Institute of Technology of Cambodia

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A CASE STUDY OF RENEWABLE ENERGIES INVESTMENT CALCULATION FOR THE ANLONG TAMEY VILLAGE, BATTAMBANG PROVINCE

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A CASE STUDY OF RENEWABLE ENERGIES INVESTMENT CALCULATION FOR THE ANLONG TAMEY VILLAGE, BATTAMBANG PROVINCE

For a case study of renewable energies investment calculation for the Anlong Tamey gasifier in Battambang province, we study the following:

Part I: VILLAGE ELECTRIFICATION WITH DIFFERENT TECHNOLOGIES

***Chapter* 1: Gasifier village electrification**

***Chapter* 2: PV village electrifications**

***Chapter* 3: Hydro village electrification**

***Chapter* 4: Diesel village electrification**

***Chapter* 5: Conclusion**

Part II: VILLAGE BATTERY CHARGING WITH DIFFERENT TECHNOLOGIES

***Chapter* 1: Gasifier village battery charging**

***Chapter* 2: PV village battery charging**

***Chapter* 3: Hydro village battery charging**

***Chapter* 4: Diesel village battery charging**

***Chapter* 5: Conclusion**

Note:

- Our investment started operation in 2009.
- The numbers in red of all tables vary with the interest rate, electricity consumption and diesel price.
- For all the chapters, we assume to increase 50% of electricity consumption and diesel price while choose high interest rate 25% and low interest rate 2.9%, when analyze the sensitivity.
- Increase 50% in consumption, mean increase all the numbers in red 50% of its value except for the numbers in red of grid cost just only 25% of its value.
- The diesel generation efficiency is fixed, 20%.

PREFACE

Reading this report is intended to be enjoyable our working on a **Case Study of Renewable Energies Investment Calculation** for the Anlong Tamey Village, in Battambang Province. Including graphic details and tables of the results, it is necessary to make you know clear about our working. We, the group members, are trying to allocate the ideas that we experienced a lot of difficulties in both village electrification and battery charging of this case study such as Gasifier, PV, Hydro, and Diesel. We honestly trust that all the readers who use this report will gain the precious information.

ACKNOWLEDGEMENTS

We would like to say thank to **the Director of Electrical and Energy Engineering Department**, who always pays attention on our education, for instance providing such a good seminar. Moreover, we want to thank to the group of professors from **Finland Future Research Centre** for giving us the course and the chance to do the report.

ABOUT THE REPORT

Firstly, our group members were very pleased to analyze this case study and decide to do the presentation as well as the reports. In fact, the more we had done the much more difficulties we had met. For example, we have studied many formulas of financial management such as SSP, ROI, IRR, FV, PV, NVP and etc., in order to estimate a new case study. However, we could not reach our purpose, because the time is limited for us and we had to learn other courses.

Further more, we meet some difficulties with Ms. Excel, Ms. Words, and Ms. PowerPoint such as lacking of data, changing table of result many times, try to make our quite long report in the shortest one, and making the summary with the purpose of doing the presentation. Despite of our obstacles, we still have developed this case study from time to time. Finally, we can produce the report, although the mistakes happen accidentally.

Our report is divided into 2 main parts. Part I presents about Village electrification with different technologies and Part II introduces about Village Battery charging with different technologies.

We eventually had tried on our bottom to complete this report. Therefore, if there are some mistakes, please forgive us. We are looking forward to all of the your critiquing.

Phnom Penh, 28 Nov. 2009

Group members: Miss. **KALO Sorita**, Mr. **PHAN Samsak** and Mr. **PHOR Vicheka**

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DIFFERENT TECHNOLOGIES

PART I

VILLAGE ELECTRIFICATION WITH DIFFERENT TECHNOLOGIES

CHAPTER 1

GASIFIER VILLAGE ELECTRIFICATION

I. Technology Cost and Performance Data

I.1 Performance Data

We need to find out all the data for running this project. By observing and estimation by the list of the questions below:

List of questions

Electrical Consumption:

1. How many house need electrical supply? (200)
2. How many kWh/month using in each house? (2.5 kWh/month)
3. Do they need battery charging? (Yes)
4. How many batteries would be enough for customer/day? (30batteries)
5. How many kWh/day using for battery charging? (0.6kWh/day)
6. Total of Electrical energy needed for supply in (kWh/month)? (1040kWh/month)

Data for supply engine:

1. How much power (kW) of each machine would be enough for the consumer?
2. How much it cost for that machine? ($4800/15years)
3. How much we spend for Repairing, Operation& Maintenance? ($540/year)
4. Does it need Grid Construction? (Yes)
5. How much it cost for the Grid construction? ($8000)

Supplier:

1. What kind of energy source that we need? (Wood)
2. Does it need other source in operation process? (Diesel engine)
3. How much it cost for energy source ($/year)? ($700/year)
4. How many worker we need to work in this field? (2 persons)
5. How about their salary ($/month)? ($50/month)
6. Does it have other expense such as taxes, phone &accounting? (Yes)
7. If have, How much we spend per month ($/month)? ($840/year)

Investment Cost:

1. How much we need for investment? ($56000)
2. Do we need to owe from the bank? ($56000 in 1st year)
3. Interest rate /year? (%25/year)
4. And so on.

Then we get the performance data for the calculation of Energy Supply investment in **Table. 1: Village electrification with different technologies** below:

Table. 1: Village electrification with different technologies

The village has 200 households. Every household has 2 lamps of 7 W, consuming 2.5 kWh of electricity per month (about 6 hours for 2 lamps per day)
In addition, 30 batteries are charged every day consuming 540 kWh per month
Electricity can be produced by: (1) biomass gasifier (using diesel as support fuel), (2) solar energy PV units, (3) using 24 pico hydro units (250 W each) or (4) one 5 kW diesel aggregate
Electricity grid needs to be constructed except for PV units
The need for manpower in operating the electricity production system varies according to the technology
Accounting and systems management is assumed to cost same amount for all the systems

User can change the basic data of electricity consumption and other figures by changing the contents of the **yellow cells**
Do not change figures in **blue cells** (they are calculated by the programme)
The calculations for different technologies are performed on the following sheets

INPUT DATA																					
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	15	15	15	15	15	15
Number of households	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Electricity consumption kWh per household per month	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Electricity consumption by all houselds kWh per month	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Number of batteries charged per day	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Electricity price US$/kWh for households	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375
Electricity price US$/kWh for battery charging	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Battery capacity Ah	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Electricity consumption per one battery charging kWh	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Electricity consumption in battery charging per month kWh	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
Grid construction price for village US$	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
Diesel aggregate 5 kW investment cost US$	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850
Biomass gasifies + generator kW investment cost US$	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000
PV 5 kW investment cost USD	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000	66000
Pico hydro 250 W unit investment cost US$	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Worker average salary US$ per month	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Phone + accounting + other per month US$	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Loan interest rate % per month	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %	2.1 %
Loan interest rate % per year	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
VAT %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

I.2 Technology Cost

After getting the performance data, we need to analyze the type of data. We divided our cost data into two types of cost and into a specific cost category.

Two types of cost:

1. ***Variable Costs*** are those which vary directly with the output of a particular plant or production process, such as fuel costs.
2. ***Fixed Costs*** are those costs which are not dependent on plant or process output such as customer service.

A specific cost category:

1. ***Investment costs include:***

➢ Construction:
- Direct costs: site preparation, civil works, material, equipment & manpower
- Indirect costs: design, engineering & supervision, assembly and commissioning, provisional equipment & operation, worksite & administrative expenses
- Owner's costs: general administration, capital insurance, pre-operation, R&D (plant specific), spare parts, site selection, licensing & public relations, taxes, customs, duties, fees (local/regional, plant specific)

➢ Other overnight capital costs:
- Major refurbishment
- Decommissioning
- Others

➢ Contingency (share of base cost when specified)

2. ***O&M costs include:*** Operation, Maintenance (material, manpower, services), Engineering support staff, Administration, General expenses of central services, Taxes & duties (plant specific), Insurance (plant specific), Major Refurbishment, Operating waste disposal, Others.

3. ***Fuel costs (FO, diesel, coal, gas...):*** Fuel price at the border or domestic mine, Transportation to the power plant, Taxes on fuel, others

4. ***Customer services include cost on:*** Cost of service connections, Cost of metering and billing, Cost of electricity lost, DSM (Demand Side Management) measures

In our case study

1. ***Variable Costs:***
   a. Investment costs: Construction costs (grid cost), Loan
   b. Operation & Maintenance costs: Repair & Maintenance, Lubricant, Worker
   c. Fuel cost: Wood and Diesel
2. ***Fixed Costs:***
   a. Customer service: Phone & Accounting

II. Methodology

The methodology used in the calculations is divided into 3 points: Operation costs, Incomes and others.

II.1 Operation Costs

Methodology of operation costs calculation includes:

1. Variable Costs:

a. Investment costs:

- Grid cost = US$ 8000

- Interest of loan (US$)/year = Loan interest (%)/year × Loan form bank

Where:
- Loan interest (%)/year = Loan interest (%)/month × 12
- Loan form bank (US$) = Machinery cost + Grid Cost + Own invest

- Loan payback (2 years) = Loan form bank ($)

b. Operation & Maintenance costs:

- Repair & Maintenance cost/year = Repair & Maintenance cost/month × 12

- Lubricant cost/year = Lubricant cost/month × 12

- Worker salary/year =Personal salary/month × Number of worker ×12

c. Fuel costs:

- Wood payment/year = Wood payment/month × 12

- Diesel payment/year =Diesel payment/month × 12

2. Fixed Costs:

a. Investment costs:

- Machinery cost (15 years) = US$ 48000

b. Customer service (Phone & Accounting):

- Phone & Accounting/year = Phone & accounting/month × 12

3. *Total Operation Costs:*

- **Total operation costs/year = Machinery Cost (15 years) + Grid Cost + Interest of loan ($)/year + Loan payback (2 years) + Repair and maintenance cost/year + Lubricant cost/year + Worker salary/year + Wood Payment/year + Diesel Payment/year + Phone & Accounting/year**

II.2 Incomes

Methodology of incomes calculation includes:

1. *Income from Batteries Charging:*

- Electricity price for all battery/month = Electricity for all battery charging KWh/month × Price for battery charging (US$)/battery

Where:

- Electricity for all batteries KWh/month = Number of Batteries/day × Electricity for one battery charging /day × 30
- Electricity for one battery charging KWh/day = Time of Machinery operation × Battery capacity / 1000

2. *Income from Households Consumption:*

- Electricity price for all household (US$)/month = Household number × Electricity consumption for one household KWh/month × Household electricity price (US$)/KWh

3. *Total Incomes:*

- **Sales Revenue (US$/year) = Electricity price for all battery/month + Electricity price for all household (US$)/month × 12**

II.3 Others

Methodology of others calculation includes:

1. ***Total Gains:*** is the sum of sales revenue/year and loan form bank.

- Total Gains = Sales revenue/year + Loan form bank

2. ***Net Annual Profit or Cash Flow:*** is the balance of cash inflows and outflows during a specific period.

- Net Annual profit = (Own invest + Loan + Sale revenue) - (Total operation cost + VAT)

3. ***Break Even Point or Cumulative Earnings:*** is the level of operation at which a business's revenues and expired cost are exactly equal.

- First year of cumulative earning = The first year of Net annual profit (US$)
- The following year of cumulative earning = The previous one+ Net annual of

4. ***Simple Payback Period (SPP):*** is the simple period needed to recover the capital invested from returns in an investment project.

$$SPP = \frac{First\ Cost}{Cash\ Flow}$$

5. ***Return on Investment (ROI)***: express the annual return from the project as a percentage of capital cost and it present in percentage.

$$ROI = \frac{Net\ Annual\ Cash\ Flow}{Capital\ Cost} \times 100$$

6. ***NPV (Net Present Value):*** is the sum of the present values of all cash flows of an investment project over its lifetime.

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$$

Where CF_t = Cash flow occurring at the end of year t
N = life of project
k = Discount rate

7. ***Future Value (FV):*** is the value of money change with time.

$$FV = NPV(1+k)^n$$

Where NPV = Net Present Value of cash flow
k = Interest or Discount rate
N = number of years in the future

8. ***IRR (Internal Rate of Return):*** is the discount rate, which makes its net present value (NPV) equal to zero. It is the discount rate in the equation:

$$\sum_{t=0}^{n} \frac{CF_t}{(1+k)^t} = 0$$

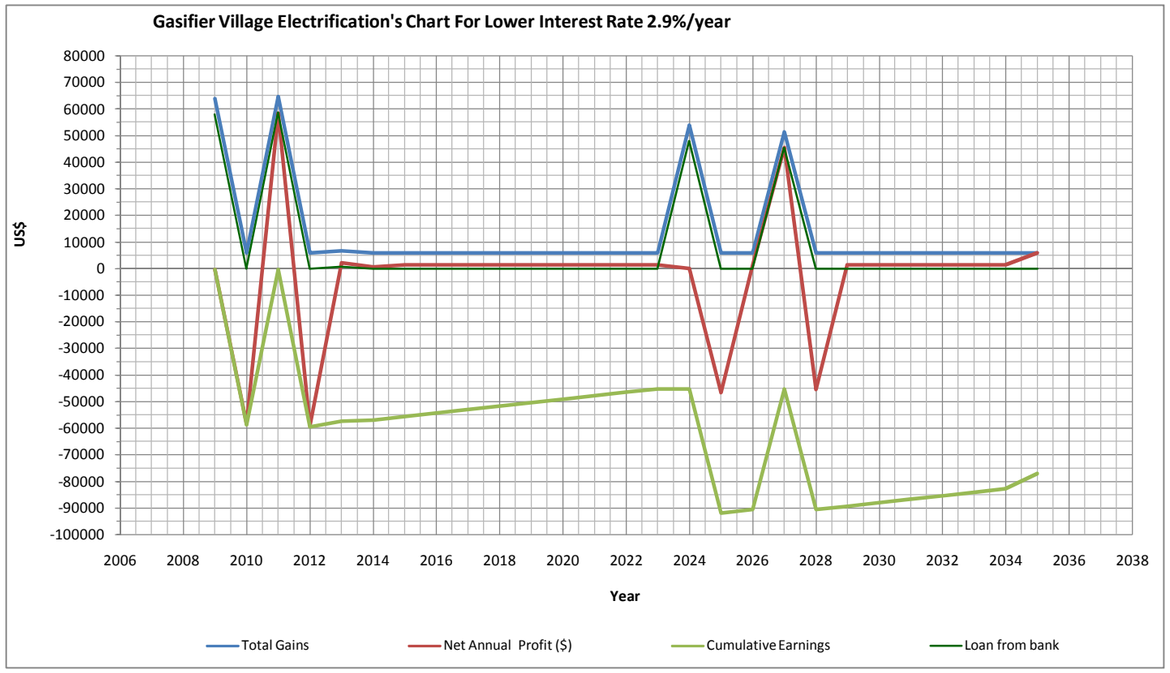
III. Results

The following is the **Table. 2: Results of gasifier village electrification**, at Anlong Tamey in Battambang province, from calculations based on the methodology presented previously. We choose the Low Loan interest rate (%)/year = 2.9%/year.

Table. 2: Results of gasifier village electrification

50% 0%

				Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Variable costs	Operating &Maintenance costs	Worker		Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
				Number of Workers	3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons
				Worker Salary/year	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**
		Lubricant		Lubricant cost/ month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month
				Lubricant cost /year	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**
		Repairing		Repair and maintenance costs/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month
				Repair and maintenance costs/year	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**
	Fuel cost	Wood		Wood payment/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month
				Payment of wood /year	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**
		Diesel		Diesel payment /month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month
				Diesel payment /year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
	Investment costs	Loan		**Interest of loan($)/year**	**1682 US$/year**	**1682 US$/year**	**1704 US$/year**	**1704 US$/year**	**23 US$/year**	**23 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
				Loan payback (2years)	**0 US$/year**	**58000 US$/year**	**0 US$/year**	**58754 US$/year**	**0 US$/year**	**798 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
		construction costs		Grid Cost	10000 US$									
				Machinery Cost(15Years)	48000 US$									
Fixed costs	Customer service costs	Phone + Accounting		Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
				Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation costs/year					**64182 US$/year**	**64182 US$/year**	**6204 US$/year**	**64958 US$/year**	**4523 US$/year**	**5321 US$/year**	**4500 US$/year**	**4500 US$/year**	**4500 US$/year**	**4500 US$/year**
Incomes				Time of Machinery operation/day	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
		Batteries		Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
				Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
				Number of Battery/day	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries
				Electric for one battery charging kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
				Electric for all battery charing kwh/month	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**
				Electricity price for all battery /month	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**
		Households		Household number	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
				Electricity consumtion for One Household(KWh/month)	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month
				Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
				Electricity price for all househod (US$)/month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**
				Sales revenue(US$/year)	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**
Own invest ($)					0	0	0	0	0	0	0	0	0	0
Vat ($)					0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month					0.2417%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%
Loan interest (%)/year					**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**
Loan form Bank($)					**58000 US$/year**	**0 US$/year**	**58754 US$/year**	**0 US$/year**	**798 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
Total Gains					**63805 US$/year**	**5805 US$/year**	**64559 US$/year**	**5805 US$/year**	**6603 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**
Net Annual Profit ($)					**-377 US$/year**	**-58377 US$/year**	**58355 US$/year**	**-59153 US$/year**	**2080 US$/year**	**484 US$/year**	**1305 US$/year**	**1305 US$/year**	**1305 US$/year**	**1305 US$/year**
Cumulative Earnings					**-377 US$/year**	**-58754 US$/year**	**-399 US$/year**	**-59552 US$/year**	**-57472 US$/year**	**-56988 US$/year**	**-55683 US$/year**	**-54378 US$/year**	**-53073 US$/year**	**-51768 US$/year**


Gasifier Village Electrification's Chart For Lower Interest Rate 2.9%/year
US$
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-50000
-60000
-70000
-80000
-90000
-100000
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
Year
Total Gains
Net Annual Profit ($)
Cumulative Earnings
Loan from bank

2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons	3persons
1800 US$/year	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**
37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month
450 US$/year	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**
30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month
360 US$/year	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**
63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month
750 US$/year	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**
25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month
300 US$/year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**1392 US$/year**	**0 US$/year**	**0 US$/year**	**1316 US$/year**	**1316 US$/year**	**1 US$/year**	**1 US$/year**	**0 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**48000 US$/year**	**0 US$/year**	**0 US$/year**	**45390 US$/year**	**0 US$/year**	**23 US$/year**	**0 US$/year**
					48000 US$							
70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
4500 US$/year	**4500 US$/year**	**4500 US$/year**	**4500 US$/year**	**4500 US$/year**	**53892 US$/year**	**52500 US$/year**	**4500 US$/year**	**5816 US$/year**	**51206 US$/year**	**4501 US$/year**	**4523 US$/year**	**4500 US$/year**
12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
810Kwh/month	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**
203 US$/month	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**
200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
281 US$/month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**
5805 US$/year	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%
2.900%	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**48000 US$/year**	**0 US$/year**	**0 US$/year**	**45390 US$/year**	**0 US$/year**	**23 US$/year**	**0 US$/year**	**0 US$/year**
5805 US$/year	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**53805 US$/year**	**5805 US$/year**	**5805 US$/year**	**51195 US$/year**	**5805 US$/year**	**5828 US$/year**	**5805 US$/year**	**5805 US$/year**
1305 US$/year	**1305 US$/year**	**1305 US$/year**	**1305 US$/year**	**1305 US$/year**	**-87 US$/year**	**-46695 US$/year**	**1305 US$/year**	**45379 US$/year**	**-45401 US$/year**	**1327 US$/year**	**1282 US$/year**	**1305 US$/year**
-50463 US$/year	**-49158 US$/year**	**-47853 US$/year**	**-46548 US$/year**	**-45243 US$/year**	**-45330 US$/year**	**-92025 US$/year**	**-90720 US$/year**	**-45341 US$/year**	**-90743 US$/year**	**-89416 US$/year**	**-88134 US$/year**	**-86829 US$/year**

2032	2033	2034	2035
50 US$/month	50 US$/month	50 US$/month	50 US$/month
3persons	3persons	3persons	3persons
1800 US$/year	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**
37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month
450 US$/year	**450 US$/year**	**450 US$/year**	**450 US$/year**
30 US$/month	30 US$/month	30 US$/month	30 US$/month
360 US$/year	**360 US$/year**	**360 US$/year**	**360 US$/year**
63 US$/month	63 US$/month	63 US$/month	63 US$/month
750 US$/year	**750 US$/year**	**750 US$/year**	**750 US$/year**
25 US$/month	25 US$/month	25 US$/month	25 US$/month
300 US$/year	**300 US$/year**	**300 US$/year**	**300 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**
70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**
4500 US$/year	**4500 US$/year**	**4500 US$/year**	
12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah
45batteries	45batteries	45batteries	45batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
810Kwh/month	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**
203 US$/month	**203 US$/month**	**203 US$/month**	**203 US$/month**
200houses	200houses	200houses	200houses
3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
281 US$/month	**281 US$/month**	**281 US$/month**	**281 US$/month**
5805 US$/year	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**
0	0	0	0
0	0	0	0
0.242%	0.242%	0.242%	0.242%
2.900%	**2.900%**	**2.900%**	**2.900%**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**
5805 US$/year	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**
1305 US$/year	**1305 US$/year**	**1305 US$/year**	**5805 US$/year**
-85524 US$/year	**-84219 US$/year**	**-82914 US$/year**	**-77109 US$/year**

IV. Sensitivity Analysis

The present day cash flow can usually be estimated fairly accurately. Cash flow in some certainty, it should always be remembered that they are only estimates. Cash flows in future years normally contain inflation components which are often "**guess-times**" at best. The project life itself is an estimate that can vary significantly.

Sensitivity analysis is an assessment of risk. Because of the uncertainty in assigning values to the analysis, it is recommended that a sensitivity analysis be carried out particularly on projects where the feasibility is marginal.

Sensitivity analysis is undertaken to identify those parameters that are both uncertain and for which the project decision, taken through the NPV or IRR, is sensitive. Switching values showing the change in a variable required for the project decision to change from acceptance to rejection are presented for key variables and can be compared with post evaluation results or similar projects.

Sensitivity and risk analysis should lead to improved project design, with actions militating against major sources of uncertainty being outlined.

The various micro and macro factors that are considered for the sensitivity analysis are:

- Micro Factors:
  - Operating expense
  - Capital structure
  - Costs of debit & equity
  - Changing of the form of finance
  - Changing the project duration
- Macro Factors:
  - Changes in IR
  - Changes in the tax rates
  - Changes in the accounting standards
  - Chang in depreciation rates
  - Changes in energy price
  - Extension of various governments subsidize projects
  - General employment trends
  - Imposition of regulation on environmental and safety issues in the industry
  - Development of Technological

For sensitivity analysis of our case study, we analyze the following:

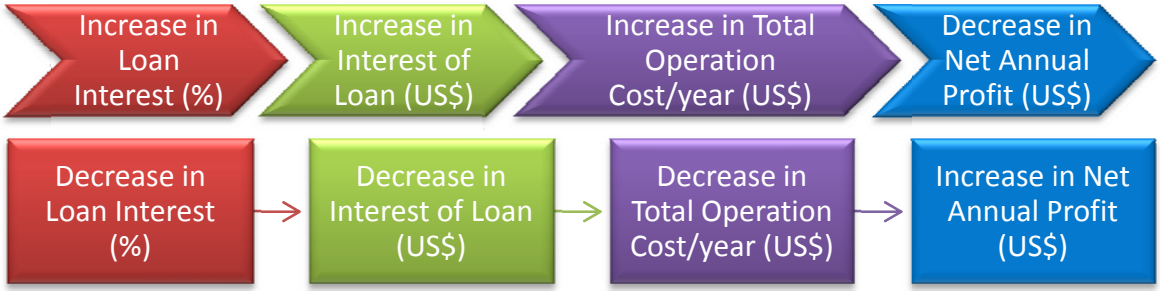
1. Analyze the impacts of changes in interest rate
   A. Higher interest rate
   B. Low interest rate (e.g. 2.9 % per annum from World Bank)
2. Analyze the increase in electricity consumption:
   A. Need for new investments
   B. Need for increased work input
   C. Need for increased maintenance
   D. Need for grid extension
3. Analyze the impact of the change in diesel price and diesel generation efficiency
4. Analyze different combinations of changes 1. – 3.

***Note*: The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment**.

IV.1 Analyze the Impacts of Changes in Interest Rate

The formulas which related with the interest rate changing are the following:

- Interest of loan (US$)/year = Loan interest (%)/year × Loan form bank
- Total operation cost/year = Machinery Cost (15 years) + Grid Cost + Interest of loan ($)/year + Loan payback (2 years) + Repair and maintenance cost/year + Lubricant cost/year + Worker salary/year + Wood Payment/year + Diesel Payment/year + Phone & Accounting/year
- Net Annual profit = (Own invest + Loan + Sale revenue) - (Total operation cost + VAT)



IV.1.A Results

By Choosing Low Loan interest rate (%)/year = 2.9% and High Loan interest rate (%)/year = 25%, the results are in the **Table. 3: Analyze the Impacts of Changes in Interest Rate** below.

Table. 3: Analyze the Impacts of Changes in Interest Rate

				Lower Loan interest (%)/year = 2.9%			Higher Loan interest (%)/year = 25%		
			Year	2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	2persons	2persons	2persons	2persons	2persons	2persons
			Worker Salary/year	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**
		Lubricant	Lubricant cost/ month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month
			Lubricant cost /year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
			Repair and maintenance costs/year	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
	Fuel cost	Wood	Wood payment/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month
			Payment of wood /year	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**
		Diesel	Diesel payment /month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month
			Diesel payment /year	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**1626 US$/year**	**1626 US$/year**	**1686 US$/year**	**14000 US$/year**	**14000 US$/year**	**20705 US$/year**
			Loan payback (2years)	**0 US$/year**	**56000 US$/year**	**0 US$/year**	**0 US$/year**	**56000 US$/year**	**0 US$/year**
		construction costs	Grid Cost	8000 US$			8000 US$		
			Machinery Cost(15Years)	48000 US$			48000 US$		
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation cost/year				**60906 US$/year**	**60906 US$/year**	**4966 US$/year**	**73280 US$/year**	**73280 US$/year**	**23985 US$/year**
Income			Time of Machinery operation/day	12hours	12hours	12hours	12hours	12hours	12hours
		Batteries	Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
			Electric for one battery charging kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
		Households	Household number	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all househod (US$)/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
		Sales revenue(US$/year)		**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Own invest ($)				0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0
Loan interest(%) /month				0.2420%	0.242%	0.242%	2.0833%	2.083%	2.083%
Loan interest (%)/year				**2.9%**	**2.9%**	**2.9%**	**25.000%**	**25.000%**	**25.000%**
Loan form Bank($)				**56000 US$/year**	**0 US$/year**	**58072 US$/year**	**56000 US$/year**	**0 US$/year**	**82820 US$/year**
Total Gains				**59870 US$/year**	**3870 US$/year**	**61942 US$/year**	**59870 US$/year**	**3870 US$/year**	**86690 US$/year**
Net Annual Profit ($)				**-1036 US$/year**	**-57036 US$/year**	**56976 US$/year**	**-13410 US$/year**	**-69410 US$/year**	**62705 US$/year**
Cumulative Earnings				**-1036 US$/year**	**-58072 US$/year**	**-1096 US$/year**	**-13410 US$/year**	**-82820 US$/year**	**-20115 US$/year**

IV.1.B Charts

Low Interest Rate (2.9%/year)

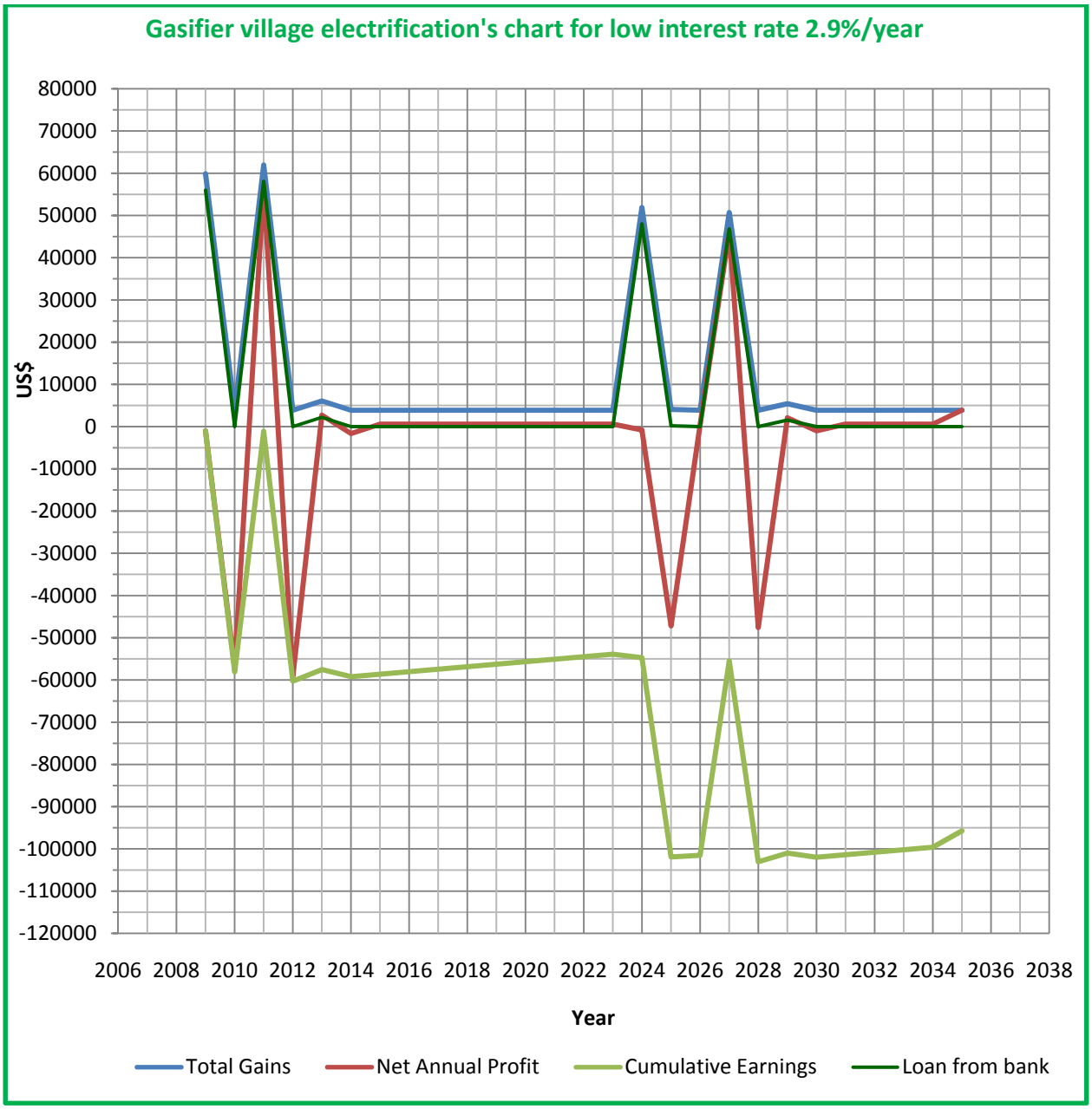


Figure 1: Gasifier village electrification's chart for low interest rate 2.9%/year

As can be seen in the chart, it shows us that:

2009-2014: Total Gains, Net Annual Profit and Loan from bank start to fluctuate tending to zero. Cumulative Earnings are fluctuated downward and tending to slowly increasing.

2014-2023: Loan from bank = 0

2024: Since the Machinery Cost (Machinery Last 15 years) occurs, Total Gains, Net Annual Profit and Loan from bank restart to fluctuate tending to zero. Cumulative Earnings are fluctuated downward and tending to slowly increasing.

High Interest Rate (25%/year)

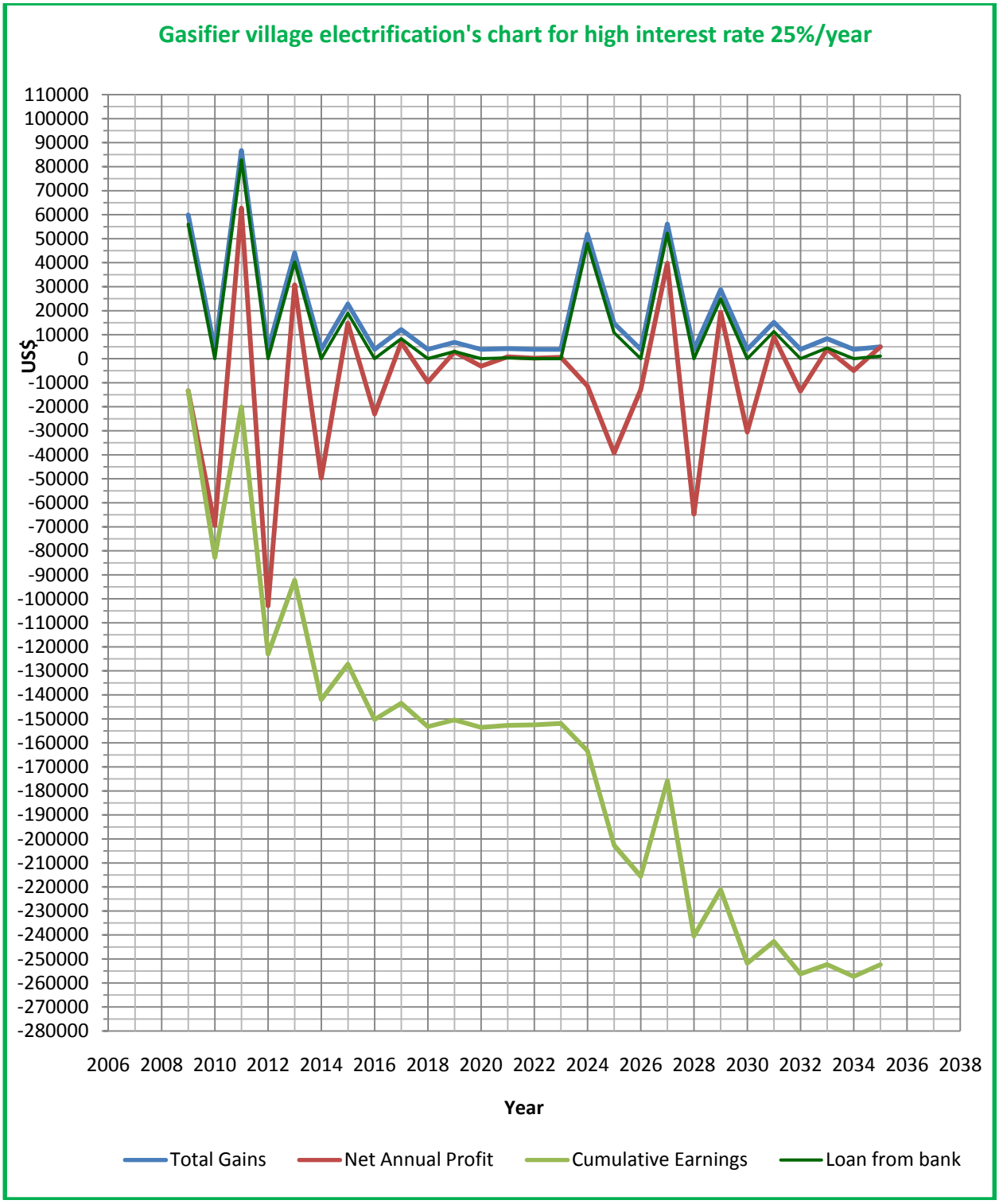


Figure 2: Gasifier village electrification's chart for high interest rate 25%/year

As can be seen in the chart, it shows us that:

2009-2022: Total Gains, Net Annual Profit and Loan from bank start to fluctuate tending to zero. Cumulative Earnings are fluctuated downward and tending to slowly increasing.

2022-2023: Loan from bank = 0

2024: Since the Machinery Cost (Machinery Last 15 years) occurs, Total Gains, Net Annual Profit and Loan from bank restart to fluctuate tending to zero. Cumulative Earnings are fluctuated downward and tending to slowly increasing.

IV.2 Analyze the Increase in Electricity Consumption

The formulas and items which are related with the increase in electricity consumption are the following:

1. Operation Costs

a. Investment costs:

- Grid cost (US$ 8000) will increase
- Interest of loan (US$)/year = Loan interest (%)/year × Loan from bank

Where:
- Loan interest (%)/year = Loan interest (%)/month × 12
- Loan from bank (US$) = Machinery cost + Grid Cost + Own invest

b. Operation & Maintenance costs:

- Repair & Maintenance cost/year = Repair & Maintenance cost/month × 12
- Lubricant cost/year = Lubricant cost/month × 12
- Worker salary/year =Personal salary/month × Number of worker ×12

c. Fuel costs:

- Wood payment/year = Wood payment/month × 12
- Diesel payment/year =Diesel payment/month × 12

d. Total operation costs:

- Total operation costs/year = Machinery Cost (15 years) + Grid Cost + Interest of loan ($)/year + Loan payback (2 years) + Repair and maintenance cost/year + Lubricant cost/year + Worker salary/year + Wood Payment/year + Diesel Payment/year + Phone & Accounting/year

2. Incomes

a. Income from Batteries Charging:

- Electricity price for all battery/month = Electricity for all battery charging KWh/month × Price for battery charging (US$)/battery

Where:
- Electricity for all batteries KWh/month = Number of Batteries/day × Electricity for one battery charging /day × 30
- Electricity for one battery charging KWh/day = Time of Machinery operation × Battery capacity / 1000

b. Income from Households Consumption:

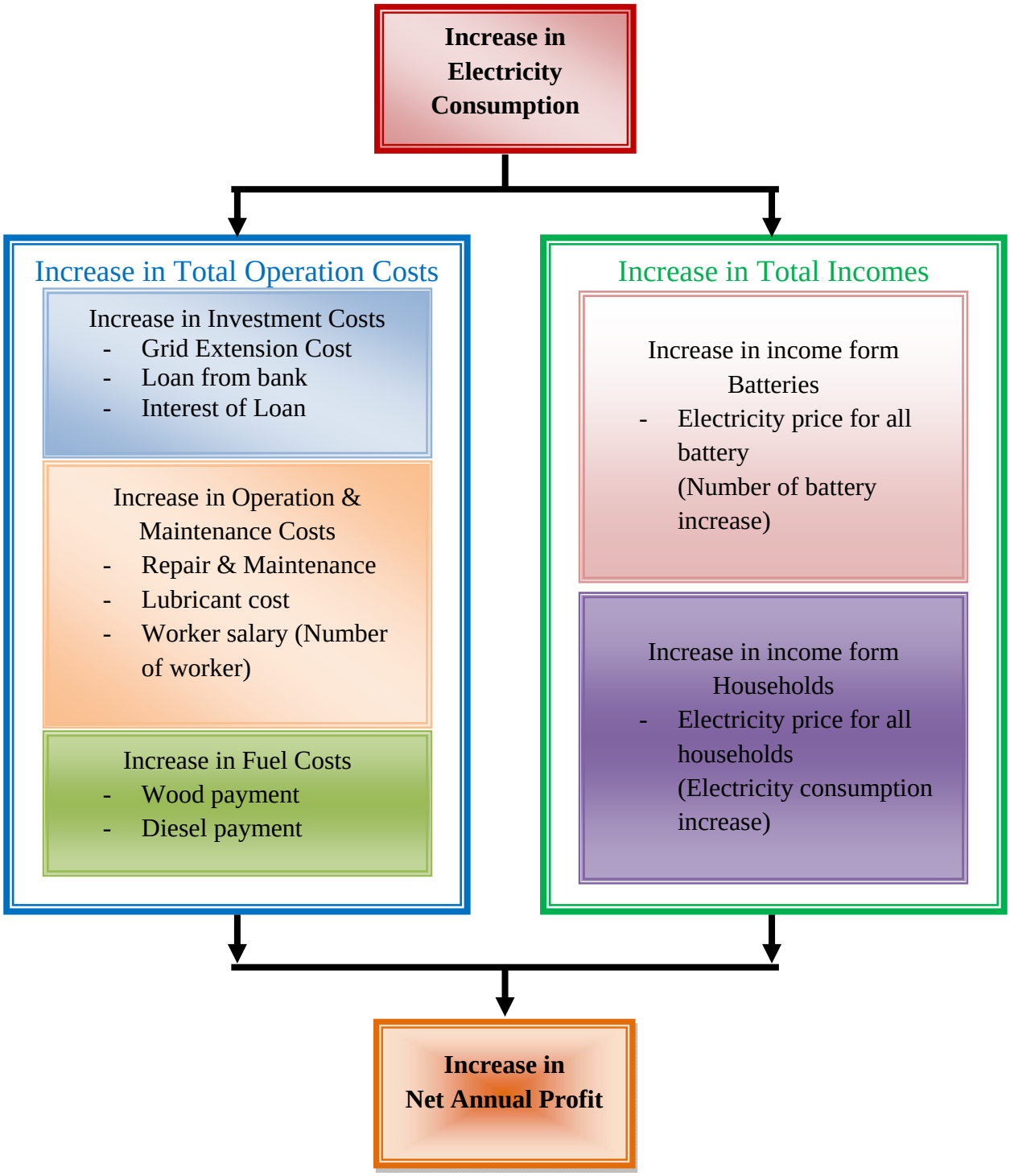
- Electricity price for all household (US$)/month = Household number × Electricity consumption for one household KWh/month × Household electricity price (US$)/KWh

c. Total Incomes:

- Sales Revenue (US$/year) = Electricity price for all battery/month + Electricity price for all household (US$)/month × 12

3. Others cost

- Total Gains = Sales revenue/year + Loan from bank
- Net Annual profit = (Own invest + Loan + Sale revenue) - (Total operation cost + VAT)
- First year of cumulative earning = The first year of Net annual profit (US$)
- The following year of cumulative earning = The previous one+ Net annual of that year



IV.2.A Results

By increasing 50% in the electricity consumption except the grid just only 25% and choose Low Loan interest rate (%)/year = 2.9%, the results are in the **Table. 4: Analyze the Increase in Electricity Consumption** below.

