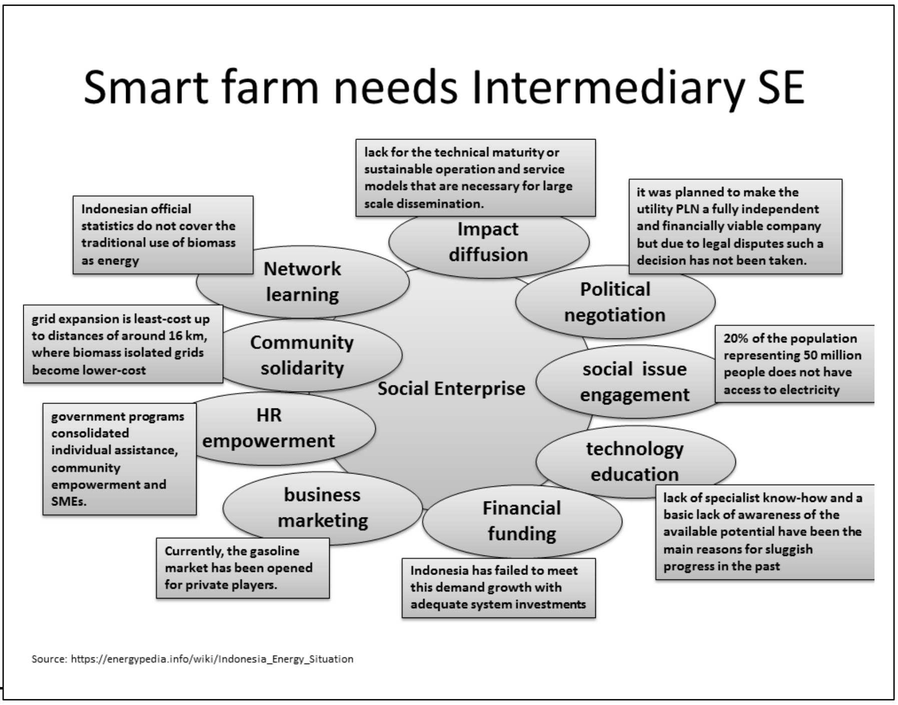
Fig. 6.2 The capabilities/capacities a social enterprise must be empowered around renewable energy-based business ecosystem

Fig. 6.2 shows the collaboration of social entrepreneurship with technology application process by smart farming. An entrepreneurship is characterized through mutual learning process around a renewable energy-based smart farming. The inner-circle of smart farming has barriers with huge cost and expertise. The outer-circle collaborated then a possible learning process for dissolving the barriers through social entrepreneurship.

6.3 Social Entrepreneurship: One of the Ways to Sustainable Smart Farm

6.3.1 Sustainability through social entrepreneurship[34]

Figure 6.3 demonstrates constraints/opportunities of Indonesian business ecosystem of green energy why a social enterprise could function as an intermediary entity tackling the problems of sustainability. They imply also managerial and market chances for social enterprises in their intermediary niches. If a social enterprise can find an appropriate business model to meet the needs and wants of the local households or agriculture smart farming in senses of green energy solution. The ecosystem constraints will be converted to big market chances like some in social innovative enterprise.



[34] Source: https://energypedia.info/wiki/Indonesia_Energy_Situation

Fig. 6.3 Intermediary situation of a social enterprise in a green energy business

Indeed, the intermediary functions have advantages of values creating, for example crowd-funding, voluntary initiatives, mutual learning, public campaign etc.. Through these functions a social enterprise can help a female worker learning in a relatively stable and consistent condition to access integrated resources fulfilling the mission on different levels. Moreover, a social enterprise can serve stakeholders in different professional way to meet varieties of needs and wants. Besides, communication is also a core competency of a social enterprise to solve problems in a holistic way of action. The so-called "arm-length-principle" make a social enterprise more flexible and collaborative.

6.3.2 Social entrepreneurship and sustainable smart farming?

Social problems are not isolated issues. They are close related with climate change and global sustainability which are the direct issues of smart farming. Without social thinking the smart farming would be "just smart". Nevertheless, social problems "share" the same conditions of smart farming as they are close associated in a unique local area where a social enterprise need to develop a glocalized strategy together with their local stakeholders.

