PROJECT ON PROMOTING BIOMASS ENERGY FOR ASEAN REGIONAL AGRICULTURAL AND RURAL DEVELOPMENT COMMUNITIES

REPORT

MODEL OF USING BIOENERGY TO PRODUCE ELECTRICITY TO SERVE DAILY NEEDS IN DAIRY FARMS IN SON LA PROVINCE

Implementing Agency: Vietnam Academy of Agriculture Sciences

Ha Noi, 2021

Contents

I. GENERAL INFORMATION ABOUT THE MODEL OF PROJECT

1.1. Project name: Promoting biomass energy for ASEAN region's agricultural and rural development communities

1.2. Implementation model: The model of using bioenergy to produce electricity to serve daily needs in dairy farms

1.3. Donor: The Government of Japan through the ASEAN - Japan Integration Fund (JAIF)

1.4. Name and contact address of the executing agency and the project owner.

- Line agency: Ministry of Agriculture and Rural Development.

- Project implementing unit: Vietnam Academy of Agricultural Science.

1.5. Project implementation period: 5/2018 - 5/2020

1.6. Location of the project model: Moc Chau district, Son La province

II. OBJECTIVES, SOLUTIONS, CONTENT AND METHOD OF IMPLEMENTATION

2.1. Model implementation goals

- Effectively use biogas from biogas plants in the waste treatment process in dairy farming.

- Meeting a part of the demand for electric energy used in dairy farms.

2.2. Technology Solutions

- Improving and completing biogas works in dairy farms to meet the demand for biogas resources.

- Install and operate a generator system to meet the electricity demand for centralized dairy farms.

2.3. Implementation content

- Implementation location: Moc Chau district, Son La province

- Implementation time: 2018 -2020

- Scale: 100 - 150 dairy cows / farm

- The main implementation contents are as follows:

+ Activity 1: Collect data, investigate, survey, and evaluate the irrational points of biogas plants in the treatment of livestock wastes;

- Investigate and collect primary and secondary data locally
- Report writing and data analysis

- Evaluate current status of local biogas plants, analyze irrational points in biogas plants

+ Activity 2: Select and design biogas generator models

- Surveying households to choose households to build appropriate models
- Development of power generation model design

+ Activity 3: Building models:

- Renovate and complete biogas works in livestock waste treatment in concentrated dairy farms
- Construction and installation of generator systems using biogas energy sources;
- Evaluate the model's economic, social and environmental efficienc

+ Activity 4: Training and propaganda

- 01 training course on the model of using biogas for farm-scale power generation systems
- Project review workshop
- Report on research results.

2.4. Methods of implementation

- Methods of collecting information related to biogas plant systems, analyzing and evaluating technical parameters related to equipment and operation.
- Research and manufacture of air filtration systems and evaluate the treatment efficiency of manufactured air filtration systems; sampling the inlet and outlet gas of the biogas filter system;
- Evaluate the efficiency of the air filtration system in filtering gas sources from biogas plants.
- Method of installing and operating biogas power generation systems.
- Methods of analyzing the economic and social efficiency of biogas power generation models.

III. RESULTS OF MODEL IMPLEMENTATION

3.1. Selecting a site for model implementation and data collection, investigation, survey, and evaluation of the inadequacies of biogas plants in livestock waste treatment.

3.1.1. Choose a location for the pilot implementation

In order to implement the project's model, the unit implementing the project model in coordination with the consultants involved in the project implementation surveyed and evaluated the selection of the location to deploy the pilot. On the basis of the implementation plan, the unit leading

the pilot to coordinate professional consultants to build a set of criteria for selecting households to participate in the pilot as follows:

- The scale of dairy farming in Moc Chau district is from 150 dairy cows or more;

- Having medium or higher biogas plants; not using biogas for generator systems;

- Ability to cooperate with the project in implementing the pilot;

- Suitable for demonstration; visit and replicate the pilot;

Based on the given criteria, through field survey and assessment in Moc Chau district, Son La province, the project's model leader has identified and selected a dairy farm in Loi Tuoi Agricultural Service Cooperative, owned by Mr. Nguyen Thach Loi.

Loi Tuoi Agricultural Service Cooperative is located in sub-area 67, Nong Truong town, Moc Chau district, Son La province. Le Tuoi Agricultural Service Cooperative is a unit that produces and trades in many fields such as: cultivation and trading in agricultural materials and dairy cows. In which, dairy farming is the main business. The current status of the farm has 200 dairy cows in the business period.