Table. 4: Analyze the Increase in Electricity Consumption

				Loan interest (%)/year = 2.9%					
				Increase in electricity consumption 0%			Increase in electricity consumption 50%		
			Year	2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	2persons	2persons	2persons	3persons	2persons	2persons
			Worker Salary/year	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1800 US$/year**	**1200 US$/year**	**1200 US$/year**
		Lubricant	Lubricant cost/ month	25.0 US$/month	25.0 US$/month	25.0 US$/month	37.5 US$/month	25.0 US$/month	25.0 US$/month
			Lubricant cost /year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**450 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	20 US$/month	20 US$/month	20 US$/month	30 US$/month	20 US$/month	20 US$/month
			Repair and maintenance costs/year	**240 US$/year**	**240 US$/year**	**240 US$/year**	**360 US$/year**	**240 US$/year**	**240 US$/year**
	Fuel cost	Wood	Wood payment/month	42 US$/month	42 US$/month	42 US$/month	63 US$/month	42 US$/month	42 US$/month
			Payment of wood /year	**500 US$/year**	**500 US$/year**	**500 US$/year**	**750 US$/year**	**500 US$/year**	**500 US$/year**
		Diesel	Diesel payment /month	17 US$/month	17 US$/month	17 US$/month	25 US$/month	25 US$/month	25 US$/month
			Diesel payment /year	**200 US$/year**	**200 US$/year**	**200 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**1626 US$/year**	**1626 US$/year**	**1686 US$/year**	**1682 US$/year**	**1682 US$/year**	**1728 US$/year**
			Loan payback (2years)	**0 US$/year**	**56000 US$/year**	**0 US$/year**	**0 US$/year**	**58000 US$/year**	**0 US$/year**
		construction costs	Grid Cost	8000 US$			10000 US$		
			Machinery Cost(15Years)	48000 US$			48000 US$		
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation cost/year				**60906 US$/year**	**60906 US$/year**	**4966 US$/year**	**64182 US$/year**	**63062 US$/year**	**5108 US$/year**
Income			Time of Machinery operation/day	12hours	12hours	12hours	12hours	12hours	12hours
		Batteries	Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	30batteries	30batteries	30batteries	45batteries	30batteries	30batteries
			Electric for one battery charging kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**810Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**203 US$/month**	**135 US$/month**	**135 US$/month**
		Households	Household number	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all househod (US$)/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**281 US$/month**	**188 US$/month**	**188 US$/month**
			Sales revenue(US$/year)	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**5805 US$/year**	**3870 US$/year**	**3870 US$/year**
Own invest ($)				0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0
Loan interest(%) /month				0.2420%	0.242%	0.242%	0.2417%	0.242%	0.242%
Loan interest (%)/year				**2.9%**	**2.9%**	**2.9%**	**2.900%**	**2.900%**	**2.900%**
Loan form Bank($)				**56000 US$/year**	**0 US$/year**	**58072 US$/year**	**58000 US$/year**	**0 US$/year**	**59569 US$/year**
Total Gains				**59870 US$/year**	**3870 US$/year**	**61942 US$/year**	**63805 US$/year**	**3870 US$/year**	**63439 US$/year**
Net Annual Profit ($)				**-1036 US$/year**	**-57036 US$/year**	**56976 US$/year**	**-377 US$/year**	**-59192 US$/year**	**58331 US$/year**
Cumulative Earnings				**-1036 US$/year**	**-58072 US$/year**	**-1096 US$/year**	**-377 US$/year**	**-59569 US$/year**	**-1238 US$/year**

IV.2.B Charts

The figure 3 is the same as the figure 2.

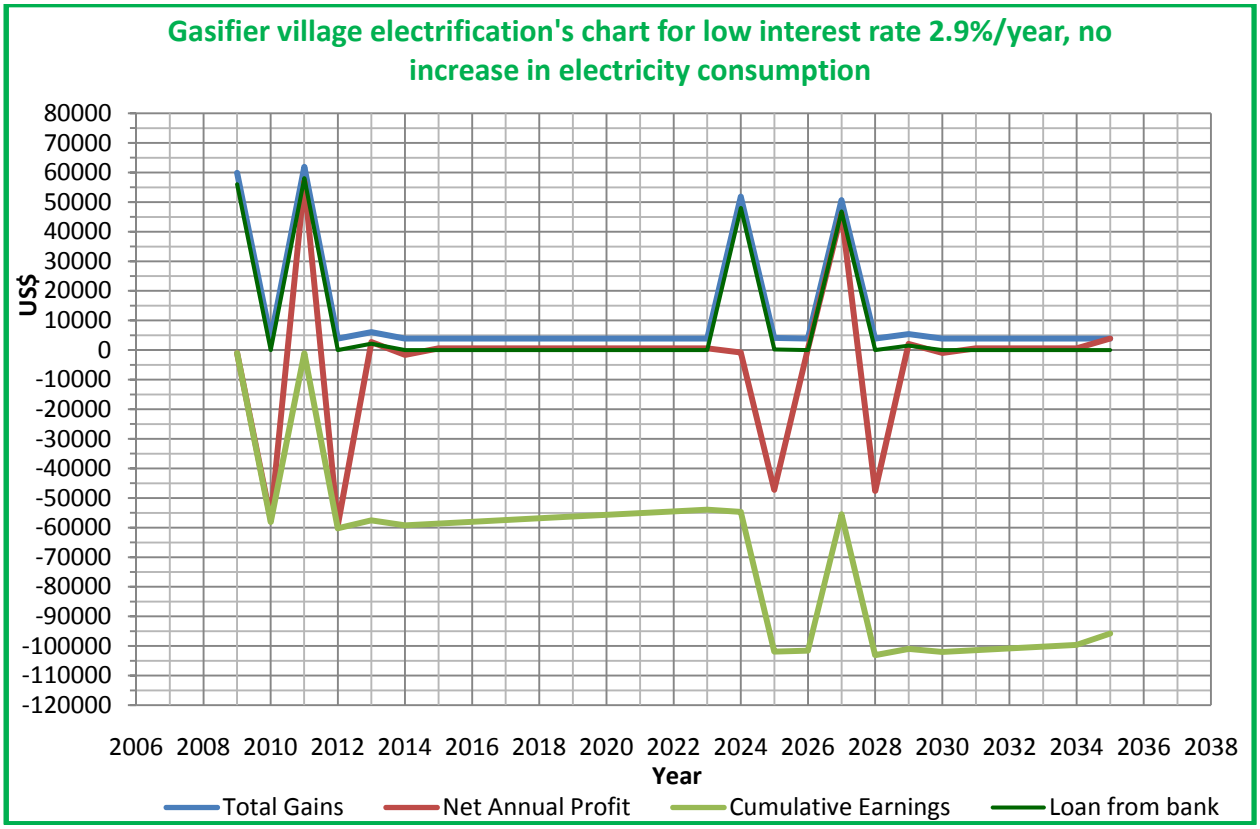


Figure 3: Gasifier village electrification's chart for low interest rate 2.9%/year, no increase in electricity consumption

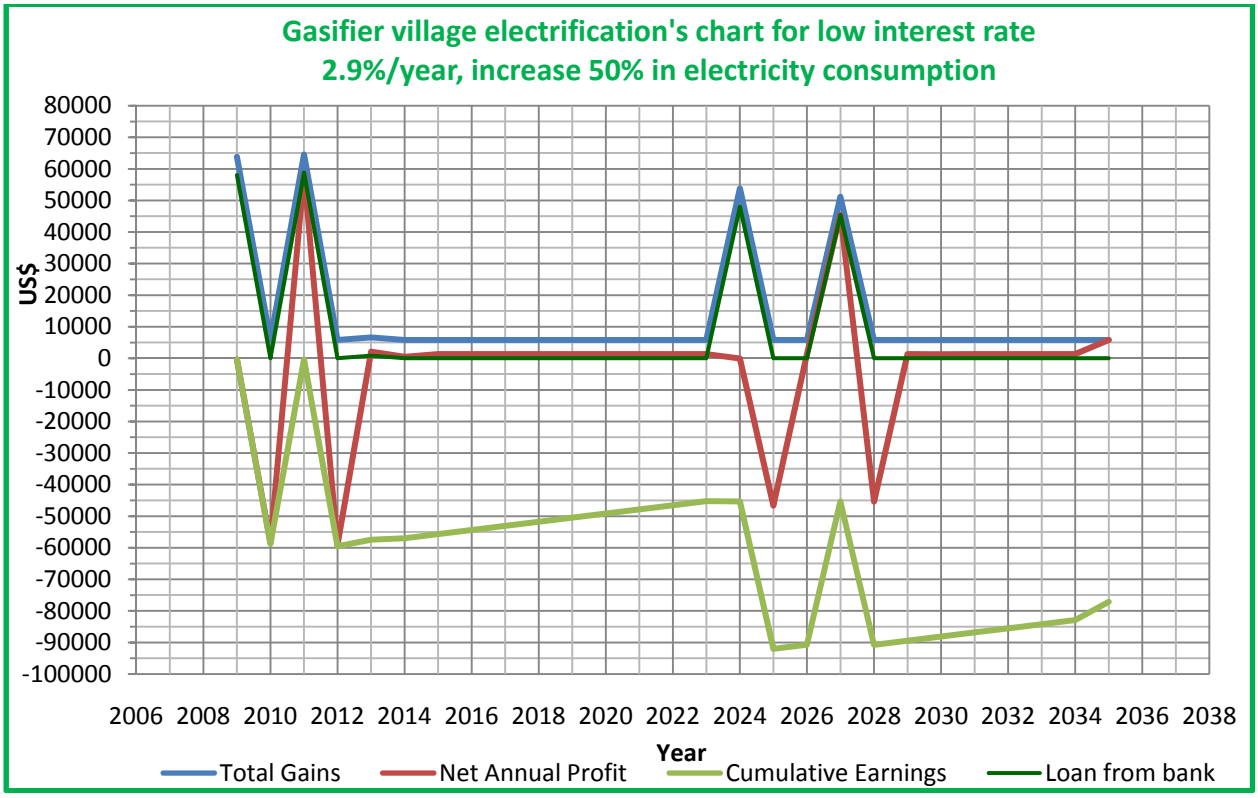


Figure 4: Gasifier village electrification's chart for low interest rate 2.9%/year, increase 50% in electricity consumption

By comparing the two charts above (**Figure 3** and **Figure 4**), we can see that the loan from bank of both chart are equal to zero in 2014. However, the loan from bank of **Figure 4** is better than the one of **Figure 3** because **during the period 2012-2014**, the chart shows that loan from bank of **Figure 4** is nearly as **a straight line** unlike the one of **Figure 3**.

IV.3 Analyze the impact of the change in diesel price and diesel generation efficiency

The formulas and items which are related with the increase in diesel price are the following:

1. Operation Costs

a. Fuel costs:

- Wood payment/year = Wood payment/month × 12
- Diesel payment/year =Diesel payment/month × 12

b. Total operation costs:

- Total operation costs/year = Machinery Cost (15 years) + Grid Cost + Interest of loan ($)/year + Loan payback (2 years) + Repair and maintenance cost/year + Lubricant cost/year + Worker salary/year + Wood Payment/year + Diesel Payment/year + Phone & Accounting/year

2. Others cost

- Total Gains = Sales revenue/year + Loan form bank
- Net Annual profit = (Own invest + Loan + Sale revenue) - (Total operation cost + VAT)
- First year of cumulative earning = The first year of Net annual profit (US$)
- The following year of cumulative earning = The previous one+ Net annual of that year

IV.3.A Results

By increasing 50% in diesel price and choose Low Loan interest (%)/year = 2.9%, the results are in the **Table. 5: Analyze the Increase in diesel price** below.

***Note*: The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.**

Table. 5: Analyze the Increase in diesel price

				Loan interest (%)/year = 2.9%					
				Increase in diesel price 0%			Increase in diesel price 50%		
Year				2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	2persons	2persons	2persons	2persons	2persons	2persons
			Worker Salary/year	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**
		Lubricant	Lubricant cost/ month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month
			Lubricant cost /year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
			Repair and maintenance costs/year	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
	Fuel cost	Wood	Wood payment/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month
			Payment of wood /year	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**
		Diesel	Diesel payment /month	17 US$/month	17 US$/month	17 US$/month	25 US$/month	25 US$/month	25 US$/month
			Diesel payment /year	**200 US$/year**	**200 US$/year**	**200 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**1626 US$/year**	**1626 US$/year**	**1686 US$/year**	**1624 US$/year**	**1624 US$/year**	**1690 US$/year**
			Loan payback (2years)	**0 US$/year**	**56000 US$/year**	**0 US$/year**	**0 US$/year**	**56000 US$/year**	**0 US$/year**
		construction costs	Grid Cost	8000 US$			8000 US$		
			Machinery Cost(15Years)	48000 US$			48000 US$		
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation cost/year				**60906 US$/year**	**60906 US$/year**	**4966 US$/year**	**61004 US$/year**	**61004 US$/year**	**5070 US$/year**
Income			Time of Machinery operation/day	12hours	12hours	12hours	12hours	12hours	12hours
		Batteries	Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
			Electric for one battery charging kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
		Households	Household number	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all househod (US$)/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
			Sales revenue(US$/year)	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Own invest ($)				0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0
Loan interest(%) /month				0.2420%	0.242%	0.242%	0.2417%	0.242%	0.242%
Loan interest (%)/year				**2.9%**	**2.9%**	**2.9%**	**2.900%**	**2.900%**	**2.900%**
Loan form Bank($)				**56000 US$/year**	**0 US$/year**	**58072 US$/year**	**56000 US$/year**	**0 US$/year**	**58268 US$/year**
Total Gains				**59870 US$/year**	**3870 US$/year**	**61942 US$/year**	**59870 US$/year**	**3870 US$/year**	**62138 US$/year**
Net Annual Profit ($)				**-1036 US$/year**	**-57036 US$/year**	**56976 US$/year**	**-1134 US$/year**	**-57134 US$/year**	**57068 US$/year**
Cumulative Earnings				**-1036 US$/year**	**-58072 US$/year**	**-1096 US$/year**	**-1134 US$/year**	**-58268 US$/year**	**-1200 US$/year**

IV.3.B Chart

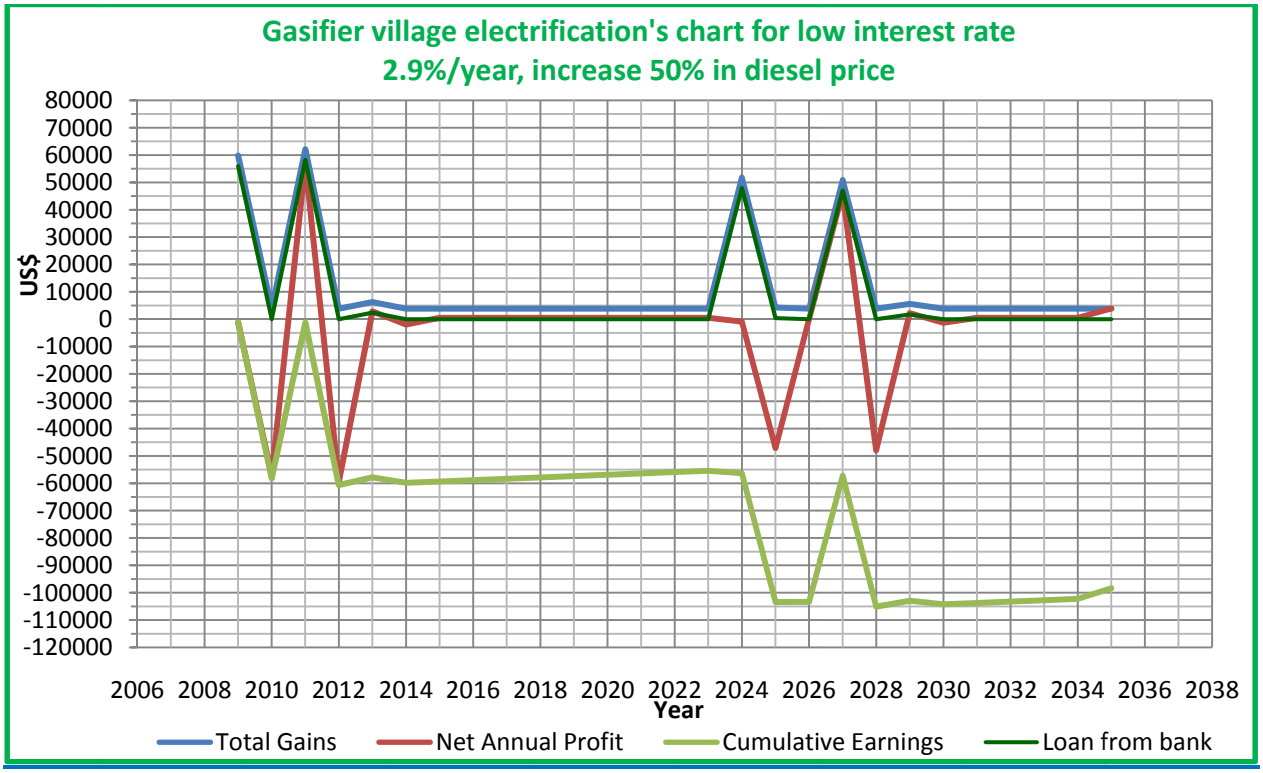


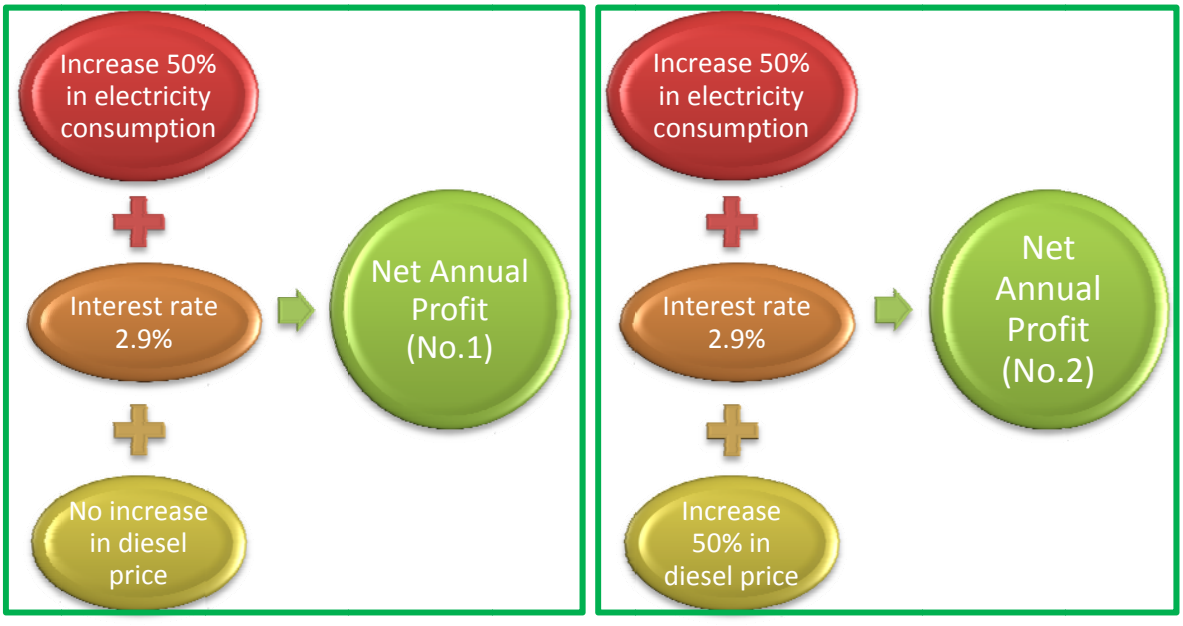
Figure 5: Gasifier village electrification's chart for low interest rate 2.9%/year, increase 50% in diesel price

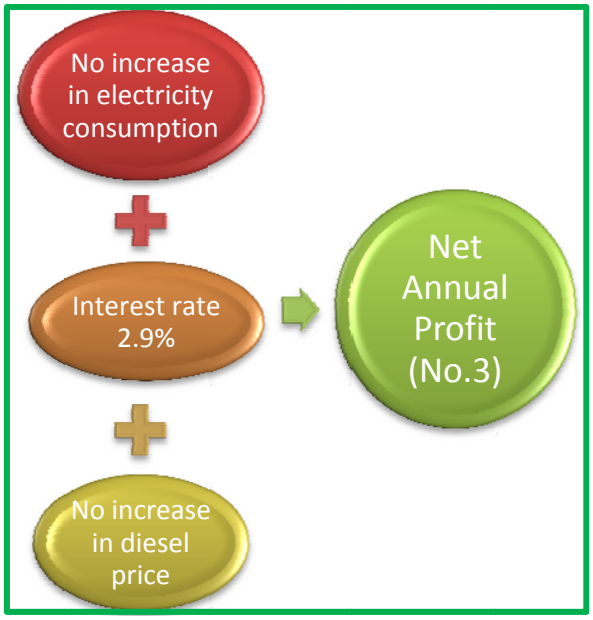
By comparing the two charts of figure 2 and figure 5, we can see that both charts are nearly the same, but the different of earning in US dollar of both charts is quite high.

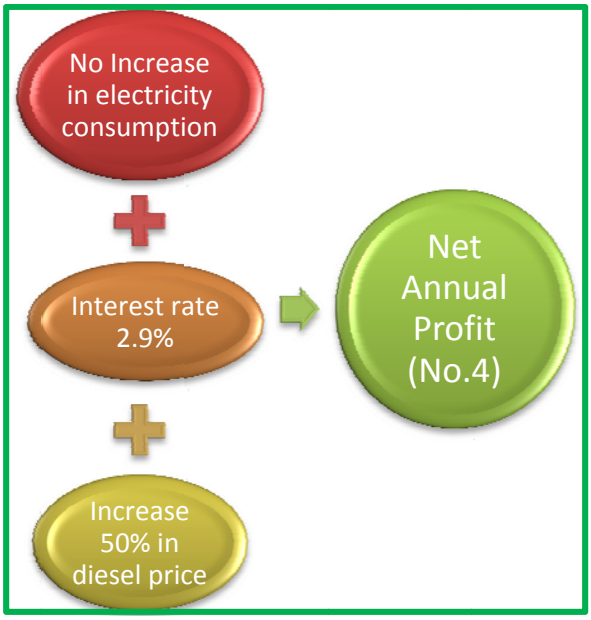
IV.4 Analyze different combinations of changes 1. – 3.

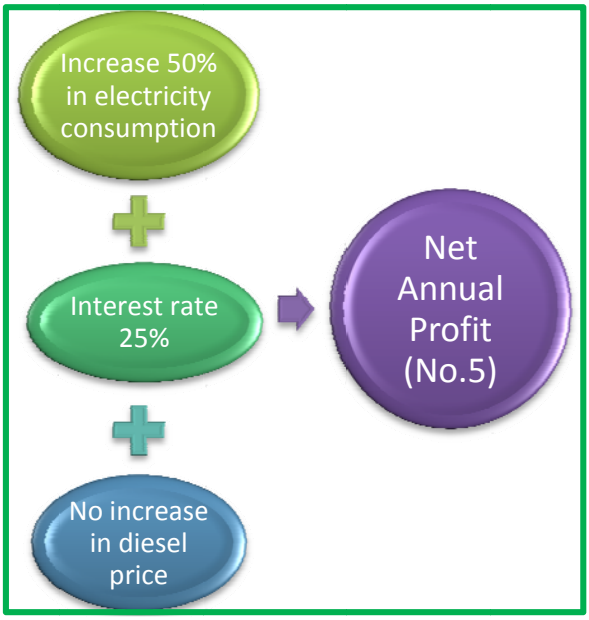
There are 8 cases for analyzing different combinations of changes IV.1 to IV.3. The different combinations of changes IV.1 to IV.3 will cause the Net Annual Profit vary from better to worse ranking from No.1 (the best Net Annual Profit) to No.8 (the worst Net Annual Profit).

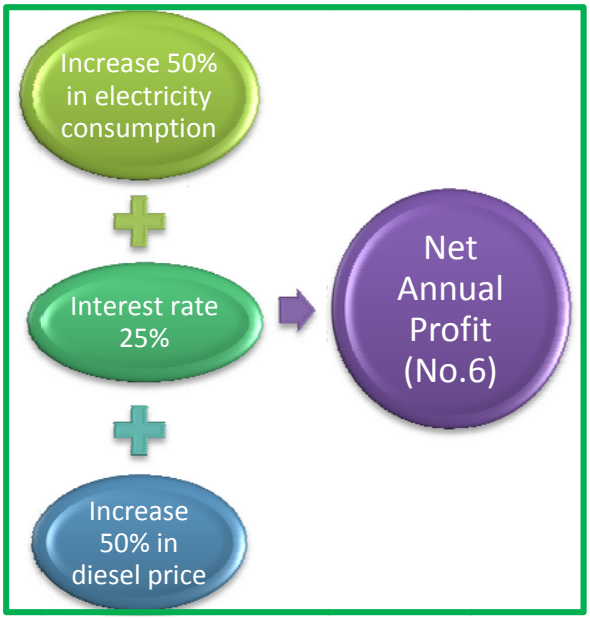
The change of Net Annual Profit (No.1: The best to No.8: The worst) is in the graphics below:

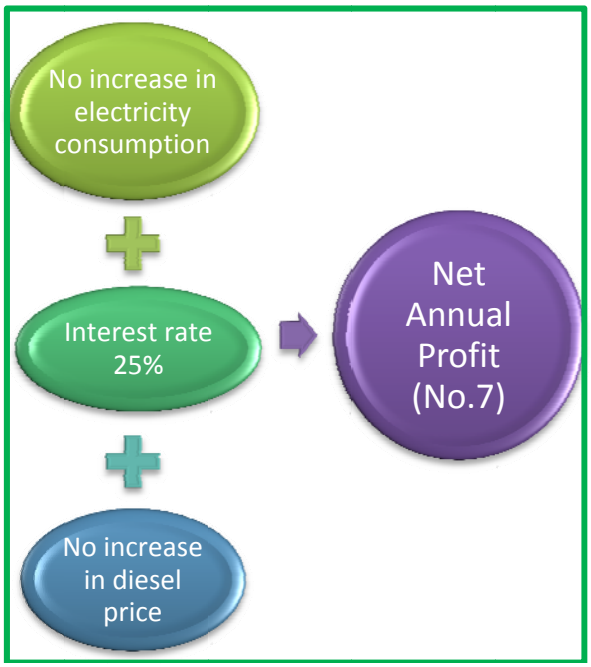


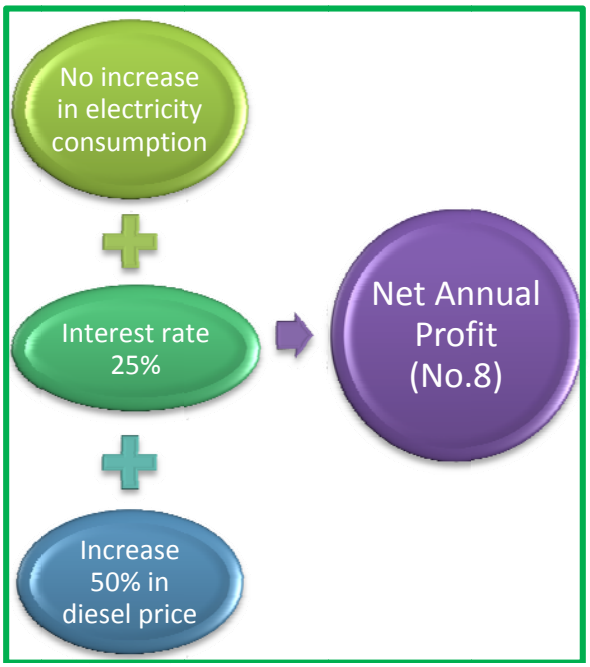

No increase in electricity consumption
Interest rate 2.9%
No increase in diesel price
Net Annual Profit (No.3)


No Increase in electricity consumption
Interest rate 2.9%
Increase 50% in diesel price
Net Annual Profit (No.4)


Increase 50% in electricity consumption
Interest rate 25%
No increase in diesel price
Net Annual Profit (No.5)


Increase 50% in electricity consumption
Interest rate 25%
Increase 50% in diesel price
Net Annual Profit (No.6)


No increase in electricity consumption
Interest rate 25%
No increase in diesel price
Net Annual Profit (No.7)


No increase in electricity consumption
Interest rate 25%
Increase 50% in diesel price
Net Annual Profit (No.8)

IV.4.A Results

The results of different combinations of changes IV.1 to IV.3 are in the **Table. 6: The results of different combinations of changes of gasifier village electrification** which show all 8 cases during 3 years from 2009 to 2011.

As there are 8 cases of different combinations of changes IV.1 to IV.3, we choose two cases to study:

1. The best Net Annual Profit No.1 **(Figure 6)**: Increase 50% in electricity consumption, Interest rate 2.9%, No Increase in diesel price
2. The worst Net Annual Profit No.8 **(Figure 7)**: No increase in electricity consumption, Interest rate 25%, Increase 50% in diesel price

These results are showed in the **Table. 7: The best and the worst Net Annual Profit** below.

Table. 6: The results of different combinations of changes of gasifier village electrification

				increase interest rate increase comsumption increase diesel price	2.9% 50% 0%	Case 1	increase interest rate increase comsumption increase diesel price	2.9% 50% 50%	Case 2	increase interest rate increase comsumption increase diesel price	2.9% 0% 0%	Case 3	increase interest rate increase comsumption increase diesel price	2.9% 0% 50%
			Year	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	3persons	3persons	3persons	3persons	3persons	3persons	2persons	2persons	2persons	2persons	2persons
			Worker Salary/year	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**
		Lubricant	Lubricant cost/ month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month
			Lubricant cost /year	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
			Repair and maintenance costs/year	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
	Fuel cost	Wood	Wood payment/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month
			Payment of wood /year	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**
		Diesel	Diesel payment /month	25 US$/month	25 US$/month	25 US$/month	33 US$/month	33 US$/month	33 US$/month	17 US$/month	17 US$/month	17 US$/month	25 US$/month	25 US$/month
			Diesel payment /year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**400 US$/year**	**400 US$/year**	**400 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**300 US$/year**	**300 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**1682 US$/year**	**1682 US$/year**	**1704 US$/year**	**1682 US$/year**	**1682 US$/year**	**1710 US$/year**	**1624 US$/year**	**1624 US$/year**	**1624 US$/year**	**1624 US$/year**	**1624 US$/year**
			Loan payback (2years)	**0 US$/year**	**58000 US$/year**	**0 US$/year**	**0 US$/year**	**58000 US$/year**	**0 US$/year**	**0 US$/year**	**56000 US$/year**	**0 US$/year**	**0 US$/year**	**56000 US$/year**
		construction costs	Grid Cost	10000 US$			10000 US$			8000 US$			8000 US$	
			Machinery Cost(15Years)	48000 US$			48000 US$			48000 US$			48000 US$	
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation costs/year				**64182 US$/year**	**64182 US$/year**	**6204 US$/year**	**64282 US$/year**	**64282 US$/year**	**6310 US$/year**	**60904 US$/year**	**60904 US$/year**	**4904 US$/year**	**61004 US$/year**	**61004 US$/year**
Incomes			Time of Machinery operation/day	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
	Batteries		Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	30batteries	30batteries	30batteries	30batteries	30batteries
			Electric for one battery charging kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**135 US$/month**	**203 US$/month**	**203 US$/month**	**135 US$/month**	**203 US$/month**
	Households		Household number	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all household (US$)/month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
			Sales revenue(US$/year)	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Own investment ($)				0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				0.2417%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%
Loan interest (%)/year				**2.9%**	**2.9%**	**2.9%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**	**2.900%**
Loan form Bank($)				**58000 US$/year**		**58754 US$/year**	**58000 US$/year**		**58954 US$/year**	**56000 US$/year**		**58068 US$/year**	**56000 US$/year**	
Total Gains				**63805 US$/year**	**5805 US$/year**	**64559 US$/year**	**63805 US$/year**	**5805 US$/year**	**64759 US$/year**	**59870 US$/year**	**3870 US$/year**	**61938 US$/year**	**59870 US$/year**	**3870 US$/year**
Net Annual Profit ($)				**-377.00 US$/year**	**-58377.00 US$/year**	**58355.13 US$/year**	**-477.00 US$/year**	**-58477.00 US$/year**	**58449.33 US$/year**	**-1034.00 US$/year**	**-57034.00 US$/year**	**57034.00 US$/year**	**-1134.00 US$/year**	**-57134.00 US$/year**
Cumulative Earnings				**-377 US$/year**	**-58754 US$/year**	**-399 US$/year**	**-477 US$/year**	**-58954 US$/year**	**-505 US$/year**	**-1034 US$/year**	**-58068 US$/year**	**-1034 US$/year**	**-1134 US$/year**	**-58268 US$/year**
			Rank	1			2			3			4	

Case 4	increase interest rate increase comsumption increase diesel price	25% 50% 0%	Case 5	increase interest rate increase comsumption increase diesel price	25% 50% 50%	Case 6	increase interest rate increase comsumption increase diesel price	25% 0% 0%	Case 7	increase interest rate increase comsumption increase diesel price	25% 0% 50%	Case 8
2011	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
2persons	3persons	3persons	3persons	3persons	3persons	3persons	2persons	2persons	2persons	2persons	2persons	2persons
1200 US$/year	1800 US$/year	1800 US$/year	1800 US$/year	1800 US$/year	1800 US$/year	1800 US$/year	1200 US$/year	1200 US$/year	1200 US$/year	1200 US$/year	1200 US$/year	1200 US$/year
25.0 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	37.5 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month
300 US$/year	450 US$/year	450 US$/year	450 US$/year	450 US$/year	450 US$/year	450 US$/year	300 US$/year	300 US$/year	300 US$/year	300 US$/year	300 US$/year	300 US$/year
20 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
240 US$/year	360 US$/year	360 US$/year	360 US$/year	360 US$/year	360 US$/year	360 US$/year	240 US$/year	240 US$/year	240 US$/year	240 US$/year	240 US$/year	240 US$/year
42 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month
500 US$/year	750 US$/year	750 US$/year	750 US$/year	750 US$/year	750 US$/year	750 US$/year	500 US$/year	500 US$/year	500 US$/year	500 US$/year	500 US$/year	500 US$/year
25 US$/month	25 US$/month	25 US$/month	25 US$/month	33 US$/month	33 US$/month	33 US$/month	17 US$/month	17 US$/month	17 US$/month	25 US$/month	25 US$/month	25 US$/month
300 US$/year	300 US$/year	300 US$/year	300 US$/year	400 US$/year	400 US$/year	400 US$/year	200 US$/year	200 US$/year	200 US$/year	300 US$/year	300 US$/year	300 US$/year
1624 US$/year	14500 US$/year	14500 US$/year	14500 US$/year	14500 US$/year	14500 US$/year	14500 US$/year	14000 US$/year	14000 US$/year	14000 US$/year	14000 US$/year	14000 US$/year	14000 US$/year
0 US$/year	0 US$/year	58000 US$/year	0 US$/year	0 US$/year	58000 US$/year	0 US$/year	0 US$/year	56000 US$/year	0 US$/year	0 US$/year	56000 US$/year	0 US$/year
	10000 US$			10000 US$			8000 US$			8000 US$		
	48000 US$			48000 US$			48000 US$			48000 US$		
70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year
5004 US$/year	77000 US$/year	77000 US$/year	19000 US$/year	77100 US$/year	77100 US$/year	19100 US$/year	73280 US$/year	73280 US$/year	17280 US$/year	73380 US$/year	73380 US$/year	17380 US$/year
12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
30batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day
540Kwh/month	810Kwh/month	810Kwh/month	810Kwh/month	810Kwh/month	810Kwh/month	810Kwh/month	540Kwh/month	540Kwh/month	540Kwh/month	540Kwh/month	540Kwh/month	540Kwh/month
203 US$/month	203 US$/month	203 US$/month	203 US$/month	203 US$/month	203 US$/month	203 US$/month	135 US$/month	203 US$/month	203 US$/month	135 US$/month	203 US$/month	203 US$/month
200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
2.50Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
188 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month	188 US$/month	188 US$/month	188 US$/month	188 US$/month	188 US$/month	188 US$/month
3870 US$/year	5805 US$/year	5805 US$/year	5805 US$/year	5805 US$/year	5805 US$/year	5805 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0.242%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
2.900%	25.000%	25.000%	25.000%	25.000%	25.000%	25.000%	25.000%	25.000%	25.000%	25.000%	25.000%	25.000%
58268 US$/year	58000 US$/year		84390 US$/year	58000 US$/year		84590 US$/year	56000 US$/year		82820 US$/year	56000 US$/year		83020 US$/year
62138 US$/year	63805 US$/year	5805 US$/year	90195 US$/year	63805 US$/year	5805 US$/year	90395 US$/year	59870 US$/year	3870 US$/year	86690 US$/year	59870 US$/year	3870 US$/year	86890 US$/year
57134.00 US$/year	-13195.00 US$/year	-71195.00 US$/year	71195.00 US$/year	-13295.00 US$/year	-71295.00 US$/year	71295.00 US$/year	-13410.00 US$/year	-69410.00 US$/year	69410.00 US$/year	-13510.00 US$/year	-69510.00 US$/year	69510.00 US$/year
-1134 US$/year	-13195 US$/year	-84390 US$/year	-13195 US$/year	-13295 US$/year	-84590 US$/year	-13295 US$/year	-13410 US$/year	-82820 US$/year	-13410 US$/year	-13510 US$/year	-83020 US$/year	-13510 US$/year

	5	6	7	8

Table. 7: The best and the worst Net Annual Profit

50% increase comsumtion | 0% increase diesel price | 50% increase interest rate | 25%

				Increase 50% in electricity consumption & Interest rate 2.9% & No Increase in diesel price			No increase in electricity consumption & Interest rate 25% & Increase 50% in diesel price		
Year				2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	3persons	3persons	3persons	2persons	3persons	3persons
			Worker Salary/year	**1800 US$/year**	**1800 US$/year**	**1800 US$/year**	**1200 US$/year**	**1800 US$/year**	**1800 US$/year**
		Lubricant	Lubricant cost/ month	37.5 US$/month	37.5 US$/month	37.5 US$/month	25.0 US$/month	37.5 US$/month	37.5 US$/month
			Lubricant cost /year	**450 US$/year**	**450 US$/year**	**450 US$/year**	**300 US$/year**	**450 US$/year**	**450 US$/year**
		Repairing	Repair and maintenance costs/month	30 US$/month	30 US$/month	30 US$/month	20 US$/month	30 US$/month	30 US$/month
			Repair and maintenance costs/year	**360 US$/year**	**360 US$/year**	**360 US$/year**	**240 US$/year**	**360 US$/year**	**360 US$/year**
	Fuel cost	Wood	Wood payment/month	63 US$/month	63 US$/month	63 US$/month	42 US$/month	63 US$/month	63 US$/month
			Payment of wood /year	**750 US$/year**	**750 US$/year**	**750 US$/year**	**500 US$/year**	**750 US$/year**	**750 US$/year**
		Diesel	Diesel payment /month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month
			Diesel payment /year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**1682 US$/year**	**1682 US$/year**	**1704 US$/year**	**14000 US$/year**	**14000 US$/year**	**20551 US$/year**
			Loan payback (2years)	**0 US$/year**	**58000 US$/year**	**0 US$/year**	**0 US$/year**	**56000 US$/year**	**0 US$/year**
Fixed costs		construction costs	Grid Cost	10000 US$			8000 US$		
			Machinery Cost(15Years)	48000 US$			48000 US$		
	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation cost/year				**64182 US$/year**	**64182 US$/year**	**6204 US$/year**	**73380 US$/year**	**74500 US$/year**	**25051 US$/year**
Income		Time of Machinery operation/day		12hours	12hours	12hours	12hours	12hours	12hours
		Batteries	Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	45batteries	45batteries	45batteries	30batteries	45batteries	45batteries
			Electric for one battery charging kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**540Kwh/month**	**810Kwh/month**	**810Kwh/month**
			Electricity price for all battery /month	**203 US$/month**	**203 US$/month**	**203 US$/month**	**135 US$/month**	**203 US$/month**	**203 US$/month**
		Households	Household number	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	3.75Kwh/month	3.75Kwh/month
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all househod (US$)/month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**188 US$/month**	**281 US$/month**	**281 US$/month**
		Sales revenue(US$/year)		**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**3870 US$/year**	**5805 US$/year**	**5805 US$/year**
Own invest ($)				0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0
Loan interest(%) /month				0.2417%	0.2417%	0.2417%	2.0833%	2.083%	2.083%
Loan interest (%)/year				**2.9%**	**2.9%**	**2.9%**	**25.000%**	**25.000%**	**25.000%**
Loan form Bank($)				**58000 US$/year**	**0 US$/year**	**58754 US$/year**	**56000 US$/year**	**0 US$/year**	**82205 US$/year**
Total Gains				**63805 US$/year**	**5805 US$/year**	**64559 US$/year**	**59870 US$/year**	**5805 US$/year**	**88010 US$/year**
Net Annual Profit ($)				**-377 US$/year**	**-58377 US$/year**	**58355 US$/year**	**-13510 US$/year**	**-68695 US$/year**	**62959 US$/year**
Cumulative Earnings				**-377 US$/year**	**-58754 US$/year**	**-399 US$/year**	**-13510 US$/year**	**-82205 US$/year**	**-19246 US$/year**

IV.4.B Charts

Net Annual Profit No. 1:

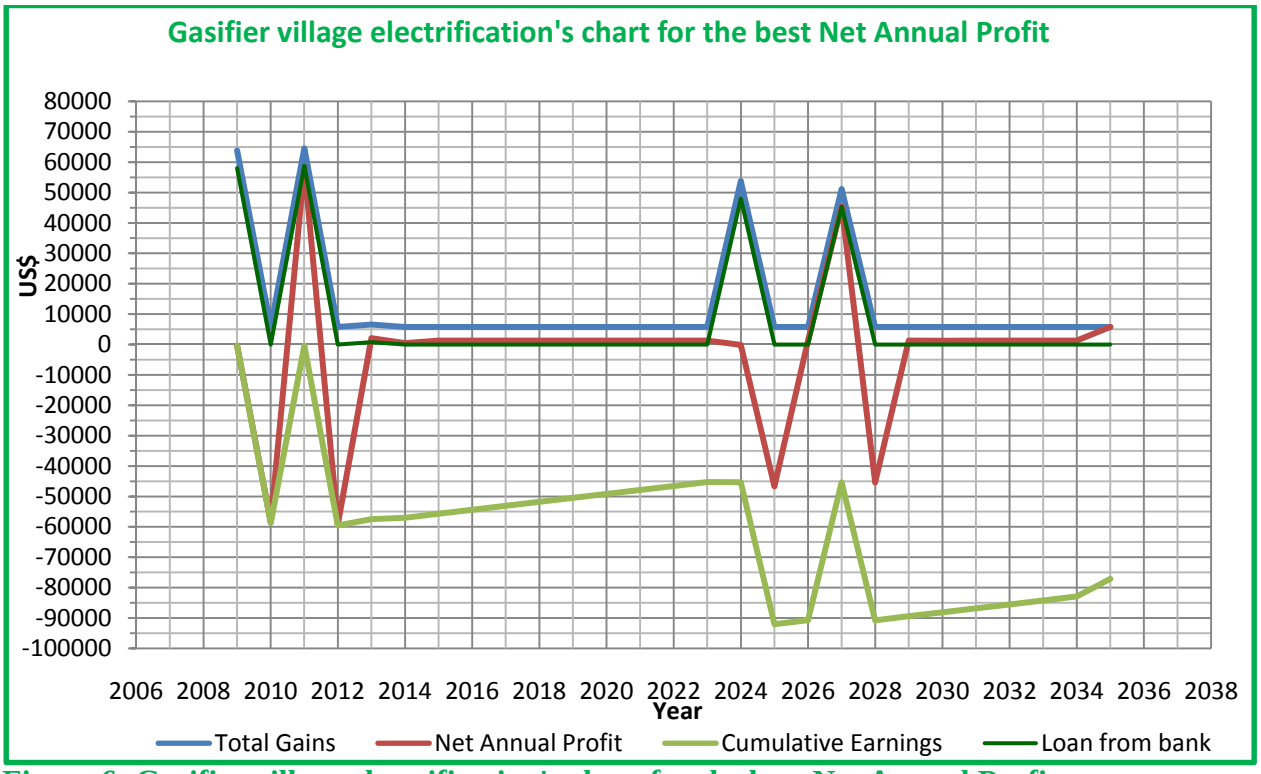


Figure 6: Gasifier village electrification's chart for the best Net Annual Profit

Net Annual Profit No. 8:

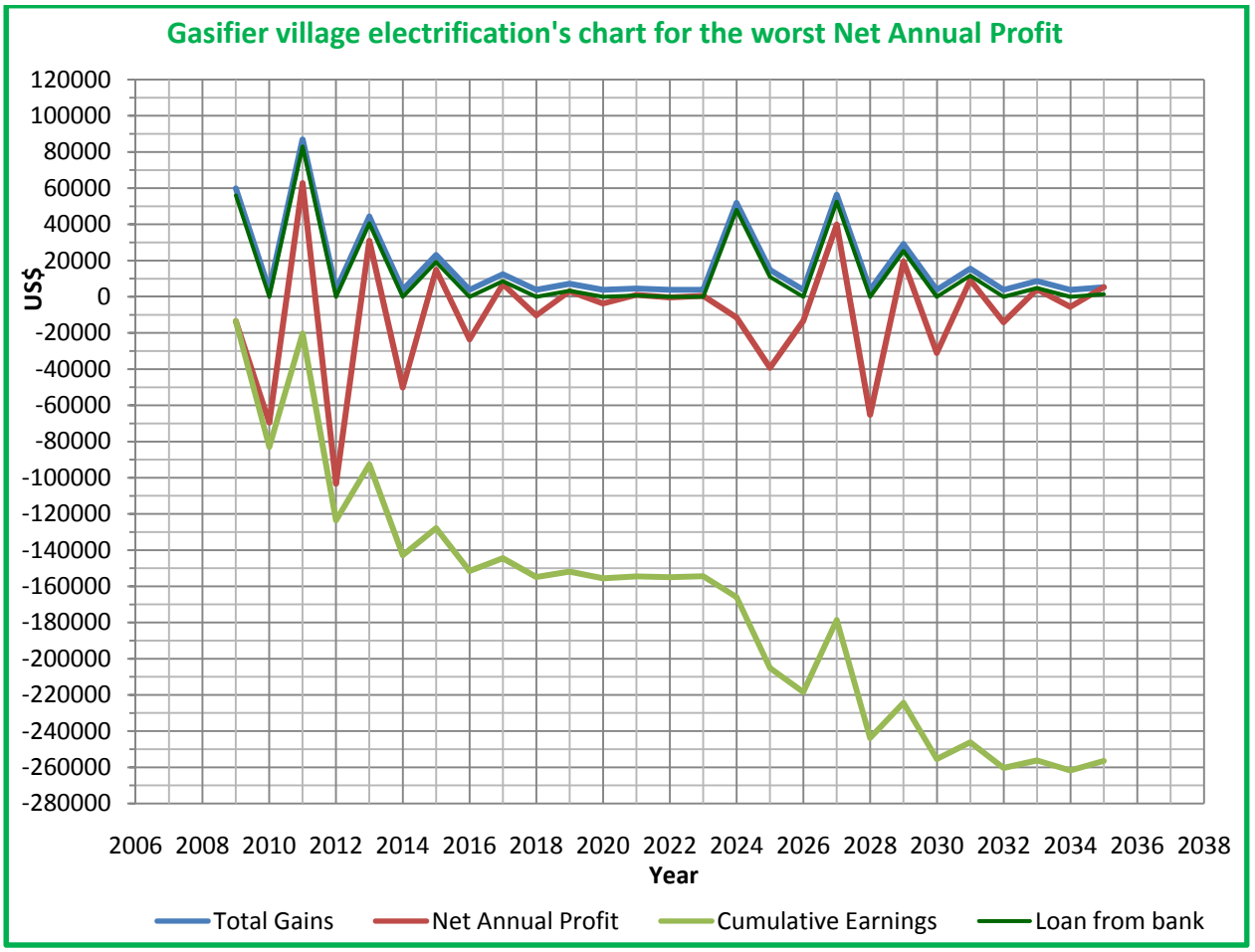


Figure 7: Gasifier village electrification's chart for the worst Net Annual Profit

By comparing the two charts of **Figure 6** and **Figure 7**, we can see that both charts are far different from each other. The Loan from bank of **Figure 6** is equal to zero in 2014, unlike the one of **Figure 7** is equal to zero in 2023 which is 9 years different from **Figure 6**.