Table 6.1 All-dimensional holistic development of smart farm sustainability

		Goals dimension: Sustainability			
		business	social	environment	governance
Initiative	technology	O2O, P2P	learning	carbon	expertise

dimension:	procedure	Cross-border	recruitment	cycled	communication
Innovation	concept	Fair-trade	Flip-over	renewable	network

Table 6.1 shows a complicated situation a local smart farming would challenge. Although "Greater competition from abroad may trigger improvements in productivity through greater investment, R&D, technology spillover.[35]" "Indeed, the constraints faced by rural women, in terms of lack of access to productive factors, such as land, credit, inputs, storage and technology, may undermine their capacity to adopt new technologies and/or take advantage of economies of scale to improve their competitiveness. In several developing economies, female small farmers who are unable to compete with cheaper agricultural imports have been forced to abandon or sell their farms, which in turn can contribute to their food insecurity."[36]

In facts in this table the third dimension will be "level" which demonstrates the dynamic social process through which we will watch the change, i.e. the I-O-O-I (input-output-outcome-impact) process of smart farming. It should disclose a social innovation action to be driven from any level, i.e., on micro-individual action, meso-network collaboration or macro-political regulation. Through mutual learning and innovative diffusion a social enterprise will build its own business model and find its way of sustainability.

The biggest challenge for social enterprise is then to develop sustainable business model (see figure 1-3, table 1) through self-empowerment. A smart farm costs much, hard to get

[35] IFAD, Food and Agriculture Organization 2015: The State of Food Insecurity in the World, United Nations.

[36] WomenWatch. 2011. Gender equality and trade policy. Resource paper (available at http://www.un.org/ womenwatch/feature/trade/gender_equality_and_trade_policy.pdf).

profit, need expertise and require long-term business strategy, not to mention the political barriers. Money, timing, passion and professional solution are four dominant factors which build social trust for social entrepreneurial development.

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Appendix

Guidebook for Building a Green Energy Smart Farm

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Guidebook for Building a Green Energy Smart Farm

APEC Project EWG 23 2015A

Best Practices for Developing the Green Energy Smart Farm in the APEC Region

CONTENT

1. Introduction

Renewable energy offers additional benefits over fossil fuels besides reducing pollution and carbon emissions. These decentralized power sources could potentially increase electrification rates cheaply in rural areas. The establishment of Green Energy Smart Farm could achieve the sustainable and efficient usage on agriculture resources and generate electricity for local needs. It could also provide new technologies and job opportunities for local new residents. Local women would be able to improve their income and living qualities by recycling agriculture waste and reducing the usage of chemical fertilizations. The improvement of local economic income could stable the society and enhance the protection of nature environment.

A robust legal framework must enable these projects to ensure that producers, whether self- generating or regional can supply electricity to users. Within APEC we see a wide variety of domestic strategies to develop both renewable energy and self-generation systems (micro-grids). Using data from the International Energy Agency (IEA) we surveyed: renewable energy generation, feed-in-tariff laws, and micro-grid laws in order to find successful examples of self-generation of renewable energy. In the survey we found economies fell into three categories: renewable and micro-grid laws, feed-in-tariff law only, and no supporting laws.

2. Scope and Objectives

Most of APEC members do not have economy-wide power grid to cover all territory and some area are located in quite remote without effective installation of electricity equipment. A remote farm could provide sufficient agriculture waste and materials in four seasons. Those materials can be produced to biomass and using as energy resource to generate power for local needs. Burning biomass could reduce methane emission from agriculture sectors and address climate change. Using renewable energy is not favor in only one single source but exclude other options. A smart farm using green energy is encouraging the usage of various energy resources within its environment. The green energy concept also means the increasing energy resources to produce electricity but not simply replace the usage of conventional energy in remote area.

Adopted renewable energy is one of options to reduce emission of greenhouse gas from using fossil fuel, especially the economies taking commitment under the climate convention. The convention required its member states to produce domestic adaption policies to address impacts of climate change. The renewable energy regulations help the APEC members to achieve their reduction goal and assist the development of renewable energies. Therefore, the establishing of green energy smart farm shall starts from the analysis of renewable energy development regulations.

3. Legal Concerns on establishing Green Energy Smart Farm

Establishing green energy smart farm involves both renewable energy and electricity regulations. Following suggestions are given for the project owner and investors.

3.1 Review Domestic Renewable Energy Regulations

In order to establish an energy smart farm, the project owner shall review whether their economy published the regulations to promote renewable energy development. Some economies might concentrate on limited renewable energy types but some encourage all different types of new energies. The authorized renewable resources by law could be a driven force to encourage users to develop more activities. Using the authorized renewable resources could increase the development confident of users and increase potential interests. Therefore, the user shall review the domestic renewable energy regulations and choice the most favorable renewable resources as its development materials.