Location of the pilot implementation: The dairy farm of Loi Tuoi Agricultural Service Cooperative, located in sub-area 67, Farm town, Moc Chau district, Son La province.

- Size of the farm: The farm uses 200 dairy cows on the farm's total area of 10 hectares; the farm is divided into separate areas in which the largest area is the grass growing area. Next is the dairy cow breeding area; office area.

- The farm has separate waste treatment area including compost and compost area; wastewater treatment area by biogas system of HDPE tunnel with a capacity of 500m3. The waste treatment area is built next to the barn area to facilitate the process of collecting manure and treating wastewater.

Based on the selection criteria and survey reality, the unit in charge of the pilot of selecting a dairy farm of the *Loi Tuoi* Agricultural Service Cooperative as a place to perform the demonstration pilot.

3.1.2. Survey and investigate the environmental status in dairy farming at the pilot implementation site

Carrying out data collection, investigation, survey and assessment of the current environmental status at the project's plilot implementation facility, a dairy farm in Loi Tuoi Agricultural Service Cooperative, led by

Mr. Nguyen Thach Loi.

Loi Tuoi Agricultural Service Cooperative is located in sub-area 67, Nong Truong town, Moc Chau district, Son La province. Loi Tuoi Agricultural Service Cooperative is a unit that produces and trades in many fields such as: cultivation and trading in agricultural materials and dairy cows. In which, dairy farming is the main business. The current status of the farm has 200 dairy cows in the business period.

Survey and assessment of the current state of environmental quality in dairy farms show that, basically the farm has invested quite methodically from livestock infrastructure to environmental treatment solutions. The environmental quality assessment at this facility is recorded as follows:

Table 1. Evaluation of odor at the dairy farm of the Loi Tuoi Agricultural Service Cooperative

No	The location on the farm	Odor	Measures for environmental management
1	Barn	mild stench	Regular cleaning 02 times a day (morning-afternoon)
2	Office area	mild stench	Regular cleaning once a day (in the evening)
3	Environmental treatment area	stench	3-5 days to clean up once
4	Grass growing area	mild stench	Not regulated

The assessment results show that, the effect of odors from waste sources in dairy farming at the facility is basically well managed. In the cow breeding areas, the barn cleaning is conducted regularly every day so the office area and the barn have a slight odor, which is suitable for cattle farms.

In the livestock waste treatment area including the manure warehouse, the wastewater treatment facility with the HDPE biogas system often has a stench, because this is a gathering area containing waste sources collected daily from in the camp's husband.

In the grass growing area, there is a slight odor caused by the use of wastewater after the biogas HDPE system to irrigate the grass. The use of this water is not regular 7 days, watering once every 7 days, but because in the process of watering, this water still smells so bad when watering on the grassland still smells of cow manure.

The assessment of the wastewater quality of the farm showed that the source of wastewater for cattle breeding was generated from the cleaning of cows, barns, feeding troughs…. Cow breeding wastewater contains a lot of cow waste, food chips, straw, rice husks in the barn. The farm's cow breeding wastewater is treated through the farm's 500m3 HDPE biogas plant system. All wastewater, a part of solid waste is put into this treatment system. The results of wastewater quality analysis after the HDPE biogas system are gathered in Table 2.

Table 2. Waste water quality after the HDPE biogas plant at Loi Tuoi Agricultural Service Cooperative

No	Parameter	Unit	Level	Vietnamese Standards 62-MT:2016/BTNMT	
				Column A	Column B
1	pH	-	7,5	6,0-9,0	5,5-9,0
2	BOD	mg/l	1.506	40	100
3	COD	mg/l	2.543	100	300
4	TSS	mg/l	1.221	50	150
5	N ts	mg/l	745	50	150
6	Coliform	MPN/100ml	$3,0 \times 10^4$	3000	4000

The analysis results of the above table show that the characteristic properties of cow breeding wastewater after the HDPE biogas plant system at the dairy farm of Loi Tuoi Agricultural Service Cooperative are as follows:

Cow breeding wastewater has a very high concentration of pollution, especially organic substances that make BOD and COD many times higher than the regulations, which directly affects the ecosystem if not treated.

