On behalf of:

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Ministry of Industry and Trade

Summary of Policy Guidelines for Developing Support Mechanisms for Grid-connected Bioenergy Power in Viet Nam

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Abbreviations

BMU	German Federal Ministry for Environment, Nature Conservation and Nuclear Safety
CDM	Clean Development Mechanism
CERs	Certified Emission Reduction
CIF	Cost, Insurance and Freight
EVN	Electricity of Vietnam
GDE	General Directorate of Energy
GDP	Gross Domestic Products
GHG	Green House Gases
GIZ	German International Cooperation
IRR	Internal Rate of Return
MOIT	Ministry of Industry and Trade
NPV	Net Present Value
O&M	Operation and Maintenance
PDP 7	Power Development Plan 7
TKV	Vietnam Coal and Mining Corporation
TOE	Ton of Oil Equivalent
VDB	Vietnam Development Bank
VGGS	Vietnam Green Growth Strategy
WACC	Weighted Average Cost of Capital

1. Background

Vietnam's high economic growth rate has led to increasing demand for electricity. Between 2001 and 2010, electricity production (including imported electricity) increased at average annual growth rate of 13.8%, nearly double the rate of overall economic growth. Electricity demand is expected to keep growing significantly in the forthcoming period, 2011–2030 forecasted at 10% per year[1], driven by increasing urbanization, population growth, as well as economic growth and industrialization. This development raises the questions regarding the availability of energy resources and environmental issues.

Vietnam has important fossil fuel resources but the reserves are not large. Total coal reserves are approximately 6.1 billion tons. Total oil and gas potential has been verified at about 1.05-1.14 billion tons of oil equivalent (TOE) with gas share accounted for more than 60 percent. Over the past years, these primary energy resources have contributed greatly to meet the increasing demand. However, the exploitation of coal so far has been focusing on open-pit mine which is depleting. An increase in the exploitation level would very much depending on the ability to apply advanced exploitation technology and the cost of doing it. At the present Vietnam is still a net energy exporter but it is very likely that this will soon change.

However, Vietnam has quite good renewable energy potential thanks to its geographic and climatic characteristics. The technical potential of hydropower in Vietnam is estimated at about 75 - 80 billion kWh with corresponding capacity of 18,000-20,000 MW. The solar energy potential in Vietnam is quite good because of being close to the equator. Annual average radiation ranges from 2.74 kWh/m2/day to 5.37 kWh/m2/day with the average number of sunny hours being from 1800 to 2800 hours. About the wind energy, according to evaluation of the World Bank, Vietnam has the largest wind potential amongst four countries: Vietnam, Thailand, Laos and Cambodia in which the proven potential is about 10,000 MW (GIZVN, 2010). Biomass including fuel wood and agricultural waste was estimated to be around 35 million and 75 million tons (in physical unit) in 2010. The other renewable energy sources include biogas, solid waste and geothermal. The draft renewable energy development master plan estimated their potentials of 100 MW, 320 MW and 472 MW, respectively (MOIT, 2009).

Realizing the problems, the Vietnamese government has decided to increase its reliance on renewable energy sources for electricity generation. The power development plan for period 2011-2020 with outlook to 2030 (in short, called as Power Development Plan 7 or PDP7) sets the target for renewable at 4.5% total electricity generation output by 2020 and 6% by 2030 from about 3.5% in 2010 - which are substantially higher than those set in previous power development plan[1]. Additionally, under Vietnam National Climate Change Strategy, approved in December 2011[2] and the Vietnam Green Growth Strategy, approved in September 2012[3], renewable energy development is also seen as important measure to mitigate climate change and to drive sustainable economic growth.

The country has issued a number of financial policies to promote renewable energy development including support on land use and capital, tax incentives, fees for environmental protection activities etc. Additionally, two renewable energy technologies receive preferential purchasing

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[1] Vietnam Power Development Plan for period 2011-2020 with outlook to 2030 has been approved by the Prime Minister at Decision No. 1208/2011/QD-TTg dated 21 July 2011 (in short, called as Power Development Plan 7).
[2] Climate change response strategy approved by the Prime Minister at Decision No. 2139/QD-TTg dated 5 December 2011
[3] National Green Growth Strategy approved by the Prime Minster at Decision No. 1393/QD-TTg dated 25 September 2012

price. Supportive tariff for grid-connected small hydropower is governed by the Decision number 18/2008/QD-BCT while grid connected wind power is by Decision number 37/2011/QD-TTg.

The legal framework for wind energy has benefited from a project titled "Establishment of legal framework for wind energy in Vietnam" which was sponsored by the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) and jointly implemented by GTZ (now GIZ) and the Ministry of Industry and Trade of Vietnam. The project completed in 2012.

For bioenergy (biomass, biogas and solid waste to energy) which is also an important and diverse energy source and one that the country is endowed in, the Vietnam government has the plan to develop separate support mechanism to promote the development of power projects based on these sources, similar to that of wind energy. In this regard, the GIZ and General Directorate of Energy (GDE) under the Ministry of Industry and Trade (MoIT) have organized the implementation of the studies on support mechanisms for grid-connected projects as basis for the development of support mechanism. They were conducted in the framework of the GIZ-GDE/MOIT Renewable Energy Support Project which is a subsequent project to the above described wind energy project and were carried out by consultants from the Institute of Energy and an international consultant from Germany.

Three reports have been prepared to examine the potential of biomass, biogas and municipal solid waste respectively and to develop financial supportive mechanisms for the development of grid connected power plants based on these sources. Each report extends over 100 pages.

Recognizing bioenergy for power generation is still in early stage while those reports are long, it is necessary to provide a summary of the key content and recommendations emerging from those studies to reach to wider audience.

This brochure is developed based primarily on these three reports. However, in some cases, original documents which were cited in those reports are examined so as to highlight important aspects.

This brochure proceeds as follows. Section 2 provides a summary of bioenergy potential including biomass, biogas and waste to energy to provide background information for the subsequent sections. Section 3 presents the methodology for establishing supporting mechanism which includes review of supporting mechanisms and existing supporting mechanisms in neighboring countries. Section 4 discusses the results and section 5 provides some conclusions.

2. Potential and current development status of bioenergy

Vietnam has a total land area of about 330,095 square kilometers, of which agriculture production area makes up 31% and forestry area 46%. Thus, agriculture is the major economic sector of Vietnam. Actually, agriculture is providing employment for about 70% of the population.

In 2012, agriculture had a growth rate of 2.86% and contributed 19.67% to the national GDP. The Socio-economic development Strategy 2011-2020 attaches great importance to the agriculture by orienting its development towards modernization, productivity enhancement and sustainable development, aiming at having more products with high added value. Thus, agriculture is and remains an important sector and consequently, agriculture by- products are and will be important and sustainable source of energy. It is estimated that presently approximately 90% of domestic energy consumption in rural areas is derived from biomass such as fuel wood, agriculture residues (e.g., rice straw and husks) and charcoal.

The good point about this source of energy is it is available locally because agriculture production area and forestry areas are everywhere distributed (Figure 1). According to the 2012 annual statistics, most of provinces/cities have a combined agriculture production area and forestry area higher than 50% of their land area[4].