Some Renewable Energy Regulations with APEC members provide low standard and recognize the small-scale renewable energy users as power generators. Take Chinese Taipei As example, its Renewable Energy Development and Management Act requires the owner whose power generator can produce 500 kW/h shall be treated as power generation business and regulated by the electricity Law. Those regulations prevent the renewable energy users to use heat-electricity operation and limit both usage and interests from the renewable energy.

3.2 Distinguish the power generation business in the Electricity Law

The Electricity Law provides management methods on the operation and governs competitive activities in the electricity market. Some Electricity Law in APEC members only allow the State entities to establish and operate electricity business, especially the developing economies in APEC region. Some APEC members even limited the assessment of the electricity business for foreign investors since the regulation limited the electricity business as limited investment item. A smart farm project owner shall review the electricity law and confirm the private sector could be able to assess into the electricity business by their domestic regulations.

Some APEC member aims to protect its economic development and requires the power generation and power supply sectors shall maintain "non-stop guarantee" policy in their region. Therefore, even small-scale power generators are treated as power generation business and limited their self-usage purpose. A smart Farm project will start from self-usage stage in the first of beginning, the limitation on power generation business shall be prevented and noted.

3.3 Fed-in-Tariffs policies within Renewable Energy Laws

Fed-in-Tariffs (FITs) is a financial assistant resource given by the government with a fix price to purchase electricity produced by the renewable resources. It also provides the most economic benefit and direct effects on developing of using renewable resources. Most of FITs policies are included in the renewable energy regulations. The user can produce electricity by using renewable resources and sell the electricity to government. It provides extra financial interests and attracts extra investors to join the renewable energy development activities. The smart farm project owner shall confirm whether the FITs policy is granted by the renewable energy development regulations.

3.4 Review General Utility Purchase Agreement

Some electricity laws also provide protections on public grid and only allow the grid shall be owned and controlled by government or state-owned company. The power grid became the most essential infrastructure to provide non-stop power supply and secure non-stop utility supply. Although some economies encourage usage of utility generated from renewable energy, the operator and owners of the grid own the final decision to install connections with the farm. It is useless unless the green energy utility could be delivered to the grid. The terms and conditions on the utility purchase agreement is a key document needs to be read. The utility buyer is obligated to implement the facility and connect the utility with the power grid.

3.5 Connection between Electricity Law and Renewable Energy Development Act

Most of the government uses separate regulations to encourage developing of renewable energy and manage the electricity business. The electricity law not only manages the demand and utility generation but also maintains protection of the electricity facilities. Some economies adopt strict regulation on power generations and require even small power generators shall be connected with public grid. The more restrict limitation on establishing power generation will limit the development of green power which generated from the renewable resources. The smart farm project is usually located in remote area without public grid coverage. The main purpose of using renewable energy in smart farm is using utility from renewable energy to improve living quality and sustainable development of the farm. When the electricity law requires most of power generator shall be regulated as commercialized operation but not self-usage power generator, it will increase the establishment cost and limit the development of the renewable energy. Therefore, the project owner shall review both renewable energy law and electricity laws and confirms the utility produced by the renewable energy could be adopted as internal usage.

3.6 Review the Regulations on Land

Some smart farm project is located in remote area without power grid coverage.

Establishing its own power cable and connect with other building or facilities are important to deliver electricity. The land regulations might grant the owner with extremely ownership rights and prevent any interference activities such as power cable installation cross above the land. Based on the Electricity Law, the power cable installation might need to apply license or installation permits from the government, and also permission from the landowner.

4. Financial Issue on Establishing Green Energy Smart Farm

Since the renewable energy gain the global interest, especially the integration to agriculture sectors or knows as smart farm implementation. The real case smart farm required the financial for farmers or investor in order to determine the investment. This session shows the economic analysis of developing the solar power to the smart farm in different regions.

4.1 Initial Cost and Maintenance

The substantial factors of investment determination, initial cost and maintenance hold the significant part of the financial calculations. Theoretically, initial cost calculated by these indicators: a) material required; b) installation labor; c) land incentives; d) tax and legalization; e) profit and commission. In another case, the investment depends on maintenance cost, and the basic factors may be different by investment type.