Solids present in water prevent the water from becoming cloudy brown. If released into the environment, it will affect the water source and the growth of organisms in the water by reducing the amount of light shining into the water.

N nutrient has a very high concentration, causing eutrophication of water if discharged into the environment

In particular, harmful microorganisms in wastewater can cause diseases for humans and nearby organisms such a*s dysentery, typhoid,*

diarrhea, ...

3.1.3. Analyzing and evaluating the current environmental situation at the establishment implementing the pilot

+ The total amount of farm waste is calculated as follows:

- Total amount of solid waste: 200 dairy cow's x 15kg/head/day = 3,000kg/day;

- Total amount of wastewater: 200 dairy cow's x 50 liters/head/day = 10,000 liters/day;

Thus, according to calculations, the total amount of waste from dairy farming on the farm discharges an average of about 3 tons of fresh manure and 10m3 of wastewater. Calculated in a month, the amount of waste is cow dung about 100 tons and 300m3 of wastewater. The total amount of waste discharged into the environment is about 400 tons per month on average.

Thus, the cause of the emission of odor and waste water not yet reached is due to the overloaded waste treatment system, the solid waste collection system and the waste water that have not reached the time of treatment in the biogas system and discharged.

+ Regarding the current status of waste treatment facilities and biogas sources from waste treatment facilities on farms:

- The farm has invested in a separator system to reduce the load of manure and the biogas work system; separated solid waste is composted; All wastewater is treated by a 500m3 biogas plant system.

- The system of works was built for 3 years; however, the actual status of the biogas plant has deteriorated; many holes were punctured; The quality of the biogas is not stable.

- The whole amount of biogas generated a small part is used for cooking purposes on the farm; Most of the remaining gas is disposed of in the form of direct burning, causing waste.

3.2. Design models of biogas power generation

+ Design of generator house

Based on the field survey results, the pilot's design consultant cooperates with the farm owner to select the location of the generator and at the same time coordinates with the construction contractor, Construction Design Consulting Co., Ltd. and Dang Quang trade proceeded to design; Calibrate the technical parameters to build a warehouse and install generators and air purification systems.

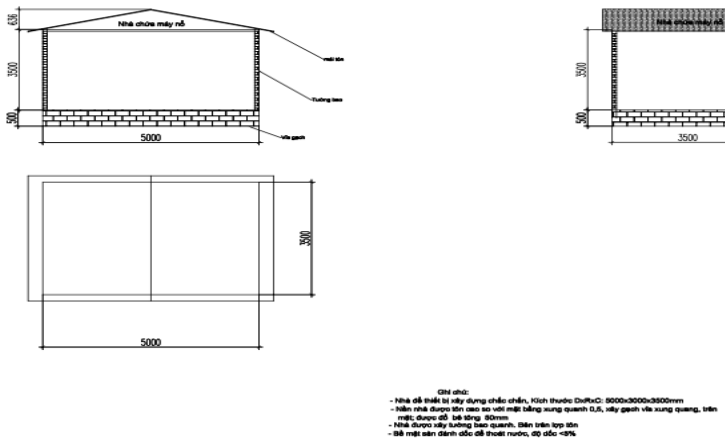

Figure 1. Generator house drawing

+ Design models of biogas power generation

Design consulting in collaboration with chief consultant, environmental and consultant and waste management consultant; coordinating with the contractor of Thai Ha Investment and Services Joint Stock Company to design and adjust technical parameters to build and design biogas generator models.

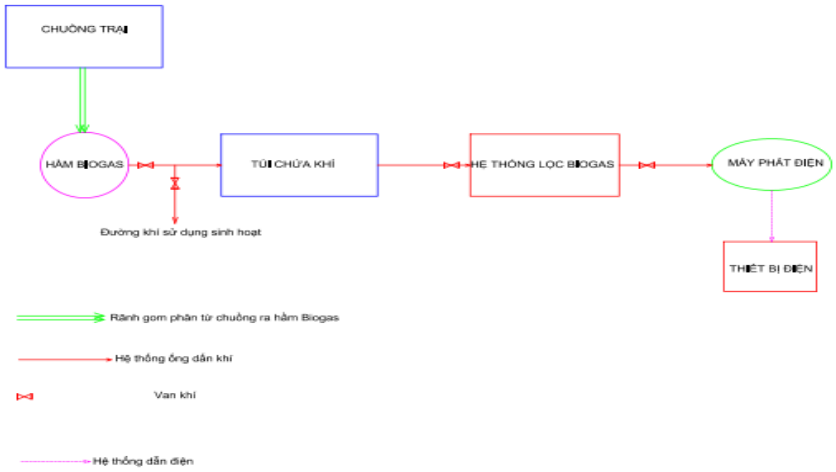

Figure 2. Diagram drawing of biogas power generation pilot

Design consultant coordinates with chief consultant, professional consultant to give the technical parameters to the contractor to design and make appropriate drawings.