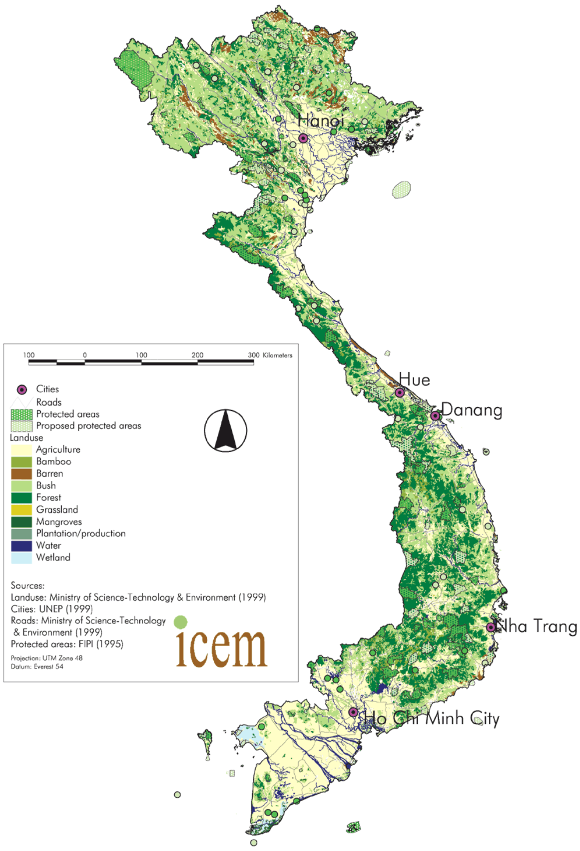

Figure 1: Land use in Vietnam

[4] Vietnam Statistical Yearbook 2012

2.1 Bioenergy potential

In this study, bioenergy comprises biomass, biogas and solid waste to energy.

a. **Biomass**: Primary solid biomass sources in Vietnam comprise: (i) wood fuel; (ii) wood processing waste, and (iii) agriculture waste

- Wood fuel: is understood as wood based fuel , including fuel wood such as tree trunk, tree branch, shrub, etc., that are collected by cutting or pruning trees. Wood fuel is harvested from natural forest (deforestation, forest fires, etc.), production forest, forest plantation, bareland[5] and through the thinning and pruning of industrial perennials (tea, coffee, rubber, cashew, etc.), fruit trees (orange, longan, etc.) and scattered trees. Estimation of fuel wood is based just on the area covered by a defined plant, its volume per area, its growth and its residue index (reduced by the amount that could be used in other non-energy uses).

  The total sustainable fuel wood supply was estimated to be about 35.81 million ton in 2010 and details are summarized in table 1.

Table 1: Harvestable amount of wood energy in 2010

Supply source of wood energy	Forested land (Mill. ha)	Harvestable amount of wood energy (million tons in 2010)
Natural forest	10.45	14.07
Forest plantation	3.63	9.07
Bareland	6.41	2.47
Industrial perennial	1.63	2.00
Fruit tree	0.82	0.41
Scattered tree	4.45	7.79
Total	**27.39**	**35.81**

- Wood processing waste: Wood waste at wood processors (sawmills and furniture makers) include wood chips, butt ends, bark and sawdust. The amount of wood waste is calculated on the basis of domestic wood production and sawn wood[6] that includes also the annually imported. In 2010, about 16 million m^3 was processed to produce 6.5 million m^3 of sawn wood. The ratio between wood waste and processing wood is 0.6[7] (10% of sawdust and 50% of other wood waste). The total amount of wood waste produced from sawmills in 2010 was 9.5 million m^3, equivalent to 6.7 million tons, including 5.58 million tons of wood waste and 1.12 million tons of sawdust waste.
  Wood wastes are also derived from replacement of old and defective woody materials in buildings, fences and other structures, especially from rural houses. The amount of fuel wood would be roughly 0.8 million tons per year.

[5] Bareland includes unused land and harvested forest. It is often covered with grass, shrub and small woody trees.
[6] Vietnam Statistical Yearbook of 2010
[7] Institute of Energy, 2009, Vietnam Renewable Energy Planning.

Table 2: Wood waste usable for energy production

Sources of wood waste	Wood waste useful for energy production (million tons in 2010)
Wood processing	
- Butt ends and tree bark	5.58
- Sawdust and shavings	1.12
Building (timber formwork and house repairs)	0.80
Total	**7.50**

- Agriculture waste: Annual agricultural waste comes in 2 main types: i). postharvest residues such as rice straw, sugarcane leaves and buds, corn leaves and stems and cobs, cassava stems, coconut shells and coir, etc., and ii). food processing waste such as rice husks, bagasse, groundnuts shell and coffee bean shells, etc..

  The amount of waste is based on crop residue index (residue to crop ratio in ton of residue per ton of crop production) issued by the Institute of Forestry.

  Total agriculture waste was estimated at 74.9 million ton in 2010 and details are summarized in table 3

Table 3: Agriculture waste in 2010

Agricultural waste	Usable agricultural waste (million tons in 2010)
Rice straw	40.00
Posthavest sugarcane residues	7.80
Postharvest corn residues	9.20
Cassava stems	2.49
Rice husks	8.00
Bagasse	7.80
Groundnut shells	0.15
Coffee bean shells	0.17
Cashew nut shells	0.09
Others (coconut, soybeans, etc.)	4.00
Total	**74.90**

b. **Biogas**: Biogas potential comes from two sources: (i) livestock waste (manure), and (ii) food processing waste water.

Livestock waste: The major livestock populations in Vietnam are pig, cattle, buffalo and poultry. Number of other livestock (horses, goats, sheep, etc) is small in comparison.

In 2010, there were about 8.5 million household-level animal farms and 18,000 centralized animal farms. With the total flock of 300 million poultry and the total home-bred animal herd of more than 37 million heads, livestock waste released into the environment has reached up to 84.45 million tons a year. The biggest proportion of livestock waste is from pig raising (24.96 million tons), followed by the amount of waste from poultry raising (21.96 million tons) and cattle (21.61 million tons)

As for food processing waste water, suitable waste water for biogas development come mainly from brewery and beverage establishments, rubber and coffee or seafood processing establishments, canned fruit factories, tapioca starch processing plants, or ethanol plants. However, no estimate has been made on the waste water amount from these sectors. However, Just from the fishery sector and trade villages the waste water discharge has been estimated at 1.5 billion m3 per day which has a high content of organic matter (80%) and can be suitable for biogas production.

Currently, there are about 150 cassava starch processing plants across the country with the processing capacity from 50 to several hundred tons of starch per day. These plants generate a huge amount of wastewater: every ton of starch produced generates 12 m3 of waste water, the COD and BOD contents of which are 18,000 – 20,000 mg/litre and 8,000 – 10,000 mg/litre, respectively.

c. **Solid wastes**: Solid wastes in Vietnam are commonly grouped into four categories: municipal; construction; rural, agriculture and trade village waste; industrial; and healthcare waste. Additionally, waste can be divided into two categories, namely hazardous waste and normal waste. For each category, there are different features in terms of composition and quantity value.

At the present, there is only some data on solid waste from urban areas and industrial parks. There is hardly any data on solid waste in rural areas. Nationwide from 2003 to 2008, the amount of solid waste has been increased by 150 - 200% on the average, the amount of municipal domestic solid waste increased by more than 200%, and that for industrial waste increased by 181% and expected to increase further in the coming time.

The amount of municipal solid waste in 2010 was estimated at 26,224 ton/day (9.57 million ton/year) or 1 kg/person/day. However, the collection rate is approx. 83 - 85%. Still, about 15÷ 17% of municipal solid waste are still disposed into the environment, e.g. pits, ponds and lakes; or get burnt in the open air, causing pollution to the environment.

As for industrial solid waste, according to the Department of Economic Zones Management under the Ministry of Planning and Investment, every day the industrial zones in Vietnam are generating about 8,000 tons of solid waste, equivalent to around 3 million tons of solid waste every year. However, the amount of solid waste is increasing with the increased rate of occupancy. On the average nationwide, in the two years 2005 – 2006, every hectare of rented land usually generated about 134 tons of solid waste per year. Then in the two years of 2008-2009, this number already reached to 204 tons per year, i.e. increased by nearly 50% for the total, and 10% on the yearly basis. The increase of emission per unit of land area has reflected changes in composition of industries in the industrial zones which are characterized by the emergence of several industries with bigger size and higher rate of emission. According to present forecasts, the total amount of solid waste from industrial zones will be around 6 to 7.5 million tons per year by 2015, and will reach 9 to 13.5 million tons per year by 2020 from 3.2 million tons in 2010.