V. Conclusion

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment. For our gasifier village electrification (started operation in 2009), the year of Loan from bank started to remain zero is in the interval of 2014 and 2023.

The minimum year of Loan from bank started to remain zero is in year 2014 which is the case of the best Net Annual Profit No.1: Increase 50% in electricity consumption, Interest rate 2.9%, No Increase in diesel price. **(Figure 6)**

The maximum year of Loan from bank started to remain zero is in year 2023 which is the case of the worst Net Annual Profit No.8: No increase in electricity consumption, Interest rate 25%, Increase 50% in diesel price. **(Figure 7)**

CHAPTER 2

PV VILLAGE ELECTRIFICATION

I. Results

By using technology cost and performance data and methodology of calculation, we get the results in the **Table. 8: Results of PV village electrification** and the chart below:

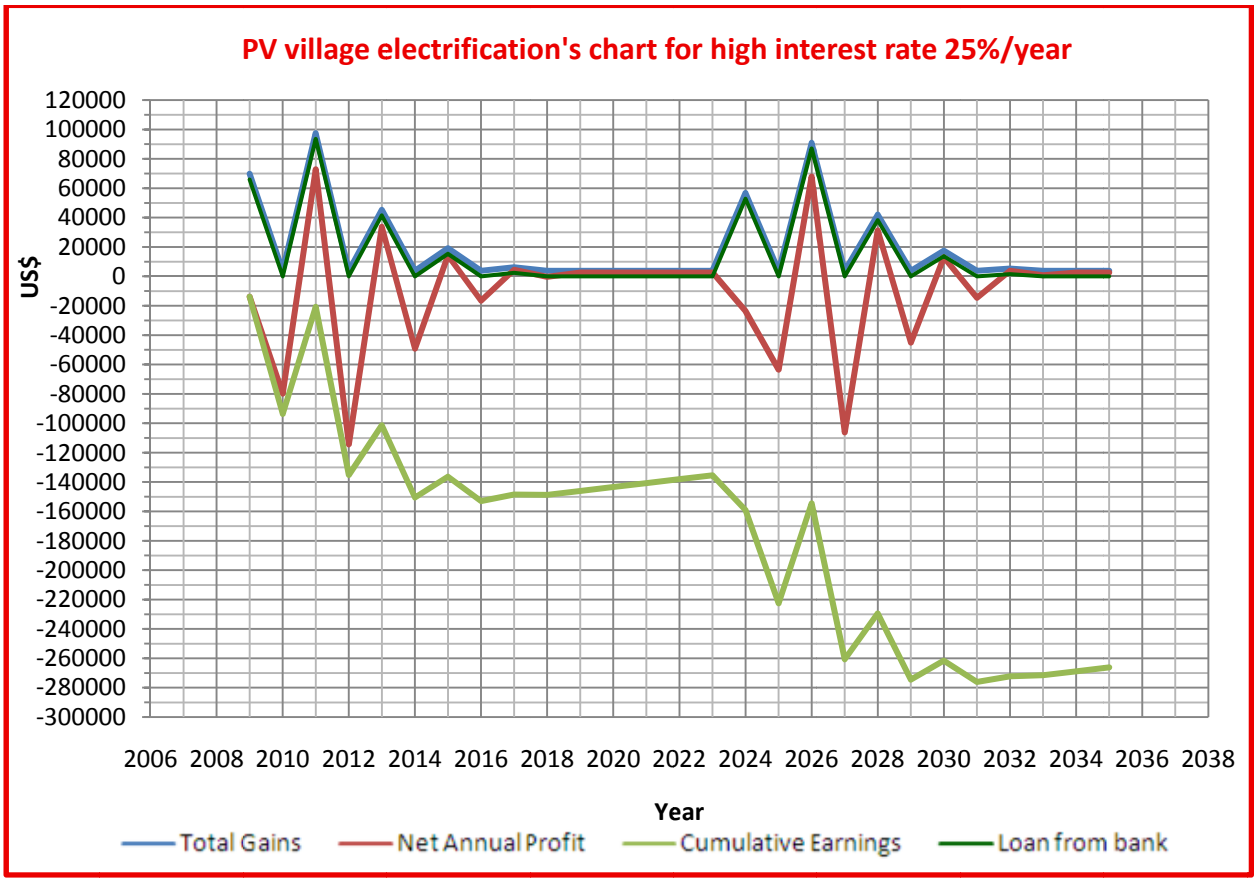


Figure 8: PV village electrification's chart for high interest rate 25%/year

II. Sensitivity Analysis

For sensitivity analysis of our case study, PV village electrification, we analyze the following:

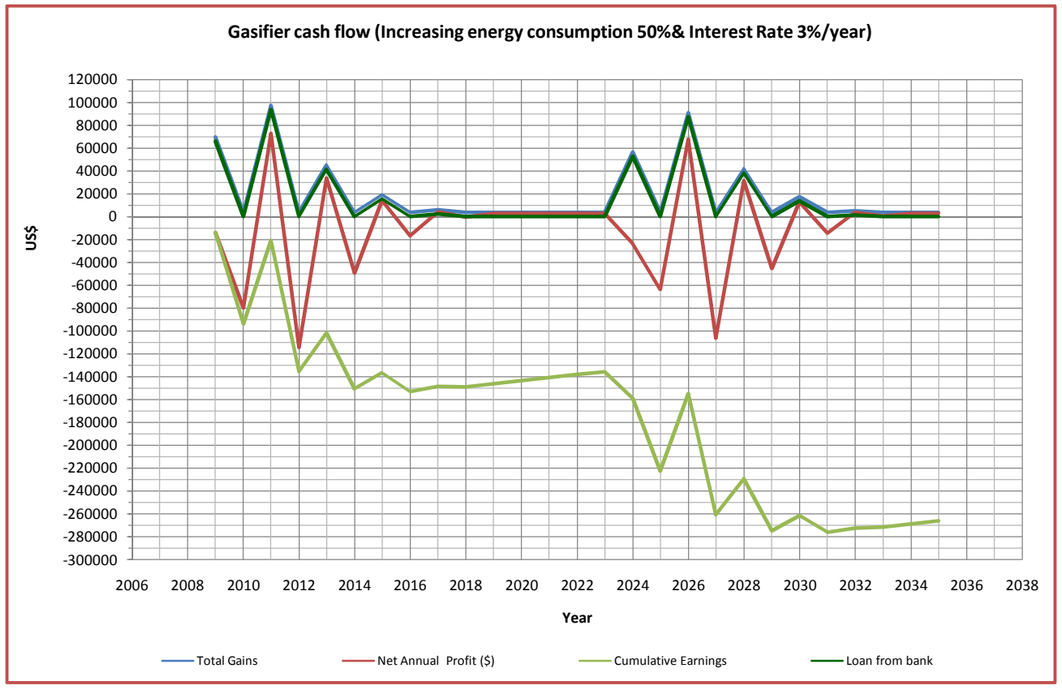
1. Analyze the impacts of changes in interest rate
2. Analyze the increase in electricity consumption
3. Analyze different combinations of changes 1. – 2. (4 cases)

Note: **The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.**

The results of different combinations of changes 1. – 2. are in the **Table. 9: The results of different combinations of changes of PV village electrification** which show all 4 cases during 3 years from 2009 to 2011.

Table. 8: Results of PV village electrification

				Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Variable costs	Operating &Maintenance costs	Worker		Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
				Number of Workers	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
				Worker Salary/year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing		Repair and maintenance costs/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month
				Repair and maintenance costs/year	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**
	Investment costs	Loan		**Interest of loan($)/year**	**16500 US$/year**	**16500 US$/year**	**23415 US$/year**	**23415 US$/year**	**10373 US$/year**	**10373 US$/year**	**3851 US$/year**	**3851 US$/year**	**591 US$/year**	**591 US$/year**
				Loan payback (2years)		**66000 US$/year**	**0 US$/year**	**93660 US$/year**	**0 US$/year**	**41490 US$/year**	**0 US$/year**	**15405 US$/year**	**0 US$/year**	**2363 US$/year**
		construction costs		Grid Cost	0 US$									
				Machinery Cost(15Years)	66000 US$									
Fixed costs	Customer service costs	Phone + Accounting		Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
				Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation costs/year					**83700 US$/year**	**83700 US$/year**	**24615 US$/year**	**118275 US$/year**	**11573 US$/year**	**53063 US$/year**	**5051 US$/year**	**20456 US$/year**	**1791 US$/year**	**4153 US$/year**
Incomes	Time of Machinery operation/day				12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
	Batteries			Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
				Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
				Number of Battery/day	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
				Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
				Electric for all battery charing kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
				Electricity price for all battery /month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
	Households			Household number	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
				Electricity consumtion for One Household(KWh/month)	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
				Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
				Electricity price for all household (US$)/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
	Sales revenue(US$/year)				**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Own invest ($)					0	0	0	0	0	0	0	0	0	0
Vat ($)					0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month					2.08%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
Loan interest (%)/year					**25.00%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**
Loan from Bank($)					**66000 US$/year**	**0 US$/year**	**93660 US$/year**	**0 US$/year**	**41490 US$/year**	**0 US$/year**	**15405 US$/year**	**0 US$/year**	**2363 US$/year**	**0 US$/year**
Total Gains					**69870 US$/year**	**3870 US$/year**	**97530 US$/year**	**3870 US$/year**	**45360 US$/year**	**3870 US$/year**	**19275 US$/year**	**3870 US$/year**	**6233 US$/year**	**3870 US$/year**
Net Annual Profit ($)					**-13830 US$/year**	**-79830 US$/year**	**72915 US$/year**	**-114405 US$/year**	**33788 US$/year**	**-49193 US$/year**	**14224 US$/year**	**-16586 US$/year**	**4442 US$/year**	**-283 US$/year**
Cumulative Earnings					**-13830 US$/year**	**-93660 US$/year**	**-20745 US$/year**	**-135150 US$/year**	**-101363 US$/year**	**-150555 US$/year**	**-136331 US$/year**	**-152918 US$/year**	**-148476 US$/year**	**-148759 US$/year**



	Value in 2009	Increase Energy Cons.
Personal salary /month	50 US$/month	50 US$/month
Number of Workers	2persons	2persons
Worker Salary/year	**1200 US$/year**	**1200 US$/year**
Wood payment/month	42 US$/month	42 US$/month
Payment of wood /year	**500 US$/year**	**500 US$/year**
Diesel payment /month	17 US$/month	17 US$/month
Diesel payment /year	**200 US$/year**	**200 US$/year**
Lubricant cost/ month	25.0 US$/month	25.0 US$/month
Lubricant cost /year	**300 US$/year**	**300 US$/year**
Repair and maintenance costs/month	20 US$/month	20 US$/month
Repair and maintenance costs/year	**240 US$/year**	**240 US$/year**
Phone+accounting/month	70 US$/month	70 US$/month
Phone+accounting/year	**840 US$/year**	**840 US$/year**

Number of Battery/day	30batteries	30batteries
Electric for one battery charing kwh/day	**0.00Kwh/day**	**0.00Kwh/day**
Electric for all battery charing kwh/month	**0Kwh/month**	**0Kwh/month**
Electricity price for all battery /month	**0 US$/month**	**0 US$/month**

Electricity consumtion for One Household(KWh/month)	2.50Kwh/month	2.50Kwh/month
Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month
Electricity price for all househod (US$)/month	**1 US$/month**	**1 US$/month**
Sales revenue(US$/year)	**11 US$/year**	**11 US$/year**

	Value in 2009	**Increase Energy Cons.(50%)**
Number of Workers	2persons	3persons
Wood payment/month	$42/month	$63/month
Diesel payment /month	$17/month	$25/month
Lubricant cost/ month	$25/month	$37.5/month
Repair and maintenance costs/month	$20/month	$30/month
Phone+accounting/month	$70/month	$105/month
Number of Battery/day	30batteries	45batteries
Electricity consumtion for One Household(KWh/month)	2.5kWh/month	3.75kWh/month

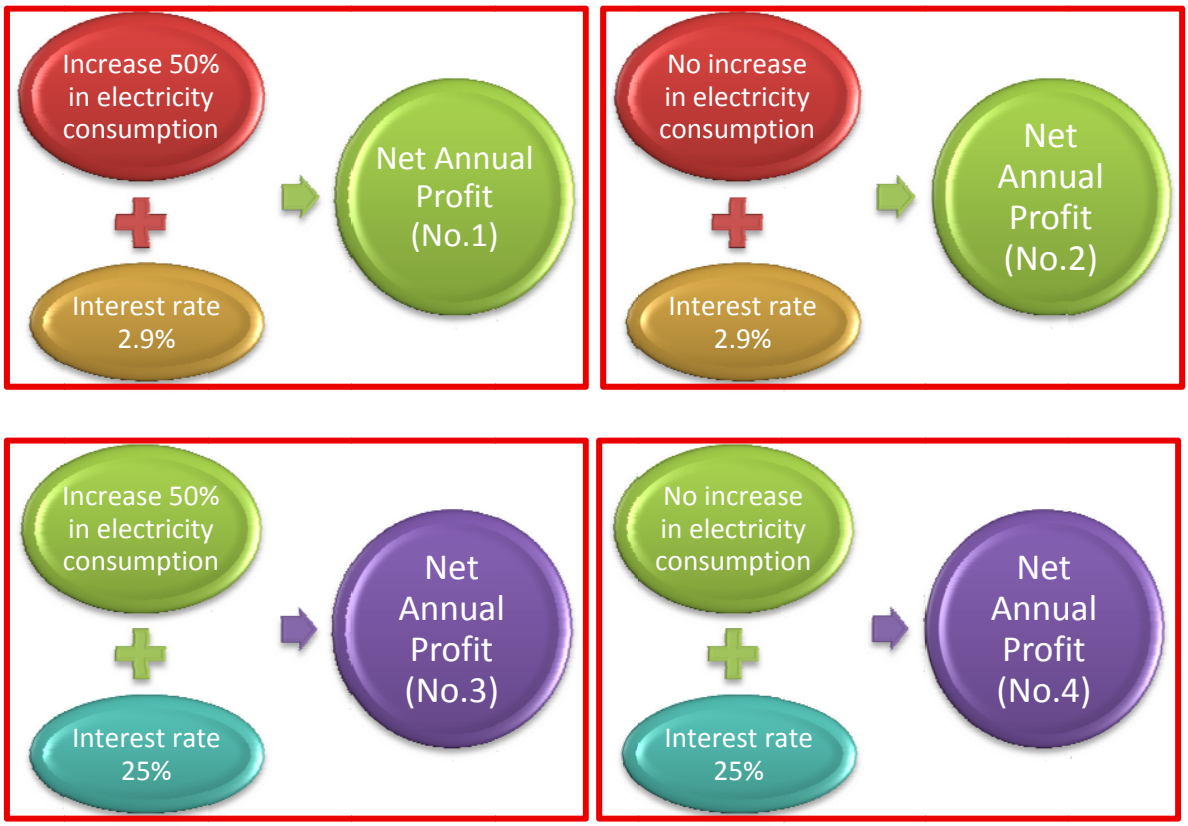
2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
300 US$/year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month
60 US$/year	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**13233 US$/year**	**13233 US$/year**	**21782 US$/year**	**21782 US$/year**	**9556 US$/year**	**9556 US$/year**	**3443 US$/year**	**3443 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**52933 US$/year**	**0 US$/year**	**87127 US$/year**	**0 US$/year**	**38223 US$/year**	**0 US$/year**	**13772 US$/year**
					66000 US$							
70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
1200 US$/year	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**1200 US$/year**	**80433 US$/year**	**67366 US$/year**	**22982 US$/year**	**110108 US$/year**	**10756 US$/year**	**48979 US$/year**	**4643 US$/year**	**18415 US$/year**
12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
540Kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
135 US$/month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
188 US$/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
3870 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
25.000%	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**52933 US$/year**	**0 US$/year**	**87127 US$/year**	**0 US$/year**	**38223 US$/year**	**0 US$/year**	**13772 US$/year**	**0 US$/year**
3870 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**56803 US$/year**	**3870 US$/year**	**90997 US$/year**	**3870 US$/year**	**42093 US$/year**	**3870 US$/year**	**17642 US$/year**	**3870 US$/year**
2670 US$/year	**2670 US$/year**	**2670 US$/year**	**2670 US$/year**	**2670 US$/year**	**-23630 US$/year**	**-63496 US$/year**	**68015 US$/year**	**-106238 US$/year**	**31337 US$/year**	**-45109 US$/year**	**12999 US$/year**	**-14545 US$/year**
-146089 US$/year	**-143419 US$/year**	**-140749 US$/year**	**-138079 US$/year**	**-135409 US$/year**	**-159039 US$/year**	**-222535 US$/year**	**-154520 US$/year**	**-260759 US$/year**	**-229421 US$/year**	**-274530 US$/year**	**-261532 US$/year**	**-276076 US$/year**

2032	2033	2034	2035
50 US$/month	50 US$/month	50 US$/month	50 US$/month
1person	1person	1person	1person
300 US$/year	**300 US$/year**	**300 US$/year**	**300 US$/year**
5 US$/month	5 US$/month	5 US$/month	5 US$/month
60 US$/year	**60 US$/year**	**60 US$/year**	**60 US$/year**
386 US$/year	**386 US$/year**	**0 US$/year**	**0 US$/year**
0 US$/year	**1546 US$/year**	**0 US$/year**	**0 US$/year**
70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**
1586 US$/year	**3132 US$/year**	**1200 US$/year**	**1200 US$/year**
12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah
30batteries	30batteries	30batteries	30batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
540Kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
135 US$/month	**135 US$/month**	**135 US$/month**	**135 US$/month**
200houses	200houses	200houses	200houses
2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
188 US$/month	**188 US$/month**	**188 US$/month**	**188 US$/month**
3870 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
0	0	0	0
0	0	0	0
2.083%	2.083%	2.083%	2.083%
25.000%	**25.000%**	**25.000%**	**25.000%**
1546 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**
5416 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
3829 US$/year	**738 US$/year**	**2670 US$/year**	**2670 US$/year**
-272247 US$/year	**-271509 US$/year**	**-268839 US$/year**	**-266169 US$/year**

Table. 9: The results of different combinations of changes of PV village electrification

				increase interest rate increase comsumption increase diesel price	2.9% 50% 0%	Case 1	increase interest rate increase comsumption increase diesel price	2.9% 0% 0%	Case 2	increase interest rate increase comsumption increase diesel price	25% 50% 0%	Case 3	increase interest rate increase comsumption increase diesel price	25% 0% 0%	Case 4
			Year	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
			Worker Salary/year	**450 US$/year**	**450 US$/year**	**450 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	8 US$/month	8 US$/month	8 US$/month	5 US$/month	5 US$/month	5 US$/month	8 US$/month	8 US$/month	8 US$/month	5 US$/month	5 US$/month	5 US$/month
			Repair and maintenance costs/year	**90 US$/year**	**90 US$/year**	**90 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**90 US$/year**	**90 US$/year**	**90 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**
	Investment costs	Loan	Interest of loan($)/year	1914 US$/year	1914 US$/year	1768 US$/year	1914 US$/year	1914 US$/year	1870 US$/year	16500 US$/year	16500 US$/year	22538 US$/year	16500 US$/year	16500 US$/year	23415 US$/year
			Loan payback (2years)		66000 US$/year	0 US$/year		66000 US$/year	0 US$/year		66000 US$/year	0 US$/year		66000 US$/year	0 US$/year
		construction costs	Grid Cost	0 US$			0 US$			0 US$			0 US$		
			Machinery Cost(15Years)	66000 US$			66000 US$			66000 US$			66000 US$		
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation costs/year				**69294 US$/year**	**69294 US$/year**	**3148 US$/year**	**69114 US$/year**	**69114 US$/year**	**3070 US$/year**	**83880 US$/year**	**83880 US$/year**	**23918 US$/year**	**83700 US$/year**	**83700 US$/year**	**24615 US$/year**
Incomes	Time of Machinery operation/day			12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
	Batteries		Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	45batteries	45batteries	45batteries	30batteries	30batteries	30batteries	45batteries	45batteries	45batteries	30batteries	30batteries	30batteries
			Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**203 US$/month**	**203 US$/month**	**203 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
	Households		Household number	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all househod (US$)/month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
	Sales revenue(US$/year)			**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Own investment ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				0.24%	0.242%	0.242%	0.24%	0.242%	0.242%	2.08%	2.083%	2.083%	2.08%	2.083%	2.083%
Loan interest (%)/year				**2.90%**	**2.900%**	**2.900%**	**2.90%**	**2.900%**	**2.900%**	**25.00%**	**25.000%**	**25.000%**	**25.00%**	**25.000%**	**25.000%**
Loan form Bank($)				**66000 US$/year**		**60978 US$/year**	**66000 US$/year**		**64488 US$/year**	**66000 US$/year**		**90150 US$/year**	**66000 US$/year**		**93660 US$/year**
Total Gains				**71805 US$/year**	**5805 US$/year**	**66783 US$/year**	**69870 US$/year**	**3870 US$/year**	**68358 US$/year**	**71805 US$/year**	**5805 US$/year**	**95955 US$/year**	**69870 US$/year**	**3870 US$/year**	**97530 US$/year**
Net Annual Profit ($)				**2511 US$/year**	**-63489 US$/year**	**63635 US$/year**	**756 US$/year**	**-65244 US$/year**	**65288 US$/year**	**-12075 US$/year**	**-78075 US$/year**	**72038 US$/year**	**-13830 US$/year**	**-79830 US$/year**	**72915 US$/year**
Cumulative Earnings				**2511 US$/year**	**-60978 US$/year**	**2657 US$/year**	**756 US$/year**	**-64488 US$/year**	**800 US$/year**	**-12075 US$/year**	**-90150 US$/year**	**-18113 US$/year**	**-13830 US$/year**	**-93660 US$/year**	**-20745 US$/year**
Rank				1			2			3			4		

The change of Net Annual Profit (No.1: The best to No.4: The worst) is in the graphics below:



The cases of sensitivity analysis will be shown in the chart below from the Net Annual Profit No.1 (**Figure 9**) to the Net Annual Profit No.3 (**Figure 11**). The chart of Net Annual Profit No. 4 is the **Figure 8**.

Net Annual Profit No. 1:

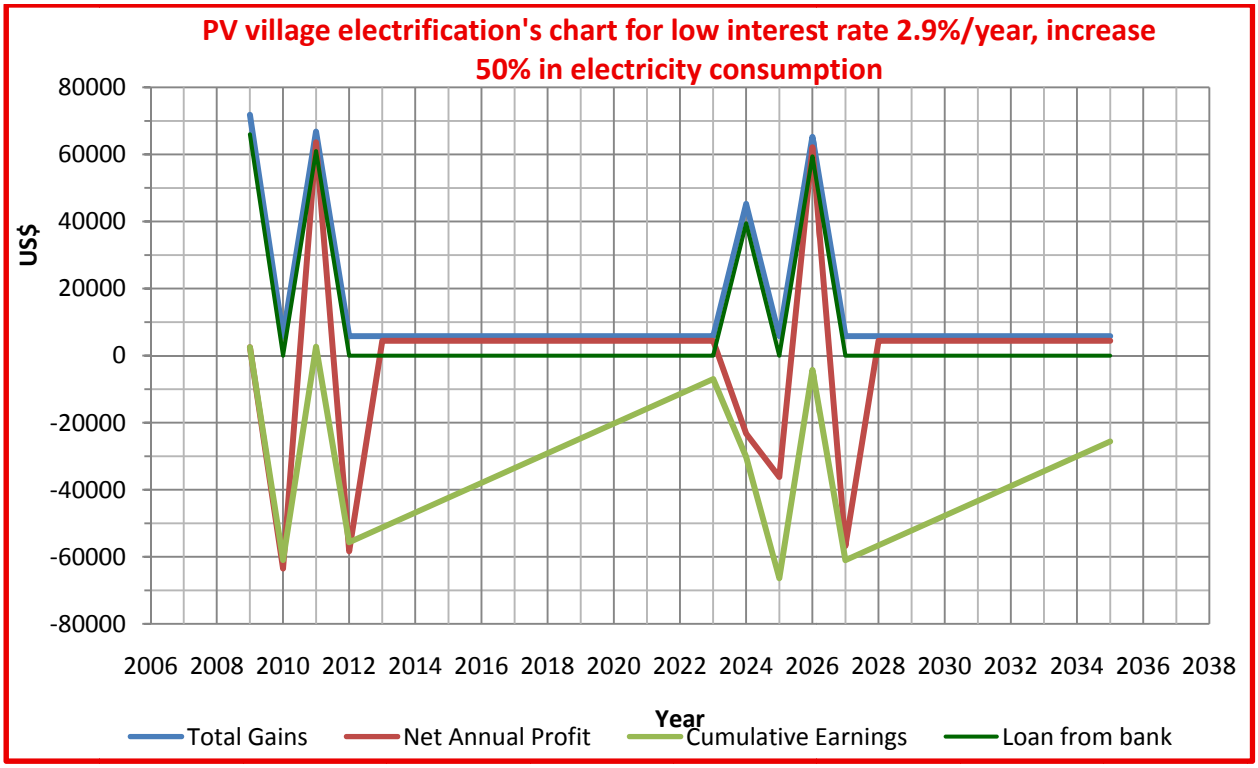


Figure 9: PV village electrification's chart for low interest rate 2.9%/year, increase 50% in electricity consumption

Net Annual Profit No. 2:

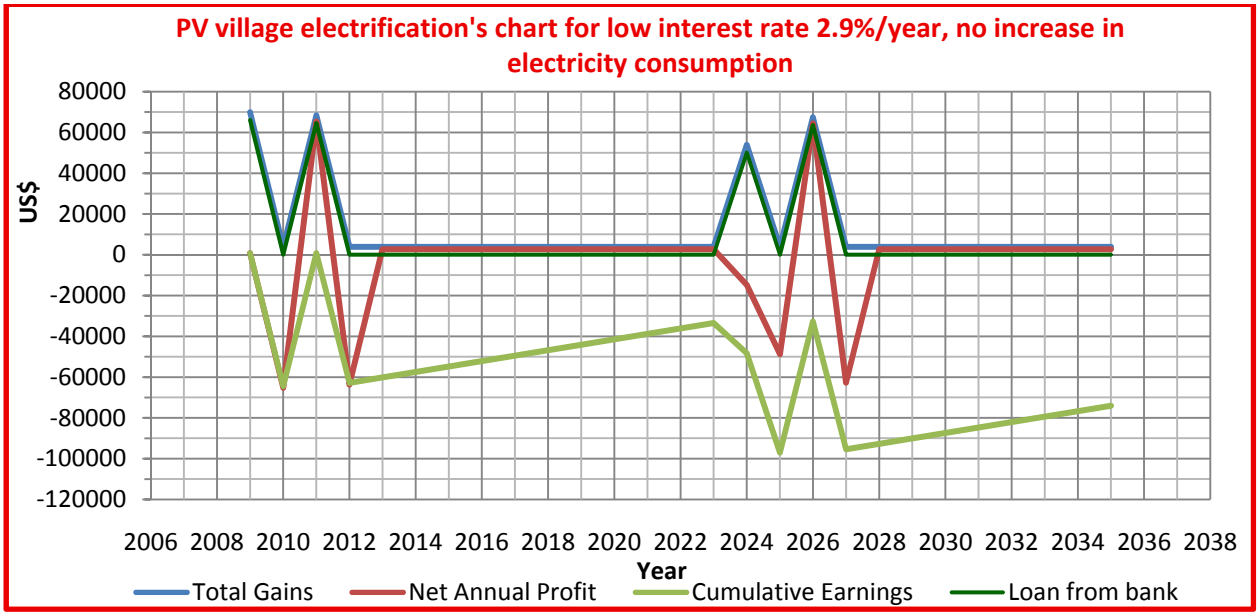


Figure 10: PV village electrification's chart for low interest rate 2.9%/year, no increase in electricity consumption

Net Annual Profit No. 3:

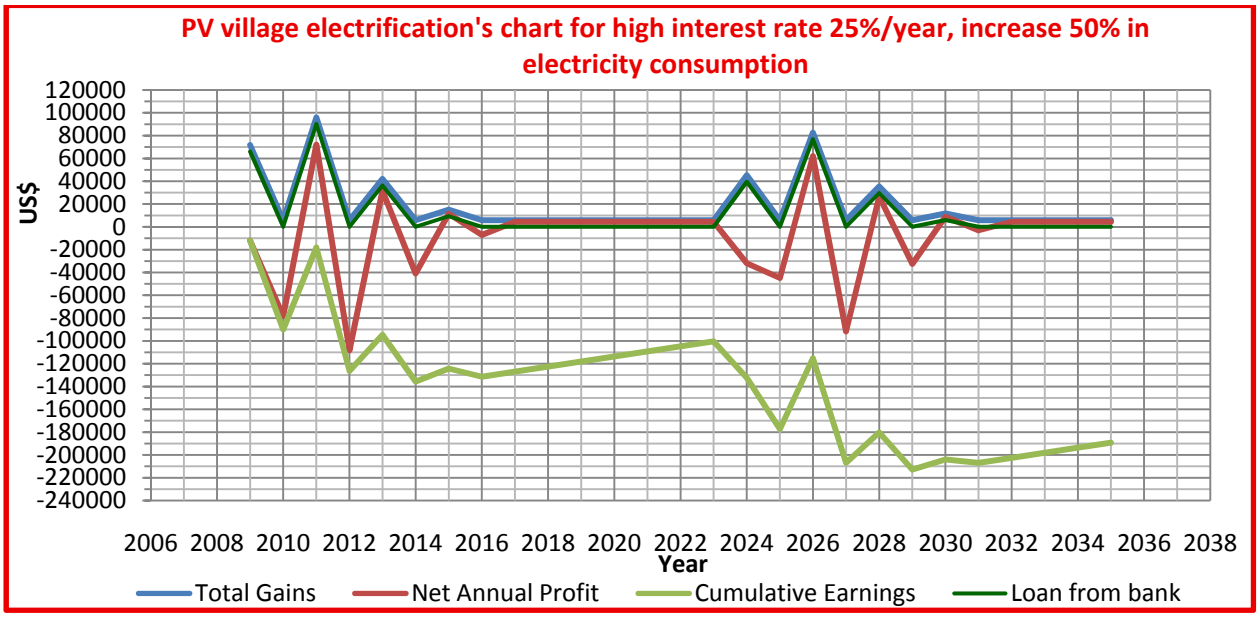


Figure 11: PV village electrification's chart for high interest rate 25%/year, increase 50% in electricity consumption

III. Conclusion

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment. For our PV village electrification, the year of Loan from bank started to remain zero is in the interval of 2012 and 2018.

The minimum year of Loan from bank started to remain zero is in year 2012 which is the case of the best Net Annual Profit No.1: Increase 50% in electricity consumption, Low Interest rate 2.9%. (**Figure 9**)

The maximum year of Loan from bank started to remain zero is in year 2018 which is the case of the worst Net Annual Profit No.4: No increase in electricity consumption, High Interest rate 25%. (**Figure 8**)

CHAPTER 3

HYDRO VILLAGE ELECTRIFICATION

I. Results

By using technology cost and performance data and methodology of calculation, we get the results in the **Table. 10: Results of Hydro village electrification** and the chart below:

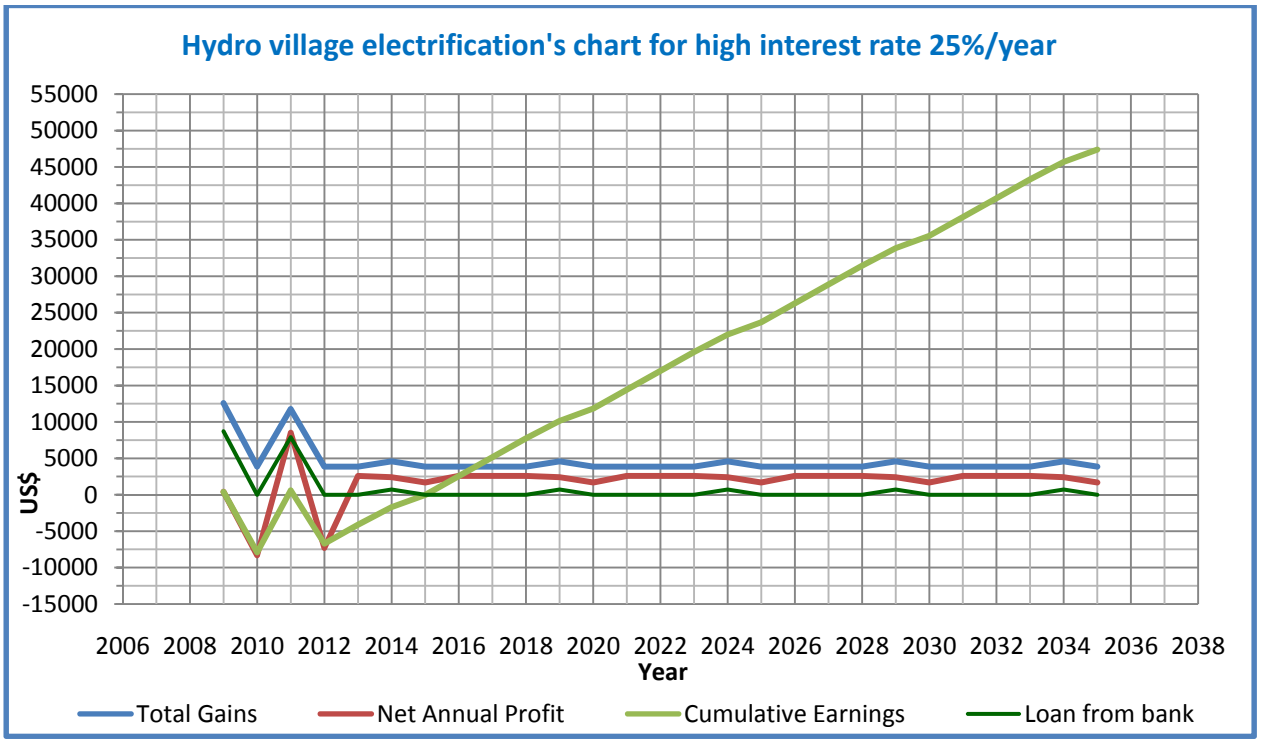


Figure 12: Hydro village electrification's chart for high interest rate 25%/year

II. Sensitivity Analysis

For sensitivity analysis of our case study, Hydro village electrification, we analyze the following:

1. Analyze the impacts of changes in interest rate
2. Analyze the increase in electricity consumption
3. Analyze different combinations of changes 1. – 2. (4 cases)

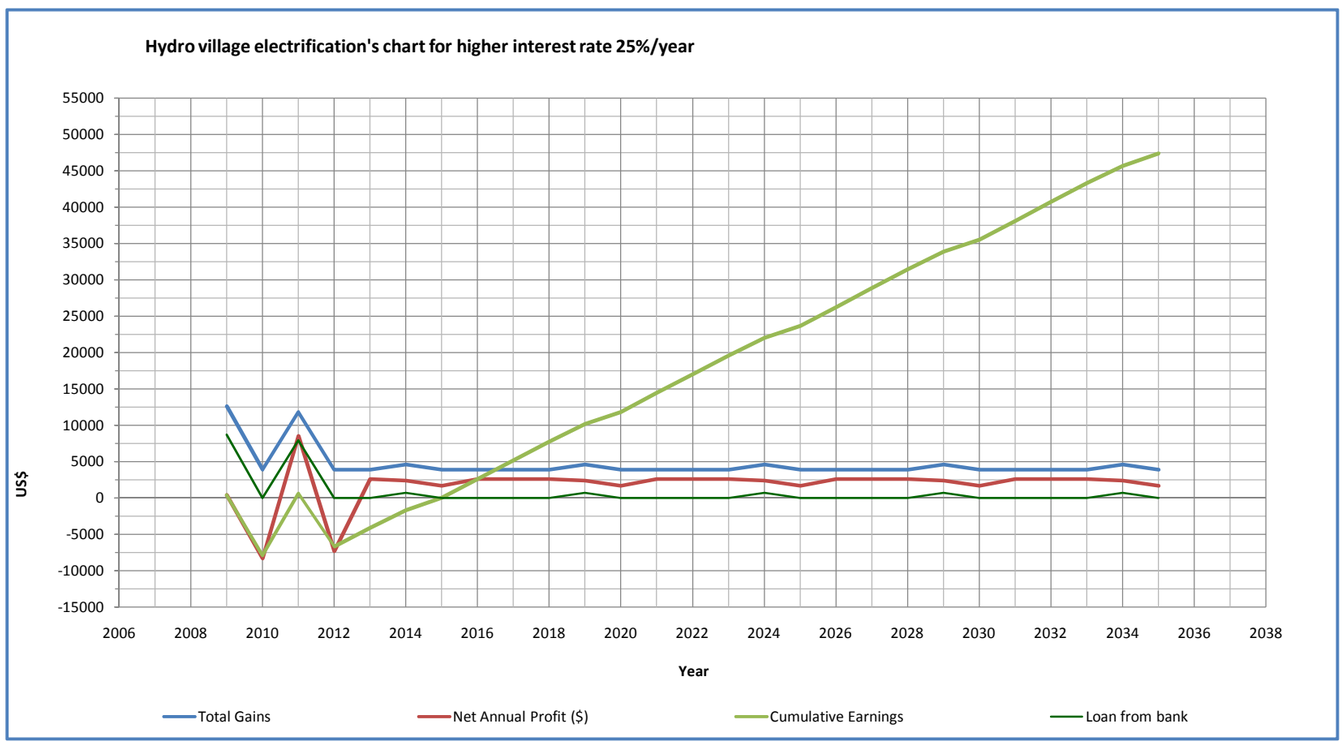
Note: **The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.**

The results of different combinations of changes 1. – 2. are in the **Table. 11: The results of different combinations of changes of hydro village electrification** which show all 4 cases during 3 years from 2009 to 2011.