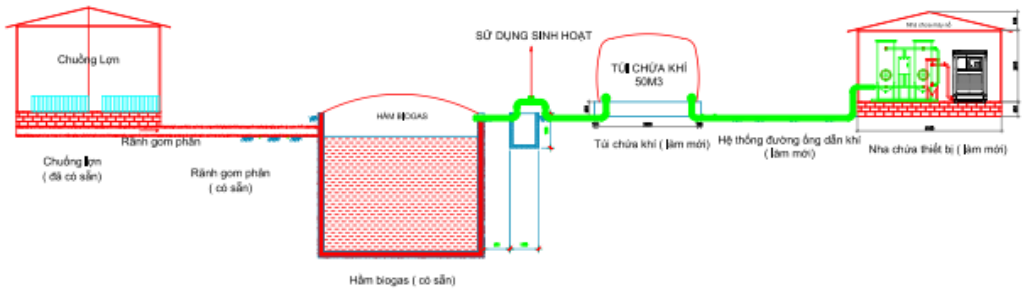

Figure 3. Overall drawing of biogas power generation pilot

Design consultant coordinates with chief consultant, professional consultant to give the technical parameters to the contractor to design and make appropriate drawings.

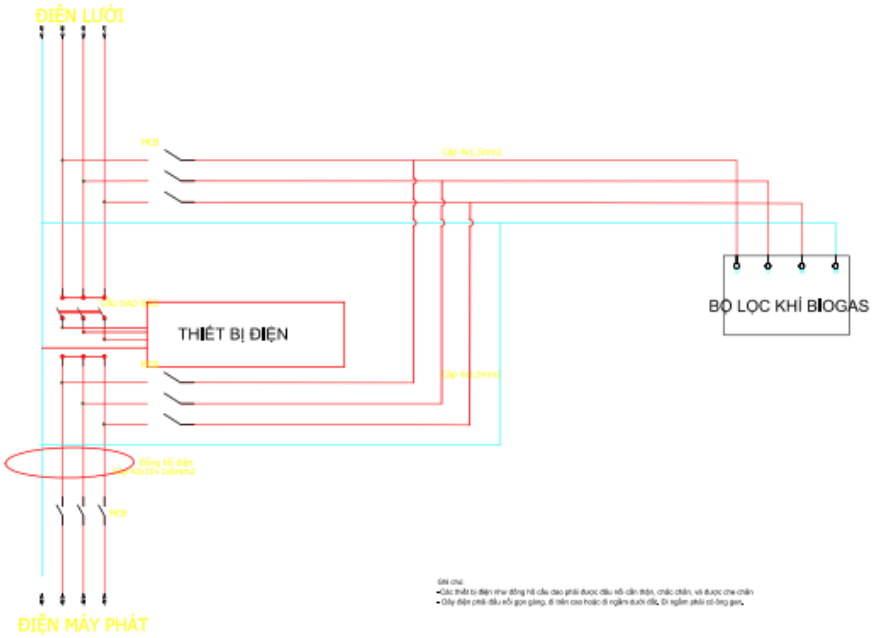

Figure 4. Model of biogas generation

Design consultant coordinates with chief consultant, professional consultant to give the technical parameters to the contractor to design and make appropriate drawings.

3.3. Pilot of using biogas to generate electricity in dairy farms

3.3.1. Improving and repairing the biogas plant system at the facility where the model is deployed.

Implementing the project's pilot, the unit in charge of implementing the pilot coordinates with the farm owner who is the basis of the project's pilot implementation to renovate and repair the biogas system. Appropriate to use biogas for generator systems.

The implemented work items include:

- Coordinate with the farm to dredge the farm's old HDPE biogas plant with a capacity of 500m3.

- Coordinate with the farm to re-fill the canvas to cover the 500m3 HDPE biogas plant.