The case of solar energy investment required the solar module, inverter, electrical equipment, installation equipment for racking, installation labor, land incentives for lease, and legalization. The financial calculation is based on per kilowatt peak or hour installed. The price is dependent on the quality and locations, for example, the installation labor in Thailand and Viet Nam are different.

The solar module is divided by the quality and type. The monocrystalline as the original of photovoltaics modules is characterized as a higher efficient and crystal framework for tropical area. Polycrystalline module is the synonym for monocrystalline which made by pouring molten silicon into a cast. It has lower efficiency and characterized as thicker a millimeter. Polycrystalline and monocrystalline are the most installed modules as solar farm, rooftop, and new invention electronical. Other types of photovoltaics module are dependent on the usage and installation region.

The inverter is an electronic device or circuitry that changes direct current (DC) to alternating current (AC).The input voltage, output voltage and frequency, and overall power handling depends on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

The electrical installation equipment is dependent on the mechanics and situations. The farm installations required rack, meanwhile for rooftop required roof constructions. The land incentives are also dependent on the places, basically calculated as acres or square meter. In Thailand case it calculated as Rai (1 Rai = 1,600 m^2). The profit and commissioning depend on the company or developer.

Tax and legalization incentives might hold the significant part for start-up also their sustainability development. The most updated policy review required for the commercial used. The most case of solar energy contract is Power Purchase

Agreement (PPA) and Commercial on Date (COD) agreement. Both agreements discussed about the cooperation between investor or developer with government for commercial usage.

4.2 The Investment Analysis Theory

For an investment of a project, the investor should understand about the current condition and hope to reap benefits in the future. Regarding the return on investment that must be considered is the result of changes made from the profit. Based on Frank Reilly and Keith C. Brown theory, a period duration of investment is the holding period. Then payback period of the investment is HPR (Holding Payback Period) by using following formula

$$HPR = (End\ Value - Initial\ Value) / Initial\ Value$$

PR usually is bigger or equal with 0, if the value is bigger than 1. It meant that the profit is existed, as a flipside if lower than 1 or equal with 0 thus the investor failed to reap the profit from the investment. For evaluation of the percentage yearly profit, thus HPR must be converted into annual HPY (Holding Period Yield).

Annual HPY = $HPR^{1/n}$, where n is total years of investment.

Appropriate comparison between the total revenues in the future with overall spending in the present or in the future is important to note because there are differences in currency values calculated time period. This imbalance can be overcome by using time value of money concept. Based on this concept, the revenue and expenditure throughout the project are estimated to exist in the future. It is calculated by giving additional factor worth present value of the future. Thus, it can be seen in now and can be compared with the present condition. Present worth factor used in calculating the value of investment projects can use the market interest rate or bank rate. The formula of present worth factor is $DF = 1 / (1+r)^n$, where DF is discount factor, *r* is discounted level, and n is total years of investment.

Net Present Value (NPV)

Net Present Value (NPV) is a measurement of the profitability of an undertaking that is calculated by subtracting the present values of cash outflows (including initial cost) from the present values of cash inflows over a period of time. Incoming and outgoing cash flows can also be described as benefit and cost cash flows.

$$NPV = \sum_{t=1}^{T} \frac{Ct}{(1+t)^t} - Co$$

Ct : net cash inflow during the period *t*

Co : total initial investment costs

r : discount rate

t : number of time periods

Discounted Payback Period (DPP)

The discounted payback period is a capital budgeting procedure used to determine the profitability of a project. A discounted payback period gives the number of years, and it takes to break even from undertaking the initial expenditure, by discounting future cash flows and recognizing the time value of money. Good investment is that if the condition of DPP is lower than project period.

$$Discounted\ Cash\ Inflow = \frac{Actual\ Cash\ Inflow}{(1+i)^n}$$

i : the discount rate

n : the period to which the cash inflow relates

$$Discounted\ Payback\ Period = A + \frac{B}{C}$$

A : Last period with a negative discounted cumulative cash flow

B : Absolute value of discounted cumulative cash flow at the end of the period A

C : Discounted cash flow during the period after A.

Benefit Cost Ratio

A benefit-cost ratio (BCR) is an indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values.