Table. 10: Results of Hydro village electrification

Year				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month
			Number of Workers	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
			Worker Salary/year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month
			Repair and maintenance costs/year	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**
	Investment costs	Loan	Interest of loan($)/year	2180 US$/year	2180 US$/year	1977 US$/year	1977 US$/year	0 US$/year	180 US$/year	180 US$/year	0 US$/year	0 US$/year	0 US$/year
			Loan payback (2years)	0 US$/year	8720 US$/year	0 US$/year	7908 US$/year	0 US$/year	0 US$/year	720 US$/year	0 US$/year	0 US$/year	0 US$/year
		construction costs	Grid Cost	8000 US$									
			Pico hydro 250W unit	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$
			Number of units(6hours operating)	24units	24units	24units	24units	24units	24units	24units	24units	24units	24units
Fixed costs			Machinery Cost(5Years)	720 US$					720 US$				
	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation costs/year				**12184 US$/year**	**12184 US$/year**	**3261 US$/year**	**11169 US$/year**	**1284 US$/year**	**2184 US$/year**	**2184 US$/year**	**1284 US$/year**	**1284 US$/year**	**1284 US$/year**
Incomes	Time of Machinery operation/day			12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
	Batteries		Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
			Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
	Households		Household number	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
			Electricity consumtion for all household Kwh/month	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all household (US$)/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
			Electricity produced kwh/month	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**
	Sales revenue(US$/year)			3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	3870 US$/year
Own invest ($)				0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
Loan interest (%)/year				**25.00%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**
Loan from Bank($)				**8720 US$/year**	**0 US$/year**	**7908 US$/year**	**0 US$/year**	**0 US$/year**	**720 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
Total Gains				**12590 US$/year**	**3870 US$/year**	**11778 US$/year**	**3870 US$/year**	**3870 US$/year**	**4590 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Net Annual Profit ($)				**406 US$/year**	**-8314 US$/year**	**8517 US$/year**	**-7299 US$/year**	**2586 US$/year**	**2406 US$/year**	**1686 US$/year**	**2586 US$/year**	**2586 US$/year**	**2586 US$/year**
Cumulative Earnings				**406 US$/year**	**-7908 US$/year**	**609 US$/year**	**-6690 US$/year**	**-4104 US$/year**	**-1698 US$/year**	**-12 US$/year**	**2574 US$/year**	**5160 US$/year**	**7746 US$/year**

Note: Repair and maintenance costs/month = 20%*machinery cost (20% is the percentage of maintenance cost)


Hydro village electrification's chart for higher interest rate 25%/year
US$
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
Year
Total Gains
Net Annual Profit ($)
Cumulative Earnings
Loan from bank

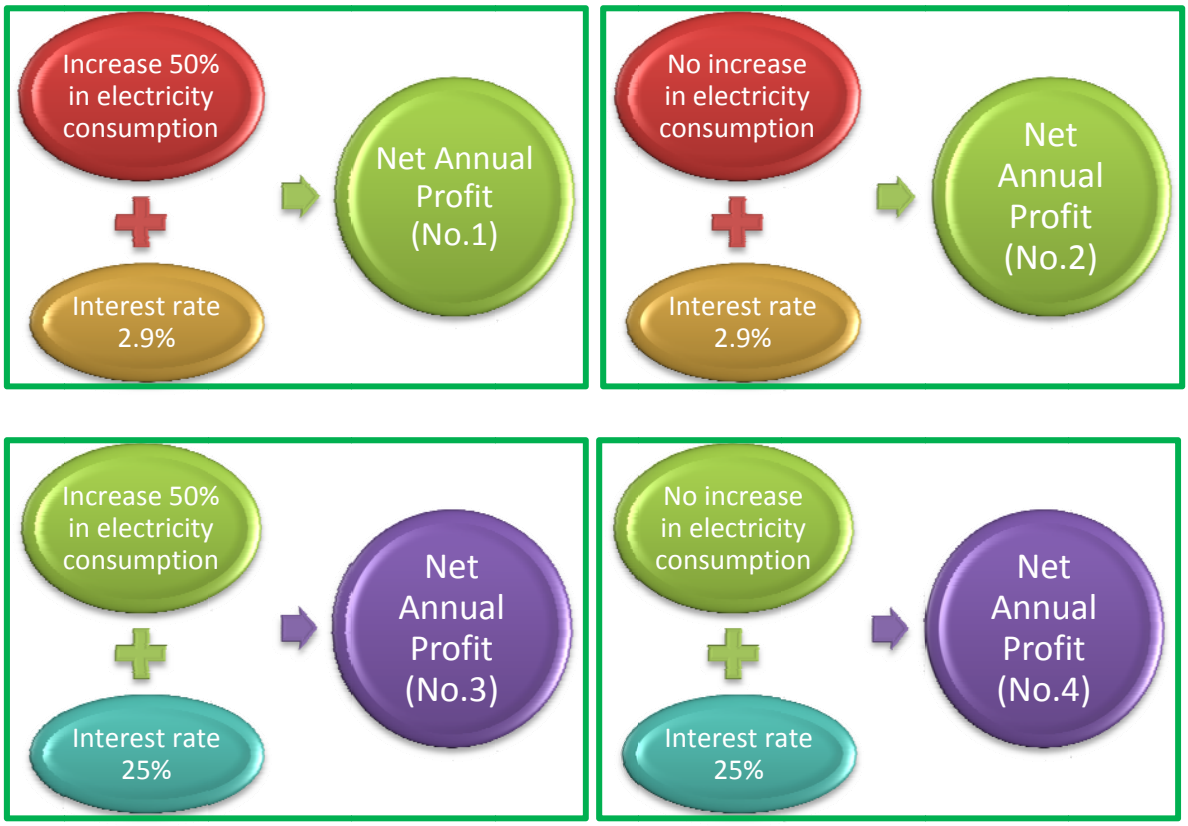
2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month
1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
300 US$/year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month	12 US$/month
144 US$/year	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**
180 US$/year	180 US$/year	0 US$/year	0 US$/year	0 US$/year	180 US$/year	180 US$/year	0 US$/year	0 US$/year	0 US$/year	180 US$/year	180 US$/year	0 US$/year
0 US$/year	720 US$/year	0 US$/year	0 US$/year	0 US$/year	0 US$/year	720 US$/year	0 US$/year	0 US$/year	0 US$/year	0 US$/year	720 US$/year	0 US$/year
30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$
24units	24units	24units	24units	24units	24units	24units	24units	24units	24units	24units	24units	24units
720 US$					720 US$					720 US$		
70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
2184 US$/year	**2184 US$/year**	**1284 US$/year**	**1284 US$/year**	**1284 US$/year**	**2184 US$/year**	**2184 US$/year**	**1284 US$/year**	**1284 US$/year**	**1284 US$/year**	**2184 US$/year**	**2184 US$/year**	**1284 US$/year**
12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
540Kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
135 US$/month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
500.00Kwh/month	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
188 US$/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
1040 kwh/month	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**
3870 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
25.000%	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**
720 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**720 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**720 US$/year**	**0 US$/year**	**0 US$/year**
4590 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**4590 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**4590 US$/year**	**3870 US$/year**	**3870 US$/year**
2406 US$/year	**1686 US$/year**	**2586 US$/year**	**2586 US$/year**	**2586 US$/year**	**2406 US$/year**	**1686 US$/year**	**2586 US$/year**	**2586 US$/year**	**2586 US$/year**	**2406 US$/year**	**1686 US$/year**	**2586 US$/year**
10152 US$/year	**11838 US$/year**	**14424 US$/year**	**17010 US$/year**	**19596 US$/year**	**22002 US$/year**	**23688 US$/year**	**26274 US$/year**	**28860 US$/year**	**31446 US$/year**	**33852 US$/year**	**35538 US$/year**	**38124 US$/year**

2032	2033	2034	2035
25 US$/month	25 US$/month	25 US$/month	25 US$/month
1person	1person	1person	1person
300 US$/year	**300 US$/year**	**300 US$/year**	**300 US$/year**
12 US$/month	12 US$/month	12 US$/month	12 US$/month
144 US$/year	**144 US$/year**	**144 US$/year**	**144 US$/year**
0 US$/year	**0 US$/year**	**180 US$/year**	**180 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**720 US$/year**
30 US$	30 US$	30 US$	30 US$
24units	24units	24units	24units
		720 US$	
70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**
1284 US$/year	**1284 US$/year**	**2184 US$/year**	**2184 US$/year**
12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah
30batteries	30batteries	30batteries	30batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
540Kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
135 US$/month	**135 US$/month**	**135 US$/month**	**135 US$/month**
200houses	200houses	200houses	200houses
2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
500.00Kwh/month	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
188 US$/month	**188 US$/month**	**188 US$/month**	**188 US$/month**
1040 kwh/month	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**
3870 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
0	0	0	0
0	0	0	0
2.083%	2.083%	2.083%	2.083%
25.000%	**25.000%**	**25.000%**	**25.000%**
0 US$/year	**0 US$/year**	**720 US$/year**	**0 US$/year**
3870 US$/year	**3870 US$/year**	**4590 US$/year**	**3870 US$/year**
2586 US$/year	**2586 US$/year**	**2406 US$/year**	**1686 US$/year**
40710 US$/year	**43296 US$/year**	**45702 US$/year**	**47388 US$/year**

Table. 11: The results of different combinations of changes of hydro village electrification

				increase interest rate increase comsumption increase diesel price	2.9% 50% 0%	Case 1	increase interest rate increase comsumption increase diesel price	2.9% 0% 0%	Case 2	increase interest rate increase comsumption increase diesel price	25% 50% 0%	Case 3	increase interest rate increase comsumption increase diesel price	25% 0% 0%	Case 4
			Year	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month	25 US$/month
			Number of Workers	2person	2person	2person	1person	1person	1person	2person	2person	2person	1person	1person	1person
			Worker Salary/year	**450 US$/year**	**450 US$/year**	**450 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	18 US$/month	18 US$/month	18 US$/month	12 US$/month	12 US$/month	12 US$/month	18 US$/month	18 US$/month	18 US$/month	12 US$/month	12 US$/month	12 US$/month
			Repair and maintenance costs/year	**216 US$/year**	**216 US$/year**	**216 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**	**216 US$/year**	**216 US$/year**	**216 US$/year**	**144 US$/year**	**144 US$/year**	**144 US$/year**
	Investment costs	Loan	Interest of loan($)/year	321 US$/year	321 US$/year	91 US$/year	253 US$/year	253 US$/year	118 US$/year	2770 US$/year	2770 US$/year	233 US$/year	2180 US$/year	2180 US$/year	229 US$/year
			Loan payback (2years)	0 US$/year	11080 US$/year	0 US$/year	0 US$/year	8720 US$/year	0 US$/year	0 US$/year	11080 US$/year	0 US$/year	0 US$/year	8720 US$/year	0 US$/year
		construction costs	Grid Cost	10000 US$			8000 US$			10000 US$			8000 US$		
			Pico hydro 250W unit	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$
			Number of units(6hours operating)	36units	36units	36units	24units	24units	24units	36units	36units	36units	24units	24units	24units
			Machinery Cost(5Years)	1080 US$			720 US$			1080 US$			720 US$		
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation costs/year				**12907 US$/year**	**12907 US$/year**	**1597 US$/year**	**10257 US$/year**	**10257 US$/year**	**1402 US$/year**	**15356 US$/year**	**15356 US$/year**	**1739 US$/year**	**12184 US$/year**	**12184 US$/year**	**1513 US$/year**
Incomes			Time of Machinery operation/day	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
		Batteries	Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	45batteries	45batteries	45batteries	30batteries	30batteries	30batteries	45batteries	45batteries	45batteries	30batteries	30batteries	30batteries
			Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**203 US$/month**	**203 US$/month**	**203 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
		Households	Household number	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
			Electricity consumtion for all household Kwh/month	**750.00Kwh/month**	**750.00Kwh/month**	**750.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**750.00Kwh/month**	**750.00Kwh/month**	**750.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**	**500.00Kwh/month**
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all household (US$)/month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
			Electricity produced kwh/month	**1560 kwh/month**	**1560 kwh/month**	**1560 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1560 kwh/month**	**1560 kwh/month**	**1560 kwh/month**	**1040 kwh/month**	**1040 kwh/month**	**1040 kwh/month**
			Sales revenue(US$/year)	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Own investment ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
Loan interest (%)/year				**2.90%**	**2.900%**	**2.900%**	**2.90%**	**2.900%**	**2.900%**	**25.00%**	**25.000%**	**2.900%**	**25.00%**	**25.000%**	**2.900%**
Loan form Bank($)				**11080 US$/year**		**3125 US$/year**	**8720 US$/year**		**4054 US$/year**	**11080 US$/year**		**8022 US$/year**	**8720 US$/year**		**7908 US$/year**
Total Gains				**16885 US$/year**	**5805 US$/year**	**8930 US$/year**	**12590 US$/year**	**3870 US$/year**	**7924 US$/year**	**16885 US$/year**	**5805 US$/year**	**13827 US$/year**	**12590 US$/year**	**3870 US$/year**	**11778 US$/year**
Net Annual Profit ($)				**3978 US$/year**	**-7102 US$/year**	**7333 US$/year**	**2333 US$/year**	**-6387 US$/year**	**6522 US$/year**	**1529 US$/year**	**-9551 US$/year**	**12088 US$/year**	**406 US$/year**	**-8314 US$/year**	**10265 US$/year**
Cumulative Earnings				**3978 US$/year**	**-3125 US$/year**	**4208 US$/year**	**2333 US$/year**	**-4054 US$/year**	**2468 US$/year**	**1529 US$/year**	**-8022 US$/year**	**4066 US$/year**	**406 US$/year**	**-7908 US$/year**	**2357 US$/year**
Rank				1			2			3			4		

The change of Net Annual Profit (No.1: The best to No.4: The worst) is in the graphics below:



The cases of sensitivity analysis will be shown in the chart below from the Net Annual Profit No.1 (**Figure 13**) to the Net Annual Profit No.3 (**Figure 15**). The chart of Net Annual Profit No. 4 is the **Figure 12**.

Net Annual Profit No. 1:

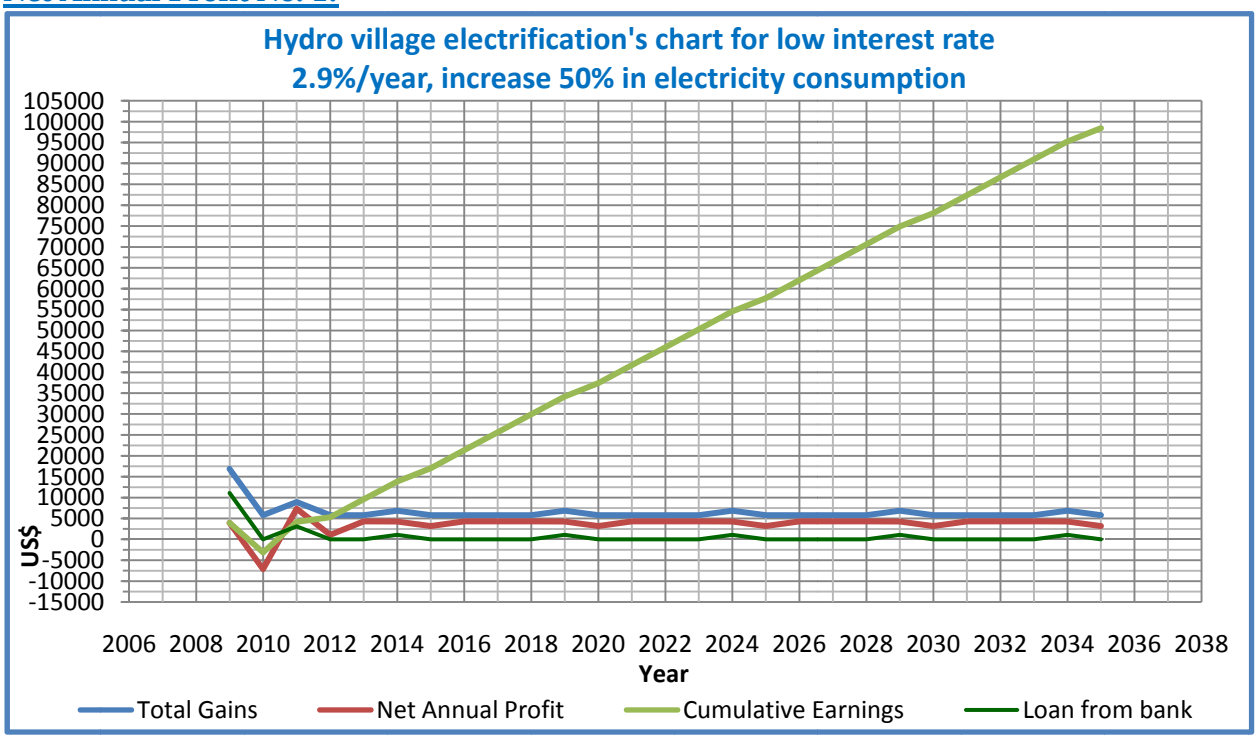


Figure 13: Hydro village electrification's chart for low interest rate 2.9%/year, increase 50% in electricity consumption

Net Annual Profit No. 2:

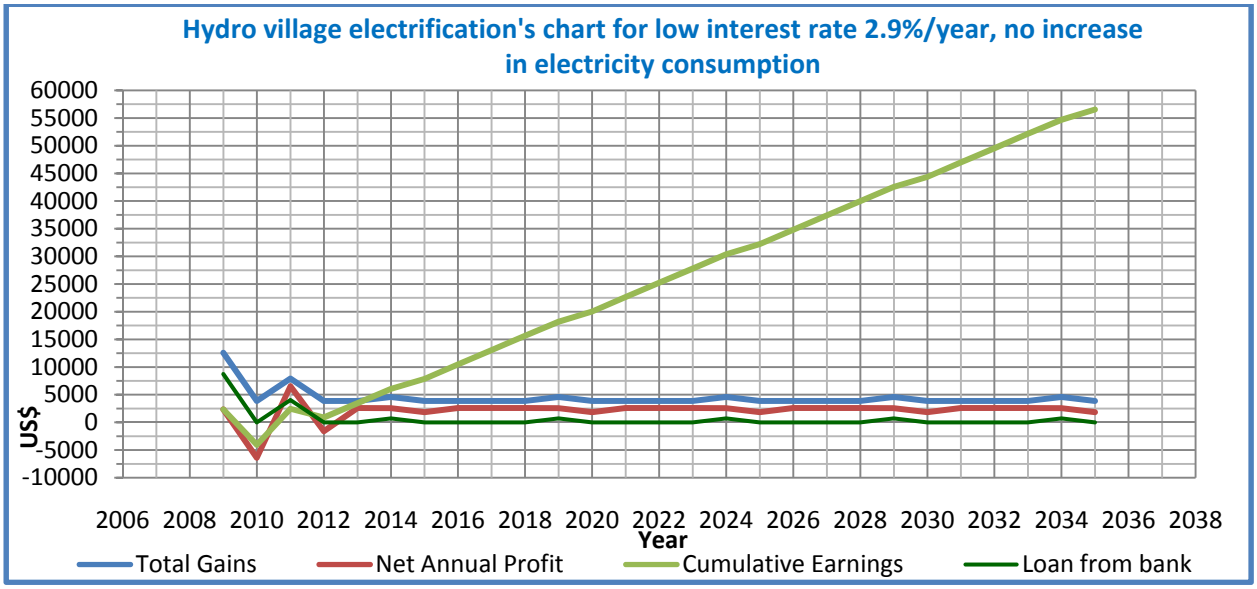


Figure 14: Hydro village electrification's chart for low interest rate 2.9%/year, no increase in electricity consumption

Net Annual Profit No. 3:

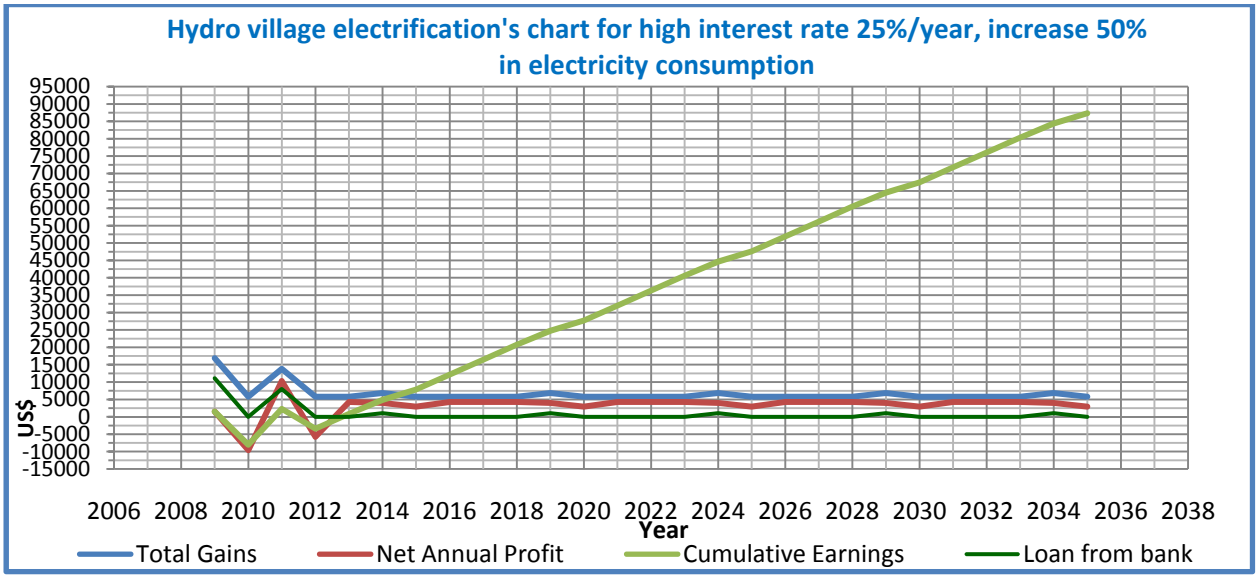


Figure 15: Hydro village electrification's chart for high interest rate 25%/year, increase 50% in electricity consumption

III. Conclusion

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment. For our Hydro village electrification, the year of Loan from bank started to remain zero is in 2012.

The best case of sensitivity analysis which Loan from bank started to remain zero is in year 2012 which is the case of the best Net Annual Profit No.1: Increase 50% in electricity consumption, Low Interest rate 2.9%. (**Figure 13**)

The worst case of sensitivity analysis which Loan from bank started to remain zero is also in year 2012 which is the case of the worst Net Annual Profit No.4: No increase in electricity consumption, High Interest rate 25%. (**Figure 12**)

Even the best case and the fairly good case of sensitivity analysis which loan form bank equal to zero is in the same year 2012, the different of earning in US dollar of both case is quite high.

CHAPTER 4

DIESEL VILLAGE ELECTRIFICATION

I. Results

By using technology cost and performance data and methodology of calculation, we get the results in the **Table. 12: Results of Diesel village electrification** and the chart below:

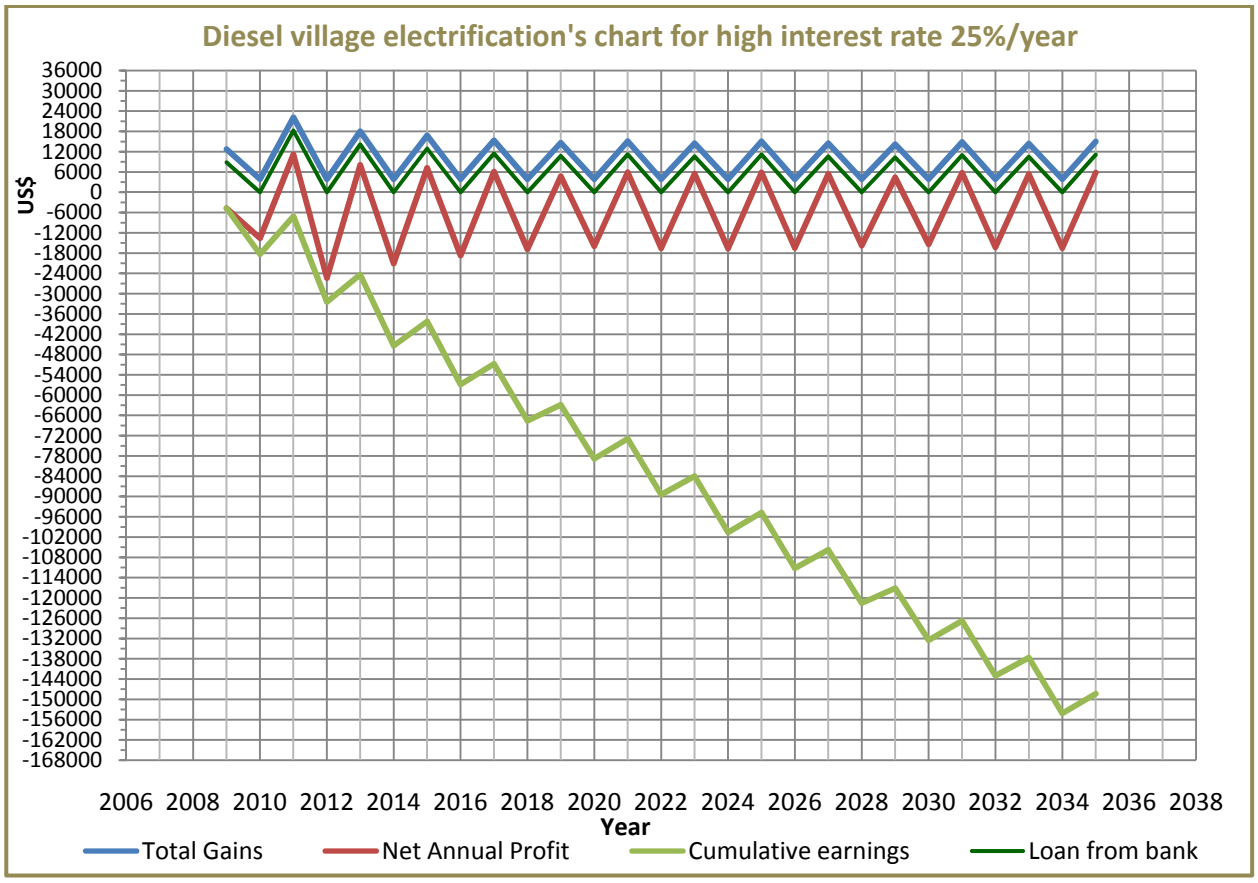


Figure 16: Diesel village electrification's chart for high interest rate 25%/year

II. Sensitivity Analysis

For sensitivity analysis of our case study, Hydro village electrification, we analyze the following:

1. Analyze the impacts of changes in interest rate
2. Analyze the increase in electricity consumption
3. Analyze the impact of the change in diesel price and diesel generation efficiency
4. Analyze different combinations of changes 1. – 3. (8 cases)

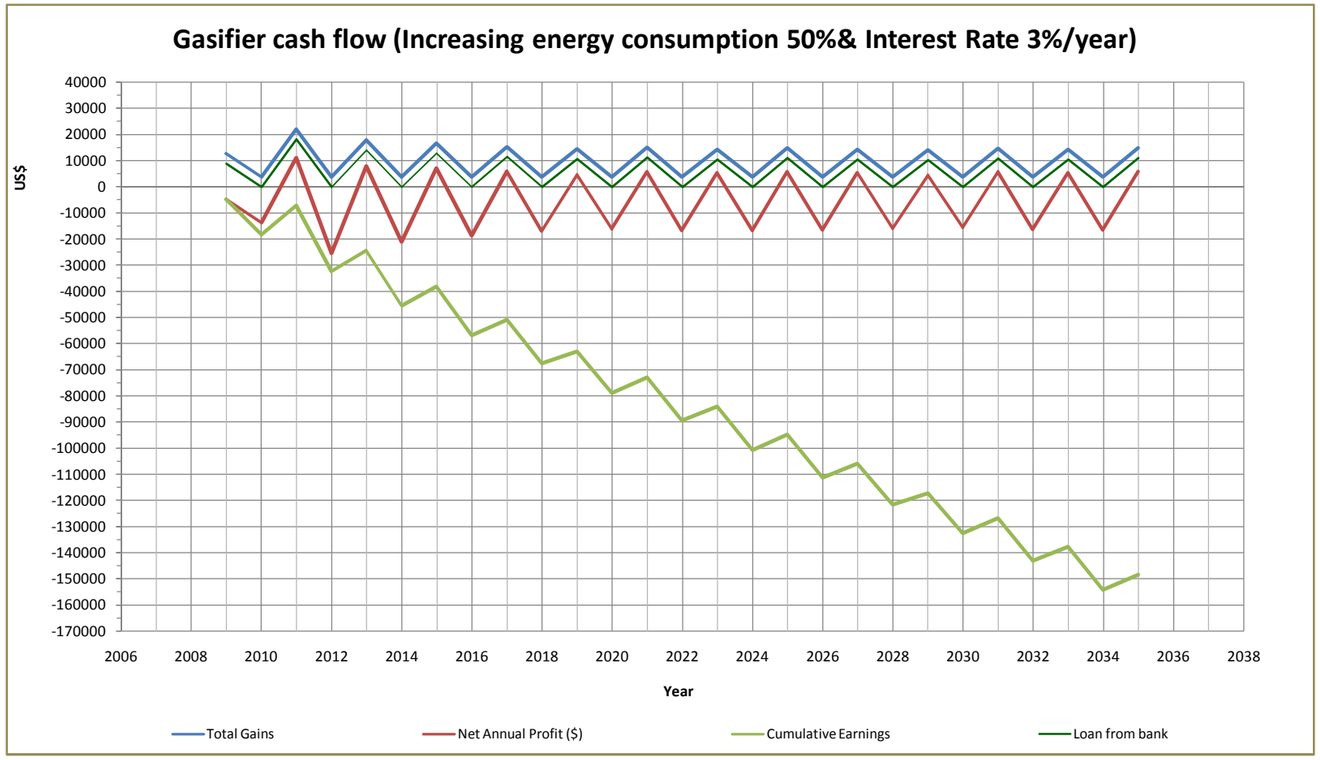
Note: **The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.**

The results of different combinations of changes 1. – 2. are in the **Table. 13: The results of different combinations of changes of diesel village electrification** which show all 4 cases during 3 years from 2009 to 2011 by fixing the diesel generation efficiency 20%.

Table. 12: Results of Diesel village electrification

Year				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
			Worker Salary/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
		Repairing	Repair and maintenance costs/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
			Repair and maintenance costs/year	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
		Diesel	Diesel payment /month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month
			Diesel payment /year	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**2213 US$/year**	**2213 US$/year**	**4571 US$/year**	**4571 US$/year**	**3537 US$/year**	**3537 US$/year**	**3233 US$/year**	**3233 US$/year**	**2868 US$/year**	**2868 US$/year**
			Loan payback (2years)	**0 US$/year**	**8850 US$/year**	**0 US$/year**	**18282 US$/year**	**0 US$/year**	**14148 US$/year**	**0 US$/year**	**12931 US$/year**	**0 US$/year**	**11473 US$/year**
		construction costs	Grid Cost	8000 US$									
Fixed costs			Machinery Cost(5Years)	850 US$					850 US$				
	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation costs/year				**17436 US$/year**	**17436 US$/year**	**10944 US$/year**	**29226 US$/year**	**9911 US$/year**	**24909 US$/year**	**9606 US$/year**	**22538 US$/year**	**9242 US$/year**	**20715 US$/year**
Incomes	Time of Machinery operation/day			12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
	Batteries		Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
			Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
	Households		Household number	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
			Electricity consumtion for all Household(KWh/month)	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all household (US$)/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
	Sales revenue(US$/year)			**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Own invest ($)				0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
Loan interest (%)/year				**25.00%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**
Loan from Bank($)				**8850 US$/year**	**0 US$/year**	**18282 US$/year**	**0 US$/year**	**14148 US$/year**	**0 US$/year**	**12931 US$/year**	**0 US$/year**	**11473 US$/year**	**0 US$/year**
Total Gains				**12720 US$/year**	**3870 US$/year**	**22152 US$/year**	**3870 US$/year**	**18018 US$/year**	**3870 US$/year**	**16801 US$/year**	**3870 US$/year**	**15343 US$/year**	**3870 US$/year**
Net Annual Profit ($)				**-4716 US$/year**	**-13566 US$/year**	**11208 US$/year**	**-25356 US$/year**	**8108 US$/year**	**-21039 US$/year**	**7195 US$/year**	**-18668 US$/year**	**6101 US$/year**	**-16845 US$/year**
Cumulative Earnings				**-4716 US$/year**	**-18282 US$/year**	**-7074 US$/year**	**-32431 US$/year**	**-24323 US$/year**	**-45362 US$/year**	**-38167 US$/year**	**-56835 US$/year**	**-50734 US$/year**	**-67579 US$/year**

Note: The efficiency of the diesel machine is fixed, 20%


Gasifier cash flow (Increasing energy consumption 50%& Interest Rate 3%/year)
US$
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-50000
-60000
-70000
-80000
-90000
-100000
-110000
-120000
-130000
-140000
-150000
-160000
-170000
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
Year
Total Gains
Net Annual Profit ($)
Cumulative Earnings
Loan from bank

2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
600 US$/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
240 US$/year	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month	391 US$/month
4694 US$/year	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**
2686 US$/year	**2686 US$/year**	**2807 US$/year**	**2807 US$/year**	**2655 US$/year**	**2655 US$/year**	**2792 US$/year**	**2792 US$/year**	**2648 US$/year**	**2648 US$/year**	**2576 US$/year**	**2576 US$/year**	**2752 US$/year**
0 US$/year	**10744 US$/year**	**0 US$/year**	**11229 US$/year**	**0 US$/year**	**10622 US$/year**	**0 US$/year**	**11168 US$/year**	**0 US$/year**	**10591 US$/year**	**0 US$/year**	**10303 US$/year**	**0 US$/year**
850 US$					850 US$					850 US$		
70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
9910 US$/year	**19803 US$/year**	**9181 US$/year**	**20410 US$/year**	**9029 US$/year**	**20501 US$/year**	**9166 US$/year**	**20334 US$/year**	**9021 US$/year**	**19613 US$/year**	**9799 US$/year**	**19252 US$/year**	**9126 US$/year**
12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
540Kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
135 US$/month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
188 US$/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
3870 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
25.000%	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**	**25.000%**
10744 US$/year	**0 US$/year**	**11229 US$/year**	**0 US$/year**	**10622 US$/year**	**0 US$/year**	**11168 US$/year**	**0 US$/year**	**10591 US$/year**	**0 US$/year**	**10303 US$/year**	**0 US$/year**	**11009 US$/year**
14614 US$/year	**3870 US$/year**	**15099 US$/year**	**3870 US$/year**	**14492 US$/year**	**3870 US$/year**	**15038 US$/year**	**3870 US$/year**	**14461 US$/year**	**3870 US$/year**	**14173 US$/year**	**3870 US$/year**	**14879 US$/year**
4704 US$/year	**-15933 US$/year**	**5918 US$/year**	**-16540 US$/year**	**5463 US$/year**	**-16631 US$/year**	**5872 US$/year**	**-16464 US$/year**	**5440 US$/year**	**-15743 US$/year**	**4374 US$/year**	**-15382 US$/year**	**5753 US$/year**
-62874 US$/year	**-78808 US$/year**	**-72889 US$/year**	**-89429 US$/year**	**-83967 US$/year**	**-100597 US$/year**	**-94725 US$/year**	**-111189 US$/year**	**-105749 US$/year**	**-121492 US$/year**	**-117118 US$/year**	**-132500 US$/year**	**-126747 US$/year**

How increase of consumtion in percentage?

Diesel fuel cost Calcula		
	Energy contain(MWh/ton)	11.8
	Desity of diesel(ton/m³)	0.845
	Energy contain per litre MWh/m³=KWh/littre	9.971
	Price per liter(US$/litter)	0.75
	Diesel price per energy (US$/kWh)	0.075
	Electricity price per energy (US$/KWh)	0.376

Machinary Feature		
	Capacity Of Machine(KWh)	5
	Time Operation (hours)	12hours
	Efficiecy of the diesel machine	20%
	Electricity operation /day	60
	Electricity operation price per day energy (US$/kwh/day)	22.56543978

2032	2033	2034	2035
50 US$/month	50 US$/month	50 US$/month	50 US$/month
1person	1person	1person	1person
600 US$/year	**600 US$/year**	**600 US$/year**	**600 US$/year**
20 US$/month	20 US$/month	20 US$/month	20 US$/month
240 US$/year	**240 US$/year**	**240 US$/year**	**240 US$/year**
391 US$/month	391 US$/month	391 US$/month	391 US$/month
4694 US$/year	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**
2752 US$/year	**2628 US$/year**	**2628 US$/year**	**2778 US$/year**
11009 US$/year	**0 US$/year**	**10512 US$/year**	**0 US$/year**
		850 US$	
70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**
840 US$/year	**840 US$/year**	**840 US$/year**	**840 US$/year**
20134 US$/year	**9001 US$/year**	**20363 US$/year**	**9152 US$/year**
12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah
30batteries	30batteries	30batteries	30batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
540Kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
135 US$/month	**135 US$/month**	**135 US$/month**	**135 US$/month**
200houses	200houses	200houses	200houses
2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
188 US$/month	**188 US$/month**	**188 US$/month**	**188 US$/month**
3870 US$/year	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
0	0	0	0
0	0	0	0
2.083%	2.083%	2.083%	2.083%
25.000%	**25.000%**	**25.000%**	**25.000%**
0 US$/year	**10512 US$/year**	**0 US$/year**	**11113 US$/year**
3870 US$/year	**14382 US$/year**	**3870 US$/year**	**14983 US$/year**
-16264 US$/year	**5380 US$/year**	**-16493 US$/year**	**5831 US$/year**
-143012 US$/year	**-137632 US$/year**	**-154125 US$/year**	**-148294 US$/year**

Table. 13: The results of different combinations of changes of diesel village electrification

				increase interest rate increase comsumption increase diesel price	2.9% 0% 0%	Case 1	increase interest rate increase comsumption increase diesel price	2.9% 50% 0%	Case 2	increase interest rate increase comsumption increase diesel price	25.0% 0% 0%	Case 3	increase interest rate increase comsumption increase diesel price	2.9% 0% 50%	Case 4
			Year	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	1person	1person	1person	2person	2person	2person	1person	1person	1person	1person	1person	1person
			Worker Salary/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**900 US$/year**	**900 US$/year**	**900 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
		Repairing	Repair and maintenance costs/month	20 US$/month	20 US$/month	20 US$/month	30 US$/month	30 US$/month	30 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
			Repair and maintenance costs/year	**240 US$/year**	**240 US$/year**	**240 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
	Fuel cost	Diesel	Diesel payment /month	391 US$/month	391 US$/month	391 US$/month	587 US$/month	587 US$/month	587 US$/month	391 US$/month	391 US$/month	391 US$/month	587 US$/month	587 US$/month	587 US$/month
			Diesel payment /year	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**7040 US$/year**	**7040 US$/year**	**7040 US$/year**	**4694 US$/year**	**4694 US$/year**	**4694 US$/year**	**7040 US$/year**	**7040 US$/year**	**7040 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**257 US$/year**	**257 US$/year**	**417 US$/year**	**315 US$/year**	**315 US$/year**	**526 US$/year**	**2213 US$/year**	**2213 US$/year**	**4571 US$/year**	**257 US$/year**	**257 US$/year**	**553 US$/year**
			Loan payback (2years)	**0 US$/year**	**8850 US$/year**	**0 US$/year**	**0 US$/year**	**10850 US$/year**	**0 US$/year**	**0 US$/year**	**8850 US$/year**	**0 US$/year**	**0 US$/year**	**8850 US$/year**	**0 US$/year**
		construction costs	Grid Cost	8000 US$			10000 US$			8000 US$			8000 US$		
Fixed costs			Machinery Cost(5Years)	850 US$			850 US$			850 US$			850 US$		
	Customer service costs	Phone + Accounting	Phone+accounting/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
			Phone+accounting/year	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**	**840 US$/year**
Total operation costs/year				**15480 US$/year**	**15480 US$/year**	**6790 US$/year**	**20305 US$/year**	**20305 US$/year**	**9667 US$/year**	**17436 US$/year**	**17436 US$/year**	**10944 US$/year**	**17827 US$/year**	**17827 US$/year**	**9273 US$/year**
Incomes			Time of Machinery operation/day	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
		Batteries	Price for battery charging US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	30batteries	30batteries	30batteries	45batteries	45batteries	45batteries	30batteries	30batteries	30batteries	30batteries	30batteries	30batteries
			Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**810Kwh/month**	**810Kwh/month**	**810Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**	**540Kwh/month**
			Electricity price for all battery /month	**135 US$/month**	**135 US$/month**	**135 US$/month**	**203 US$/month**	**203 US$/month**	**203 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**	**135 US$/month**
		Households	Household number	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
			Electricity consumtion for One Household(KWh/month)	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month
			Electricity consumtion for all Household(KWh/month)	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	750.00Kwh/month	750.00Kwh/month	750.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month
			Household Electricity price (US$/Kwh)	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
			Electricity price for all household (US$)/month	**188 US$/month**	**188 US$/month**	**188 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**	**188 US$/month**
			Sales revenue(US$/year)	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**5805 US$/year**	**5805 US$/year**	**5805 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**	**3870 US$/year**
Own investment ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	2.083%	2.083%	2.083%	0.242%	0.242%	0.242%
Loan interest (%)/year				**2.90%**	**2.900%**	**2.900%**	**2.90%**	**2.900%**	**2.900%**	**25.00%**	**25.000%**	**25.000%**	**2.90%**	**2.900%**	**2.900%**
Loan form Bank($)				**8850 US$/year**		**14371 US$/year**	**10850 US$/year**		**18150 US$/year**	**8850 US$/year**		**18282 US$/year**	**8850 US$/year**		**19064 US$/year**
Total Gains				**12720 US$/year**	**3870 US$/year**	**18241 US$/year**	**16655 US$/year**	**5805 US$/year**	**23955 US$/year**	**12720 US$/year**	**3870 US$/year**	**22152 US$/year**	**12720 US$/year**	**3870 US$/year**	**22934 US$/year**
Net Annual Profit ($)				**-2760 US$/year**	**-11610 US$/year**	**11450 US$/year**	**-3650 US$/year**	**-14500 US$/year**	**14288 US$/year**	**-4716 US$/year**	**-13566 US$/year**	**11208 US$/year**	**-5107 US$/year**	**-13957 US$/year**	**13661 US$/year**
Cumulative Earnings				**-2760 US$/year**	**-14371 US$/year**	**-2920 US$/year**	**-3650 US$/year**	**-18150 US$/year**	**-3862 US$/year**	**-4716 US$/year**	**-18282 US$/year**	**-7074 US$/year**	**-5107 US$/year**	**-19064 US$/year**	**-5403 US$/year**
			Rank	1			2			3			4		

increase interest rate	25%		increase interest rate	25%		increase interest rate	2.9%		increase interest rate	25%	
increase comsumption	50%		increase comsumption	0%		increase comsumption	50%		increase comsumption	50%	
increase diesel price	0%	Case 5	increase diesel price	50%	Case 6	increase diesel price	50%	Case 7	increase diesel price	50%	Case 8
2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
2person	2person	2person	1person	1person	1person	2person	2person	2person	2person	2person	2person
900 US$/year	900 US$/year	900 US$/year	600 US$/year	600 US$/year	600 US$/year	900 US$/year	900 US$/year	900 US$/year	900 US$/year	900 US$/year	900 US$/year
30 US$/month	30 US$/month	30 US$/month	20 US$/month	20 US$/month	20 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month
360 US$/year	360 US$/year	360 US$/year	240 US$/year	240 US$/year	240 US$/year	360 US$/year	360 US$/year	360 US$/year	360 US$/year	360 US$/year	360 US$/year
587 US$/month	587 US$/month	587 US$/month	587 US$/month	587 US$/month	587 US$/month	880 US$/month	880 US$/month	880 US$/month	880 US$/month	880 US$/month	880 US$/month
7040 US$/year	7040 US$/year	7040 US$/year	7040 US$/year	7040 US$/year	7040 US$/year	10561 US$/year	10561 US$/year	10561 US$/year	10561 US$/year	10561 US$/year	10561 US$/year
2713 US$/year	2713 US$/year	5736 US$/year	2213 US$/year	2213 US$/year	5744 US$/year	315 US$/year	315 US$/year	731 US$/year	2713 US$/year	2713 US$/year	7497 US$/year
0 US$/year	10850 US$/year	0 US$/year	0 US$/year	8850 US$/year	0 US$/year	0 US$/year	10850 US$/year	0 US$/year	0 US$/year	10850 US$/year	0 US$/year
10000 US$			8000 US$			10000 US$			10000 US$		
850 US$			850 US$			850 US$			850 US$		
70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month	70 US$/month
840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year	840 US$/year
22703 US$/year	22703 US$/year	14877 US$/year	19783 US$/year	19783 US$/year	14464 US$/year	23825 US$/year	23825 US$/year	13391 US$/year	26223 US$/year	26223 US$/year	20157 US$/year
12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery	0.25 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
45batteries	45batteries	45batteries	30batteries	30batteries	30batteries	45batteries	45batteries	45batteries	45batteries	45batteries	45batteries
0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day
810Kwh/month	810Kwh/month	810Kwh/month	540Kwh/month	540Kwh/month	540Kwh/month	810Kwh/month	810Kwh/month	810Kwh/month	810Kwh/month	810Kwh/month	810Kwh/month
203 US$/month	203 US$/month	203 US$/month	135 US$/month	135 US$/month	135 US$/month	203 US$/month	203 US$/month	203 US$/month	203 US$/month	203 US$/month	203 US$/month
200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses	200houses
3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	2.50Kwh/month	2.50Kwh/month	2.50Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month	3.75Kwh/month
750.00Kwh/month	750.00Kwh/month	750.00Kwh/month	500.00Kwh/month	500.00Kwh/month	500.00Kwh/month	750.00Kwh/month	750.00Kwh/month	750.00Kwh/month	750.00Kwh/month	750.00Kwh/month	750.00Kwh/month
0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month	0.375 US$/month
281 US$/month	281 US$/month	281 US$/month	188 US$/month	188 US$/month	188 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month
5805 US$/year	5805 US$/year	5805 US$/year	3870 US$/year	3870 US$/year	3870 US$/year	5805 US$/year	5805 US$/year	5805 US$/year	5805 US$/year	5805 US$/year	5805 US$/year
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	0.242%	0.242%	0.242%	2.083%	2.083%	2.083%
25.00%	25.000%	25.000%	25.00%	25.000%	25.000%	2.90%	2.900%	2.900%	25.00%	25.000%	25.000%
10850 US$/year		22946 US$/year	8850 US$/year		22976 US$/year	10850 US$/year		25191 US$/year	10850 US$/year		29986 US$/year
16655 US$/year	5805 US$/year	28751 US$/year	12720 US$/year	3870 US$/year	26846 US$/year	16655 US$/year	5805 US$/year	30996 US$/year	16655 US$/year	5805 US$/year	35791 US$/year
-6048 US$/year	-16898 US$/year	13874 US$/year	-7063 US$/year	-15913 US$/year	12381 US$/year	-7170 US$/year	-18020 US$/year	17604 US$/year	-9568 US$/year	-20418 US$/year	15634 US$/year
-6048 US$/year	-22946 US$/year	-9072 US$/year	-7063 US$/year	-22976 US$/year	-10594 US$/year	-7170 US$/year	-25191 US$/year	-7586 US$/year	-9568 US$/year	-29986 US$/year	-14352 US$/year