- Coordinate with the farm to re-weld the holes and complete to collect gas from the 500m3 HDPE biogas plant.

- Coordinate with the farm to make the gas path from the biogas plant to the generator installation area and the living area.

The result of the activity is that after the renovation and repair of the biogas plant system at the Loi Tuoi dairy cow farm, it is back to operation; the ability to generate gas and the quality of the gas produced is good.

Thus, in order to serve the implementation of the pilot, the unit in charge of implementing the project model has cooperated closely with the farm owner to carry out work contents such as repair, renovation to improve. quality of the farm's available biogas system to best serve the needs of gas supply for the next activities of the pilot

3.3.2. Designing and manufacturing biogas filtration systems used for biogas generators

Design consulting in collaboration with chief consultant, environmental and consultant and waste management consultant; coordinating with the contractor of Thai Ha Investment and Service Joint Stock Company to design and adjust technical parameters to build and design biogas filtration systems used for generator systems.

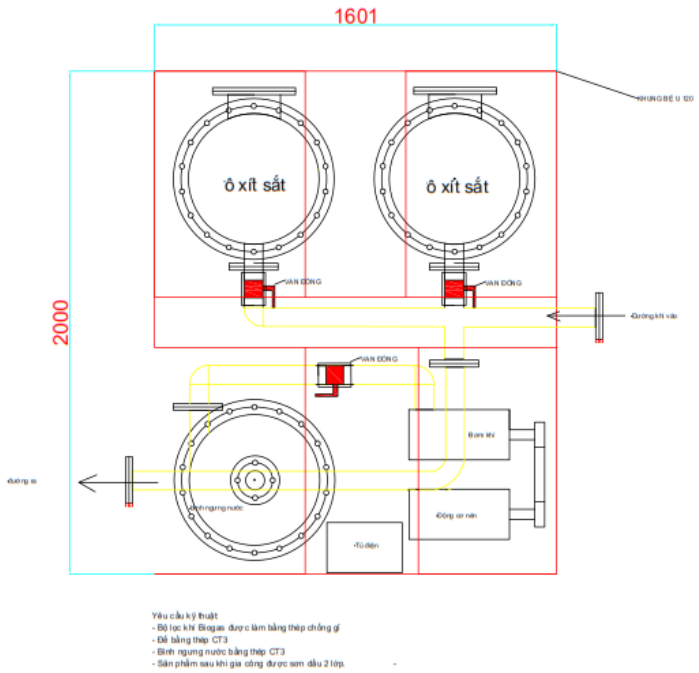

Figure 5. Design drawing of H2S filter element for biogas filter

Design consultant coordinates with chief consultant, professional consultant to give the technical parameters to the contractor to design and make ppropriate drawings.

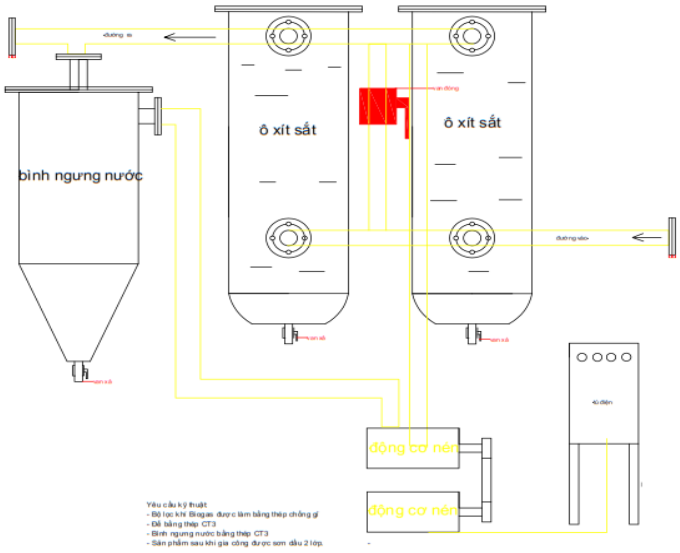

Figure 6. Model drawing of the air and water condensing elements of the biogas filtration system

Design consultant coordinates with chief consultant, professional consultant to give the technical parameters to the contractor to design and make appropriate drawings.