Also under category industrial waste is solid waste generated from brewery and beverage industries which usually composes of organic and inorganic waste. The amount in 2010 was about 27 thousand tons. Inorganic waste accounts for a much smaller proportion (around 16.5%) and may include packaging materials, filteration additives, broken glass, empty cans, etc.). Organic waste accounts for the majority of up to 83.5% and may include spent grains, etc

Table 4 provides a summary of the potential by three sources. Unfortunately, these numbers cannot be summed up as they are not in the same category. Some are secondary energies which are ready for use (biomass) while the others must be converted into useable form for example animal manure through biogas digestors to produce biogas. Anyway, from the table, biomass appears to have the biggest potential at 33.5 KTOE. It is also large in relation to other energy resources and current national consumption - total final energy consumption in Vietnam in 2010 was 50.5 KTOE.

However, it should be noted that these numbers have not taken into account the collection rate which in some cases is not high. For example, the collection rates for municipal solid waste in 2010 were varying between 50 to more than 90 per cent with big cities tending to have higher rates. Other discounting factors including ownerships, distribution and seasonality have not been considered.

Table 4: Summary of bioenergy potential in 2010

Bioenergy source	Potential in 2010
Biomass (Mill. tons)	
o Fuel wood	35.81
o Wood waste	7.50
o Agriculture residue	74.9
Biogas	
o Manure (Mill. tons)	84.45
o Food processing waste water (Bill M3/day)	1.5
Solid waste	
o Municipal solid waste (Mill. tons)	9.57
o Industrial waste (Mill. Tons)	3.20

However, it should be noted that the potential could increase in the years to come, in particular biomass as a result of afforestation program. For example, decision 18/2007/QĐ-TTg dated 5 February 2007 by the Prime Minister sets the forest coverage by 2020 of 49% against the total land area, increased from 42% in 2010. Population growth increases the amount of residential solid waste and the collection rate at the same time improves following the Decision 2149/QD-TTg dated 17 December 2009 of the Prime Minister where the target of 100% solid waste is recycled, reused, energy recovery by 2050. Similarly, an increase in the amount of manure is also expected following the decision 10/2008/QĐ-TTg dated 16 January 2008 on husbandry sector development.

2.2 Current exploitation status

a. Biomass

Total consumption of biomass in 2010 was 12.8 MTOE, making up as large as 25% of total final energy consumption of the country. Detailed consumption by purpose and by type of biomass is given in table 5. The biggest consumption was for cooking by residential sector. Fuel wood is the biggest biomass used (65% of total biomass consumption). Nevertheless, fuel wood consumption for energy just represented 61% of its potential. Bagasse is the next in terms of ratio of potential for energy at 51%, primarily for combined heat and power generation in sugar mills.

Still, consumption of biomass was significantly below its availability, at 38% in 2010.

To date, there is no operational biomass-burning power plant in Vietnam. However, data put together from local reports suggest that about 10 investors have applied to build such plants each averaging 10 MW. They include eight Vietnamese investors and two partnerships with foreign investors. The reports show that most are likely to use rice husk to generate power for sale to the national grid and employ the fluidized bed combustion (FBC) technology.

Table 5: Biomass consumption for energy (KTOE in 2010)

User		Biomass type					Total
		Fuel wood	Husk	Straw	Bagasse	Others	
Heat	Cooking stove (residential cooking)	6552	395	990	88	890	8915
	Kiln	663	405	-	-	100	1168
	Burner	1145	100	130	100	698	2173
Combined heat and power	Combined energy generation	-	-	-	552	-	552
Total		**8360**	**900**	**1120**	**740**	**1688**	**12808**
% of potential		**61**	**38**	**10**	**51**	**34**	**38.2**

Note: Heat values: Wood fuel: 3800 kcal/kg; Rice husks: 3000 kcal/kg; Straw: 2800 kcal/kg; Bagasse: 1850 kcal/kg

These candidate projects concentrate in Mekong Delta provinces, specifically two in Tien Giang; three in Dong Thap; three in Can Tho; and one in Kien Giang. The reasons for their concentration in this region are: a). This region accounts for 55% of the national total of rice husk; b). This region is distant from fossil fuel sources, especially coal; and c) there is great demand for heat and power in this region, especially in the rice harvesting season.

As for co-generation, there are now 42 energy cogeneration plants including 41 sugar mills (with a potential for power generation of more than 500 MWe) and 1 paper mill, in which 6 bagasse-fired co-generation projects connected into the national grid with the total installed capacity of 88.5MWe[8]. Their capacity ranges from 1.5 to 25 MWe. The power and steam generated from these plants is used to feed these very plants. The majority of energy produced is used to crush sugarcane and refine sugar. There are only 3 plants selling their redundant power to the national grid at the price of 4-5 US cents/kWh. Other plants are keen to sell their power on their expansion.

Table 6: Current capacity of bagasse-fired co-generation power plants in Vietnam[9]

No.	Company	Current Capacity (MW)	Investment Status	Expanded Capacity (MW)
1	Tay Ninh Bourbon JSC	24.0	Under expansion investment	34.0
2	Gia Lai Thermal Power JSC	12.0	Under expansion investment	34.0
3	Ninh Hòa Sugar JSC	9.0	Under expansion investment	30.0
4	Cam Ranh Sugar Company	25.0	No change	25.0
5	Lam Son Sugar JSC	12.5	No change	12.5
6	Soc Trang Sugar JSC	6.0	No change	6.0
	Total	**88.5**		**141.5**

b. Biogas

Currently, small scale biogas projects have been widely developed across the country with more than 1 million facilities built and operated. Some industrial scale facilities have also been

[8] Nguyen Van Loc (2014) Issues to be considered while implementing bagasse-fired co-generation projects in Vietnam. Presentation at GDE/GIZ Summer School, organized in Ho Chi Minh City.

[9] Nguyen Van Loc (2014) Issues to be considered while implementing bagasse-fired co-generation projects in Vietnam. Presentation at GDE/GIZ Summer School, organized in Ho Chi Minh City.

developed for waste and wastewater treatment at livestock farms of industrial style, factories, brewery and beverage establishments, rubber and coffee or seafood processing establishments, canned fruit factories, tapioca starch processing plants, or ethanol plants, etc. However, amongst these, there is only one facility that produces biogas for power generation at the piggery of Animal Feed San Miguel JSC in Binh Duong province. This biogas facility has the total installed capacity of 17,000 m3 (generation capacity of 2 MW) and is invested by the Philippine SURE Renewable Energy Company. The others are designed just to generate biogas to replace FO oil or coal to run boilers. Excess gas is burned off or discharged directly into the environment. However, these if developed for power generation would have relatively low installed capacity, ranging from 1 to 3 MW.

c. Waste to energy

At present, there is only one waste treatment plant which produces electricity from landfill gas recovery. It is located in Go Cat, Ho Chi Minh City and has an installed capacity of 2.4 MW. There are however, a number of projects in the pipeline. These have a combined installed capacity of 105 MW and in various phases of development. Three technologies are proposed: (i) landfill, (ii) incineration, and (iii) plasma gasification. The technology mix is as follows: land fill: 15.3 MW (14.6%), incineration: 31.9 (30.4%), and plasma gasification 57.7 MW (55.0%).

Amongst these technologies, landfill is less attractive as large land area is required and the sites can release bad smell and cause water and air pollution. Therefore, the Prime Minister's decision No. 2149/QD-TTg dated 17 Dec 2009 approving the National Strategy on integrated solid waste management by 2025 and Vision by 2050 gives less priority to this technology.