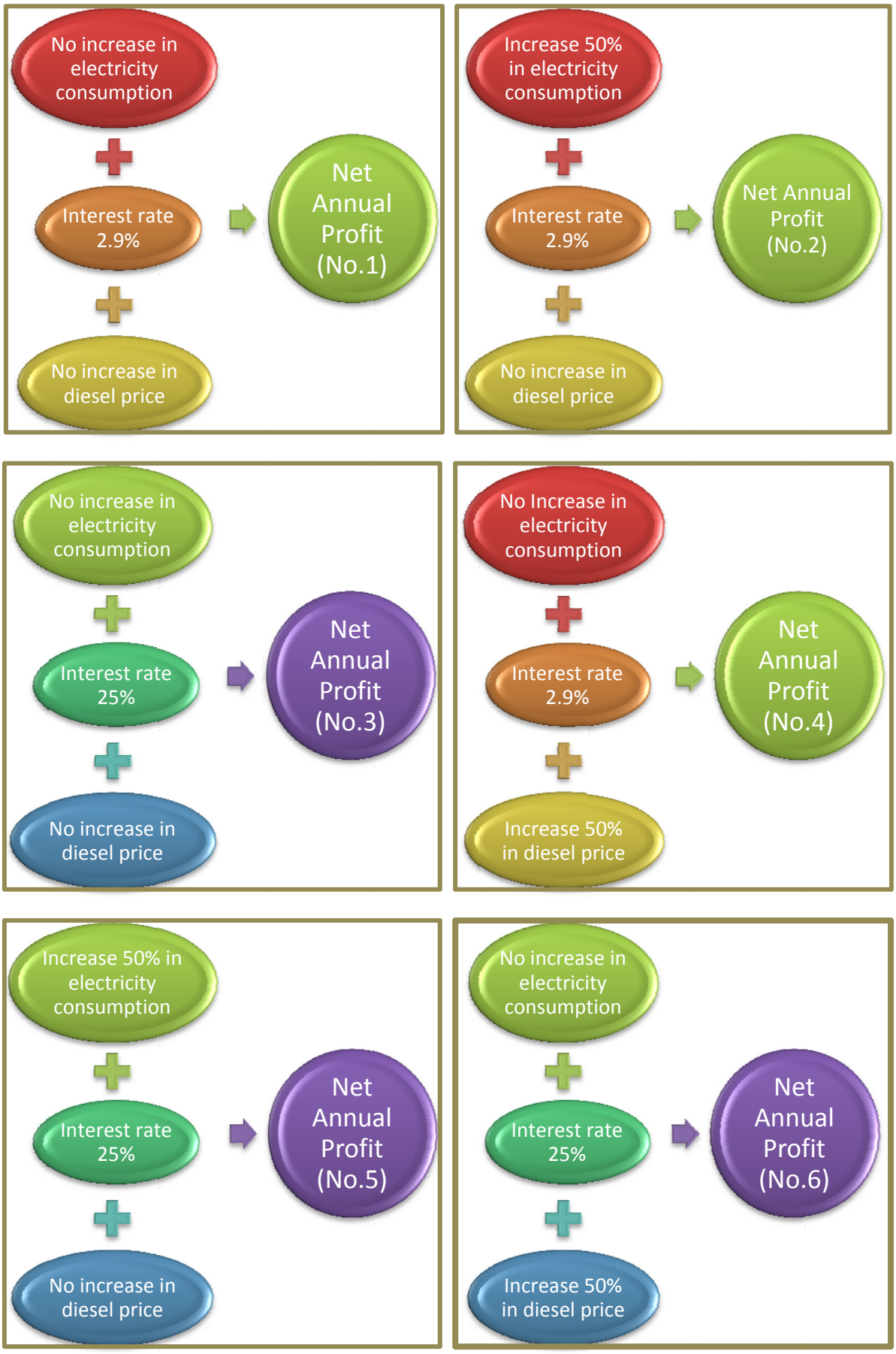
5	6	7	8

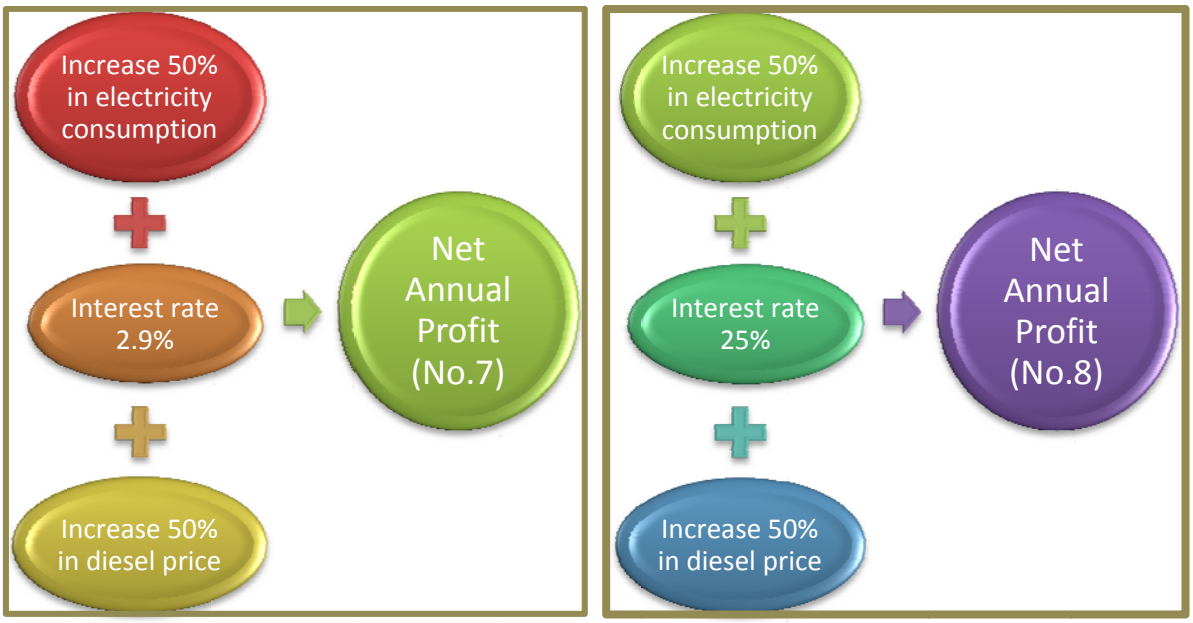
Diesel fuel cost Calcula

Machinary Feature

1	2	3	4	5

The change of Net Annual Profit (No.1: The best to No.8: The worst) is in the graphics below:





The cases of sensitivity analysis will be shown in the chart below from the Net annual profit No.1 (**Figure 17**) to the Net annual profit No.8 (**Figure 23**).

Net Annual Profit No. 1:

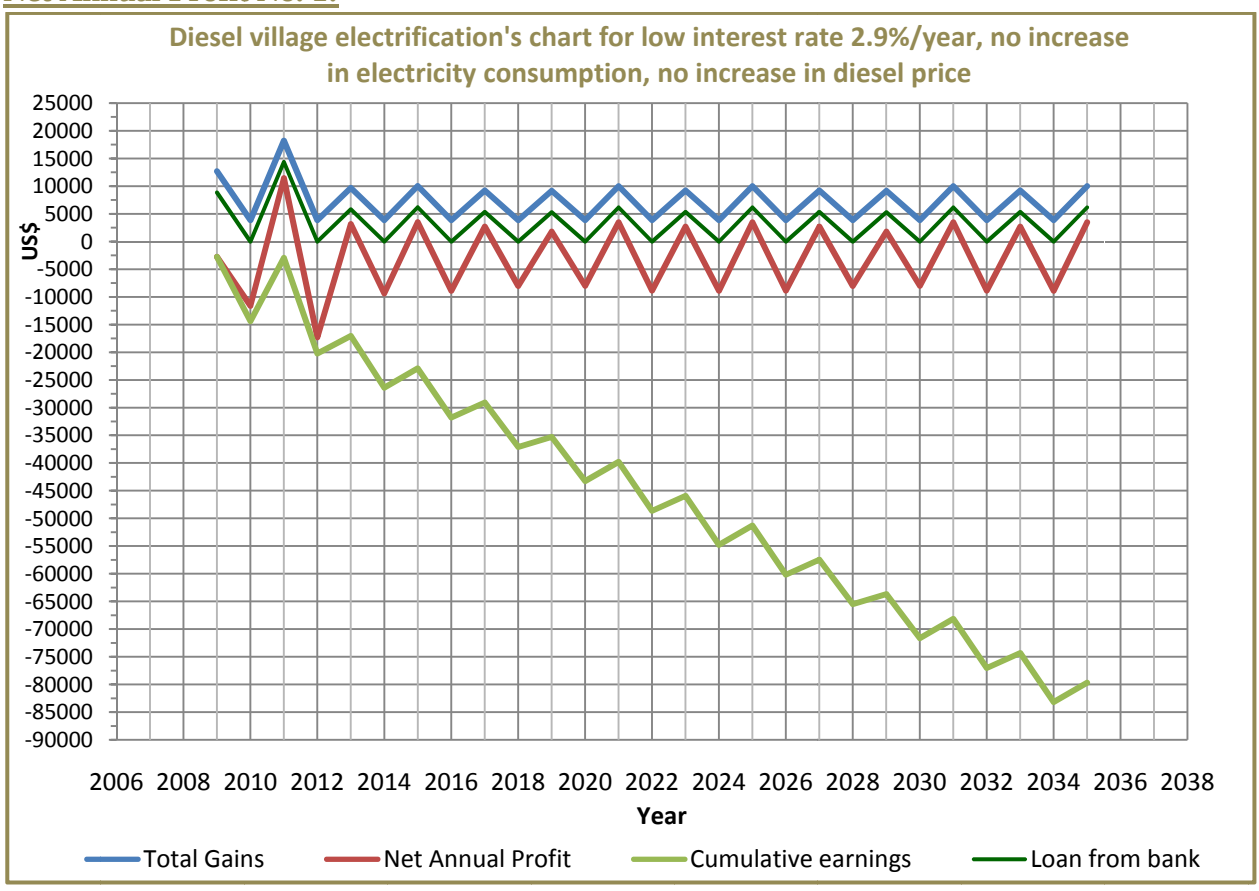


Figure 17: Diesel village electrification's chart for low interest rate 2.9%/year, no increase in electricity consumption, no increase in diesel price

Net Annual Profit No. 2:

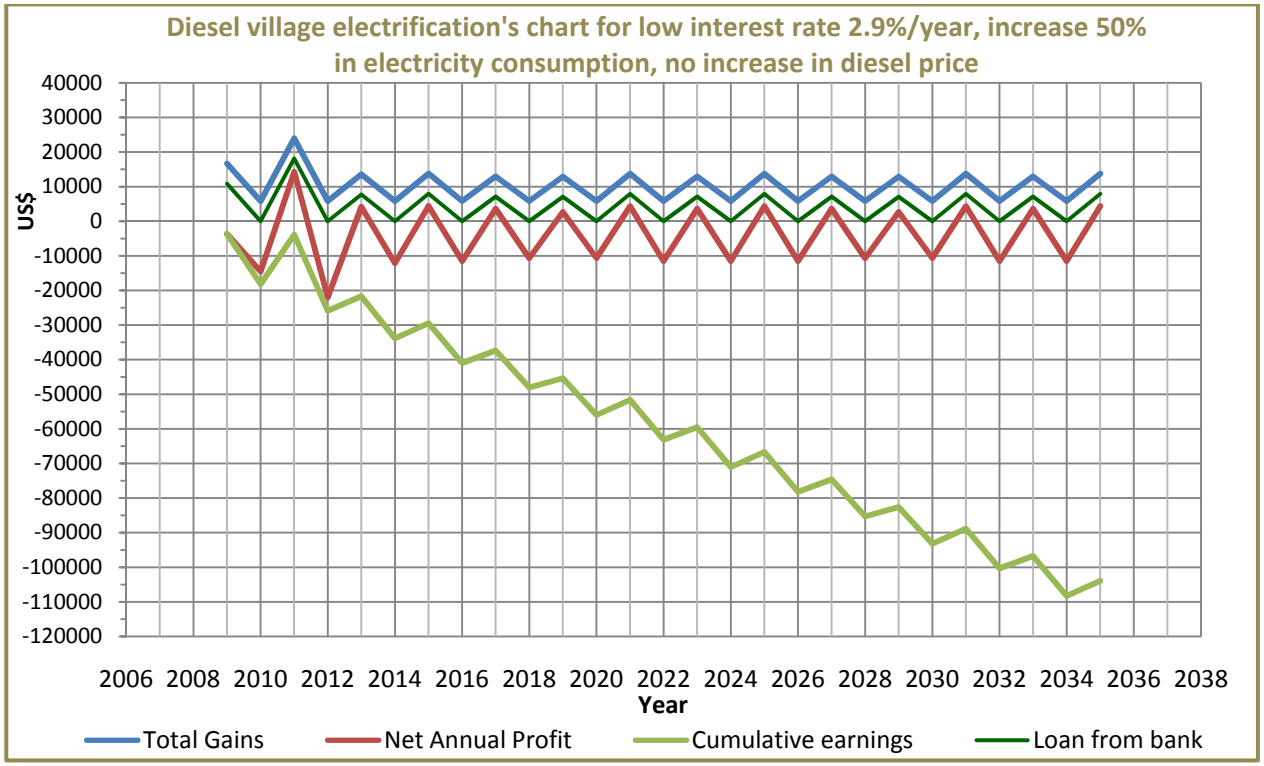


Figure 18: Diesel village electrification's chart for low interest rate 2.9%/year, increase 50% in electricity consumption, no increase in diesel price

Net Annual Profit No. 3:

Figure 16: Diesel village electrification's chart for high interest rate 25%/year (no increase in electricity consumption, no increase in diesel price)

Net Annual Profit No. 4:

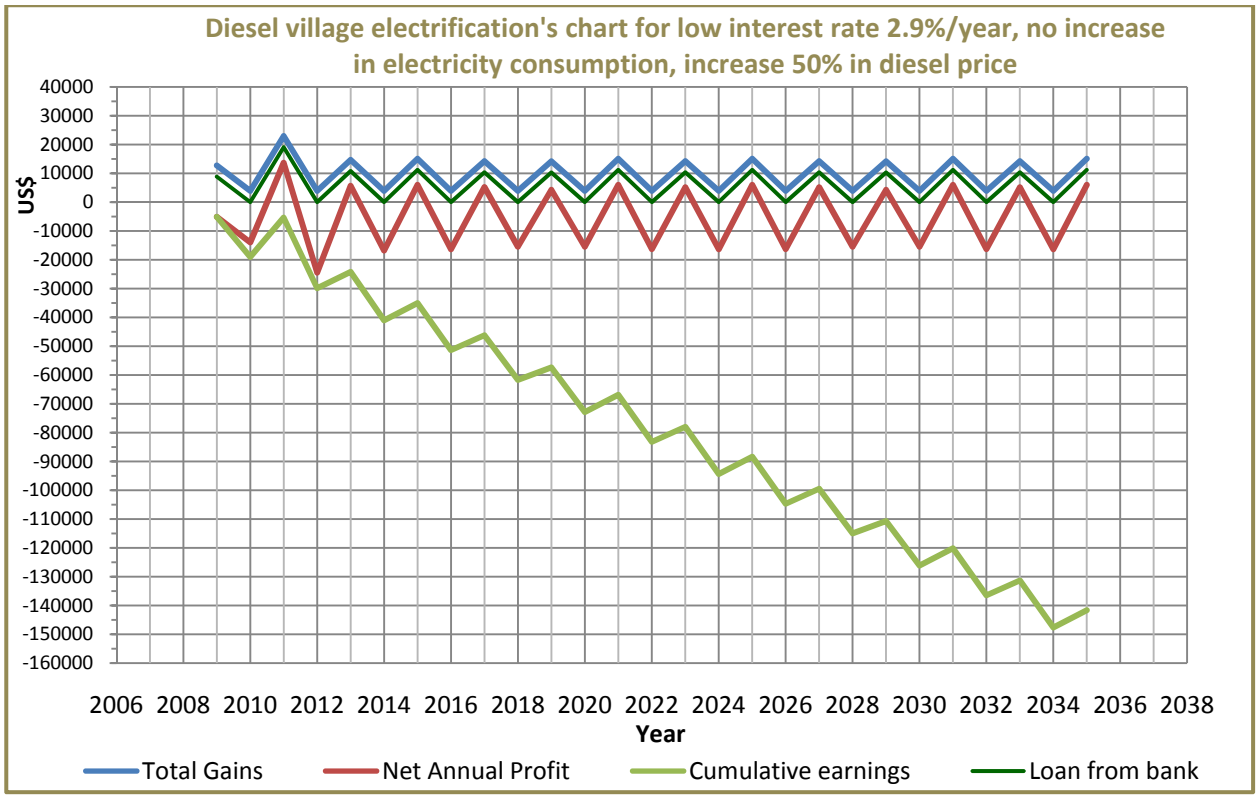


Figure 19: Diesel village electrification's chart for low interest rate 2.9%/year, no increase in electricity consumption, increase 50% in diesel price

Net Annual Profit No. 5:

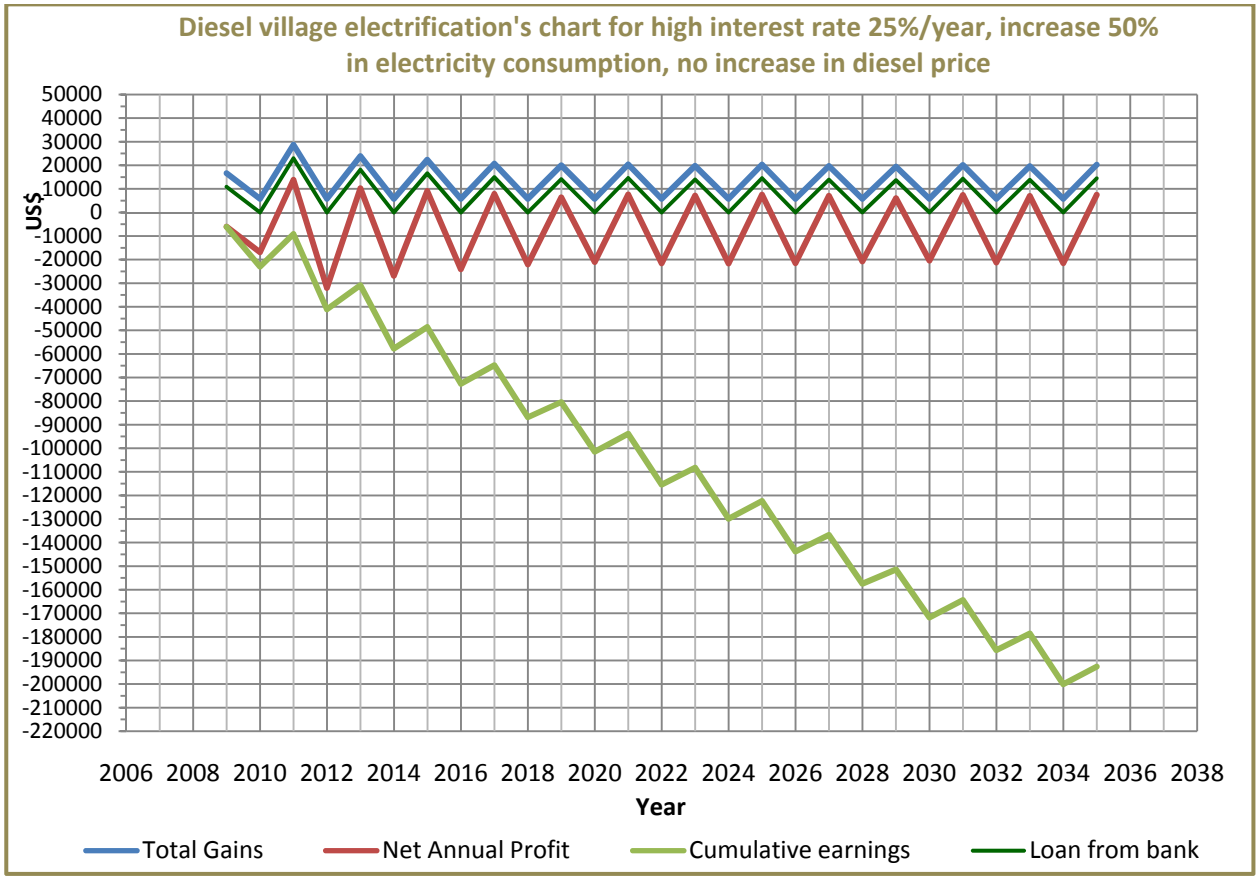


Figure 20: Diesel village electrification's chart for high interest rate 25%/year, increase 50% in electricity consumption, no increase in diesel price

Net Annual Profit No. 6:

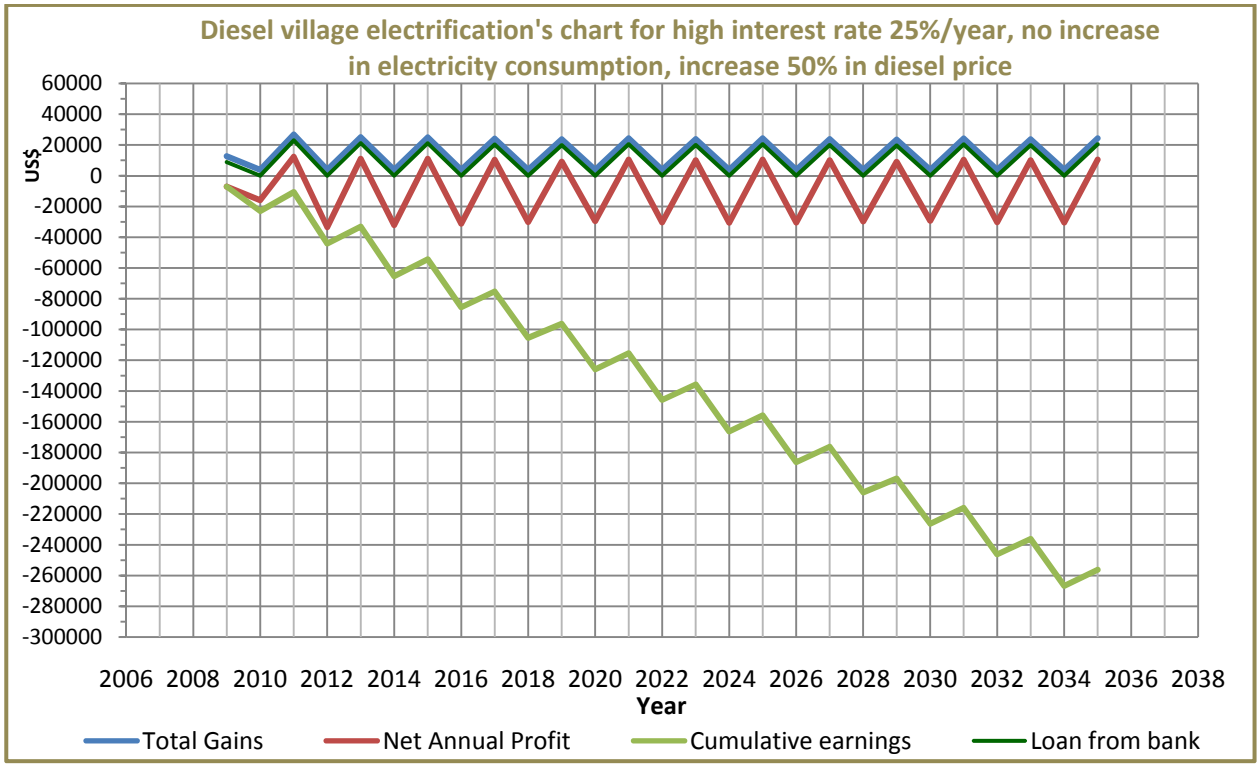


Figure 21: Diesel village electrification's chart for high interest rate 25%/year, no increase in electricity consumption, increase 50% in diesel price

Net Annual Profit No. 7:

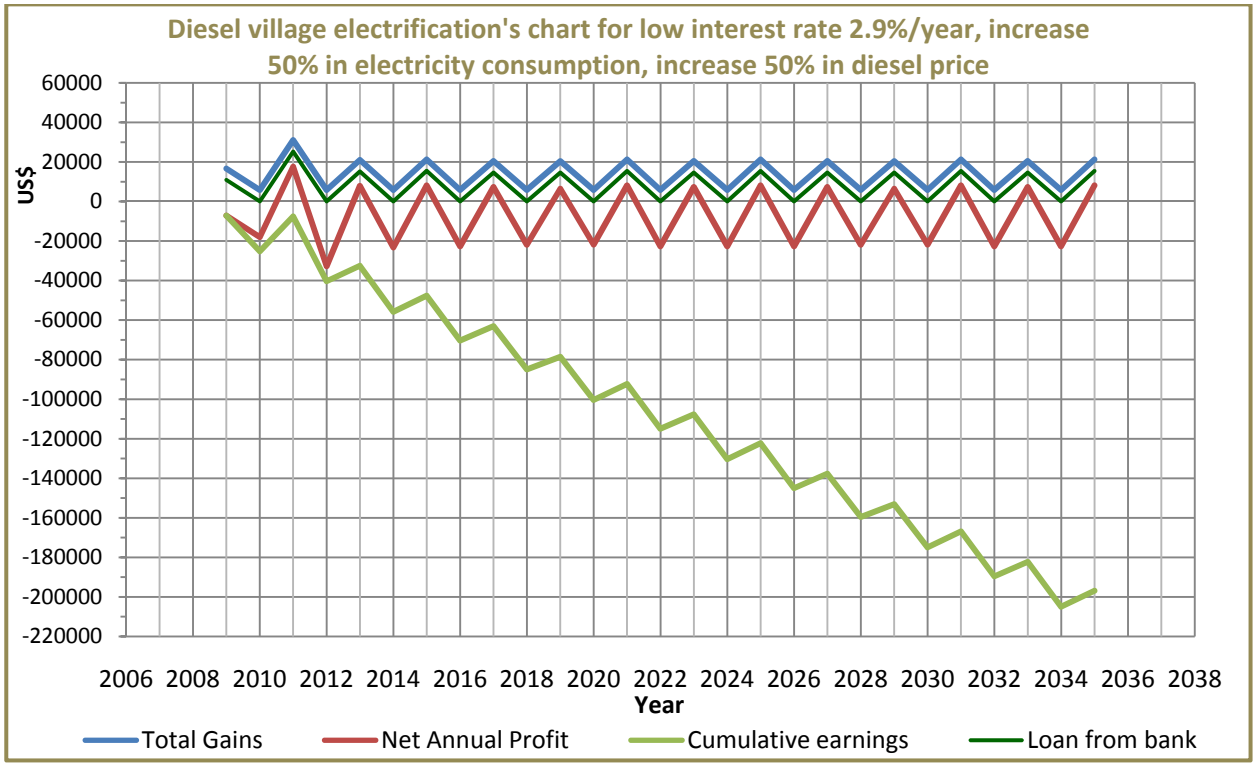


Figure 22: Diesel village electrification's chart for low interest rate 2.9%/year, increase 50% in electricity consumption, increase 50% in diesel price

Net Annual Profit No. 8:

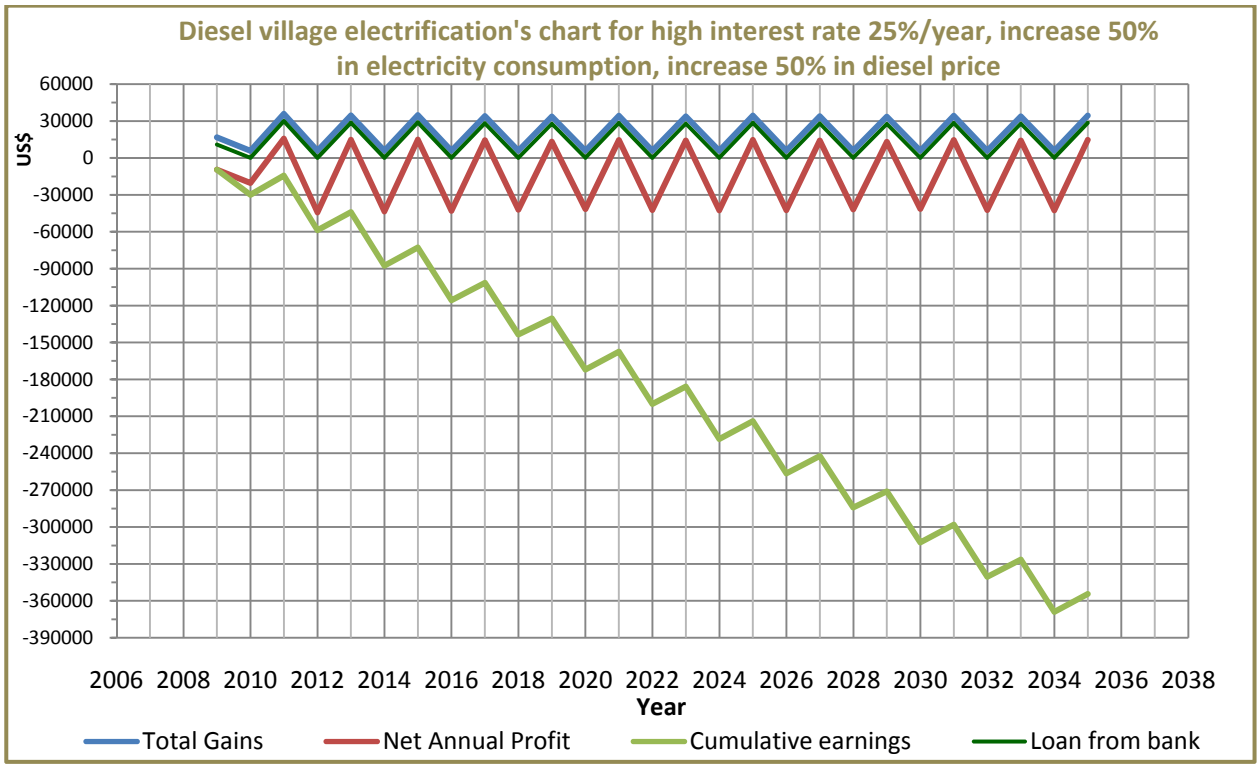


Figure 23: Diesel village electrification's chart for high interest rate 25%/year, increase 50% in electricity consumption, increase 50% in diesel price

III. Conclusion

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment. For our diesel village electrification, the year of Loan from bank is fluctuated gradually. It means that it is unacceptable investment for the cases of sensitivity analysis.

CHAPTER 5

CONCLUSION

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.

The result of sensitivity analysis during 3 years of village electrification with different technologies is shown in **Table 14: Result of sensitivity analysis of village electrification with different technologies** below.

According to Table 14, we can see that the best Net Annual Profit is Hydro village electrification. The second is PV village electrification. The third is Gasifier village electrification and the last is Diesel village electrification. Even though the Hydro village electrification and PV village electrification are better than Gasifier village electrification, we still choose Gasifier village electrification for our investment at the Anlong Tamey in Battambang province. The reason is that the SWOT for the Anlong Tamey gasifier in Battambang province gives a good result for our investment than the others.

SWOT Matrix - Anlong Thamey

SWOT analysis to identify strengths, weaknesses, opportunities and threats of bio gasifier

Strength (S)	Weakness (W)	Opportunity (O)	Threat (T)
• Community Energy Cooperative as a way of ownership and as functional structure (sense of working for a common cause) • The development of production and refining chain (growing Leuceana tree in the area) • The low price of grid electricity compared to using battery and kerosine lamps • The good quality of light • Environmentally friendly • A motivating way of producing electricity • Continuous controlling of the process possible because of labour force	• High initial investment cost • Productization of gasifiers not yet advanced • Relatively complex system, lack of local know-how • Gasifier unreliable which leads to need for additional energy supply (diesel is expensive) • Technology based on foreign equipment and components, difficult to have spare parts • Need for proactive maintenance (Filters need to be cleaned often) • The shortness of the grid • No electricity for the whole day • Not yet economically profitable • Demand is bigger than supply	• Opportunity to expand market, (mini)grids can be extended • The development of livelihood • Increase in consumption and improvement of the standard of living • More time for studying • Increase in information flow • In the future, the development of technology enables building of hybrids in which gas or diesel can be used in the same generator	• System failure due to mal operation or maintenance • Unreliability of electricity supply • Threats to the production of Leuceana • The extension of national grid will affect the local business and change livelihood • Changing Government policies

Table 14: Result of sensitivity analysis of village electrification with different technologies

1

Change interest rate	2.9%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	50%	Gasifier 1			Diesel 2			Hydro 1			PV 1		
Change Diesel cost	0%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		1682	1682	1703.87	315	315	526	321	321	91	1914	1914	1768
Total operation costs (US$/year)		64182	64182	6203.87	20305	20305	9667	12907	12907	1597	69294	69294	3148
Sales revenue(US$/year)		5805	5805	5805	5805	5805	5805	5805	5805	5805	5805	5805	5805
Loan form Bank (US$)		58000	0	58754	10850	0	18150	11080	0	3125	66000	0	60978
Total Gains (US$)		63805	5805	64559	16655	5805	23955	16885	5805	8930	71805	5805	66783
Net Annual Profit (US$)		-377	-58377	58355.1	-3650	-14500	14288	3978	-7102	7333	2511	-63489	63635
Cumulative Earnings (US$)		-377	-58754	-398.866	-3650	-18150	-3862	3978	-3125	4208	2511	-60978	2657

2

Change interest rate	2.9%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	50%	Gasifier 2			Diesel 7			Hydro			PV		
Change Diesel cost	50%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		1682	1682	1710	315	315	731						
Total operation costs (US$/year)		64282	64282	6310	23825	23825	13391						
Sales revenue(US$/year)		5805	5805	5805	5805	5805	5805						
Loan form Bank (US$)		58000	0	58954	10850	0	25191						
Total Gains (US$)		63805	5805	64759	16655	5805	30996						
Net Annual Profit (US$)		-477	-58477	58449	-7170	-18020	17604						
Cumulative Earnings (US$)		-477	-58954	-505	-7170	-25191	-7586						

3

Change interest rate	2.9%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	0%	Gasifier 3			Diesel 1			Hydro 2			PV 2		
Change Diesel cost	0%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		1624	1624	1624	257	257	417	253	253	118	1914	1914	1870
Total operation costs (US$/year)		60904	60904	4904	15480	15480	6790	10257	10257	1402	69114	69114	3070
Sales revenue(US$/year)		3870	3870	3870	3870	3870	3870	3870	3870	3870	3870	3870	3870
Loan form Bank (US$)		56000	0	58068	8850	0	14371	8720	0	4054	66000	0	64488
Total Gains (US$)		59870	3870	61938	12720	3870	18241	12590	3870	7924	69870	3870	68358
Net Annual Profit (US$)		-1034	-57034	57034	-2760	-11610	11450	2333	-6387	6522	756	-65244	65288
Cumulative Earnings (US$)		-1034	-58068	-1034	-2760	-14371	-2920	2333	-4054	2468	756	-64488	800

4

Change interest rate	2.9%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	0%	Gasifier 4			Diesel 4			Hydro			PV		
Change Diesel cost	50%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		1624	1624	1624	257	257	553						
Total operation costs (US$/year)		61004	61004	5004	17827	17827	9273						
Sales revenue(US$/year)		3870	3870	3870	3870	3870	3870						
Loan form Bank (US$)		56000	0	58268	8850	0	19064						
Total Gains (US$)		59870	3870	62138	12720	3870	22934						
Net Annual Profit (US$)		-1134	-57134	57134	-5107	-13957	13661						
Cumulative Earnings (US$)		-1134	-58268	-1134	-5107	-19064	-5403						

5

Change interest rate	25.0%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	50%	Gasifier 5			Diesel 5			Hydro 3			PV 3		
Change Diesel cost	0%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		14500	14500	14500	2713	2713	5736	2770	2770	233	16500	16500	22538
Total operation costs (US$/year)		77000	77000	19000	22703	22703	14877	15356	15356	1739	83880	83880	23918
Sales revenue(US$/year)		5805	5805	5805	5805	5805	5805	5805	5805	5805	5805	5805	5805
Loan form Bank (US$)		58000	0	84390	10850	0	22946	11080	0	8022	66000	0	90150
Total Gains (US$)		63805	5805	90195	16655	5805	28751	16885	5805	13827	71805	5805	95955
Net Annual Profit (US$)		-13195	-71195	71195	-6048	-16898	13874	1529	-9551	12088	-12075	-78075	72038
Cumulative Earnings (US$)		-13195	-84390	-13195	-6048	-22946	-9072	1529	-8022	4066	-12075	-90150	-18113

6

Change interest rate	25.0%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	50%	Gasifier 6			Diesel 8			Hydro			PV		
Change Diesel cost	50%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		14500	14500	14500	2713	2713	7497						
Total operation costs (US$/year)		77100	77100	19100	26223	26223	20157						
Sales revenue(US$/year)		5805	5805	5805	5805	5805	5805						
Loan form Bank (US$)		58000	0	84590	10850	0	29986						
Total Gains (US$)		63805	5805	90395	16655	5805	35791						
Net Annual Profit (US$)		-13295	-71295	71295	-9568	-20418	15634						
Cumulative Earnings (US$)		-13295	-84590	-13295	-9568	-29986	-14352						

7

Change interest rate	25.0%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	0%	Gasifier 7			Diesel 3			Hydro 4			PV 4		
Change Diesel cost	0%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		14000	14000	14000	2213	2213	4571	2180	2180	229	16500	16500	23415
Total operation costs (US$/year)		73280	73280	17280	17436	17436	10944	12184	12184	1513	83700	83700	24615
Sales revenue(US$/year)		3870	3870	3870	3870	3870	3870	3870	3870	3870	3870	3870	3870
Loan form Bank (US$)		56000	0	82820	8850	0	18282	8720	0	7908	66000	0	93660
Total Gains (US$)		59870	3870	86690	12720	3870	22152	12590	3870	11778	69870	3870	97530
Net Annual Profit (US$)		-13410	-69410	69410	-4716	-13566	11208	406	-8314	10265	-13830	-79830	72915
Cumulative Earnings (US$)		-13410	-82820	-13410	-4716	-18282	-7074	406	-7908	2357	-13830	-93660	-20745

8

Change interest rate	25.0%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	0%	Gasifier 8			Diesel 6			Hydro			PV		
Change Diesel cost	50%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		14000	14000	14000	2213	2213	5744						
Total operation costs (US$/year)		73380	73380	17380	19783	19783	14464						
Sales revenue(US$/year)		3870	3870	3870	3870	3870	3870						
Loan form Bank (US$)		56000	0	83020	8850	0	22976						
Total Gains (US$)		59870	3870	86890	12720	3870	26846						
Net Annual Profit (US$)		-13510	-69510	69510	-7063	-15913	12381						
Cumulative Earnings (US$)		-13510	-83020	-13510	-7063	-22976	-10594						

PART II

VILLAGE BATTERY CHARGING WITH DIFFERENT TECHNOLOGIES

CHAPTER 1

GASIFIER VILLAGE BATTERY CHARGING

I. Results

By using technology cost and performance data and methodology of calculation, we get the results in the **Table. 15: Results of gasifier village battery charging** and the chart below:

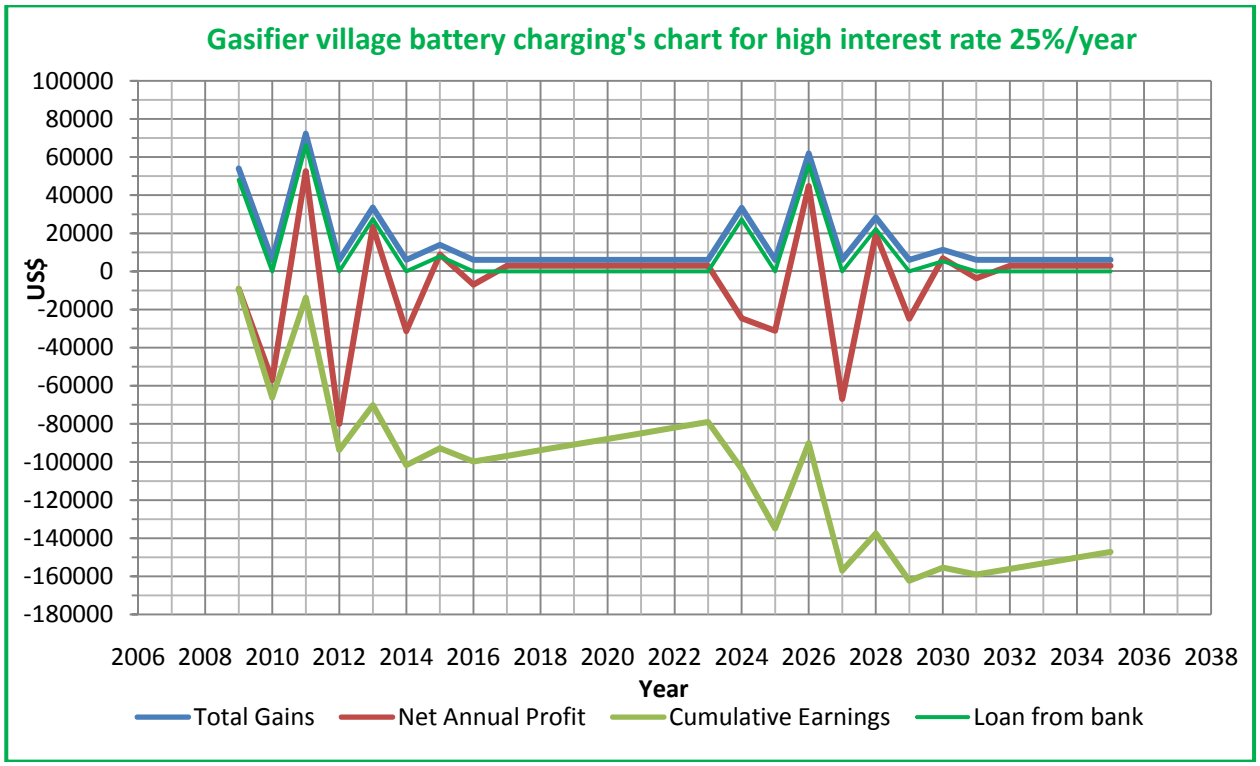


Figure 24: Gasifier village battery charging's chart for high interest rate 25%/year

II. Sensitivity Analysis

For sensitivity analysis of our case study, Gasifier village battery charging, we analyze the following:

1. Analyze the impacts of changes in interest rate
2. Analyze the increase in electricity consumption
3. Analyze the impact of the change in diesel price and diesel generation efficiency
4. Analyze different combinations of changes 1. – 3. (8 cases)

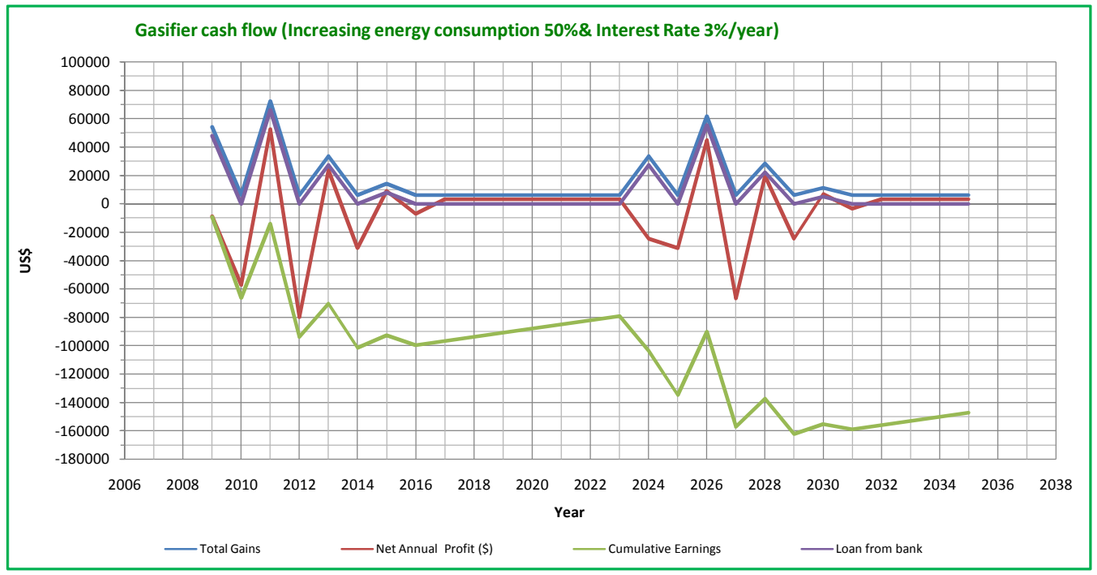
Note: **The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.**

The results of different combinations of changes 1. – 3. are in the **Table. 16: The results of different combinations of changes of gasifier village battery charging** which show all 8 cases during 3 years from 2009 to 2011.