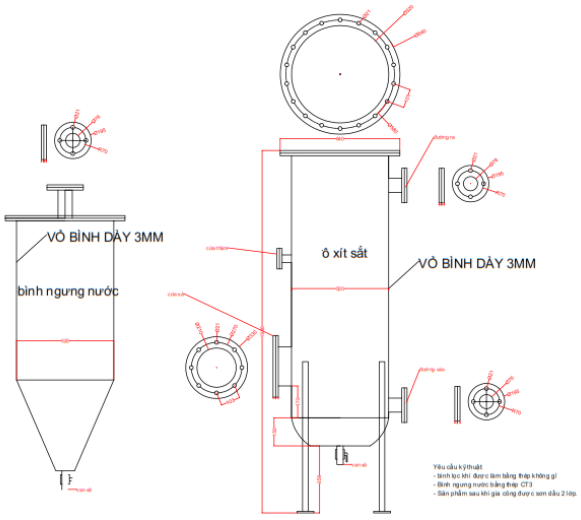

Figure 7. Detailed drawing of material thickness for the manufacturing of modules in the biogas filter system used for generators

Design consultant coordinates with chief consultant, professional consultant to give the technical parameters to the contractor to design and make appropriate drawings.

3.3.3. Purchase a generator and install and operate biogas generator systems

The biogas power generation pilot is deployed at the Loi Tuoi Agricultural Service Cooperative, located at sub-area 67, Moc Chau farm town, Moc Chau district, Son La province. Based on the specifications for the biogas generator, the unit in charge of the bidding model for package 09 has selected the contractor to provide the generator system as the company. Global HC Investment and Technology Joint Stock (Address: Lot 3-4, BT1 Area, Trung Van Residential Area, Trung Van Ward, Nam Tu Liem District, Hanoi)

Equipment system for biogas generation includes:

+ Air filtration system: The air filtration system is made in Vietnam, made by domestic technology with the function of filtering H2S gas and water vapor in the biogas.

+ Generator: The generator is invested in the model of the project under the brand name CAMDA / CHINA / KDGH-32G including the following specifications:

- Output power: ≥ 40KVA / 32KW
- Rated frequency: 50HZ
- Rated voltage: 230/400 V
- Number of phases: 3 phases
- Cos capacity factor: 0.8
- Fuel used: Biogas (biogas)

- Working pressure: 3 ~ 20kpa, pressure change rate ≤ 1kpa / min
- Minimum composition of Methane (CH4) ≤ 50%
- Ingredients gas H2S ≤200mg / Nm3
- Fuel temperature ≤40 degrees C
- Voltage stability: ≤ 2%
- Voltage stabilization time: ≤ 3 seconds
- Frequency stability: ≤ 1%
- Frequency stability time: ≤ 5 seconds
- Size: ≈ 1800mm x 720mm x 1280mm +/- 50mm
- Weight: ≥ 900kg
- Biogas fuel consumption: ≥16 Nm3 / h
- Engine
- Cylinder capacity: ≥ 3.9 L
- Compression ratio:: 11.5: 1
- Number of cylinders: ≥ 4
- Cylinder diameter: ≥102 mm
- Piston stroke: ≥120 mm
- Rated speed: ≥ 1500 rpm
- Rated power: ≤ 36 KW
- Oil consumption: ≤ 0.6 (g / kWh)
- The system starts up:
- Battery: maintenance-free dry, sealed lead-acid, ≥ 24V
- Subject: yes
- Speed control system: electronic speed regulator
- Method of cooling: Water cooled and shaft head blower
- Lubrication method: Forced
- Oil capacity: ≥11 liters
- Generator head
- Power: ≥ 30KW
- Insulation class: Class H or higher
- Protection level: IP23 and above
- Efficiency: ≥ 89%
- Excitation method: Self excitation, brushless (Brushless)
- Voltage regulation system: AVR
- Dashboard:

  - LCD display, displays generator parameters: speed, frequency, voltage, current, oil pressure, cooling water temperature. Power generator, power generated by the generator.

  - Automatically turn off when overloaded and display warnings when the machine fails

- Set to automatically start and shut down the computer in real time.

+ Ancillary equipment: gas pipeline; electrical wiring system; generator house; HDPE biogas work system with a capacity of 500m3.

*/ Installation and commissioning

Installation and operation the generator system was installed on 10/01/2020 and operated continuously for an average of 7 -10 hours/day.

Figure 8. Model biogas generator system of the project deployed in Moc Chau - Son La.