Summary for this section

- Vietnam has good bioenergy resource. Amongst three sources of bioenergy, biomass has the biggest potential at 33.5 KTOE.
- Bioenergy resource tends to increase in the coming years as a result of forest development program, population increase and efforts towards a green society.
- Current bioenergy consumption is far below the availability and mainly for heat production. Biomass consumption in 2010 was just at 38.2% of the potential.
- Total installed power generation capacity from bioenergy was 154.4 MW with 41 plants. However, amongst these, there are only 6 plants with combined capacity of about 16 MW selling electricity to the national grid. Most of cogeneration plants in sugar mills generate power to feed their own plants.
- There is good potential to develop power plants based on bioenergy. For example, In the large rice producing provinces of An Giang, Dong Thap, Tien Giang, Long An, Kien Giang and Can Tho, as many as 100 rice husk based power plants with the capacity ranging from 500 kW to 20 MW each could be built.
- There are a number of grid connected bioenergy power projects under different stages of development. However their progresses are quite slow as actually they are waiting for favorable supporting mechanism from the government.

2.3 Existing policies for bioenergy power projects

A number of documents have been issued to support the development of renewable energy in Vietnam. However, two most important documents governing development targets for renewable energies are:

- Viet Nam National Energy Development Strategy 2020 (with an outlook to 2050) approved by the Prime Minister under Decision No. 1855/QD-TTg on 27 December 2007, *and*

- Viet Nam Power Development Plan 2011-2020 (with an outlook to 2030) approved by the Prime Minister under Decision No. 1208/2011/QD-TTg on 21 July 2011 (Power Development Plan 7 for short).

The National Energy Development Strategy defines the development strategy for the energy sector, including coal, oil and gas, electricity and renewable energy up to 2020 with an outlook to 2050. Accordingly, Viet Nam will develop a comprehensive and integrated system of energy: electricity, petroleum, coal, new and renewable energy. Development of clean energy, new and renewable energy will be prioritized. The target of increasing the renewable energy rate is set at about 3% of total commercial primary energy consumption by 2010, 5% by 2020, and 11% by 2050. The national energy development strategy also makes a list of prioritized technologies to achieve the above targets which are hydropower, wind power and the utilization of agricultural by-products and waste, respectively.

The seventh Power Development Plan (PDP 7) sets the targets for renewable electricity at 4.5% of total system electricity generation by 2020 and 6.0% by 2030. These translate into 3,192 MW installed capacity by 2020 and 9,892 MW by 2030, equivalent to 4.1% and 6.9% of the total power system installed capacity in 2020 and 2030, respectively. In these, targets for wind and biomass are defined clearly. The specific targets for wind are 1,000 MW by 2020 and 6,200 MW by 2030 whereas these for biomass are 500 MW by 2020 and 2,000 MW by 2030.

Along with setting targets, the government of Vietnam has issued a number of financial policies to incentivize the investment. A summary of the incentives for grid connected renewable energy projects is provided below.

Box 1: Summary of incentives for grid-connected renewable energy projects

Project development phase:

- Import tax: exemption on goods forming fixed assets, which cannot yet be produced locally
- Investment incentive: owner of renewable energy project can obtain loans of up to 70% of the total investment cost from the Vietnam Development Bank (VDB) at an interest rate equivalent to that of a 5-year government bond plus 1% per year

Operation phase:

- Corporate tax:
    a. Tax rate: 10% for 15 years, possible extension to 30 years
    b. Tax exemption for first 4 years, 50% tax reduction for next 9 years
- Accelerated depreciation rate
- Power purchasing price: avoided cost tariff is applied
- Land use levy and fee: free
- Environment protection fee: free

Generally, avoided cost based tariff is applied to renewable energy. Essentially, the avoided cost is the system reduced cost when one (1) kWh power from renewable energy source is injected into the grid. The tariff has two cost components: energy and capacity which is detailed by season and by time of the day. Obviously, the avoided cost in dry season is higher than that in wet season due to high share of hydro in the Vietnam energy mix. No capacity is paid in wet season. By definition, wet season spans from July 1st to October 31st whereas dry season from Nov 1st to June 31st. The avoided cost tariff is calculated and is announced every year. However, the avoided cost is presently based on financial cost, in which there is some subsidy for fossil fuel for the power producer as regulated by the government thus it is varying between 4-4.5 US cent/kWh, depending on the technologies. For example, for rooftop solar PV, the avoided cost tariff is estimated at 4.4 US cent/kWh. Thus, with this tariff, only small hydro power plants can be developed. In fact, there has been a significant growth in small hydro power since the introduction of this tariff mechanism in 2008.

As for wind energy, power purchasing price is regulated at 1,614 VND/kWh excluding VAT (~7.8 US cents/kWh) for a duration of 20 years from the operation date. The tariff is based on generation cost of an imported coal based power plant.

Summary for this section

- Vietnam has developed targets for renewable energy development with specific target for bioenergy.
- The country has also released documents on financial support for renewable energy projects.
- Bioenergy based power projects are treated similarly to other renewable energy projects where the purchasing price is based on the system financial avoided cost.
- It has been shown that this purchasing price is not favorable enough. Improvement is needed to ensure the achievement of renewable energy development targets set out by the government in the PDP 7.

3 Methodology for establishing support mechanism for grid connected bioenergy power

Experience shows that hardly any country could succeed in renewable energy development without government's support for the two reasons as follows:

First, although there are many opportunities for developing renewable energy in rural as well as far and remote areas these are mostly suitable for small scale projects and beneficiaries are usually poor. Therefore private investments on their own are rather unlikely to be successful. Renewable energy development in these areas is not only limited to energy supply but also relates to wider social issues such as job creation and income improvement. That's the reason why there must be a strong support from the government to attract renewable energy investments to these areas.

Second, social and environmental benefits from renewable energy are not yet reflected in price levels of a competitive electricity market. Therefore, price competition will become more difficult and without any interventions and support from the government it will lead to less and less renewable energy projects. Many studies have shown that if on-the-spot social and environmental benefits as well as contributions to reducing GHG emissions (which are considered a major reason leading to global climate change) are quantified and included in the electricity price, several renewable energy sources can produce electricity at an equitably competitive price, as compared with electricity generated from traditional fossil fuel sources.

Thus, for grid-connected power generated from renewable energy the main reason for the government's interventions is that those interventions will support to fill in the gap in the current electricity price levels which do not yet consider external costs. At the present, avoided costs for grid-connected renewable energy are only reflecting financial costs other than economic costs, i.e. not yet presenting costs of environmental damages and losses due to electricity generation from fossil fuels.

3.1 Review of supporting mechanisms

Most of countries supporting renewable energy are applying the following 3 options for pricing electricity generated from renewable energy, *namely*:

- Based on generator's costs plus a "reasonable profit"
- Based on avoided costs for electricity buyers
- Based on market price for power generated from renewable energy

a. Pricing based on generator's costs

The approach of pricing based on generator's costs is developed by the fact that renewable is more expensive than non-renewable energy in many countries (i.e. higher than the market wholesale price); without a higher buying price electricity from renewable energy sources will not be attractive to investors and cannot be developed.