Benefit cost ratio (BCR) takes into account the amount of monetary gain realized by performing a project versus the amount which it costs to execute the project. The higher the BCR results in the better the investment. The general rule of thumb is that if the benefit is higher than the cost, the project is a good investment.

$$BCR = \frac{PVB}{PVC} = \frac{\sum_{t=1}^{n} \frac{Bt}{(1+r)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+r)^t}}$$

PVB : present value of benefits

PVC : present value of cost

B_t : monetary value of benefits incurred during the period *t*

C_t : monetary value of cost incurred during the period *t*

r : discount rate

t : number of time period

Internal Rate of Return (IRR)

Internal Rate of Return is a rate of return used in capital budgeting to measure and compare the profitability of investments. It is also called the discounted cash flow rate of return (DCFROR) or the rate of return (ROR). In the context of savings and loans, the IRR is also called the effective interest rate. The term internal refers to the fact that its calculation does not incorporate the environmental factors such as interest rate and inflation.

$$IRR = \sum_{t=1}^{n} \frac{(Bt - Ct)}{(1+r)^t} = 0$$

B_t : monetary value of benefits incurred during the period t

C_t : monetary value of cost incurred during the period t

r : discount rate

t : number of time periods

4.3 The Investment Status Determinations

This part explained the basic theory and formula that commonly used for the academic purpose. The simple calculation table can be established by using Microsoft Excel® following Table 4.1.

The maintenance cost always increases annually along with domestic growth; the minimum could calculate as 10% increase. The revenue is calculated as feed-in tariff offered multiply with capacity installed, operation hours, 365 days for annual revenue calculations. For example feed-in tariff in Thailand by 2017 is 0.181 USD for 1 MW installations for non-stop operations. The annual revenue of Thailand is 0.181 x 1000 x 24 x 365= USD 1,585,560. The annual cash flow is calculated as reduction of revenue on the year with maintenance cost on the year. Then calculation for NPV of annual cash flow is conducted. The NPV is annual cash flow divide by multiply of year with one plus discount rate. Finally, the cumulative NPV is reduction of initial cost and NPV of annual cash flow of the year and reduced continuously. The example formula is referred on Table 4.2; *i* is percentage of maintenance cost annual increase, meanwhile *r* is the discount rate.

Table 4.1 The simplify calculation of NPV

Year	Investment Cost	Revenue	Annual Cash Flow	NPV of Annual Cash Flow	Cumulative NPV
0	Initial cost	0	-Initial cost	0	-Initial cost
1	Maintenance cost for 1st year	Revenue	The reduction of Revenue with maintenance cost for 1st year	Annual Cash Flow divide by (1+r) of year	Initial cost-NPV of Annual Cash Flow
2	Maintenance cost for 2nd year	Revenue	The reduction of Revenue with maintenance cost for 2nd year	Annual Cash Flow divide by (1+r) of year	Initial cost-NPV of Annual Cash Flow

Table 4.2 The example formula to calculate NPV

Year	No.	Investment Cost	Revenue	Annual Cash Flow	NPV of Annual Cash Flow	Cumulative NPV
No.	A	B	C	D	E	F
0	1	Input	Input	=SUM(C3-B3)	=D3/(1+r)^A3	Input
1	2	Input	Input	=SUM(C3-B3)	=D3/(1+r)^A3	=F2-E3
2	3	=B3+B3*i	input	=SUM(C4-B4)	=D4/(1+r)^A4	=F3-E4
3	4	=B4+B4*i		=SUM(C5-B5)	=D5/(1+r)^A5	=F4-E5

The cumulative NPV calculations show the minus or negative. It indicated the profit paid off the initial cost. For data process, it should be manual input due change the positive initial cost to negative and the negative (after calculations) to be positive to be shown in the profit.

The indicators of health and profitable investment for renewable energy especially solar energy, the payback period is less than ten years. As interpreted from the internal return rate, the last cumulative NPV has minimum five times higher than the initial cost for twenty until twenty-five years project which is indicate the profitable investment.

4.4 Financial Method

The financial method is based on investment inquiries of investor. Since most government in Southeast Asia region have no provide the subsidy or loan, the most possibility of investment is invited the local or foreign investors, otherwise the bank for loan also has possibility for operating the start-up solar energy. However, the bank loan is could be different calculation due to interest of loan.

The investment depends more with policy and bank status in a region. The basic requirement for loan or investment proposal is feasibility study, financial assessment and payback period calculation, operation and maintenance, project plan report, and company reliability certification.

5. Remarks

RETI, a new concept (Regulations, Economy, Technologies, and Integration) is for developing the green energy smart farm.

RETI

Regulations

Economy

Technologies

Integration