Table. 15: Results of gasifier village battery charging

increase interest rate 25%
increase diesel 0%
increase consumption 0%

			Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month
			Number of Workers	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons
			Worker Salary/year	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**
		Lubricant	Lubricant cost/ month	25 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month
			Lubricant cost /year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
			Repair and maintenance costs/year	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
	Fuel cost	Wood	Wood payment/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month
			Payment of wood /year	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**
		Diesel	Diesel payment /month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month
			Diesel payment /year	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**12096 US$/year**	**12096 US$/year**	**16701 US$/year**	**16701 US$/year**	**6925 US$/year**	**6925 US$/year**	**1998 US$/year**	**1998 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
			Loan payback (2years)	**0 US$/year**	**48000 US$/year**	**0 US$/year**	**66272 US$/year**	**0 US$/year**	**27481 US$/year**	**0 US$/year**	**7930 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
Fixed costs		construction costs	Machinery Cost(15Years)	48000 US$											
	Customer service costs	Phone + Accounting	Phone+accounting/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
			Phone+accounting/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
Total operation costs/year				**63136 US$/year**	**63136 US$/year**	**19741 US$/year**	**86013 US$/year**	**9965 US$/year**	**37446 US$/year**	**5038 US$/year**	**12969 US$/year**	**3040 US$/year**	**3040 US$/year**	**3040 US$/year**	**3040 US$/year**
Incomes			Time of Machinery operation/day	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
	Batteries		Price for battery charging US$/battery	0.375 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries
			Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**
			Electricity price for all battery /month	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**
			Sales revenue(US$/year)	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**
Own invest ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Loan interest (%)/year				**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**
Loan form Bank($)				**48000 US$/year**	**0 US$/year**	**66272 US$/year**	**0 US$/year**	**27481 US$/year**	**0 US$/year**	**7930 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
Total Gains				**54000 US$/year**	**6000 US$/year**	**72272 US$/year**	**6000 US$/year**	**33481 US$/year**	**6000 US$/year**	**13930 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**
Net Annual Profit ($)				**-9136 US$/year**	**-57136 US$/year**	**52531 US$/year**	**-80013 US$/year**	**23516 US$/year**	**-31446 US$/year**	**8892 US$/year**	**-6969 US$/year**	**2960 US$/year**	**2960 US$/year**	**2960 US$/year**	**2960 US$/year**
Cumulative Earnings				**-9136 US$/year**	**-66272 US$/year**	**-13741 US$/year**	**-93753 US$/year**	**-70237 US$/year**	**-101684 US$/year**	**-92792 US$/year**	**-99761 US$/year**	**-96801 US$/year**	**-93841 US$/year**	**-90881 US$/year**	**-87921 US$/year**


Gasifier cash flow (Increasing energy consumption 50%& Interest Rate 3%/year)
US$
Year
Total Gains
Net Annual Profit ($)
Cumulative Earnings
Loan from bank

2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month
5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons	5persons
1000 US$/year	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**
25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month	25.0 US$/month
300 US$/year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
240 US$/year	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month
500 US$/year	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**
17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month
200 US$/year	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**6875 US$/year**	**6875 US$/year**	**14069 US$/year**	**14069 US$/year**	**5599 US$/year**	**5599 US$/year**	**1330 US$/year**	**1330 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**27280 US$/year**	**0 US$/year**	**55829 US$/year**	**0 US$/year**	**22218 US$/year**	**0 US$/year**	**5278 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
			48000 US$											
67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
800 US$/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
3040 US$/year	**3040 US$/year**	**3040 US$/year**	**57915 US$/year**	**37195 US$/year**	**17109 US$/year**	**72938 US$/year**	**8639 US$/year**	**30857 US$/year**	**4370 US$/year**	**9648 US$/year**	**3040 US$/year**	**3040 US$/year**	**3040 US$/year**	**3040 US$/year**
12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery	0.38 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
800Kwh/month	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**
500 US$/month	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**
6000 US$/year	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
25%	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**
0 US$/year	**0 US$/year**	**0 US$/year**	**27280 US$/year**	**0 US$/year**	**55829 US$/year**	**0 US$/year**	**22218 US$/year**	**0 US$/year**	**5278 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
6000 US$/year	**6000 US$/year**	**6000 US$/year**	**33280 US$/year**	**6000 US$/year**	**61829 US$/year**	**6000 US$/year**	**28218 US$/year**	**6000 US$/year**	**11278 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**
2960 US$/year	**2960 US$/year**	**2960 US$/year**	**-24635 US$/year**	**-31195 US$/year**	**44720 US$/year**	**-66938 US$/year**	**19579 US$/year**	**-24857 US$/year**	**6908 US$/year**	**-3648 US$/year**	**2960 US$/year**	**2960 US$/year**	**2960 US$/year**	**2960 US$/year**
-84961 US$/vear	**-82001 US$/vear**	**-79041 US$/vear**	**-103675 US$/vear**	**-134870 US$/vear**	**-90149 US$/vear**	**-157088 US$/vear**	**-137509 US$/vear**	**-162365 US$/vear**	**-155458 US$/vear**	**-159105 US$/vear**	**-156145 US$/vear**	**-153185 US$/vear**	**-150225 US$/vear**	**-147265 US$/vear**

Table. 16: The results of different combinations of changes of gasifier village battery charging

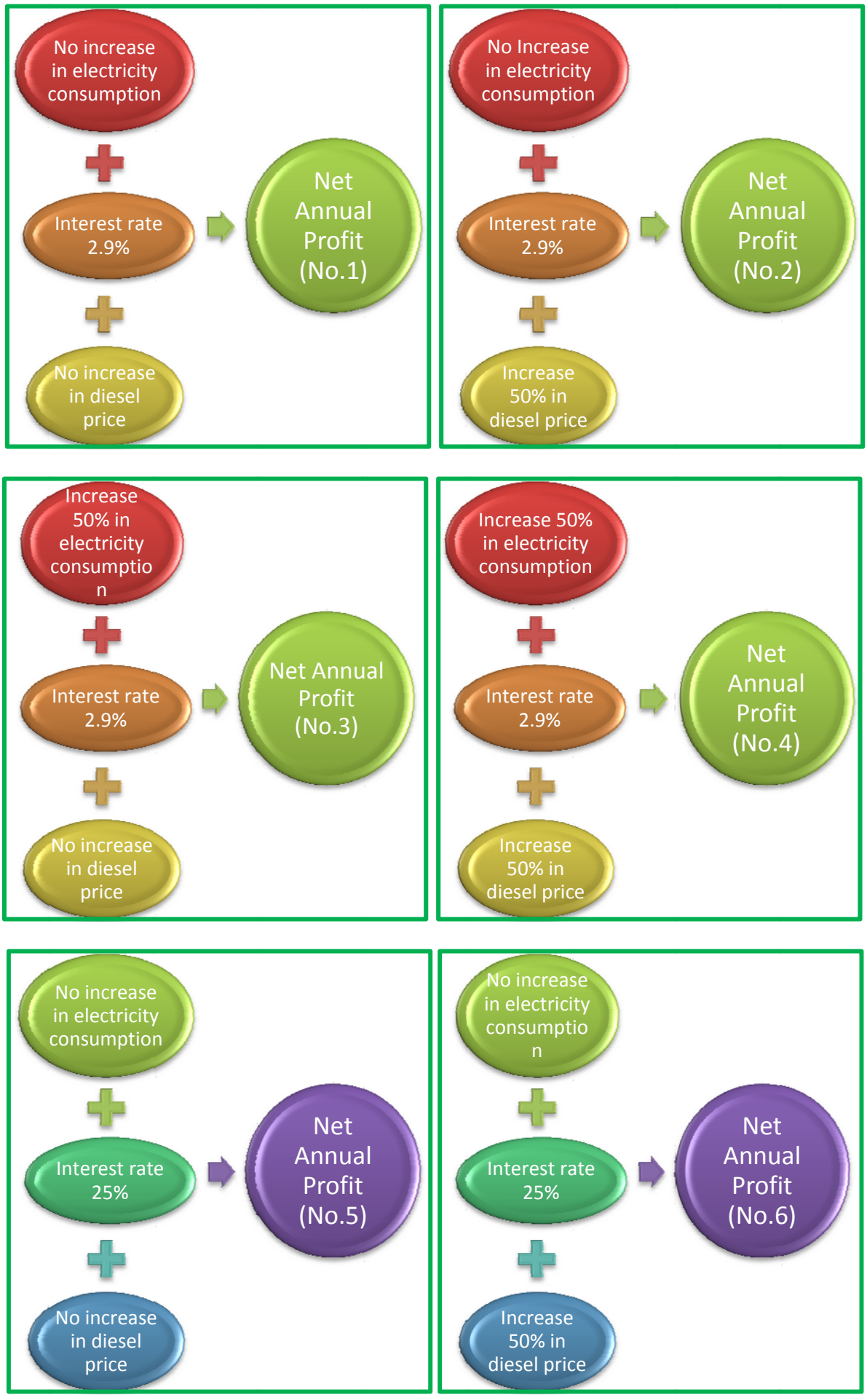
				increase interest rate 2.9% increase comsumption 50.0% increase diesel price 0.0%	Case 1	increase interest rate 2.9% increase comsumption 50.0% increase diesel price 50.0%	Case 2	increase interest rate 2.9% increase comsumption 0.0% increase diesel price 0.0%	Case 3	increase interest rate 2.9% increase comsumption 0.0% increase diesel price 50.0%	Case 4
Year				2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month
			Number of Workers	8persons	8persons	8persons	8persons	8persons	8persons	5persons	5persons	5persons	5persons	5persons	5persons
			Worker Salary/year	**1500 US$/year**	**1500 US$/year**	**1500 US$/year**	**1500 US$/year**	**1500 US$/year**	**1500 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**	**1000 US$/year**
		Lubricant	Lubricant cost/ month	38 US$/month	37.5 US$/month	37.5 US$/month	38 US$/month	37.5 US$/month	37.5 US$/month	25 US$/month	25.0 US$/month	25.0 US$/month	25 US$/month	25.0 US$/month	25.0 US$/month
			Lubricant cost /year	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**450 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
		Repairing	Repair and maintenance costs/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
			Repair and maintenance costs/year	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**360 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**	**240 US$/year**
	Fuel cost	Wood	Wood payment/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month
			Payment of wood /year	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**750 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**	**500 US$/year**
		Diesel	Diesel payment /month	25 US$/month	25 US$/month	25 US$/month	33 US$/month	33 US$/month	33 US$/month	17 US$/month	17 US$/month	17 US$/month	25 US$/month	25 US$/month	25 US$/month
			Diesel payment /year	**300 US$/year**	**300 US$/year**	**300 US$/year**	**400 US$/year**	**400 US$/year**	**400 US$/year**	**200 US$/year**	**200 US$/year**	**200 US$/year**	**300 US$/year**	**300 US$/year**	**300 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**1392 US$/year**	**1392 US$/year**	**1366 US$/year**	**1392 US$/year**	**1392 US$/year**	**1372 US$/year**	**1392 US$/year**	**1392 US$/year**	**1301 US$/year**	**1392 US$/year**	**1392 US$/year**	**1307 US$/year**
			Loan payback (2years)	**0 US$/year**	**48000 US$/year**	**0 US$/year**	**0 US$/year**	**48000 US$/year**	**0 US$/year**	**0 US$/year**	**48000 US$/year**	**0 US$/year**	**0 US$/year**	**48000 US$/year**	**0 US$/year**
Fixed costs		construction costs	Machinery Cost(15Years)	48000 US$			48000 US$			48000 US$			48000 US$		
	Customer service costs	Phone + Accounting	Phone+accounting/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
			Phone+accounting/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
Total operation costs/year				**53552 US$/year**	**53552 US$/year**	**5526 US$/year**	**53652 US$/year**	**53652 US$/year**	**5632 US$/year**	**52432 US$/year**	**52432 US$/year**	**4341 US$/year**	**52532 US$/year**	**52532 US$/year**	**4447 US$/year**
Incomes	Time of Machinery operation/day			12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
	Batteries	Price for battery charging US$/battery		0.375 US$/battery	0.38 US$/battery	0.38 US$/battery	0.375 US$/battery	0.38 US$/battery	0.38 US$/battery	0.375 US$/battery	0.38 US$/battery	0.38 US$/battery	0.375 US$/battery	0.38 US$/battery	0.38 US$/battery
		Battery capacity AH		50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
		Number of Battery/day		67batteries	67batteries	67batteries	67batteries	67batteries	67batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries
		Electric for one battery charing kwh/day		**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
		Electric for all battery charing kwh/month		**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**	**800Kwh/month**
		Electricity price for all battery /month		**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**	**500 US$/month**
	Sales revenue(US$/year)			**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**	**6000 US$/year**
Own investment ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				0.2%	0.242%	0.242%	0.2%	0.242%	0.242%	0.2%	0.242%	0.242%	0.2%	0.242%	0.242%
Loan interest (%)/year				**2.9%**	**2.900%**	**2.900%**	**2.9%**	**2.900%**	**2.900%**	**2.9%**	**2.900%**	**2.900%**	**2.9%**	**2.900%**	**2.900%**
Loan form Bank($)				**48000 US$/year**		**47104 US$/year**	**48000 US$/year**		**47304 US$/year**	**48000 US$/year**		**44864 US$/year**	**48000 US$/year**		**45064 US$/year**
Total Gains				**54000 US$/year**	**6000 US$/year**	**53104 US$/year**	**54000 US$/year**	**6000 US$/year**	**53304 US$/year**	**54000 US$/year**	**6000 US$/year**	**50864 US$/year**	**54000 US$/year**	**6000 US$/year**	**51064 US$/year**
Net Annual Profit ($)				**448 US$/year**	**-47552 US$/year**	**47578 US$/year**	**348 US$/year**	**-47652 US$/year**	**47672 US$/year**	**1568 US$/year**	**-46432 US$/year**	**46523 US$/year**	**1468 US$/year**	**-46532 US$/year**	**46617 US$/year**
Cumulative Earnings				**448 US$/year**	**-47104 US$/year**	**474 US$/year**	**348 US$/year**	**-47304 US$/year**	**368 US$/year**	**1568 US$/year**	**-44864 US$/year**	**1659 US$/year**	**1468 US$/year**	**-45064 US$/year**	**1553 US$/year**
Rank				3			4			1			2		

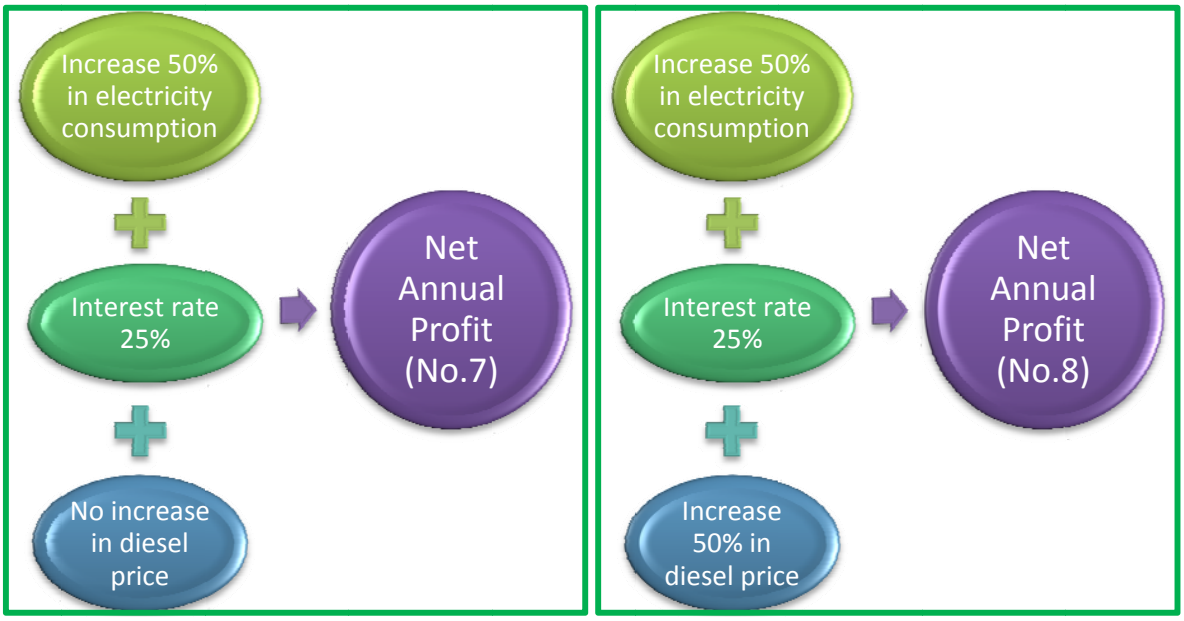
increase interest rate	25%		increase interest rate	25%		increase interest rate	25%		increase interest rate	25%	
increase comsumption	50%		increase comsumption	50%		increase comsumption	0%		increase comsumption	0%	
increase diesel price	0%	Case 5	increase diesel price	50%	Case 6	increase diesel price	0%	Case 7	increase diesel price	50%	Case 8
2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month	17 US$/month
8persons	8persons	8persons	8persons	8persons	8persons	5persons	5persons	5persons	5persons	5persons	5persons
1500 US$/year	1500 US$/year	1500 US$/year	1500 US$/year	1500 US$/year	1500 US$/year	1000 US$/year	1000 US$/year	1000 US$/year	1000 US$/year	1000 US$/year	1000 US$/year
38 US$/month	37.5 US$/month	37.5 US$/month	38 US$/month	37.5 US$/month	37.5 US$/month	25 US$/month	25.0 US$/month	25.0 US$/month	25 US$/month	25.0 US$/month	25.0 US$/month
450 US$/year	450 US$/year	450 US$/year	450 US$/year	450 US$/year	450 US$/year	300 US$/year	300 US$/year	300 US$/year	300 US$/year	300 US$/year	300 US$/year
30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	30 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month	20 US$/month
360 US$/year	360 US$/year	360 US$/year	360 US$/year	360 US$/year	360 US$/year	240 US$/year	240 US$/year	240 US$/year	240 US$/year	240 US$/year	240 US$/year
63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	63 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month	42 US$/month
750 US$/year	750 US$/year	750 US$/year	750 US$/year	750 US$/year	750 US$/year	500 US$/year	500 US$/year	500 US$/year	500 US$/year	500 US$/year	500 US$/year
25 US$/month	25 US$/month	25 US$/month	33 US$/month	33 US$/month	33 US$/month	17 US$/month	17 US$/month	17 US$/month	25 US$/month	25 US$/month	25 US$/month
300 US$/year	300 US$/year	300 US$/year	400 US$/year	400 US$/year	400 US$/year	200 US$/year	200 US$/year	200 US$/year	300 US$/year	300 US$/year	300 US$/year
12000 US$/year	12000 US$/year	17080 US$/year	12000 US$/year	12000 US$/year	17130 US$/year	12000 US$/year	12000 US$/year	16520 US$/year	12000 US$/year	12000 US$/year	16570 US$/year
0 US$/year	48000 US$/year	0 US$/year	0 US$/year	48000 US$/year	0 US$/year	0 US$/year	48000 US$/year	0 US$/year	0 US$/year	48000 US$/year	0 US$/year
48000 US$			48000 US$			48000 US$			48000 US$		
67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year
64160 US$/year	64160 US$/year	21240 US$/year	64260 US$/year	64260 US$/year	21390 US$/year	63040 US$/year	63040 US$/year	19560 US$/year	63140 US$/year	63140 US$/year	19710 US$/year
12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours	12hours
0.375 US$/battery	0.38 US$/battery	0.38 US$/battery	0.375 US$/battery	0.38 US$/battery	0.38 US$/battery	0.375 US$/battery	0.38 US$/battery	0.38 US$/battery	0.375 US$/battery	0.38 US$/battery	0.38 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
67batteries	67batteries	67batteries	67batteries	67batteries	67batteries	44batteries	44batteries	44batteries	44batteries	44batteries	44batteries
0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day
800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month	800Kwh/month
500 US$/month	500 US$/month	500 US$/month	500 US$/month	500 US$/month	500 US$/month	500 US$/month	500 US$/month	500 US$/month	500 US$/month	500 US$/month	500 US$/month
6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year	6000 US$/year
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
2.1%	2.083%	2.083%	2.1%	2.083%	2.083%	2.1%	2.083%	2.083%	2.1%	2.083%	2.083%
25.0%	25.000%	25.000%	25.0%	25.000%	25.000%	25.0%	25.000%	25.000%	25.0%	25.000%	25.000%
48000 US$/year		68320 US$/year	48000 US$/year		68520 US$/year	48000 US$/year		66080 US$/year	48000 US$/year		66280 US$/year
54000 US$/year	6000 US$/year	74320 US$/year	54000 US$/year	6000 US$/year	74520 US$/year	54000 US$/year	6000 US$/year	72080 US$/year	54000 US$/year	6000 US$/year	72280 US$/year
-10160 US$/year	-58160 US$/year	53080 US$/year	-10260 US$/year	-58260 US$/year	53130 US$/year	-9040 US$/year	-57040 US$/year	52520 US$/year	-9140 US$/year	-57140 US$/year	52570 US$/year
-10160 US$/year	-68320 US$/year	-15240 US$/year	-10260 US$/year	-68520 US$/year	-15390 US$/year	-9040 US$/year	-66080 US$/year	-13560 US$/year	-9140 US$/year	-66280 US$/year	-13710 US$/year

7	8	5	6

yearlybenefits	6000	
yearly cost	4160	
Simple payback period	#REF!	#REF!

The change of Net Annual Profit (No.1: The best to No.8: The worst) is in the graphics below:





The cases of sensitivity analysis will be shown in the chart below from the Net Annual Profit No.1 (**Figure 25**) to the Net Annual Profit No.8 (**Figure 32**). Some charts are nearly the same, but their Net Annual Profit is US$ 100 different.

Net Annual Profit No. 1:

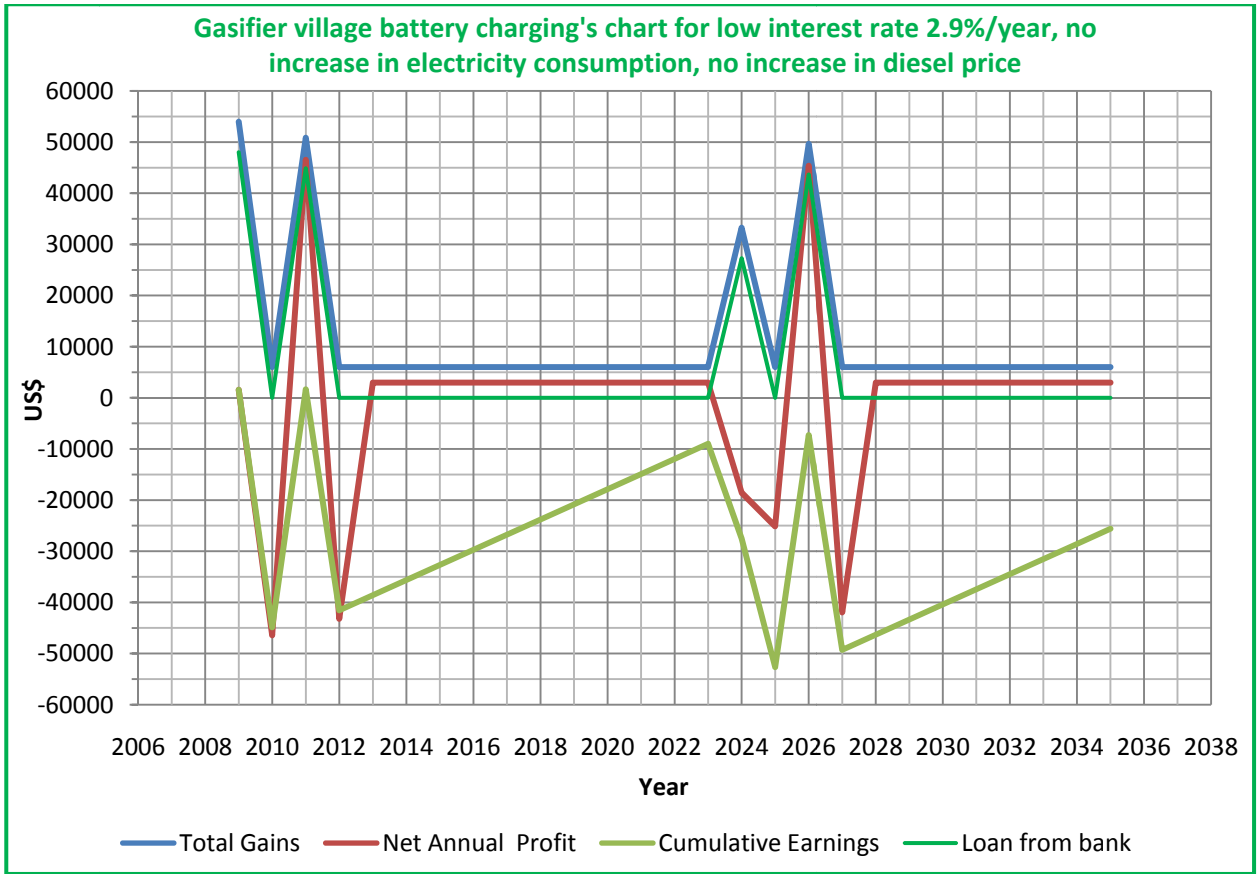


Figure 25: Gasifier village battery charging's chart for low interest rate 2.9%/year, no increase in electricity consumption, no increase in diesel price

Net Annual Profit No. 2:

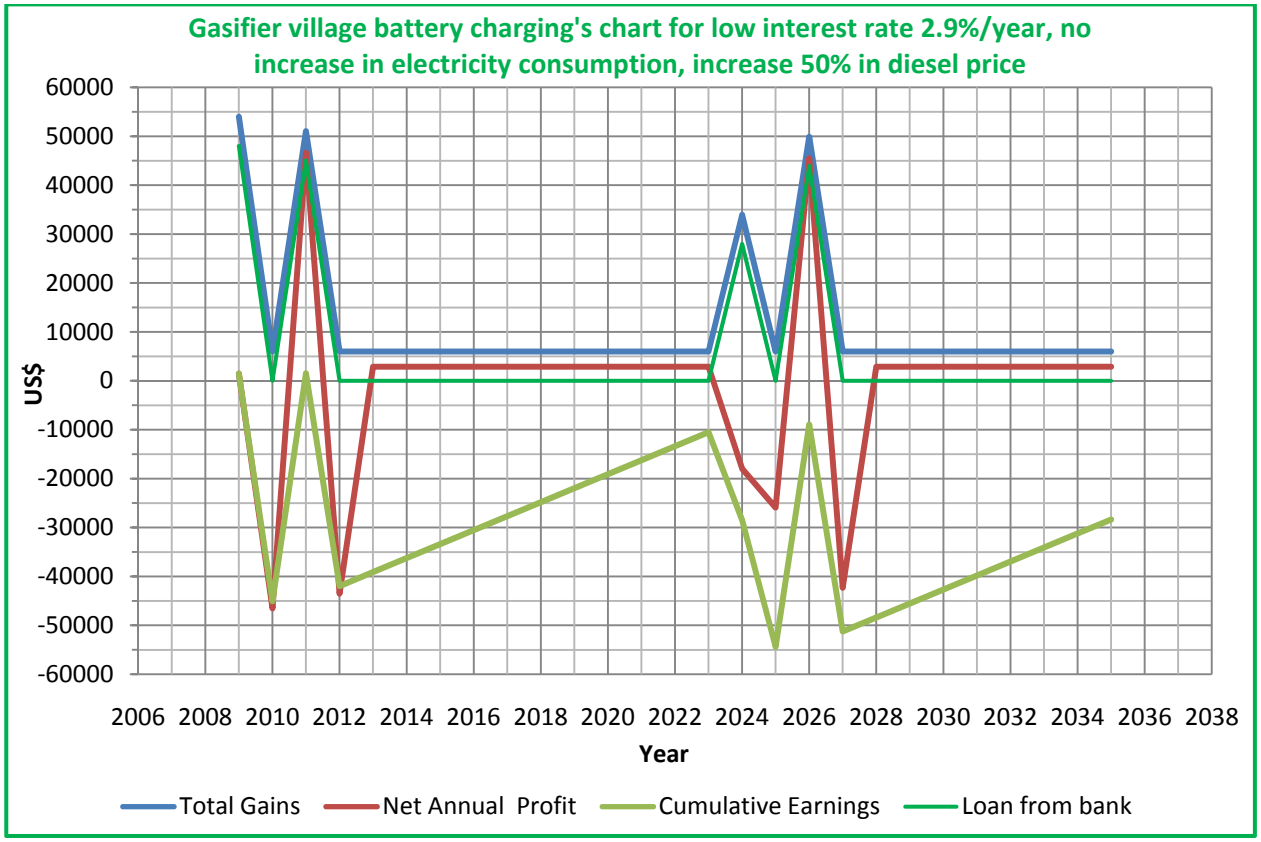


Figure 26: Gasifier village battery charging's chart for low interest rate 2.9%/year, no increase in electricity consumption, increase 50% in diesel price

Net Annual Profit No. 3:

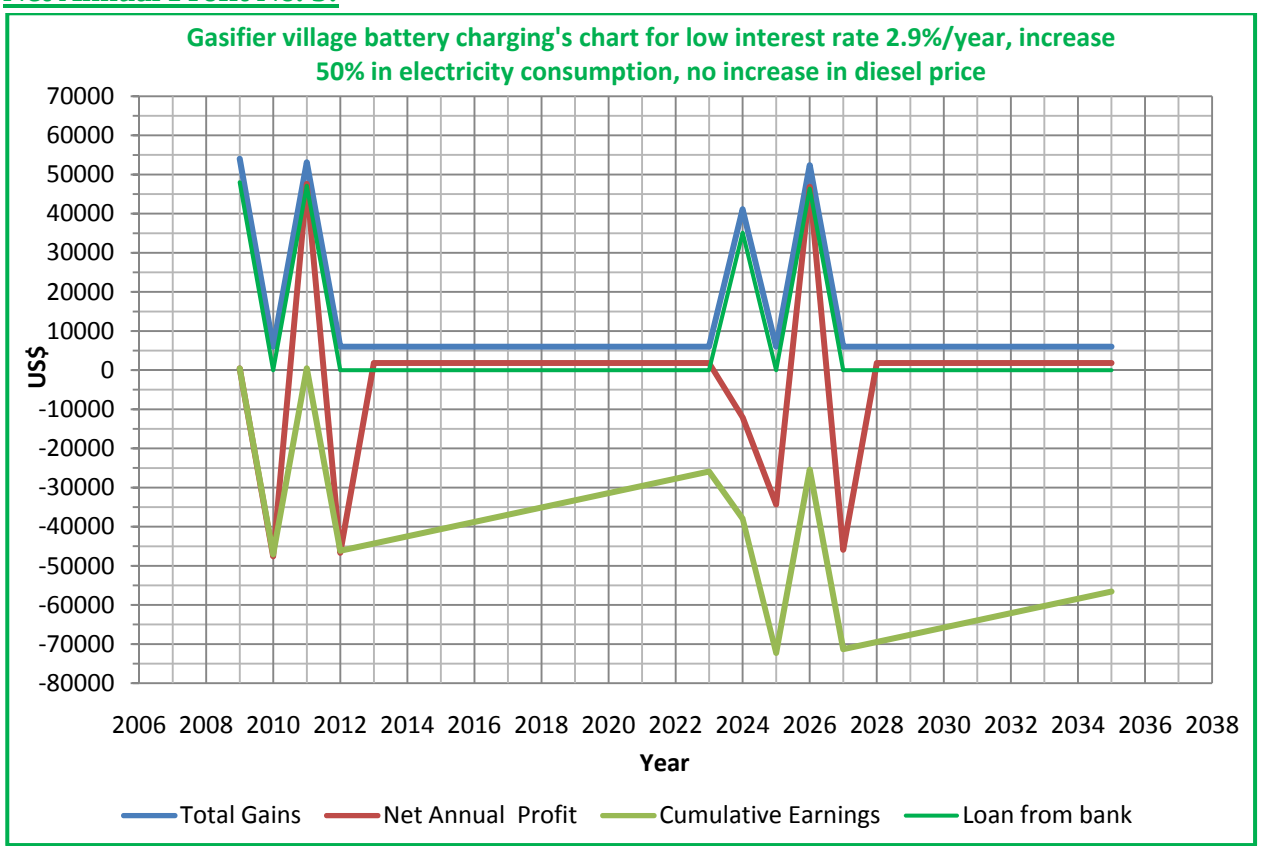


Figure 27: Gasifier village battery charging's chart for low interest rate 2.9%/year, increase 50% in electricity consumption, no increase in diesel price

Net Annual Profit No. 4:

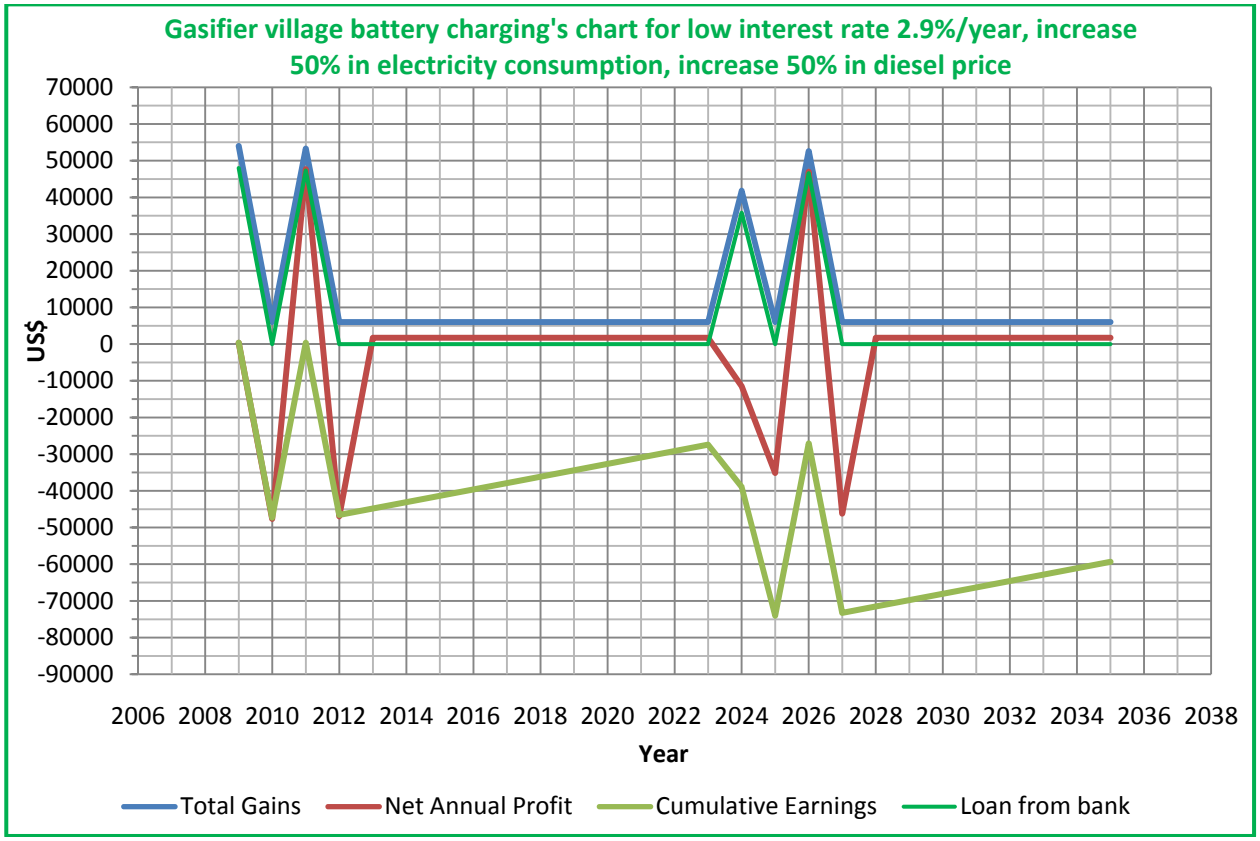


Figure 28: Gasifier village battery charging's chart for low interest rate 2.9%/year, increase 50% in electricity consumption, increase 50% in diesel price

Net Annual Profit No. 5: (The same as Figure 24)

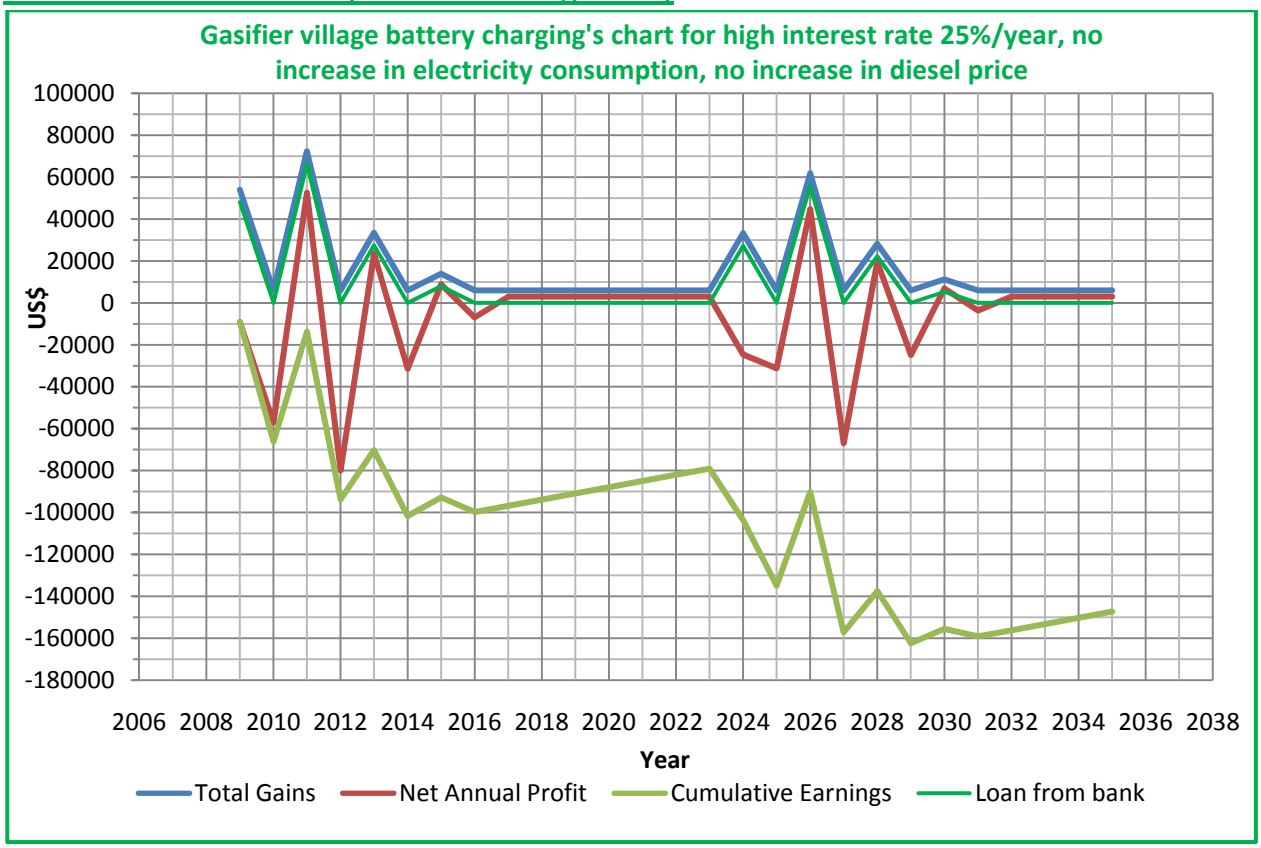


Figure 29: Gasifier village battery charging's chart for high interest rate 25%/year, no increase in electricity consumption, no increase in diesel price