For a good balance, it is necessary to set the price based on generation costs for each type of renewable energy and such a price must be relevant to the specific type of technology. For example, biomass projects are more costly than small hydropower projects, therefore these technologies must be given different electricity price levels. Another variation of this approach is to set the price based on a "reasonable profit". However, there are still debates on what should be a "reasonable" profit especially in the viewpoint of business owners. This is also a long-standing and classical concern of negotiators. One of the main advantages of the approach "announced avoided costs" is that there is no need for such a debate and/or negotiation.

b. Pricing based on buyer's avoided costs

The approach of pricing based on buyer's avoided costs, applicable to small renewable energy generators, was used for the first time in 1978 in the US along with the adoption of the Public Utility Regulatory Policies Act (PURPA). This Act is one among series of pricing solutions to reduce dependency on imported oil and increase domestic energy savings as well as energy efficiency.

c. Pricing based on market price for power

This approach is based on a hidden concept behind many supporting schemes for renewable energy, e.g. the quota system of UK, Chile and Romania. Under this approach, the government sets targets for distribution companies requesting them to buy certified renewable energy at a certain portion of the total electricity supply. Where there are many distribution companies, these "green" certificates are tradable among participating parties[10].

3.2 Consideration of options and models applicable for Vietnam

As shown in the previous part, Vietnam has taken a very first step for renewable energy price reform through the introduction of avoided costs. However this avoided cost is based on buyer's financial cost thus just a certain amount of renewable energy whose cost of generation is lower than the buyer's financial cost can be materialized. To ensure the achievement of renewable energy development targets set out by the government in the PDP 7, it is advisable that the tariff make closer to buyer's economic cost.

Analyses of existing renewable/biomass energy development models have led to several lessons of experience and suggested models for biomass energy development in Vietnam as follows:

- It is advisable to encourage support and create opportunities for every economic sector (including foreign investors) to invest in grid-connected bioenergy energy projects.
- In the early phase, it is advisable to give a strong priority to projects with prices below or equal to the price for power generated by imported coal-based thermoelectric plants. Once the projects respond to economic avoided costs, price allowances will be phased out.
- Other bioenergy power projects with prices above the price for power generated by imported coal-based plants will be supported through a competitive mechanism to receive reasonable subsidy and contribute to achieving the renewable energy targets pre-defined for the relevant year.

[10] Tradable green certificate schemes work as follows. Suppose that distribution company ***A,*** serving region ***X***, has only high cost wind power as a local renewable option. But ***A*** could also meet his renewable obligation by purchasing a green certificate from a small hydro supplier in region ***Y*** (even though that supplier may actually inject his green electricity into the grid of another company ***B****)*. This is the underlying concept for the carbon emissions trading scheme of the EU.

- It is recognized that most of biogas projects at the industrial scale are just focusing on environmental problems in livestock production and processing industries. There is a rather limited number of investment projects that set out combined objectives of environmental protection and electricity generation. Thus, it is crucial to encourage, motivate and facilitate all the economic sectors (including foreign investors) in implementing biogas projects with combined and synchronized objectives, in particular, resolving environmental problems and generating electricity to connect to the grid.
- Direct policy instruments should be used to encourage owners of existing advanced biogas facilities to expand their investments and add a grid connected electricity generation system. Examples of those direct policy instruments are price-oriented incentives, such as soft loans or tax credits. Once these projects already meet the avoided (economic) cost criteria, price subsidies will be phased out.

The reason to select generation cost of coal based power plant to represent system's avoided cost is coal is planned to provide prime power to the system in the coming period. The portion of coal-based thermal electricity in the system will increase from 18% in 2011 to 48% by 2020 and 56% by 2030. It is expected that from 2015 onward Vietnam will have to import coal for electricity generation. The national power system is increasingly relying on coal-based power and the world's coal price. According to the Power Sector Development Master Plan No. 7 (adopted in Decision 1208/QD-TTg) and the Coal Sector Development Master Plan (adopted in Decision 60/QD-TTg) the demand for imported coal for electricity generation will be around 130 to 140 million tons by 2030. Hence, it is reasonable to choose the coal-based thermo-power price as the reference and the target which is replaceable by bioenergy energy sources.

3.3 Methodology for calculating generation costs for grid-connected bioenergy projects

The levelized cost for each type of renewable energy project and imported coal based power plant which are fundamental to propose purchasing price is computed according to the following general formula:

$$\text{Gqd} = \frac{\sum_{t=1}^{n}(Cca(t)+Com(t)+Cnl(t)+Ck(t)).(1+i)^{-t}}{\sum_{t=1}^{n}S(t).(1-\Delta S\%).T\max.(1+i)^{-t}}$$

In which:

- Gqd: electricity price according to the levelized cost for the given type of project
- Cca(t): Cost recovery on the annual basis including recovered cost from the contributed equity and debt repayment (including principal and interest)
- Com(t): operation and maintenance cost for year t (including fixed and variable costs for O&M)
- Cnl(t): Fuel cost for year t
- Ck(t): Other operational costs for year t (if any)
- S(t): Capacity in year t
- ∆S%: percentage of capacity for self-consumption
- Tmax: average time when maximum capacity is used (hour)
- i: Discount factor

- t: project lifetime (economic lifetime, year)

There can be also consideration of fuel price escalations, which can be included in the fuel cost as follows:

$Cnl(t) = Cnl(t_0) \cdot (1+e)^{t-t_o}$

Where $Cnl(t_0)$ is the fuel cost of the base year t_0 not yet including the fuel price escalation factor.
e : fuel price escalation factor (%)

The discount rate is determined by the financing structure, which comes from two sources:

- Equity (investment's shares)
- Borrowing (debts)

The discounted rate is calculated by the Weighted Average Cost of Capital (WACC) which is defined as follows:

$WACC = (g \times r_d) + ((1-g) \times r_e)$

With: $g = \frac{D}{C}$

<u>*Where*</u>:

- g: Ratio of debts relative to Total investment Cost
- D: Debts
- C: Total Cost (consisting of debts and equity)
- r_d: average interest rate of all debts
- r_e: Cost of equity (shares dividend)

The question is how to define the cost of equity: r_e

The most common method is the "Capital Asset Pricing model" (CAMP) which has been applied in many countries, where:

$r_e = r_f + õ_e \times (r_m - r_f)$

$õ_e = \frac{\beta a}{(1 - g)}$

<u>*in which:*</u>

- r_m: the market average interest rate
- r_f: non-risk interest rate, which reflects the cost of borrowing from the government. The proposed non-risk interest rate is equal to the government bond's interest rate, which is the lowest one and in fact does not take into account any inflation factor.
- $õ_e$: beta coefficient of equity
- βa : beta coefficient of total asset

Use available data on the market interest rate, the average interest rate of all debts, the non-risk interest rate and the ratios of debts and equity relative to the total cost in order to define the values of r_e and WACC, which help calculate the selling price. Thus, r_e is the key among parameters used for defining a reasonable level of profit. With such approach, the interest rate for the investor's equity should be at least equal to the market average rate when the government bond's rate is equal to the market rate; that's to ensure the investor's benefits. On the other hand, when the government bond's interest rate is lower than the market rate, the biggest value of r_e should not exceed the total made up of the government bond's interest rate and the spread between the market rate and the bond interest rate corresponding to the beta coefficient of equity. That is to ensure that the shares dividend of the investor (i.e. interest from the investor's equity) is neither lower nor higher than the market rate by a substantial amount.