3.3.4. Evaluate the model's economic, social and environmental efficiency.

Generator system after being installed, calibrated the technical parameters such as: load division; load balance electricity consumption; Adjust the fuel gas supply and test and accept the equipment, then exploit and use. In the process of exploitation and use, we evaluate and analyze the economic efficiency of the pilot's using.

Table 3. Analysis of the economic efficiency of the pilot

Content	Unit of measure	Parameter
Machine running time	hour/day	10
Efficiency of motor electric conversion	%	30
Engine heat conversion efficiency	%	45
Power output	kWh/year	102,200
Peak hour electricity prices	VND/kWh	2.735

Normal electricity price	VND/kWh	1.500
Generator capacity	kW	32
Cost of generator	VND	650,000,000
Cost of supported equipment	VND	148,000,000
Tổng chi phí đầu tư	VND	798,000,000
Generator depreciation time	year	6
Operating costs	VND/kWh	23,940,000
Fixed capital		124,311,502
total cost	VND/ year	148,251,502
Electricity generation cost	VND/kWh	1,451
Total savings from biogas electricity	VND/ year	131,265,498
Benefit from electricity generation	VND/ year	204,400,000
Payback period	years	3.9

The analytical results in the table show that, if an average, one day of electricity generation with a time of 10 h; a year the generator generates an average of 102,200 kW / year. Calculating the cost of equipment depreciation, the cost of operation and maintenance will generate the average amount for 1kW of electricity is 1,451 VND / kw.

On the basis of calculation, out of total costs including operating costs and depreciation, the capital recovery period is 3.9 years.

3.4. Training and propaganda

- Organized 01 training course for farmers in Moc Chau district, Son La province on techniques of using biogas in production.

- Organized 01 workshop to summarize the implementation of the model on the use of biogas in electricity generation at livestock farms.

3.5. Synthesize the pilot implementation results

No	Content and implementation activities	Execution time	Result	Result (%)
1	Activity 1: Collect data, investigate, survey, and evaluate the inadequacies of biogas plants in livestock waste treatment;			
1.1	Investigate and collect primary and secondary data in the locality Report writing and data analysis	January - February 2019	- Complete investigation, collect primary and secondary data - BC analyzes survey data	100
1.2	Assess the current status of the local biogas plants, analyze the irrational points in the biogas plants	January - February 2019	- Complete the assessment of the current status of biogas plants in Moc Chau district - Report on current status of biogas plants in Moc Chau district.	100
2	Activity 2: Select and design biogas generator models			
2.1	Surveying households to select households to build appropriate models	March, April 2019	- Conducting household selection survey to build models. - Having selected the household of Mr. Nguyen Thach Loi, address of Sub-zone 67, Nong Truong town, MC district - Son La to build the model.	100
2.2	Build the power generation pilot design	March, April 2019	- Complete the pilot design for using biogas for power generation.	100

3	Activity 3: Building pilots			
3.1	Improving and completing biogas works in the treatment of livestock wastes in concentrated dairy farms	May, June 2019	- To renovate and complete the wastewater system into the biogas works system; - Repairing and re-maintaining the biogas system in the household of Mr. Nguyen Thach Loi, address of the sub-area 67 of Nong Nong town, Moc Chau district - Son La to build the pilot.	100
3.2	Construction and installation of generator systems using biogas energy sources;	July-August 2019	- Completing the house and installing biogas generator system. - Completing the design of the biogas filtration system and manufacturing the air filtration system in Vietnam. - Complete the bidding to buy generator equipment.	100
3.3	Evaluate the model's economic, social and environmental efficiency	August - October 2019	Completed	100
4	Activity 4: Training and propaganda			
4.1	01 training course on the	November-December	- Organized 01 training course on the model of	100

	model of using biogas for farm-scale power generation systems	2019	using biogas used for power generation systems on farm scale	
4.2	Project summary workshop	November-December 2019	- Organize 01 project summary workshop	100

IV. CONCLUSION AND RECOMMENDATION

In the framework of project implementation, the implementation pilot has implemented the specific work contents as follows:

- Completed the work according to the proposed schedule.

- Deployment model completely meets the requirements of the proposed content.

- The effective deployment model applies to the use of biogas applied in electricity generation deployed in livestock facilities in order to take advantage of the biogas resources from livestock waste treatment.

- Suggest replication pilot.

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