Net Annual Profit No. 6:

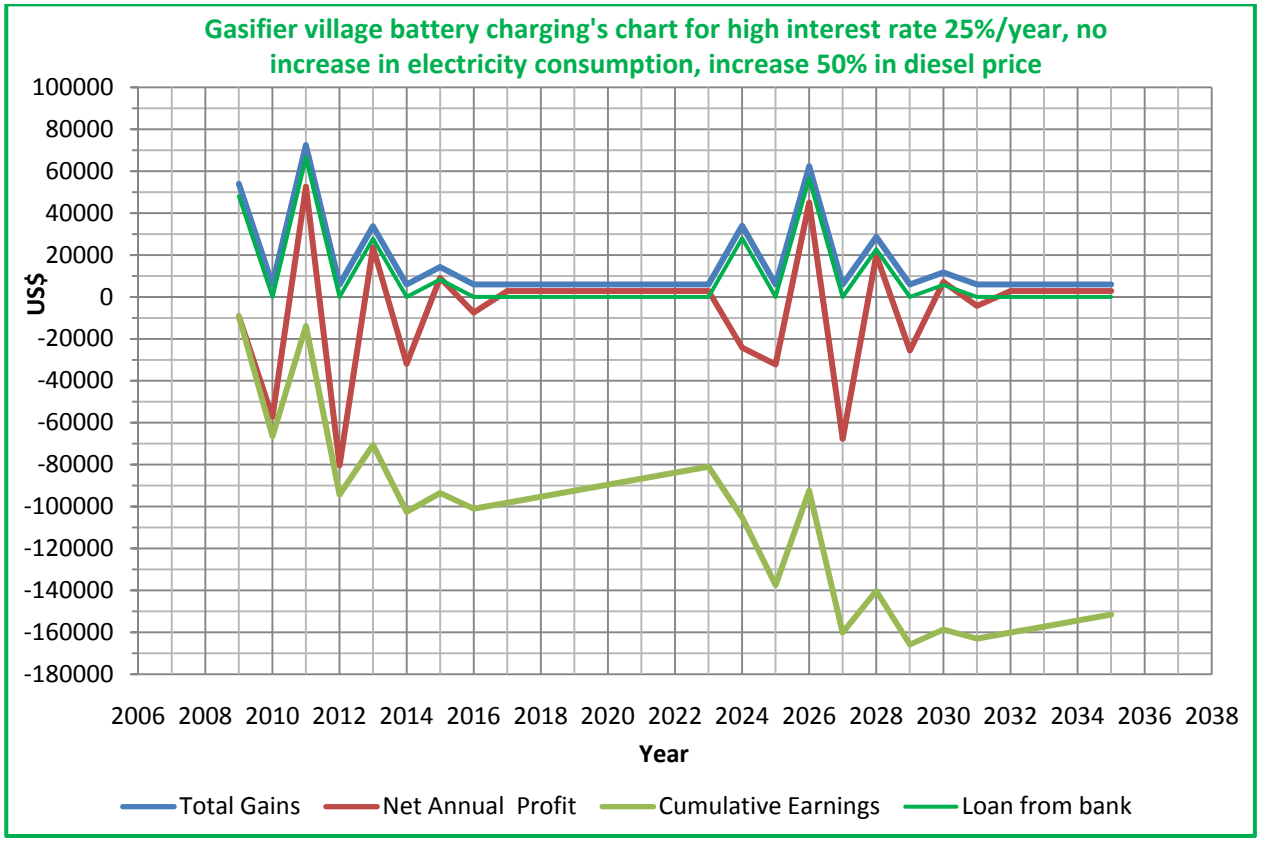


Figure 30: Gasifier village battery charging's chart for high interest rate 25%/year, no increase in electricity consumption, increase 50% in diesel price

Net Annual Profit No. 7:

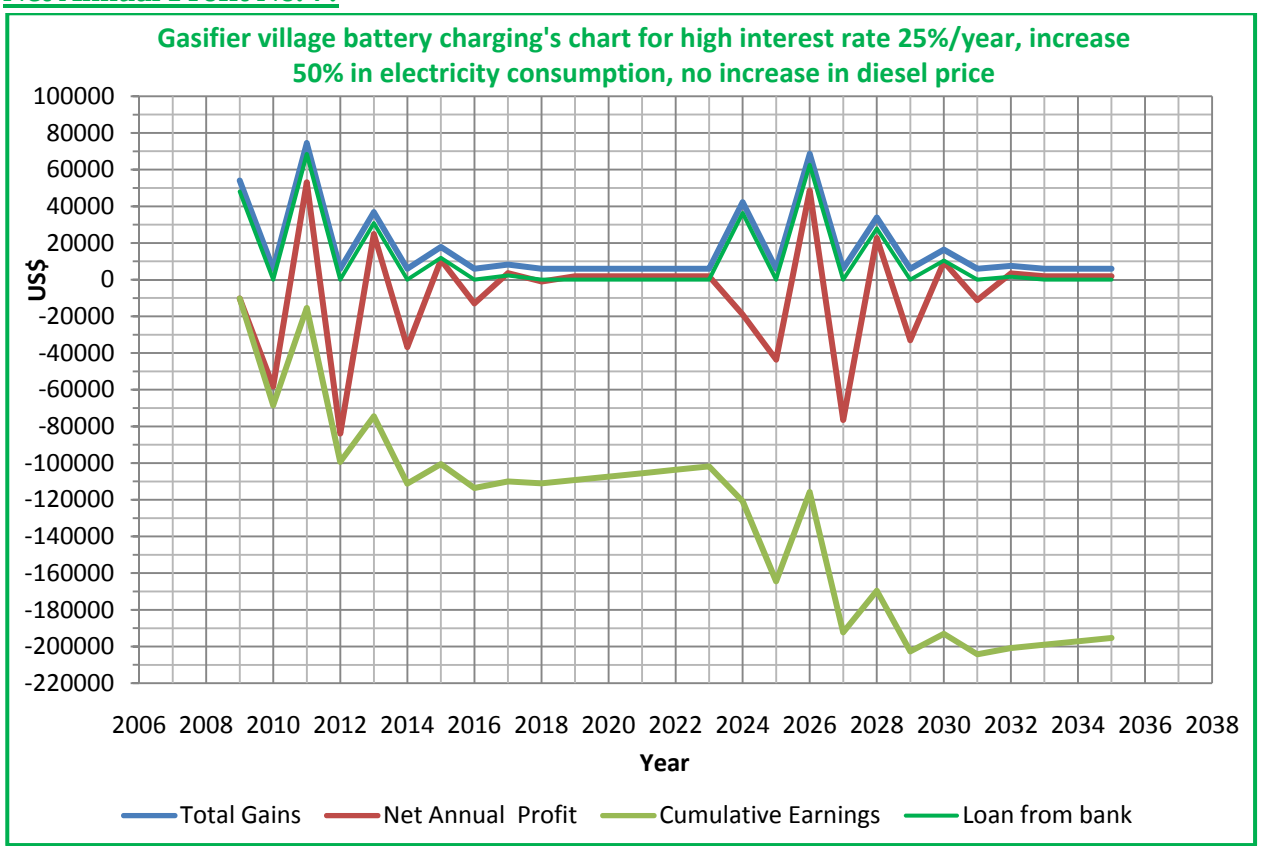


Figure 31: Gasifier village battery charging's chart for high interest rate 25%/year, increase 50% in electricity consumption, no increase in diesel price

Net Annual Profit No. 8:

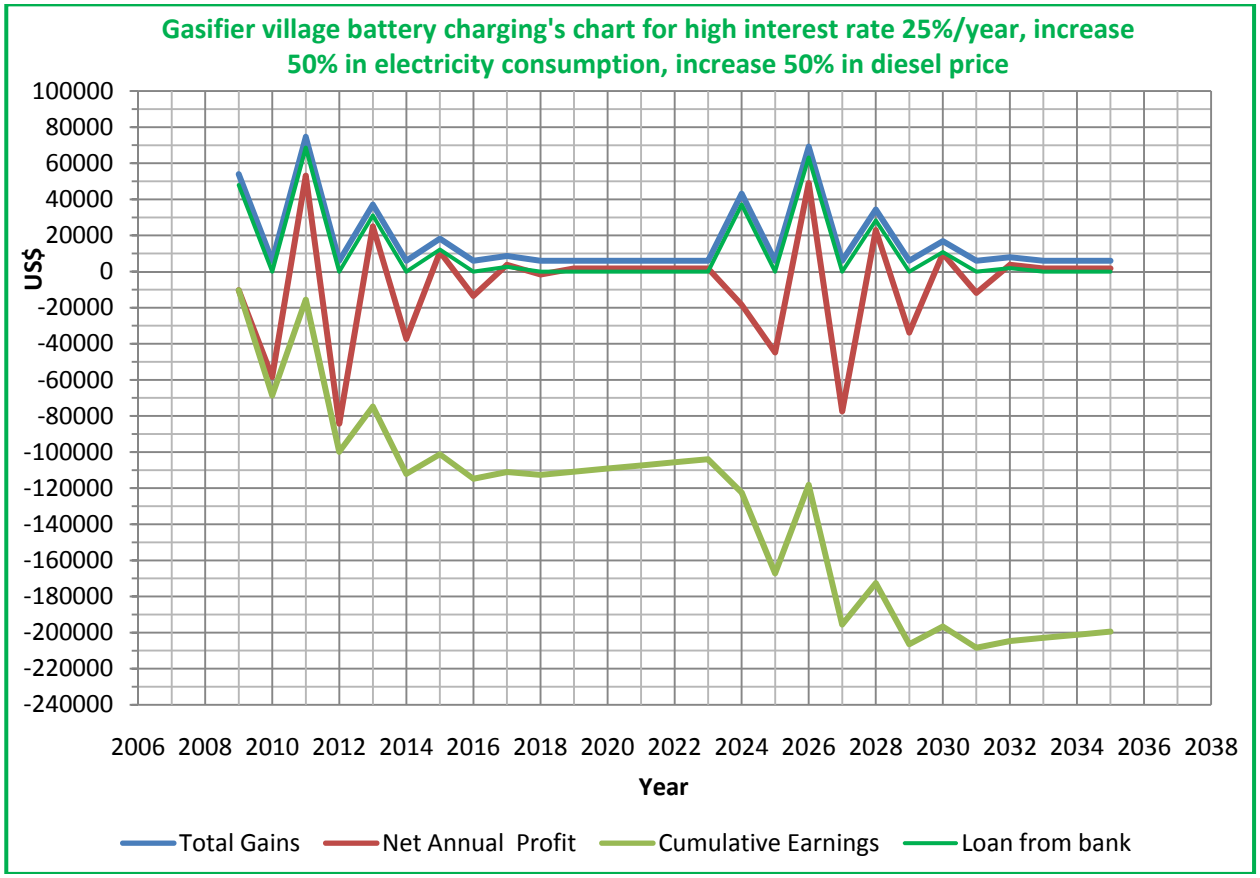


Figure 32: Gasifier village battery charging's chart for high interest rate 25%/year, increase 50% in electricity consumption, increase 50% in diesel price

III. Conclusion

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment. For our Gasifier village battery charging, the year of Loan from bank started to remain zero is in the interval of 2013 and 2019.

The minimum year of Loan from bank started to remain zero is in year 2013 which is the case of the best Net Annual Profit No.1: No increase in electricity consumption, No increase in diesel price, Low Interest rate 2.9%. (**Figure 25**)

The maximum year of Loan from bank started to remain zero is in year 2019 which is the case of the worst Net Annual Profit No.8: Increase 50% in electricity consumption, Increase 50% in diesel price, High Interest rate 25%. (**Figure 32**)

CHAPTER 2

PV VILLAGE BATTERY CHARGING

I. Results

By using technology cost and performance data and methodology of calculation, we get the results in the **Table. 17: Results of PV village battery charging** and the chart below:

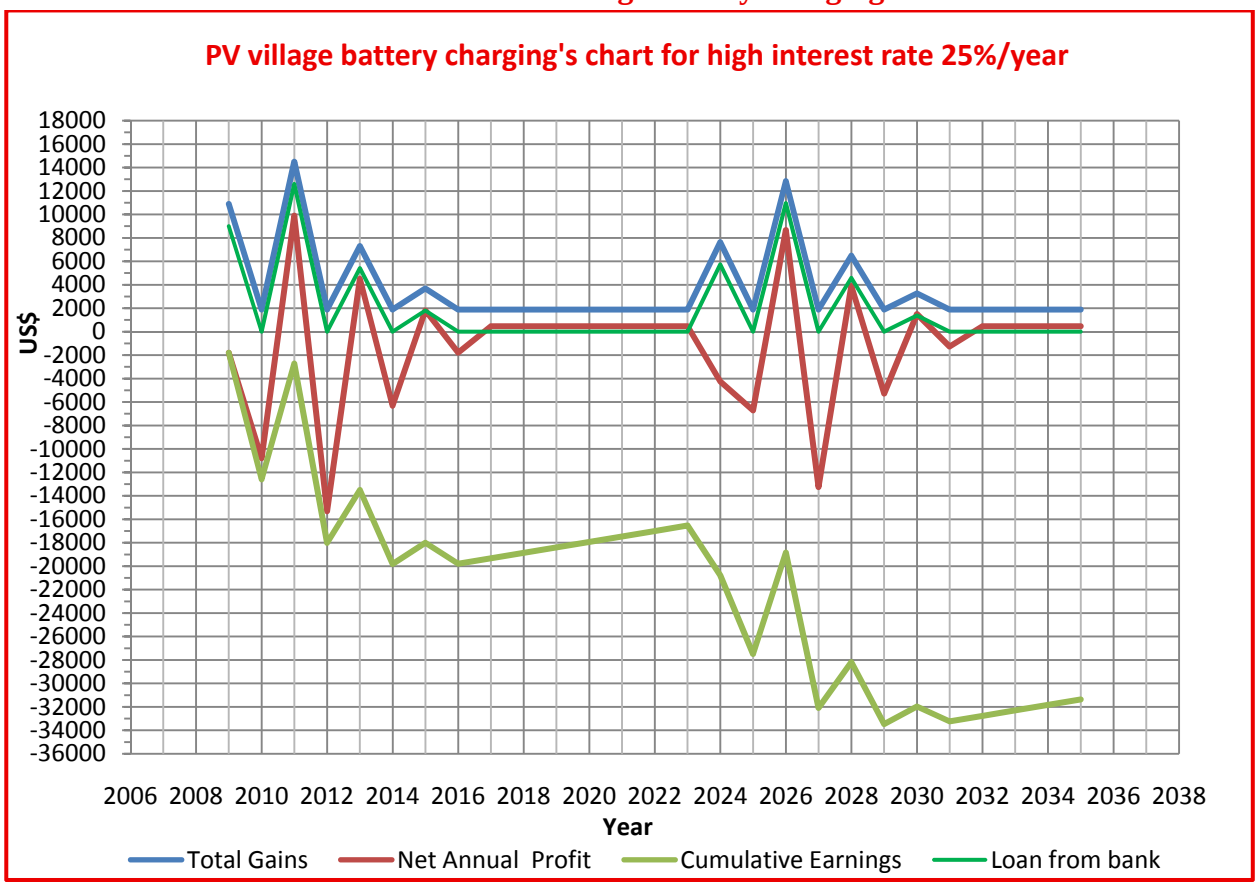


Figure 33: PV village battery charging's chart for high interest rate 25%/year

II. Sensitivity Analysis

For sensitivity analysis of our case study, PV village electrification, we analyze the following:

1. Analyze the impacts of changes in interest rate
2. Analyze the increase in electricity consumption
3. Analyze different combinations of changes 1. – 2. (4 cases)

Note: **The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.**

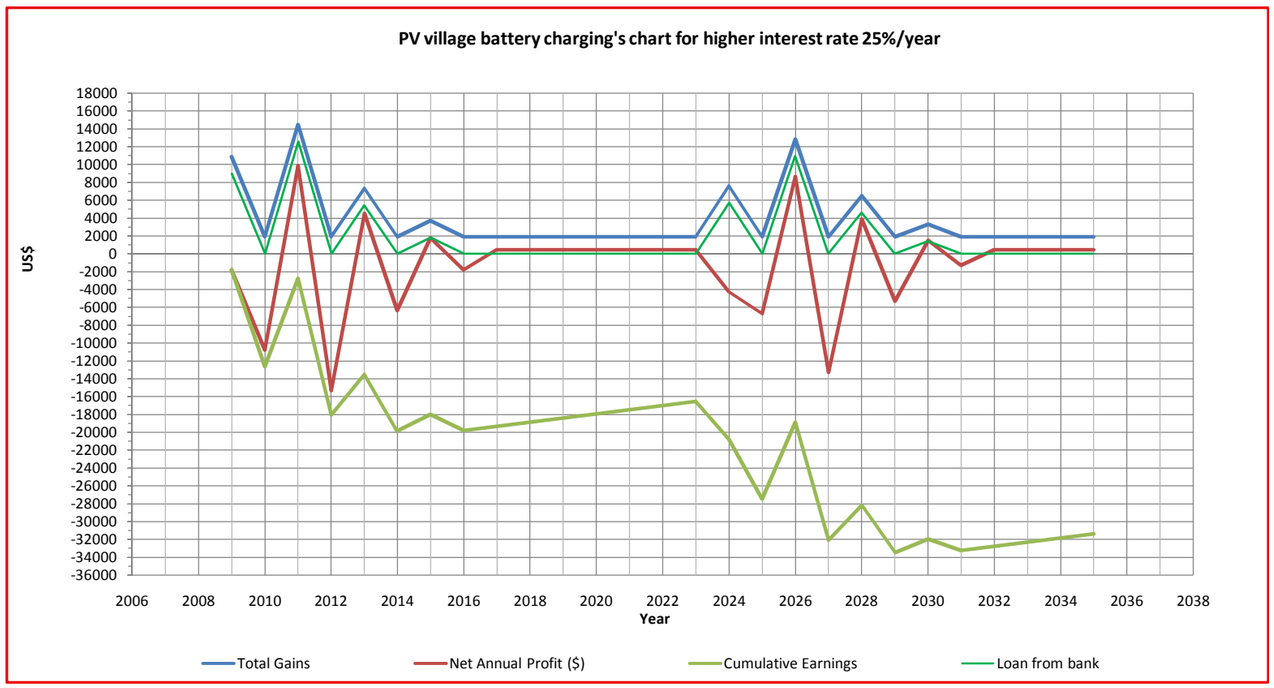
The results of different combinations of changes 1. – 2. are in the **Table. 18: The results of different combinations of changes of PV village battery charging** which show all 4 cases during 3 years from 2009 to 2011.

Table. 11: Results of PV village battery charging

increase interest rate 25%

increase consumptior 0%

			Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Variable costs	Operatng &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
			Worker Salary/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
		Repairing	Repair and maintenance costs/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month
			Repair and maintenance costs/year	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**2268 US$/year**	**2268 US$/year**	**3176 US$/year**	**3176 US$/year**	**1366 US$/year**	**1366 US$/year**	**454 US$/year**	**454 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
			Loan payback (2years)	**0 US$/year**	**9000 US$/year**	**0 US$/year**	**12604 US$/year**	**0 US$/year**	**5420 US$/year**	**0 US$/year**	**1800 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
		construction costs	Grid Cost	0 US$											
Fixed costs			Machinery Cost(15Years)	9000 US$											
	Customer service costs	Phone + Accounting	Phone+accounting/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
			Phone+accounting/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
Total operation costs/year				**12692 US$/year**	**12692 US$/year**	**4600 US$/year**	**17204 US$/year**	**2790 US$/year**	**8210 US$/year**	**1878 US$/year**	**3677 US$/year**	**1424 US$/year**	**1424 US$/year**	**1424 US$/year**	**1424 US$/year**
Incomes			Time of Machinery operation/day	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours
			Average charging power kw	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
			PV generate the Electricity kw/day	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
		Batteries	Price for battery charging US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries
			Average battery charing kwh/day	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**
			Electric for all battery charing kwh/month	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**
			Electricity price for all battery /month	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**
	Sales revenue(US$/year)			**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**
Own invest ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Loan interest (%)/year				**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**
Loan from Bank($)				**9000 US$/year**	**0 US$/year**	**12604 US$/year**	**0 US$/year**	**5420 US$/year**	**0 US$/year**	**1800 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
Total Gains				**10890 US$/year**	**1890 US$/year**	**14494 US$/year**	**1890 US$/year**	**7310 US$/year**	**1890 US$/year**	**3690 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**
Net Annual Profit ($)				**-1802 US$/year**	**-10802 US$/year**	**9894 US$/year**	**-15314 US$/year**	**4520 US$/year**	**-6320 US$/year**	**1812 US$/year**	**-1787 US$/year**	**466 US$/year**	**466 US$/year**	**466 US$/year**	**466 US$/year**
Cumulative Earnings				**-1802 US$/year**	**-12604 US$/year**	**-2710 US$/year**	**-18024 US$/year**	**-13504 US$/year**	**-19824 US$/year**	**-18012 US$/year**	**-19799 US$/year**	**-19333 US$/year**	**-18867 US$/year**	**-18401 US$/year**	**-17935 US$/year**
				1	2	3	4	5	6	7	8	9	10	11	12


PV village battery charging's chart for higher interest rate 25%/year
US$
Year
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
-12000
-14000
-16000
-18000
-20000
-22000
-24000
-26000
-28000
-30000
-32000
-34000
-36000
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
Total Gains
Net Annual Profit ($)
Cumulative Earnings
Loan from bank

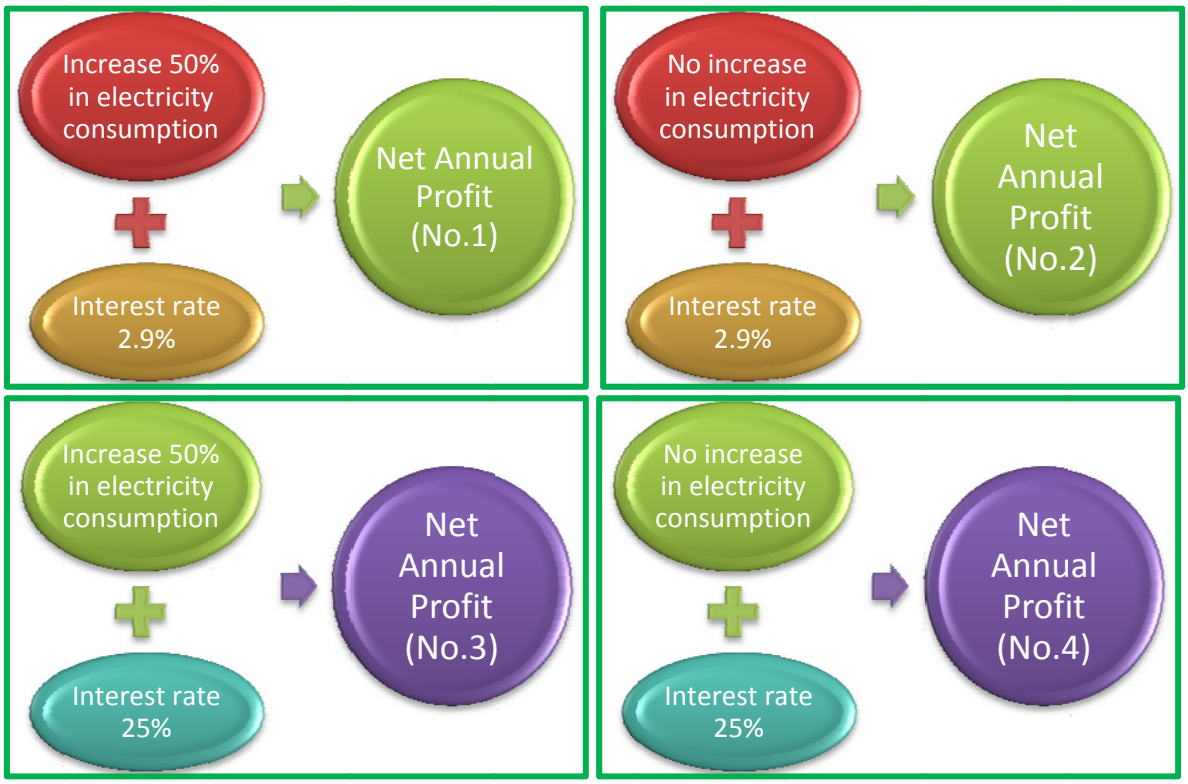
2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
600 US$/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month	2 US$/month
24 US$/year	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**	**24 US$/year**
0 US$/year	**0 US$/year**		**1446 US$/year**	**1446 US$/year**	**2762 US$/year**	**2762 US$/year**	**1157 US$/year**	**1157 US$/year**	**348 US$/year**	**348 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**0 US$/year**	**5738 US$/year**	**0 US$/year**	**10960 US$/year**	**0 US$/year**	**4592 US$/year**	**0 US$/year**	**1382 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
			9000											
67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
800 US$/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
1424 US$/year	**1424 US$/year**	**1424 US$/year**	**11870 US$/year**	**8608 US$/year**	**4186 US$/year**	**15146 US$/year**	**2581 US$/year**	**7173 US$/year**	**1772 US$/year**	**3155 US$/year**	**1424 US$/year**	**1424 US$/year**	**1424 US$/year**	**1424 US$/year**
11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours	11hours
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries	14batteries
0.6Kwh/day	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day**
231Kwh/month	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**	**231Kwh/month**
158 US$/month	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**	**158 US$/month**
1890 US$/year	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
25%	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**
0 US$/year	**0 US$/year**	**0 US$/year**	**5738 US$/year**	**0 US$/year**	**10960 US$/year**	**0 US$/year**	**4592 US$/year**	**0 US$/year**	**1382 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**
1890 US$/year	**1890 US$/year**	**1890 US$/year**	**7628 US$/year**	**1890 US$/year**	**12850 US$/year**	**1890 US$/year**	**6482 US$/year**	**1890 US$/year**	**3272 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**	**1890 US$/year**
466 US$/year	**466 US$/year**	**466 US$/year**	**-4242 US$/year**	**-6718 US$/year**	**8664 US$/year**	**-13256 US$/year**	**3901 US$/year**	**-5283 US$/year**	**1500 US$/year**	**-1265 US$/year**	**466 US$/year**	**466 US$/year**	**466 US$/year**	**466 US$/year**
-17469 US$/year	**-17003 US$/year**	**-16537 US$/year**	**-20779 US$/year**	**-27497 US$/year**	**-18833 US$/year**	**-32089 US$/year**	**-28189 US$/year**	**-33471 US$/year**	**-31972 US$/year**	**-33236 US$/year**	**-32770 US$/year**	**-32304 US$/year**	**-31838 US$/year**	**-31372 US$/year**
13	14	15	16	17	18	19	20	21	22	23	24	25	26	27

Table. 18: The results of different combinations of changes of PV village battery charging

				increase interest rate 2.9% increase comsumption 50.0% increase diesel price 0.0%	Case 1	increase interest rate 2.9% increase comsumption 0.0% increase diesel price 0.0%	Case 2	increase interest rate 25% increase comsumption 50% increase diesel price 0%	Case 3	increase interest rate 25% increase comsumption 0% increase diesel price 0%	Case 4
Year				2009	2010 2011	2009	2010 2011	2009	2010 2011	2009	2010 2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month 50 US$/month	50 US$/month	50 US$/month 50 US$/month	50 US$/month	50 US$/month 50 US$/month	50 US$/month	50 US$/month 50 US$/month
			Number of Workers	2person	2person 2person	1person	1person 1person	2person	2person 2person	1person	1person 1person
			Worker Salary/year	**900 US$/year**	**900 US$/year 900 US$/year**	**600 US$/year**	**600 US$/year 600 US$/year**	**900 US$/year**	**900 US$/year 900 US$/year**	**600 US$/year**	**600 US$/year 600 US$/year**
		Repairing	Repair and maintenance costs/month	3 US$/month	3 US$/month 3 US$/month	2 US$/month	2 US$/month 2 US$/month	3 US$/month	3 US$/month 3 US$/month	2 US$/month	2 US$/month 2 US$/month
			Repair and maintenance costs/year	**36 US$/year**	**36 US$/year 36 US$/year**	**24 US$/year**	**24 US$/year 24 US$/year**	**36 US$/year**	**36 US$/year 36 US$/year**	**24 US$/year**	**24 US$/year 24 US$/year**
	Investment costs	Loan	Interest of loan($)/year	261 US$/year	261 US$/year 205 US$/year	261 US$/year	261 US$/year 249 US$/year	2250 US$/year	2250 US$/year 2758 US$/year	2250 US$/year	2250 US$/year 3142 US$/year
			Loan payback (2years)	0 US$/year	9000 US$/year 0 US$/year	0 US$/year	9000 US$/year 0 US$/year	0 US$/year	9000 US$/year 0 US$/year	0 US$/year	9000 US$/year 0 US$/year
		construction costs	Grid Cost	0 US$		0 US$		0 US$		0 US$	
			Machinery Cost(15Years)	9000 US$		9000 US$		9000 US$		9000 US$	
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	67 US$/month	67 US$/month 67 US$/month	67 US$/month	67 US$/month 67 US$/month	67 US$/month	67 US$/month 67 US$/month	67 US$/month	67 US$/month 67 US$/month
			Phone+accounting/year	**800 US$/year**	**800 US$/year 800 US$/year**	**800 US$/year**	**800 US$/year 800 US$/year**	**800 US$/year**	**800 US$/year 800 US$/year**	**800 US$/year**	**800 US$/year 800 US$/year**
Total operation costs/year				**10997 US$/year**	**10997 US$/year 1941 US$/year**	**10685 US$/year**	**10685 US$/year 1673 US$/year**	**12986 US$/year**	**12986 US$/year 4494 US$/year**	**12674 US$/year**	**12674 US$/year 4566 US$/year**
Incomes			Time of Machinery operation/day	17hours	17hours 17hours	11hours	11hours 11hours	17hours	17hours 17hours	11hours	11hours 11hours
			Average charging power kw	0.8	0.8 0.8	0.8	0.8 0.8	0.8	0.8 0.8	0.8	0.8 0.8
			PV generate the Electricity kw/day	13.2	13.2 13.2	8.8	8.8 8.8	13.2	13.2 13.2	8.8	8.8 8.8
		Batteries	Price for battery charging US$/battery	0.375 US$/battery	0.375 US$/battery 0.375 US$/battery	0.375 US$/battery	0.375 US$/battery 0.375 US$/battery	0.375 US$/battery	0.375 US$/battery 0.375 US$/battery	0.375 US$/battery	0.375 US$/battery 0.375 US$/battery
			Battery capacity AH	50Ah	50Ah 50Ah	50Ah	50Ah 50Ah	50Ah	50Ah 50Ah	50Ah	50Ah 50Ah
			Number of Battery/day	22batteries	22batteries 22batteries	14batteries	14batteries 14batteries	22batteries	22batteries 22batteries	14batteries	14batteries 14batteries
			Average battery charing kwh/day	**0.8Kwh/day**	**0.8Kwh/day 0.8Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day 0.6Kwh/day**	**0.8Kwh/day**	**0.8Kwh/day 0.8Kwh/day**	**0.6Kwh/day**	**0.6Kwh/day 0.6Kwh/day**
			Electric for all battery charing kwh/month	**545Kwh/month**	**545Kwh/month 545Kwh/month**	**231Kwh/month**	**231Kwh/month 231Kwh/month**	**545Kwh/month**	**545Kwh/month 545Kwh/month**	**231Kwh/month**	**231Kwh/month 231Kwh/month**
			Electricity price for all battery /month	**248 US$/month**	**248 US$/month 248 US$/month**	**158 US$/month**	**158 US$/month 158 US$/month**	**248 US$/month**	**248 US$/month 248 US$/month**	**158 US$/month**	**158 US$/month 158 US$/month**
			Sales revenue(US$/year)	**2970 US$/year**	**2970 US$/year 2970 US$/year**	**1890 US$/year**	**1890 US$/year 1890 US$/year**	**2970 US$/year**	**2970 US$/year 2970 US$/year**	**1890 US$/year**	**1890 US$/year 1890 US$/year**
Own investment ($)				0	0 0	0	0 0	0	0 0	0	0 0
Vat ($)				0	0 0	0	0 0	0	0 0	0	0 0
Loan interest(%) /month				0.24%	0.242% 0.242%	0.24%	0.242% 0.242%	2.08%	2.083% 2.083%	2.08%	2.083% 2.083%
Loan interest (%)/year				**2.90%**	**2.900% 2.900%**	**2.90%**	**2.900% 2.900%**	**25.00%**	**25.000% 25.000%**	**25.00%**	**25.000% 25.000%**
Loan form Bank($)				**9000 US$/year**	**7054 US$/year**	**9000 US$/year**	**8590 US$/year**	**9000 US$/year**	**11032 US$/year**	**9000 US$/year**	**12568 US$/year**
Total Gains				**11970 US$/year**	**2970 US$/year 10024 US$/year**	**10890 US$/year**	**1890 US$/year 10480 US$/year**	**11970 US$/year**	**2970 US$/year 14002 US$/year**	**10890 US$/year**	**1890 US$/year 14458 US$/year**
Net Annual Profit ($)				**973 US$/year**	**-8027 US$/year 8083 US$/year**	**205 US$/year**	**-8795 US$/year 8807 US$/year**	**-1016 US$/year**	**-10016 US$/year 9508 US$/year**	**-1784 US$/year**	**-10784 US$/year 9892 US$/year**
Cumulative Earnings				**973 US$/year**	**-7054 US$/year 1029 US$/year**	**205 US$/year**	**-8590 US$/year 217 US$/year**	**-1016 US$/year**	**-11032 US$/year -1524 US$/year**	**-1784 US$/year**	**-12568 US$/year -2676 US$/year**

Rank	1	2	3	4
	1	2 3	4	
	973.0000 US$/year	205.0000 US$/year -1016.0000 US$/year	-1784.0000 US$/year	

The change of Net Annual Profit (No.1: The best to No.4: The worst) is in the graphics below:



The cases of sensitivity analysis will be shown in the chart below from the Net Annual Profit No.1 (**Figure 34**) to the Net Annual Profit No.3 (**Figure 36**). The chart of Net Annual Profit No. 4 is the **Figure 33**.

Net Annual Profit No. 1:

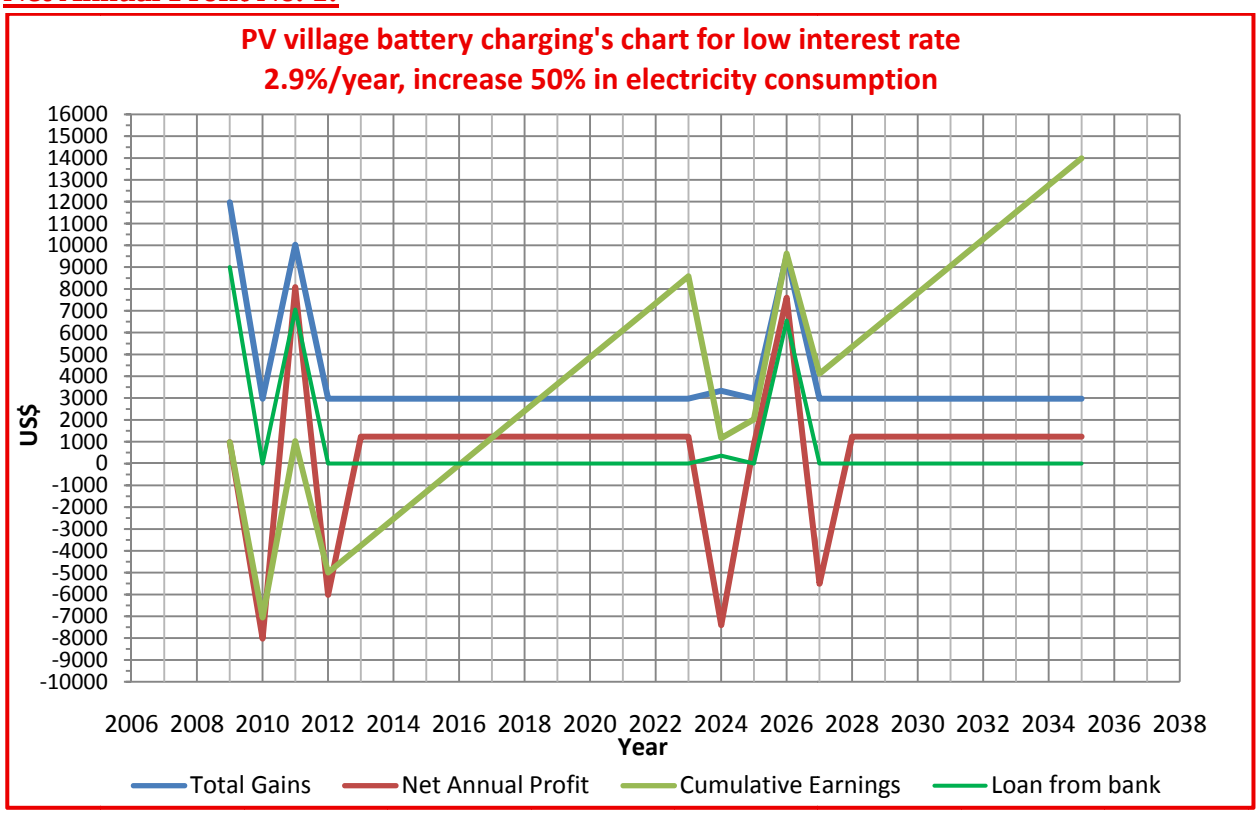


Figure 34: PV village battery charging's chart for low interest rate 2.9%/year, increase 50% in electricity consumption

Net Annual Profit No. 2:

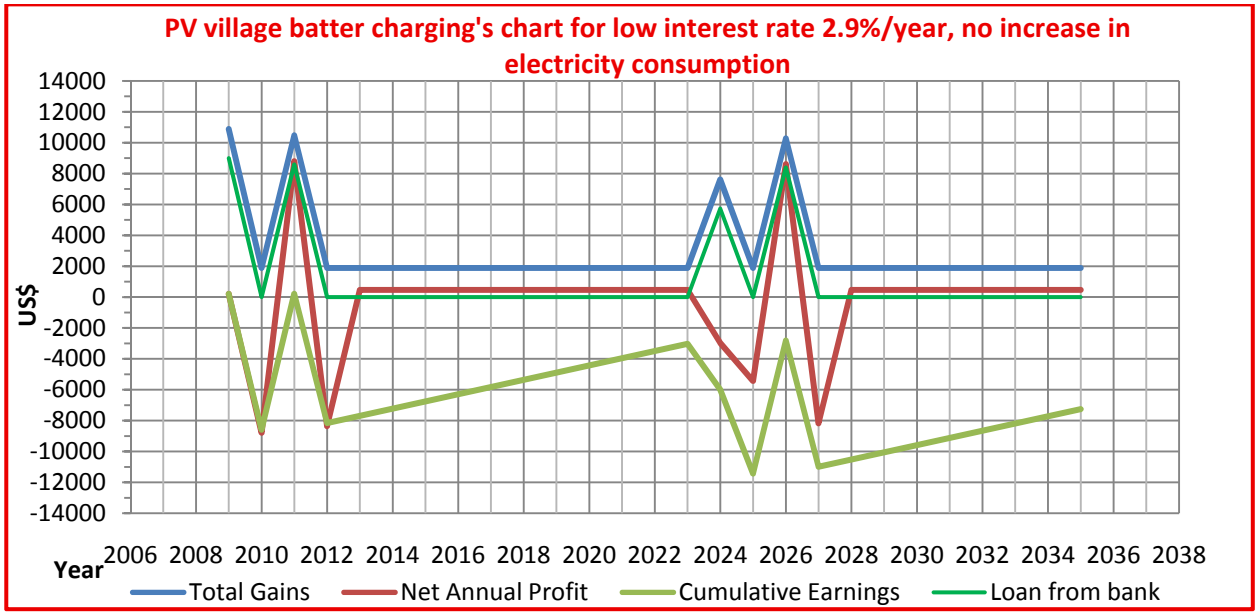


Figure 35: PV village batter charging's chart for low interest rate 2.9%/year, no increase in electricity consumption

Net Annual Profit No. 3:

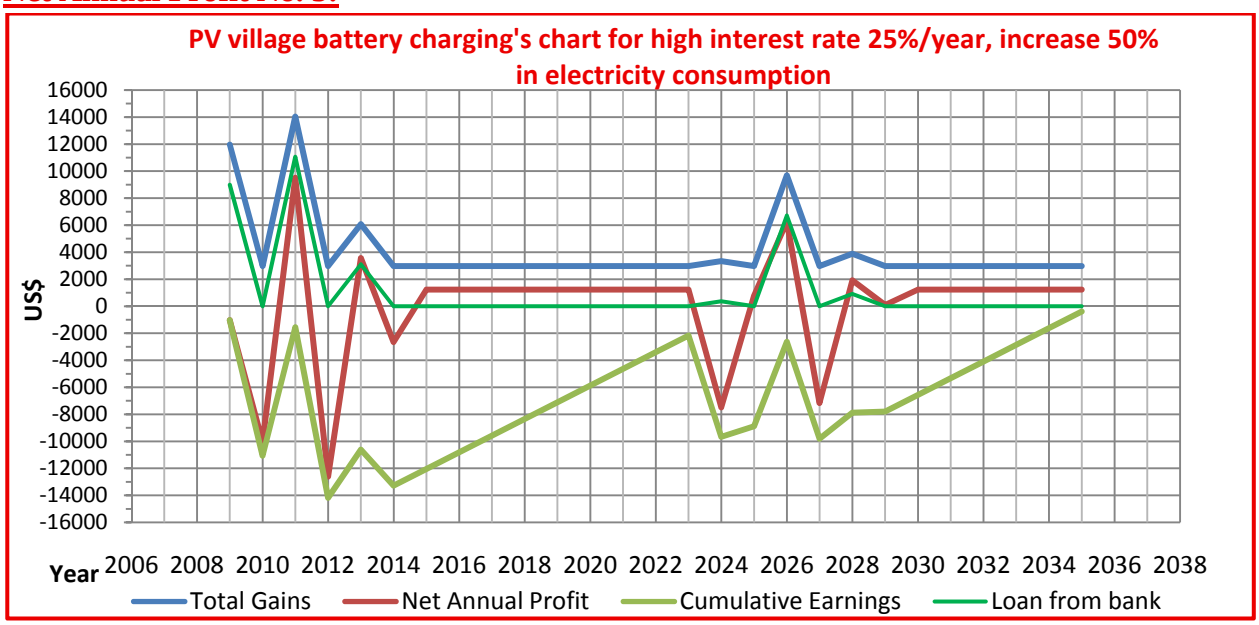


Figure 36: PV village battery charging's chart for high interest rate 25%/year, increase 50% in electricity consumption

III. Conclusion

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment. For our PV village battery charging, the year of Loan from bank started to remain zero is in the interval of 2013 and 2017.