4 Results and Discussions

4.1 Levelized cost of bioenergy energy project

The following financial data are used for the calculation:

- Proposed financing structure: equity to borrowing 30/70. By regulation, it is required that the equity (investors's share) must not less than 15% of the project total investment capital. The above structure is proposed because with it the WACC (discounted rate) is the lowest and thus most benefitial for the project.
- VDB's investment credit interest rate: lending in local currency (VND) and in the base scenario – concessional rate is 10%/year.
- Repayment term: 10 years, with a grace throughout the construction phase
- Coefficient r_f = government bond's interest rate. The successful auction price in 2012 is proposed to be the base scenario, according to which the local currency bond interest rate is 9%/year.
- Coefficient r_m = commercial market lending interest rate. The average long term lending rate in VND by the state owned commercial banks at the present time is proposed to be the base scenario which is 12%/year.
- Fast depreciation coefficient (incentive for tax reduction): 10 years
- Project lifetime: 20 years
- Tax incentive (corporate income tax): 0% for the first 4 years and at 50% for the subsequent 9 years in accordance with the Government Decree 124/2008/ND-CP dated 11/12/2008 for enterprises working on renewable energy projects
- Financial indicators forecasted for the upcoming time
  - A general tendency in the short and medium term is that interest rates will be decreased to possible levels for „rescuing" enterprises, in particular the State will make adjustments or re-discount to export credit interest rate and reduce the government bond's rate, which is expected to be as low as to 8%. It will in turns lead to a decrease of concessional rates and market commercial interest (8% – 10%). In considering such a tendency it is suggested to consider a low scenario.
  - However, if there are changes in the market conditions due to inflation or market price fluctuations some indicators may also change. Thus, a high scenario should also be considered.
  - For defining coefficient Re and WACC, financial indicators under 3 scenarios are as follows:

Table 7: Financial alternatives

Coefficient	Base Scenario	Low Scenario	High Scenario
Rd	10%	8%	12%
Rf	9%	8%	10%
Rm	12%	10%	14%
Re (30/70)	12%	10%	14%
WACC	9.73%	7.9%	11.6%

- Additionally, the following inflation and escalation rates are considered:
  - Main fuels: 3.5%/year
  - Water: 0.5%/year
  - O&M: 4.0%/year
  - Other costs: 0.1%/year

Then the leverlized cost has been calcualted for biomass, biogas and solid waste to energy under 3 financing alternatives (base scenario, low scenario, and high scenario) in order to facilitate the sensitivity analysis in a context that borrowing interest rates tend to change quickly.

For biomass, 4 types of biomass are calculated i.e., sugarcane bagasse, rice husk, rice straw, and timber waste. For biogas, 2 types of technologies considered for sources of animal dungs based, industrial waster water based are advanced technology and simple technology (HDPE covered lagoon) and for solid waste, two technologies are examined, namely landfill and incineration.

A survey has been undertaken on the existing and planned projects to get key data for the calculation i.e, specific investment cost, O&M cost, efficiency and capacity factor. Specifically, alltogether, the project has gathered data of project including 9 biogas based projects covering three technologies; 6 biomass based projects including 4 rice husk based and 2 bagasse; and 10 solid waste based power projects.

Additionally, the study has also conducted survey from equipment suppliers as well as made review of relevant studies from neighbouring countries those that have supporting framework for grid connected bioenergy projects in place including Thailand and China.

Table 7 provides key figures for selected bioenergy technologies considered in this study.

Table 8: Key figure of bioenergy based power plants

	Investment cost (USD/kW)	O&M cost (% investment cost)	Fuel cost (USD/ton)	Capacity factor (Hours of full power)	Efficiency (%)
Biomass based electricity					
• Sugarcane bagasse based electricity	1,100	4	5	5000	20
• Rice husk based electricity	1,920	4	1.5	6500	22
• Rice straw based electricity	2,000	4	20	6500	20
• Timber waste based electricity	1,900	4	20	6500	28
Biogas based electricity					
• Animal dungs based electricity	2,519	4	0	6500	
• Industrial wastewater based electricity	3,841	4	0	6000	
• HDPE covered lagoon	1,625	4	0	6000	
Solid waste based electricity					
• Land fill based electricity	2,331	10.63	0	8000	40
• Incineration based electricity	4408	8.58	0	6500	25

Some bioenergy projects have other revenues in addition to selling electricity. These include (i) selling carbon credit, and (ii) selling ash (in case of rice husk burning). For the calculation, the following assumptions in relation to these revenues have been used:

+ Rice husk ash selling price: 10 USD/ton

+ Carbon credit price: 5 USD/ton CO2

+ Emission factor: 0.54 kg CO2/kWh, applicable from 2013 onward

Table 8, 9 and 10 below provide the calculation results of the leverlized cost and some financial indicators for biomass, biogas and solid waste to energy based electricity, respectively.

Table 9: Levelized cost and financial indicators for biomass based power plants

Indicators	Financial alternative		
	Base	Low	High
Sugarcane bagasse based electricity			
• Leverlized cost (US cent/kWh)	5.6	5.15	5.85
• NPV (after tax – Thousand USD)	475	421	521
• IRR (after tax - %)	10.5	8.5	12.4
Rice husk based electricity			
• Leverlized cost (US cent/kWh)	7.34	6.87	7.84
• NPV (after tax – Thousand USD)	842	750	921
• IRR (after tax - %)	10.5	8.52	12.4
Rice straw based electricity			
• Leverlized cost (US cent/kWh)	10.79	10.35	11.27
• NPV (after tax – Thousand USD)	950	875	1015
• IRR (after tax - %)	10.6	8.6	12.5
Timber waste based electricity			
• Leverlized cost (US cent/kWh)	8.77	8.35	9.22
• NPV (after tax – Thousand USD)	827	751	892
• IRR (after tax - %)	10.6	8.6	12.5

Table 10: Levelized cost and financial indicators for biogas based power plants

Indicators	Financial alternative		
	Base	Low	High
Animal dungs based electricity			
• Leverlized cost (US cent/kWh)	7.72	7.11	8.36
• NPV (after tax – Thousand USD)	226	215	229
• IRR (after tax - %)	10.5	8.5	12.3
Industrial wastewater based electricity			
• Leverlized cost (US cent/kWh)	12.29	11.20	13.31
• NPV (after tax – Thousand USD)	604	578	612
• IRR (after tax - %)	10.4	8.5	12.3
HDPE covered lagoon			
• Leverlized cost (US cent/kWh)	6.12	5.69	6.57
• NPV (after tax – Thousand USD)	72	69	73.6
• IRR (after tax - %)	10.4	8.5	12.3

Table 11: Levelized cost and financial indicators for solid waste based power plants

Indicators	Financial alternative		
	Base	Low	High
Land fill based electricity			
• Leverlized cost (US cent/kWh)	7.28	6.65	7.95
• NPV (after tax – Thousand USD)	187	166	228
• IRR (after tax - %)	10.1	8.2	12.0
Incineration based electricity			
• Leverlized cost (US cent/kWh)	10.05	8.8	11.39
• NPV (after tax – Thousand USD)	770	648	817
• IRR (after tax - %)	10.28	8.33	12.2

From these tables, it appears that bagasse based electricity appears to have the lowest cost, followed by biogas based electricity using HDPE technology and then land fill. On the contrary, industrial wastewater based biogas has the highest cost. However, at this stage it is not known how many MW can be developed by each technology at that particular cost and thus one could not say how many MW can be developed at the cost below the leverlized cost of electricity from imported coal – which is to be calculated in the next step.

4.2 Levelized cost of imported coal based power plant

At the same time, the leverlized cost of electricity from imported coal based power plant has been calculated to serve as a threshold for setting the purchasing price for bioenergy as calculated above.

Same approach as have been applied to bioenergy will be applied for imported coal based power plant.

According to information provided by EVN and TKV as a result of international contract negotiations concerning coal imports at the end of 2012, coal with thermal power ranging from 6,450 to 6,800 kcal/kg will be priced at around 100 to 120 USD/ton once imported to Vietnam. As the world's coal price is increasing and the Chinese demand for imported coal is also increasing, the average CIF price for imported coal may range at least 105 - 110 USD/ton at this time.

To predict the price for imported coal in the future, our forecast on the coal price (CIF) has been relying on the prediction that coal price for Vietnam will be escalated by 2%/year.

Table 11 provide key figures for the calculation and the calculation results.

Table 12: Key parameters of coal based power project

I. Input parameter	Unit	Value
Technical parameters		
Capacity	**MW**	**600**
• Percentage of self-consumption	%	7%
• Efficiency	%	42%
• Load factor	h/year	6,570
• Construction time	year	4
• Project lifetime	year	30
• Thermal value of coal	kcal/kg	6,500
• Coal consumption rate	kg/kWh	0.32
• O&M costs	%	3%
• O&M fixed cost	$/kW/year	19,7
• O&M variable cost	$/MWh/year	1,4
Economic parameters		
• Investment rate including interest during construction (IDC)	USD/kW	1,500
• Discount rate	%	10%
• Coal price in 1st year of operation	USD/ton	105/110
• Coal price escalation	%/year	2%
II. Levelized cost		
Levelized cost (according to base price for coal 105/110 USD/ton)	**US cents/kWh: 7.36/7.56**	

4.3 Proposed supporting mechanism for bioenergy power in Vietnam

Level of price and price incentive to each type of bioenergy generated electricity

With the background information, rationales and advantages of biomass power as described in the beginning chapter, as well as analyses and calculations as mentioned in the previous sections, it is proposed to fix the price for biomass-generated electricity at 7.36 US cents/kWh in order to achieve the Government's biomass power targets in the Power Sector Development Master Plan No. 7 and Decision No. 1208/QD-TTg (i.e., 500 MW by 2020 and 2000 MW by 2030). The proposed price is calculated based on the reference to the levelized cost of traditional imported coal-operated thermopower plants at the coal price under the base scenario.

The price incentive should be calculated for the whole period of project lifetime. It will make investment proposals be safer and more attractive to potential investors in this field.

The average reasonable selling price will be computed on the basis of reference to levelized costs of various types of biomass, then the price structure will be analyzed for defining the level of price incentive.

The average selling price for electricity will include: the selling price for biomass-generated electricity (to be sold to the power system i.e. EVN) and the selling price for CDM, any shortage will be treated as price subsidy. If the levelized cost of biomass power projects is lower than the imported coal thermal power price (to be purchased by EVN), the EVN will buy biomass power at the levelized cost for that type of biomass.

Level of price subsidy for 1 product unit (US cent/kWh) = Levelized cost at which reasonable profit can be made (US cent/kWh) – Buying price by the power system (US cent/kWh) – Selling price for CERs (US cent/kWh)

Where:

- The levelized cost at which reasonable profit can be made is the cost that has been calculated according to financial incentive conditions as indicated in the above paragraphs. The buying price by the power system (EVN) is suggested to be the levelized cost for electricity generation from imported coal-based thermal power.
- The selling price for CERs is the real market price for that, and the amount of CERs will depend on output of electricity and GHG emission factor of the system at the time calculations are done.
- Price subsidy (the remaining part)

Details of price subsidy by technology are as follows

Sugarcane bargasse-generated electricity: According to the calculations on the levelized cost and in comparison with the proposed buying price (by EVN), which is referred to the imported coal-generated electricity price, the sugarcane bargasse projects under all 3 financial alternatives do have production cost less than the proposed buying price by EVN. Therefore, price subsidy is not needed for this type of biomass. The selling price for sugarcane bargasse-generated electricity (sold to EVN) will be the same as the levelized cost calculated above.

Rice husk-generated electricity: The base financial scenario for the levelized cost for this type of biomass is equivalent to that of imported coal thermal power. Therefore, price subsidy will not be required for the base and low financial scenarios (where the selling price to EVN will be the same as the levelized cost calculated above) but will only be considered for the high financial scenario.

Rice straw-generated electricity: All the 3 financial alternatives indicate that the levelized cost for this type of biomass is rather high and higher than the price for imported coal thermal power. Among the 4 selected types of biomass, this is in fact the type of biomass that costs the most for production. Hence, there should be price subsidy to this kind of project and the level of subsidy (after deducting the part of EVN's buying price) can be different, depending on the used financial scenario.

Wood and wooden wastes-generated electricity: All the 3 financial alternatives indicate that the levelized cost for this type of biomass is also higher than the price for imported coal thermal power. Therefore, price subsidy levels will be calculated according to the abovementioned financial scenarios (after deducting the part of EVN's buying price).

Biogas based electricity – treatment of animal dungs: According to the calculation results presented above, the levelized cost discounted in the low scenario is quite equal to the EVN's buying price, therefore, price subsidy is not necessayr. In the base and high scenarios, price subsidy will be needed at a relevant level (calculated by deducting the part to be bought by EVN).

Bigas based electricity – treatment of industrial wastewater: In all of the 3 scenarios – low, high and base scenarios, price subsidy will be needed but at different levels (calculated by deducting the part to be bought by EVN).

Biogas based electricity – HDPE covered lagoon: In all 3 financing scenarios, the levelized cost discounted is always lower than the buying price that EVN may offer. Therefore, price subsidy is not necessary, and the selling price for biogas-generated electricity with this simple technology will be exactly the same as the levelized cost discounted.

Waste-based electricity generation projects using landfill technology: Calculations under the 3 financial alternatives show that the levelized cost for waste-generated electricity is rather close to the cost for imported coal-generated electricity. Therefore, price subsidy will not be taken into account for waste-based electricity generation using landfill technology in the base and low financial alternatives. In those two scenarios, the selling price offered to EVN will be the same as the levelized cost for generation. It means that price subsidy will only be considered in the high financial scenario.

Waste-based electricity generation projects using incineration technology: With given assumptions and different financial alternatives, our calculations show that the levelized cost for waste-based electricity generation projects using incineration is higher than the cost for imported coal-based electricity generation. Therefore, the level of price subsidy will be calculated for the financial alternatives, after deducting the buying price of EVN.

Below are the levels of price subsidy for each type of biomass under each financial alternative:

Table 13: Price subsidy for each type of bioenergy

Technology	Leverlized cost (US cent/kWh)			EVN's buying price (US cent/kWh)			Price subsidy (US cent/kWh)		
	Base	Low	High	Base	Low	High	Base	Low	High
Sugarcane bagasse based electricity	5.6	5.15	5.85	5.6	5.15	5.85	-	-	-
Rice husk based electricity	7.34	6.87	7.84	7.34	6.87	7.36	-	-	0.48
Rice straw based electricity	10.79	10.35	11.27	7.36	7.36	7.36	3.43	2.99	3.91
Timber waste based electricity	8.77	8.35	9.22	7.36	7.36	7.36	1.41	0.99	1.86
Animal dungs based electricity	7.72	7.11	8.36	7.1	7.1	7.1	0.62	-	1.26
Industrial wastewater based electricity	12.29	11.20	13.31	7.1	7.1	7.1	5.13	4.10	6.21
HDPE based electricity	6.12	5.69	6.57	6.12	5.69	6.57	-	-	-
Land fill generated electricity	7.28	6.65	7.95	7.28	6.60	7.36	-	-	0.59
Incineration generated electricity	10.05	8.80	11.39	7.36	7.36	7.36	2.69	1.44	4.03

Apart from direct price subsidy which is included in the selling price for generated electricity, biomass power projects are also entitled to other prevailing incentives, the most visible of which include exemption from equipment import tax, concessional interest rate, reduction of or exemption from corporate income tax as currently regulated.

Purchase of bioenergy generated electricity

- Power companies are supposed to buy the whole output of electricity generated by grid-connected biomass power plants.
- Buying and selling biomass-generated electricity is conducted through a power purchase agreement (PPA) according to the sample PPA, without negotiations.
- The PPA duration is 20 years, starting from the day of project commercial operation.

- The seller can extend the agreement duration or renew the agreement with the buyer according to the prevailing regulations. In that case, the price for electricity will be decided according to the market mechanism.
- Any changes in the tariff due to fluctuations of the price for technology will only be applied to new projects.

5 Conclusions and Recommendations

5.1 Conclusions

Having observed actual developments of bioenergy based power projects in Vietnam in the recent years, Nine (9) types of bioenergies have been selected and analyzed for further calculation of price and suggestion of price subsidy mechanism. These are (in priority order):

- Sugarcane bagasse based electricity
- HDPE based electricity
- Rice husk based electricity
- Land fill generated electricity
- Animal dungs based electricity
- Timber waste based electricity
- Rice straw based electricity
- Industrial wastewater based electricity
- Incineration generated electricity

As a result of calculations for the period from now until 2016, it is suggested to focus on development of sugarcane bagasse, HDPE biogas (the price of which is the most relevant to the electricity price in the system and to the EVN's affordability), rice husks and land fill (with a certain number of rice husk and land fill power plants looking feasible in terms of the price). After the year 2016, when the demand for imported coal increases, the price in the system will increase closer to 8-9 US cents/kWh (see Decision No. 1208/QD-TTg), and by that time, the other rice husk and land fill projects and the remaining five types of bioenergy will need to be developed.

Investment rate: in the beginning phase, selection and application of stable technologies will be very important for Vietnam, in the condition that our infrastructure for repairs and replacement are not sufficiently developed yet by that time. The technologies to be selected must have proven a high level of reliability, or must have been widely used around the world. During the period that standards are not developed yet, the selection of technology must ensure economic and environmental effectiveness and efficiency. Especially the electricity generation efficiency and emission parameters must be controlled through project documents (investment reports) and priority should be given to technologies with origin from G7.

Cost for electricity production and conditions for calculations: When analyzing and calculating the cost for biogas electricity production, we have considered and used binding conditions, in the principle that the electricity selling price should be set in such a way that the project owner can gain a reasonable level of profit. During the process of calculations, we have also taken into account the following factors impacting on the price for biogas power:

i) Technical factors: technology, level of advancement of technology, input materials

ii) Additional factors from existing supporting mechanisms: e.g. preferential interest rate, cost sharing ratio, depreciation time, tax reduction and/or exemption (for imported equipment, or corporate income), land acquisition, land use tax, land rental, access to infrastructure (grid connection, etc.), clean development mechanism (CDM).

iii) Sensitivity analysis: following price scenarios

Based on the abovementioned conditions, we have calculated the cost for electricity production under 3 scenarios for each type of technology, as well as under the scenario when inflation has impacts on the technologies. The detailed results of calculations are presented in Table 8-10 which are appropriate and sufficient to ensure a reasonable threshold of profit for project owners with FIRR equal to 10%.

Price subsidies: The way of providing subsidies and level of subsidy have been considered on the basis of production cost, reasonable level of profit, buying price in the system and selling price for CERs. The formula indicated in the inter-ministerial circular No. 58 by the Ministry of Finance and the Ministry of Natural Resources and Environment has been used to calculate the level of subsidy under the base scenario.

5.2 Recommendations

In the early phase from now till 2016, such the scheme should be applied to all 9 selected technologies and input materials that have been mentioned in this report. However, in a later phase, there should be further studies of actual conditions in order to promote other popular or potential technologies to new projects that are under stages of project identification or FS report preparation.

It is recommended to review the revenue generating mechanism for the Vietnam Environmental Protection Fund. With the only source of revenue from selling CERs, this Fund will not be sufficient to subsidize products from renewable energy such as grid-connected biogas power and biomass power.

In such a case, i.e. the Vietnam Environmental Protection Fund cannot balance its sources of revenue and expenditure to susbsidize CDM products as indicated in the report submitted by the Ministry of Industry and Trade to the Prime Minister on "**Renewable energy development master plan for Vietnam by 2020 and vision by 2030**", it is recommended to establish a fund to support biomass power, wind power, municipal waste-based power, and biogas in particular, or to support renewable energy in general. In that case, there must be studies to calculate sources of revenue for that fund, and develop an operational procedure for the fund, so as to ensure transparency, openness and information disclosure about the use of fund to give the smallest possible support to the biggest possible number of products from renewable energy.

In terms of the selling price for CERs, this study has conducted prudent calculations of the system emission factor (as of 2013), but a similar work needs to be done for the year 2014 in order to facilitate biomass power projects associated with CDM. There should be also an in-depth study on CER pricing, in order to create the best possible source of revenue for investors, reduce the burden to the Fund, and avoid any untransparent loopholes in the relation between buyers and sellers and the level of price subsidy.

The issue of borrowing interest rate has a big impact on the production cost. On 18 March 2013, the Standing Committee to the National Assembly already adopted a plan to revise a number of articles in the Ordinance on Foreign Exchange. The latest draft has revised and amended the articles relating to resident individuals' borrowing and repaying foreign loans on their own according to the principle "borrowing by one's self and taking responsibility for repayment by one's self according to the government's regulations". Once this revised ordinance comes into effect, there will be a possibility for investors to access to foreign loans and credits from foreign banks and institutions at a rather low interest rate. This issue also needs to be considered as a supplement to the conclusions of this report. In addition, the issue of corporate income tax is being discussed towards downward trend. So as the issue of borrowing interest rate, the issue of corporate income tax needs to be examined to complement this study as well.

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Annex: Summary on decisions of the Prime Minister governing support mechanism for biomass and waste based power projects

By the time this summary was completed, the Prime Minister released two decisions providing support mechanism for biomass and waste based power projects, respectively. Understanding these were based on the three reports for which this current report has attempted to summarize we have decided to include these decisions into this report to provide a complete story of the efforts and achievement of the GIZ-GDE/MOIT Renewable Energy Support Project on the establishment of support mechanism for bioenergy-based power projects in Vietnam.

The decision 24/2014/QD-TTg by the Prime Minister on the support mechanism for biomass based power projects was released on 24 March 2014. It has 4 chapters with 17 articles. Chapter 2 with 8 articles provides regulation on the planning of biomass power and chapter 3 provides incentives. In summary, grid connected biomass based power projects are entitled to the following incentives:

- Preferential power purchasing price:
    - For combined heat and power generation projects: 1220 VND/kWh (excluding VAT, equivalent 5.8 US cent/kWh) with adjustments to actual exchange rate.
    - For other biomass power: Avoided cost based tariff is applied
    - Duration of support: 20 years
- And other incentives including equipment import tax, concessional interest rate, exemption of land use fee, reduction or exemption of corporate tax as currently regulated (pls. refer to Box 1 for details)

For local grid connected biomass, power purchasing price is subject to negotiation with subsidy if any will seek from Vietnam Environmental Protection Fund

The decision 31/2014/QD-TTg by the Prime Minister on the support mechanism for waste based power projects was released on 5 May 2014. It also comprises of 4 chapters with content similar to the decision 24/2014/QD-TTg above including incentive provisions. The power purchasing price is regulated as follows:

- For land fill gas technology: 1532 VND/kWh (excluding VAT, equivalent 7.28 US cent/kWh)
- For incineration technology: 2114 VND/kWh (equivalent 10.05 US cent/kWh, also excluding VAT)

Table below shows those decisions have adopted the proposed prices for waste based power plants and for sugarcane (the high case). However, the avoided cost based tariff are still applied other biomass power. With the release of the two decisions 2 months after each other, it is hoped that the support mechanism for biogas power will be released soon, and together with the above two decisions will set important foundations for the successful development of bioenergy power projects in Vietnam.

Table 14: Comparison regulated prices with the proposed levels

Technology	Proposed purchasing price (US cent/kWh)	Regulated level (US cent/kWh)
Sugarcane bagasse based electricity	5.6	5.8
Rice husk based electricity	7.34	Avoided cost based tariff
Rice straw based electricity	10.79	
Timber waste based electricity	8.77	
Land fill generated electricity	7.28	7.28
Incineration generated electricity	10.05	10.05