The minimum year of Loan from bank started to remain zero is in year 2013 which is the case of the best Net Annual Profit No.1: Increase 50% in electricity consumption, Low Interest rate 2.9%. (**Figure 34**)

The maximum year of Loan from bank started to remain zero is in year 2017 which is the case of the worst Net Annual Profit No.4: No increase in electricity consumption, High Interest rate 25%. (**Figure 33**)

CHAPTER 3

HYDRO VILLAGE BATTERY CHARGING

I. Results

By using technology cost and performance data and methodology of calculation, we get the results in the **Table. 19: Results of Hydro village battery charging** and the chart below:

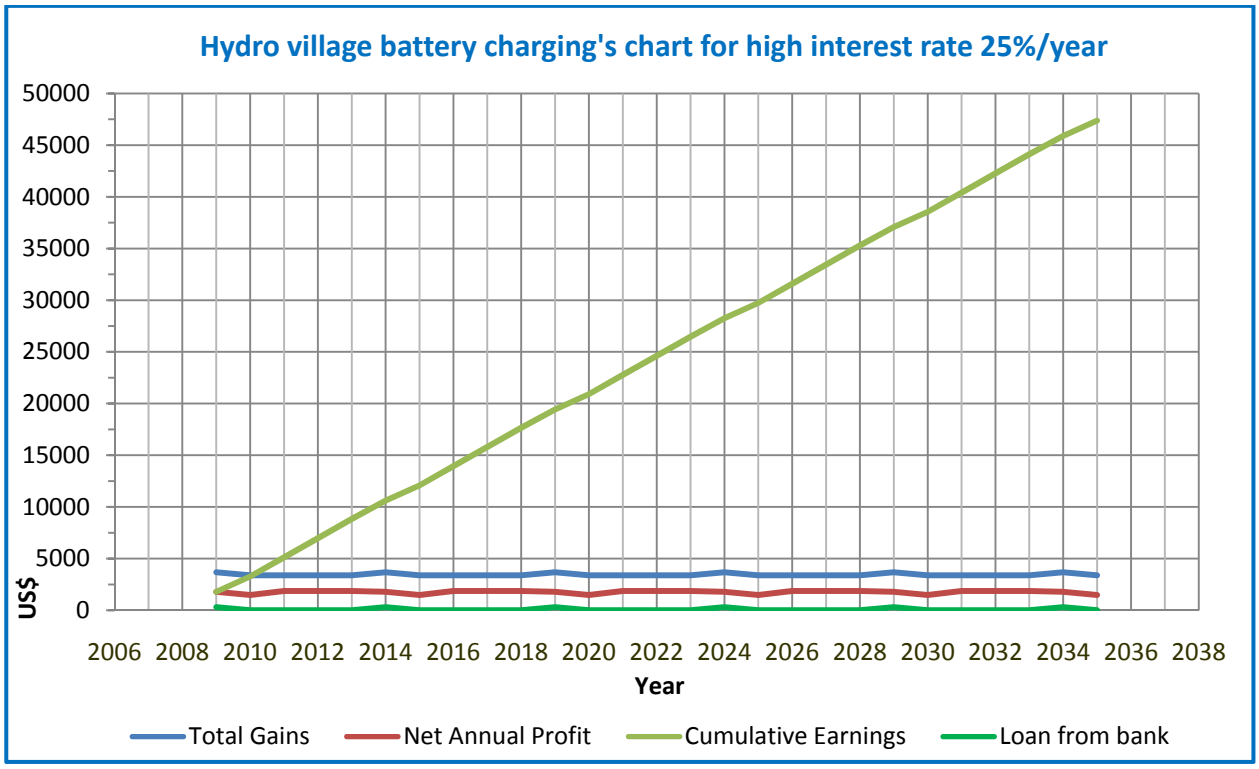


Figure 38: Hydro village battery charging's chart for high interest rate 25%/year

II. Sensitivity Analysis

For sensitivity analysis of our case study, Hydro village electrification, we analyze the following:

1. Analyze the impacts of changes in interest rate
2. Analyze the increase in electricity consumption
3. Analyze different combinations of changes 1. – 2. (4 cases)

Note: **The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.**

The results of different combinations of changes 1. – 2. are in the **Table. 20: The results of different combinations of changes of hydro village battery charging** which show all 4 cases during 3 years from 2009 to 2011.

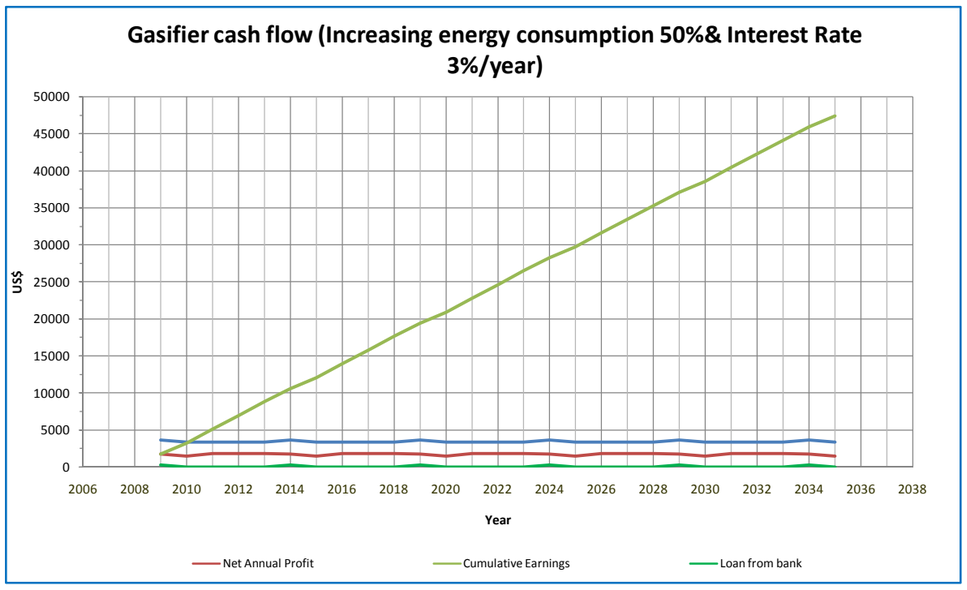
Table. 19: Results of Hydro village battery charging

increase interest rate 25%

increase consumption 0%

			Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
			Worker Salary/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
		Repairing	Repair and maintenance costs/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month
			Repair and maintenance costs/year	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**
	Investment costs	Loan	Interest of loan($)/year	76 US$/year	76 US$/year	0 US$/year	0 US$/year	0 US$/year	76 US$/year	76 US$/year	0 US$/year	0 US$/year	0 US$/year	76 US$/year	76 US$/year	0 US$/year
			Loan payback (2years)	0 US$/year	300 US$/year	0 US$/year	0 US$/year	0 US$/year	0 US$/year	300 US$/year	0 US$/year	0 US$/year	0 US$/year	0 US$/year	300 US$/year	0 US$/year
		construction costs	Grid Cost	0 US$												
			Pico hydro 250W unit	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$
			Machinery Cost(5Years)	**300 US$**					300 US$					300 US$		
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
			Phone+accounting/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
Total operation costs/year				**1896 US$/year**	**1896 US$/year**	**1520 US$/year**	**1520 US$/year**	**1520 US$/year**	**1896 US$/year**	**1896 US$/year**	**1520 US$/year**	**1520 US$/year**	**1520 US$/year**	**1896 US$/year**	**1896 US$/year**	**1520 US$/year**
Incomes			Time of Machinery operation/day	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours
			Number of unit	10units	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours
			Electricity produced kwh/month	**450Kwh/month**	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours
		Batteries	Price for battery charging US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries
			Electricity price for all battery /month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**
			Sales revenue(US$/year)	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**
Own invest ($)				0	0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Loan interest (%)/year				**25.20%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**
Loan from Bank($)				**300 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**300 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**300 US$/year**	**0 US$/year**	**0 US$/year**
Total Gains				**3675 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3675 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3675 US$/year**	**3375 US$/year**	**3375 US$/year**
Net Annual Profit				**1779 US$/year**	**1479 US$/year**	**1855 US$/year**	**1855 US$/year**	**1855 US$/year**	**1779 US$/year**	**1479 US$/year**	**1855 US$/year**	**1855 US$/year**	**1855 US$/year**	**1779 US$/year**	**1479 US$/year**	**1855 US$/year**
Cumulative Earnings				**1779 US$/year**	**3259 US$/year**	**5114 US$/year**	**6969 US$/year**	**8824 US$/year**	**10603 US$/year**	**12083 US$/year**	**13938 US$/year**	**15793 US$/year**	**17648 US$/year**	**19427 US$/year**	**20906 US$/year**	**22761 US$/year**

Note: Repair and maintenance costs/month = Number of unit * 1$, (1$ is the maintenance cost per unit).

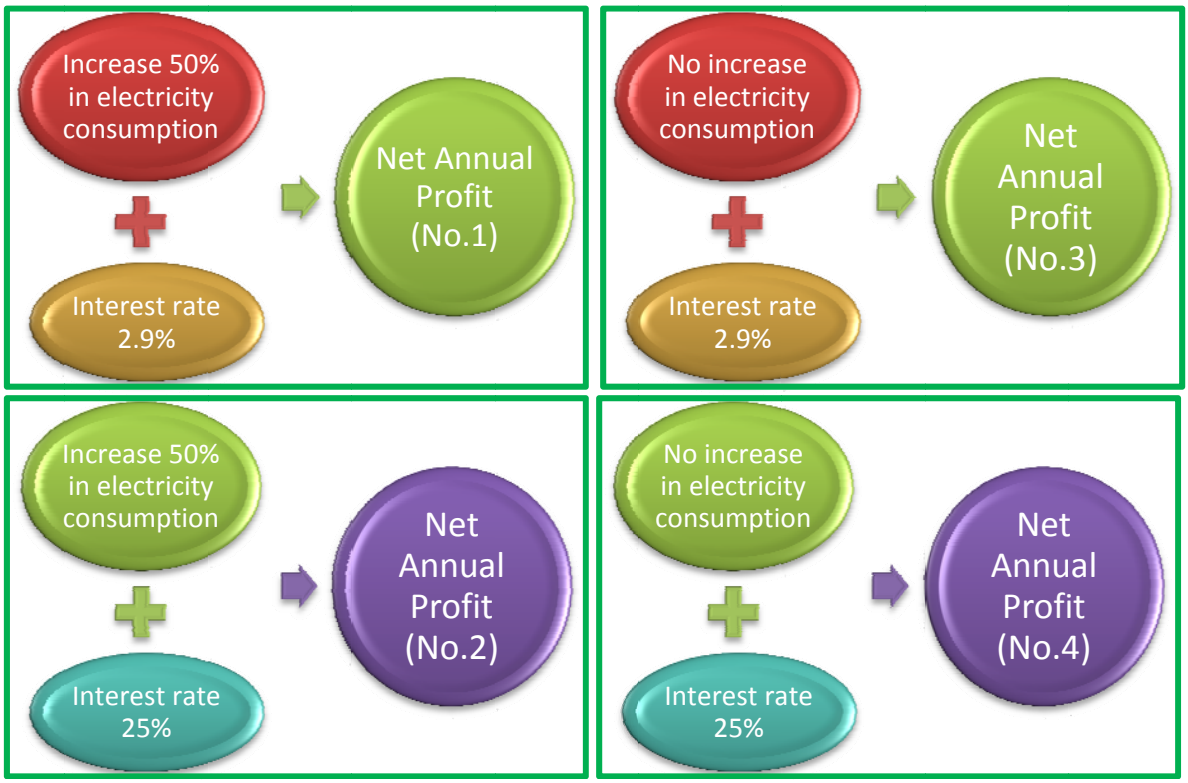

Gasifier cash flow (Increasing energy consumption 50%& Interest Rate 3%/year)
US$
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
Year
Net Annual Profit
Cumulative Earnings
Loan from bank

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
600 US$/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month	10 US$/month
120 US$/year	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**
0 US$/year	**0 US$/year**	**76 US$/year**	**76 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**76 US$/year**	**76 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**76 US$/year**	**76 US$/year**
0 US$/year	**0 US$/year**	**0 US$/year**	**300 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**300 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**300 US$/year**
30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$
		300 US$					300 US$					300 US$	
67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
800 US$/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
1520 US$/year	**1520 US$/year**	**1896 US$/year**	**1896 US$/year**	**1520 US$/year**	**1520 US$/year**	**1520 US$/year**	**1896 US$/year**	**1896 US$/year**	**1520 US$/year**	**1520 US$/year**	**1520 US$/year**	**1896 US$/year**	**1896 US$/year**
6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours
10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours
450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours	450hours
0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries
281 US$/month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**
3375 US$/year	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
25.200%	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**	**25.200%**
0 US$/year	**0 US$/year**	**300 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**300 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**0 US$/year**	**300 US$/year**	**0 US$/year**
3375 US$/year	**3375 US$/year**	**3675 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3675 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3675 US$/year**	**3375 US$/year**
1855 US$/year	**1855 US$/year**	**1779 US$/year**	**1479 US$/year**	**1855 US$/year**	**1855 US$/year**	**1855 US$/year**	**1779 US$/year**	**1479 US$/year**	**1855 US$/year**	**1855 US$/year**	**1855 US$/year**	**1779 US$/year**	**1479 US$/year**
24616 US$/year	**26471 US$/year**	**28251 US$/year**	**29730 US$/year**	**31585 US$/year**	**33440 US$/year**	**35295 US$/year**	**37075 US$/year**	**38554 US$/year**	**40409 US$/year**	**42264 US$/year**	**44119 US$/year**	**45898 US$/year**	**47378 US$/year**

Table. 20: The results of different combinations of changes of hydro village battery charging

				increase interest rate 2.9% increase comsumtion 50.0% increase diesel price 0.0%	Case 1	increase interest rate 2.9% increase comsumtion 0.0% increase diesel price 0.0%	Case 2	increase interest rate 25% increase comsumtion 50% increase diesel price 0%	Case 3	increase interest rate 25% increase comsumtion 0% increase diesel price 0%	Case 4
			Year	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	2person	2person	2person	1person	1person	1person	2person	2person	2person	1person	1person	1person
			Worker Salary/year	**900 US$/year**	**900 US$/year**	**900 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**900 US$/year**	**900 US$/year**	**900 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
		Repairing	Repair and maintenance costs/month	15 US$/month	15 US$/month	15 US$/month	10 US$/month	10 US$/month	10 US$/month	15 US$/month	15 US$/month	15 US$/month	10 US$/month	10 US$/month	10 US$/month
			Repair and maintenance costs/year	**180 US$/year**	**180 US$/year**	**180 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**	**180 US$/year**	**180 US$/year**	**180 US$/year**	**120 US$/year**	**120 US$/year**	**120 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**9 US$/year**	**9 US$/year**	**0 US$/year**	**9 US$/year**	**9 US$/year**	**0 US$/year**	**75 US$/year**	**75 US$/year**	**0 US$/year**	**75 US$/year**	**75 US$/year**	**0 US$/year**
			Loan payback (2years)	0 US$/year	300 US$/year	0 US$/year	0 US$/year	300 US$/year	0 US$/year	0 US$/year	300 US$/year	0 US$/year	0 US$/year	300 US$/year	0 US$/year
		construction costs	Grid Cost	0 US$			0 US$			0 US$			0 US$		
			Pico hydro 250W unit	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$	30 US$
			Machinery Cost(5Years)	**300 US$**			**300 US$**			**300 US$**			**300 US$**		
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
			Phone+accounting/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
Total operation costs/year				**2189 US$/year**	**2189 US$/year**	**1880 US$/year**	**1829 US$/year**	**1829 US$/year**	**1520 US$/year**	**2255 US$/year**	**2255 US$/year**	**1880 US$/year**	**1895 US$/year**	**1895 US$/year**	**1520 US$/year**
Incomes			Time of Machinery operation/day	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours	6hours
			Number of unit	10units	10hours	10hours	10units	10hours	10hours	10units	10hours	10hours	10units	10hours	10hours
			Electricity produced kwh/month	**450Kwh/month**	450hours	450hours	**450Kwh/month**	450hours	450hours	**450Kwh/month**	450hours	450hours	**450Kwh/month**	450hours	450hours
		Batteries	Price for battery charging US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
			Battery capacity AH	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah	50Ah
			Number of Battery/day	38batteries	38batteries	38batteries	25batteries	25batteries	25batteries	38batteries	38batteries	38batteries	25batteries	25batteries	25batteries
			Electricity price for all battery /month	**422 US$/month**	**422 US$/month**	**422 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**422 US$/month**	**422 US$/month**	**422 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**
			Sales revenue(US$/year)	**5063 US$/year**	**5063 US$/year**	**5063 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**5063 US$/year**	**5063 US$/year**	**5063 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**
Own investment ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
Loan interest (%)/year				**2.90%**	**2.900%**	**2.900%**	**2.90%**	**2.900%**	**2.900%**	**25.00%**	**25.000%**	**25.000%**	**25.00%**	**25.000%**	**25.000%**
Loan form Bank($)				**300 US$/year**		**0 US$/year**	**300 US$/year**		**0 US$/year**	**300 US$/year**		**0 US$/year**	**300 US$/year**		**0 US$/year**
Total Gains				**5363 US$/year**	**5063 US$/year**	**5063 US$/year**	**3675 US$/year**	**3375 US$/year**	**3375 US$/year**	**5363 US$/year**	**5063 US$/year**	**5063 US$/year**	**3675 US$/year**	**3375 US$/year**	**3375 US$/year**
Net Annual Profit ($)				**3174 US$/year**	**2874 US$/year**	**3183 US$/year**	**1846 US$/year**	**1546 US$/year**	**1855 US$/year**	**3108 US$/year**	**2808 US$/year**	**3183 US$/year**	**1780 US$/year**	**1480 US$/year**	**1855 US$/year**
Cumulative Earnings				**3174 US$/year**	**6048 US$/year**	**9230 US$/year**	**1846 US$/year**	**3393 US$/year**	**5248 US$/year**	**3108 US$/year**	**5915 US$/year**	**9098 US$/year**	**1780 US$/year**	**3260 US$/year**	**5115 US$/year**
Rank				1			3			2			4		

The change of Net Annual Profit (No.1: The best to No.4: The worst) is in the graphics below:



The cases of sensitivity analysis will be shown in the chart below from the Net Annual Profit No.1 (**Figure 39**) to the Net Annual Profit No.3 (**Figure 41**). The chart of Net Annual Profit No. 4 is the **Figure 38**.

Net Annual Profit No. 1:

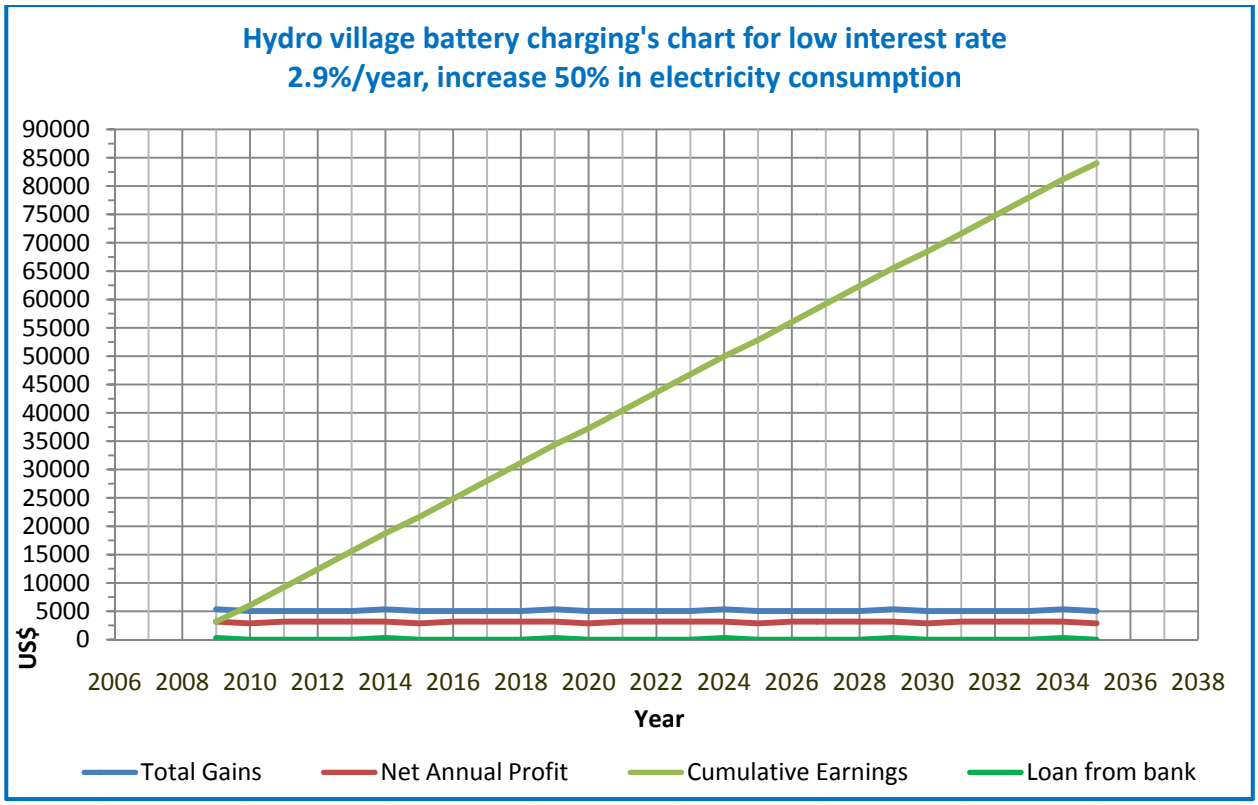


Figure 39: Hydro village battery charging's chart for low interest rate 2.9%/year, increase 50% in electricity consumption

Net Annual Profit No. 2:

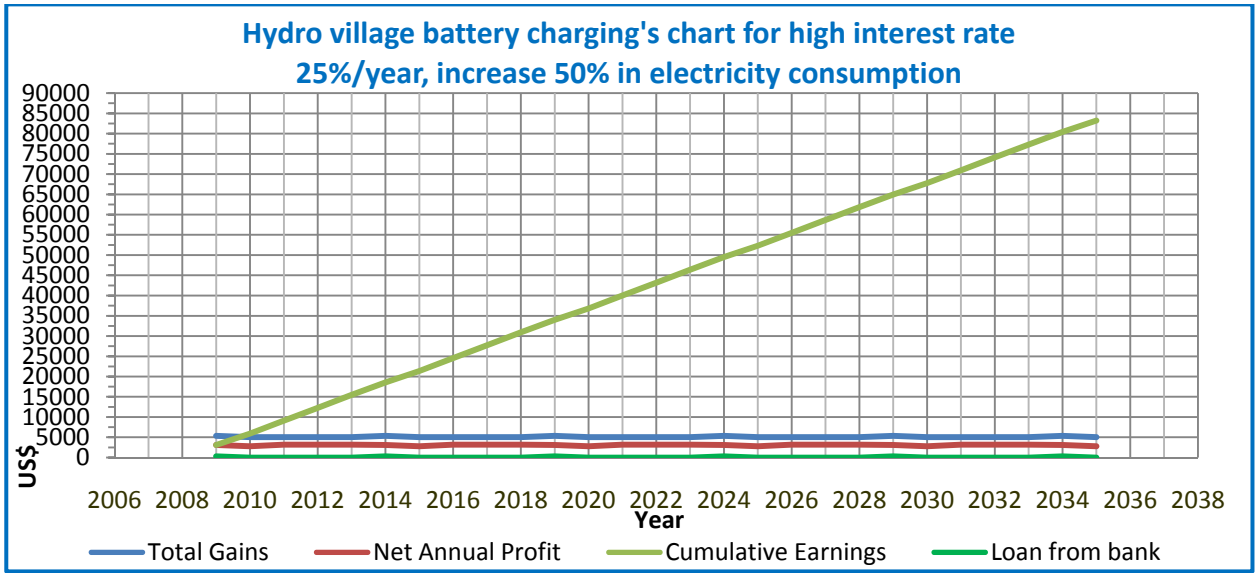


Figure 40: Hydro village battery charging's chart for high interest rate 25%/year, increase 50% in electricity consumption

Net Annual Profit No. 3:

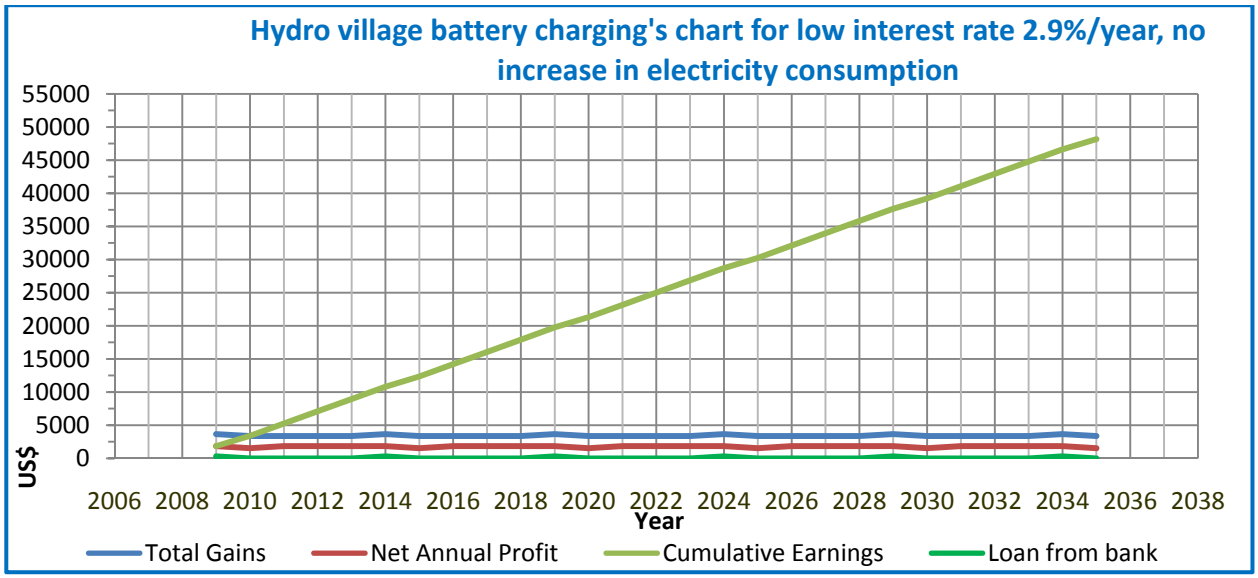


Figure 41: Hydro village battery charging's chart for low interest rate 2.9%/year, no increase in electricity consumption

III. Conclusion

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment. For our Hydro village battery charging, the year of Loan from bank started to remain zero is in 2010.

The best case of sensitivity analysis which Loan from bank started to remain zero is in year 2010 which is the case of the best Net Annual Profit No. 1: Increase 50% in electricity consumption, Low Interest rate 2.9%. (**Figure 39**)

The worst case of sensitivity analysis which Loan from bank started to remain zero is also in year 2010 which is the case of the worst Net Annual Profit No.4: No increase in electricity consumption, High Interest rate 25%. (**Figure 38**)

Even the best case and the fairly good case of sensitivity analysis which loan form bank equal to zero is in the same year 2012, the different of earning in US dollar of both case is quite high.

CHAPTER 4

DIESEL VILLAGE BATTERY CHARGING

I. Results

By using technology cost and performance data and methodology of calculation, we get the results in the **Table. 21: Results of Diesel village battery charging** and the chart below:

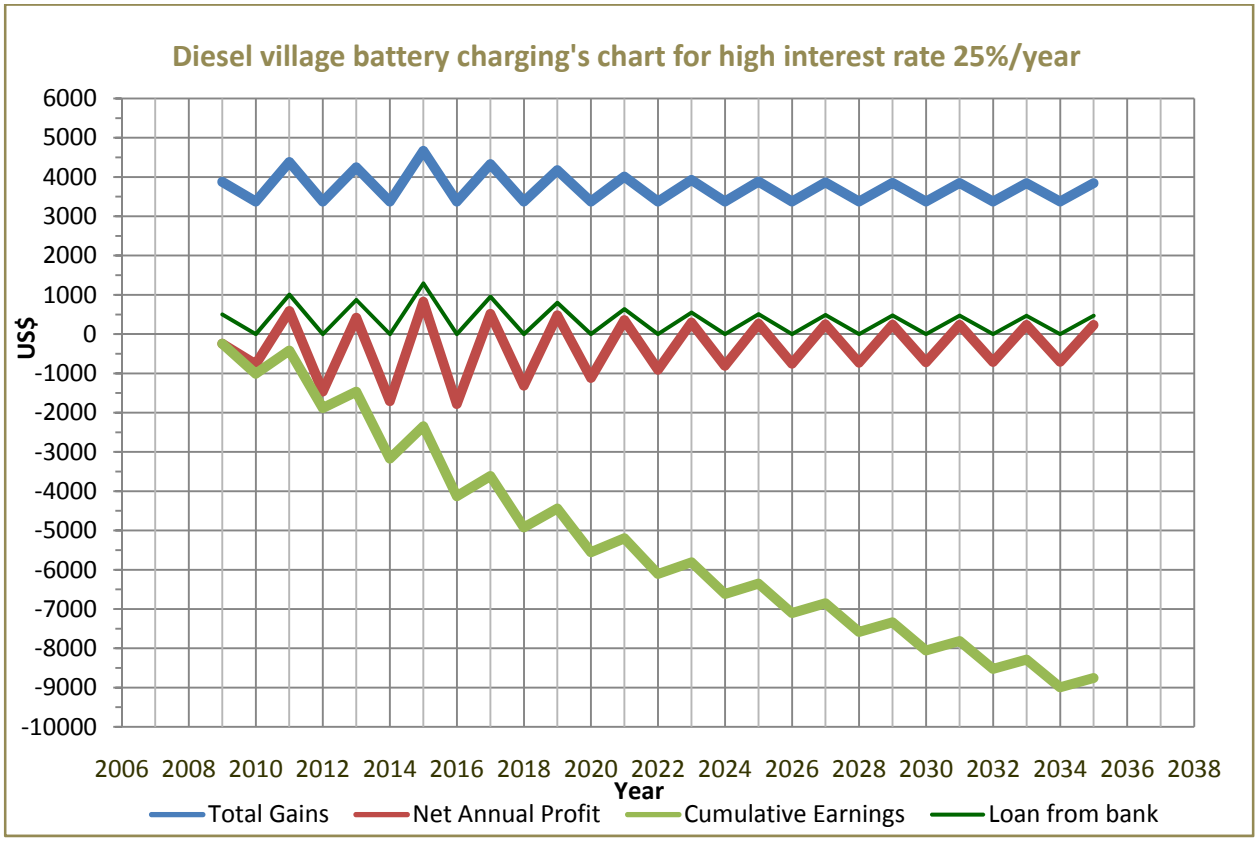


Figure 42: Diesel village battery charging's chart for high interest rate 25%/year

II. Sensitivity Analysis

For sensitivity analysis of our case study, Hydro village electrification, we analyze the following:

1. Analyze the impacts of changes in interest rate
2. Analyze the increase in electricity consumption
3. Analyze the impact of the change in diesel price and diesel generation efficiency
4. Analyze different combinations of changes 1. – 3. (8 cases)

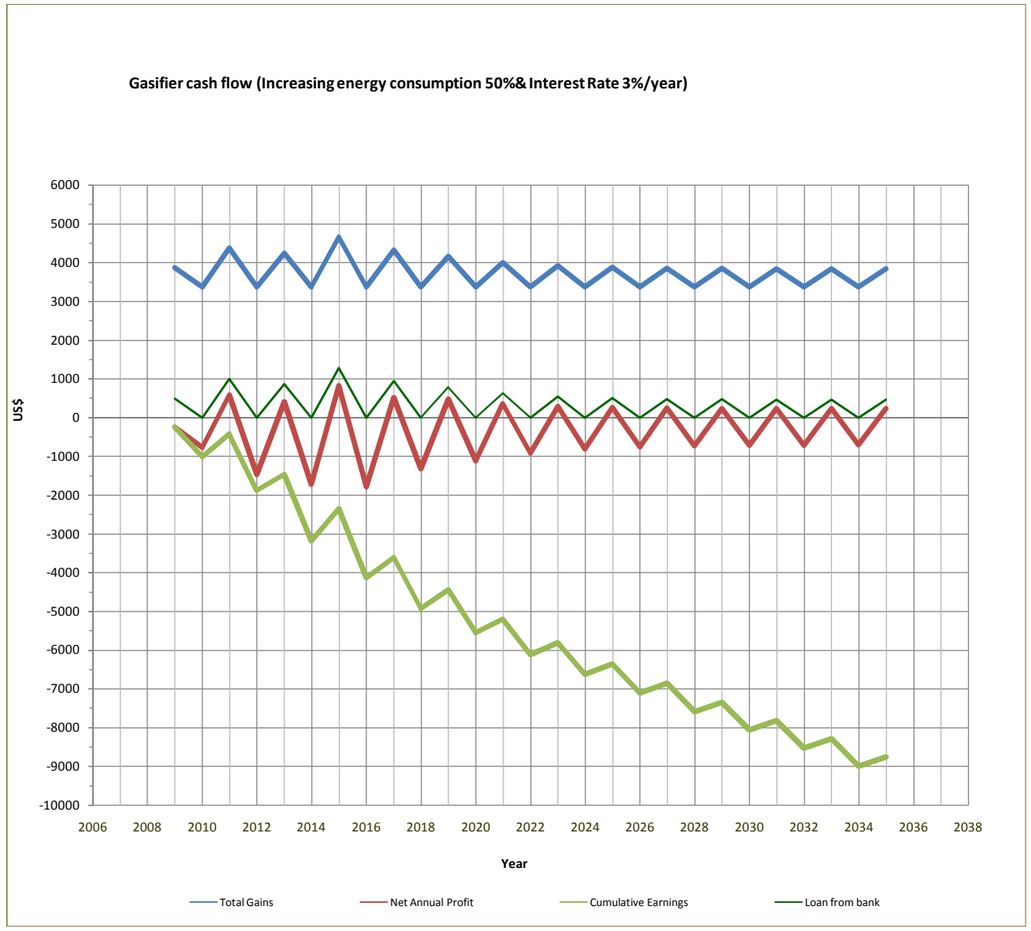
Note: **The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.**

The results of different combinations of changes 1. – 2. are in the **Table. 22: The results of different combinations of changes of diesel village battery charging** which show all 4 cases during 3 years from 2009 to 2011, by fixing the diesel generation efficiency 20%.

Table. 21: Results of Diesel village battery charging

Year				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
			Worker Salary/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
		Repairing	Repair and maintenance costs/month	5 US$/month	7 US$/month	9 US$/month	12 US$/month	15 US$/month	5 US$/month	7 US$/month	9 US$/month	12 US$/month	5 US$/month	5 US$/month	5 US$/month
			Repair and maintenance costs/year	**60 US$/year**	**84 US$/year**	**108 US$/year**	**144 US$/year**	**180 US$/year**	**60 US$/year**	**84 US$/year**	**108 US$/year**	**144 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**
		Diesel	Diesel payment /month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month
			Diesel payment /year	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	**126 US$/year**	**126 US$/year**	**254 US$/year**	**254 US$/year**	**220 US$/year**	**220 US$/year**	**325 US$/year**	**325 US$/year**	**241 US$/year**	**241 US$/year**	**201 US$/year**	**201 US$/year**
			Loan payback (2years)	**0 US$/year**	**500 US$/year**	**0 US$/year**	**1008 US$/year**	**0 US$/year**	**872 US$/year**	**0 US$/year**	**1291 US$/year**	**0 US$/year**	**955 US$/year**	**0 US$/year**	**797 US$/year**
		construction costs	Grid Cost	0 US$											
			Machinery(1.5 kw)Cost+ inverter(5Years)	500 US$					500 US$						
Fixed costs	Customer service costs	Phone + Accounting	Phone+accounting/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
			Phone+accounting/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
Total operation costs/year				**4117 US$/year**	**4141 US$/year**	**3793 US$/year**	**4837 US$/year**	**3831 US$/year**	**5082 US$/year**	**3840 US$/year**	**5155 US$/year**	**3815 US$/year**	**4686 US$/year**	**3692 US$/year**	**4489 US$/year**
Incomes			Time of Machinery operation/day	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours
			Diesel Generate the electric power kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day
		Batteries	Price for battery charging US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
			Number of Battery/day	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries
			Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**
			Electricity price for all battery /month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**
			Sales revenue(US$/year)	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**
Own invest ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Loan interest (%)/year				**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**
Loan from Bank($)				**500 US$/year**	**0 US$/year**	**1008 US$/year**	**0 US$/year**	**872 US$/year**	**0 US$/year**	**1291 US$/year**	**0 US$/year**	**955 US$/year**	**0 US$/year**	**797 US$/year**	**0 US$/year**
Total Gains				**3875 US$/year**	**3375 US$/year**	**4383 US$/year**	**3375 US$/year**	**4247 US$/year**	**3375 US$/year**	**4666 US$/year**	**3375 US$/year**	**4330 US$/year**	**3375 US$/year**	**4172 US$/year**	**3375 US$/year**
Net Annual Profit				**-242 US$/year**	**-766 US$/year**	**590 US$/year**	**-1462 US$/year**	**416 US$/year**	**-1707 US$/year**	**826 US$/year**	**-1780 US$/year**	**514 US$/year**	**-1311 US$/year**	**480 US$/year**	**-1114 US$/year**
Cumulative Earnings				**-242 US$/year**	**-1008 US$/year**	**-418 US$/year**	**-1879 US$/year**	**-1463 US$/year**	**-3171 US$/year**	**-2345 US$/year**	**-4125 US$/year**	**-3611 US$/year**	**-4922 US$/year**	**-4442 US$/year**	**-5555 US$/year**

Note: The efficiency of the diesel machine is fixed, 20%.


Gasifier cash flow (Increasing energy consumption 50%& Interest Rate 3%/year)
US$
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000
-10000
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
Year
Total Gains
Net Annual Profit
Cumulative Earnings
Loan from bank

2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person	1person
600 US$/year	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month
60 US$/year	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**
169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month	169 US$/month
2031 US$/year	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**
160 US$/year	**160 US$/year**	**139 US$/year**	**139 US$/year**	**128 US$/year**	**128 US$/year**	**123 US$/year**	**123 US$/year**	**120 US$/year**	**120 US$/year**	**119 US$/year**	**119 US$/year**	**118 US$/year**	**118 US$/year**	**118 US$/year**
0 US$/year	**633 US$/year**	**0 US$/year**	**551 US$/year**	**0 US$/year**	**509 US$/year**	**0 US$/year**	**489 US$/year**	**0 US$/year**	**478 US$/year**	**0 US$/year**	**473 US$/year**	**0 US$/year**	**470 US$/year**	**0 US$/year**
67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
800 US$/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
3651 US$/year	**4284 US$/year**	**3630 US$/year**	**4181 US$/year**	**3619 US$/year**	**4129 US$/year**	**3614 US$/year**	**4103 US$/year**	**3611 US$/year**	**4089 US$/year**	**3610 US$/year**	**4083 US$/year**	**3609 US$/year**	**4079 US$/year**	**3609 US$/year**
10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours
15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day
0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries
0.60Kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
450Kwh/month	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**
281 US$/month	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**
3375 US$/year	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
25%	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**
633 US$/year	**0 US$/year**	**551 US$/year**	**0 US$/year**	**509 US$/year**	**0 US$/year**	**489 US$/year**	**0 US$/year**	**478 US$/year**	**0 US$/year**	**473 US$/year**	**0 US$/year**	**470 US$/year**	**0 US$/year**	**469 US$/year**
4008 US$/year	**3375 US$/year**	**3926 US$/year**	**3375 US$/year**	**3884 US$/year**	**3375 US$/year**	**3864 US$/year**	**3375 US$/year**	**3853 US$/year**	**3375 US$/year**	**3848 US$/year**	**3375 US$/year**	**3845 US$/year**	**3375 US$/year**	**3844 US$/year**
358 US$/year	**-909 US$/year**	**296 US$/year**	**-806 US$/year**	**265 US$/year**	**-754 US$/year**	**250 US$/year**	**-728 US$/year**	**242 US$/year**	**-714 US$/year**	**238 US$/year**	**-708 US$/year**	**236 US$/year**	**-704 US$/year**	**235 US$/year**
-5197 US$/year	**-6106 US$/year**	**-5810 US$/year**	**-6616 US$/year**	**-6351 US$/year**	**-7104 US$/year**	**-6855 US$/year**	**-7582 US$/year**	**-7341 US$/year**	**-8055 US$/year**	**-7817 US$/year**	**-8525 US$/year**	**-8289 US$/year**	**-8994 US$/year**	**-8759 US$/year**

Diesel fuel cost Calculation		
	Energy contain(MWh/ton)	11.8
	Desity of diesel(ton/m³)	0.845
	Energy contain per litre MWh/m³=KWh/littre	9.971
	Price per liter(US$/litter)	0.75
	Diesel price per energy (US$/kWh)	0.075
	Electricity price per energy (US$/KWh)	0.376

Machinary Feature		
	Capacity Of Machine(KWh)	5
	Time Operation (hours)	12hours
	Efficiecy of the diesel machine	20%
	Electricity operation /day (Khw/day)	60
	Electricity operation price per day energy (US$/kwh/day)	22.56543978

Table. 22: The results of different combinations of changes of diesel village battery charging

				increase interest rate 2.9% increase comsumption 50.0% increase diesel price 0.0%	Case 1	increase interest rate 2.9% increase comsumption 50.0% increase diesel price 50.0%	Case 2	increase interest rate 2.9% increase comsumption 0.0% increase diesel price 0.0%	Case 3	increase interest rate 2.9% increase comsumption 0.0% increase diesel price 50.0%	Case 4
Year				2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Variable costs	Operating &Maintenance costs	Worker	Personal salary /month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
			Number of Workers	2person	2person	2person	2person	2person	2person	1person	1person	1person	1person	1person	1person
			Worker Salary/year	**900 US$/year**	**900 US$/year**	**900 US$/year**	**900 US$/year**	**900 US$/year**	**900 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**	**600 US$/year**
		Repairing	Repair and maintenance costs/month	8 US$/month	8 US$/month	8 US$/month	8 US$/month	8 US$/month	8 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month
			Repair and maintenance costs/year	**90 US$/year**	**90 US$/year**	**90 US$/year**	**90 US$/year**	**90 US$/year**	**90 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**	**60 US$/year**
	Fuel	Diesel	Diesel payment /month	254 US$/month	254 US$/month	254 US$/month	381 US$/month	381 US$/month	381 US$/month	169 US$/month	169 US$/month	169 US$/month	254 US$/month	254 US$/month	254 US$/month
			Diesel payment /year	**3046 US$/year**	**3046 US$/year**	**3046 US$/year**	**4570 US$/year**	**4570 US$/year**	**4570 US$/year**	**2031 US$/year**	**2031 US$/year**	**2031 US$/year**	**3046 US$/year**	**3046 US$/year**	**3046 US$/year**
	Investment costs	Loan	**Interest of loan($)/year**	15 US$/year	15 US$/year	2 US$/year	15 US$/year	15 US$/year	91 US$/year	15 US$/year	15 US$/year	22 US$/year	15 US$/year	15 US$/year	81 US$/year
			Loan payback (2years)	0 US$/year	500 US$/year	0 US$/year	0 US$/year	500 US$/year	0 US$/year	0 US$/year	500 US$/year	0 US$/year	0 US$/year	500 US$/year	0 US$/year
Fixed costs		construction costs	Grid Cost	0 US$			0 US$			0 US$			0 US$		
			Machinery(1.5 kw)Cost+ inverter(5Years)	500 US$			500 US$			500 US$			500 US$		
	Customer service costs	Phone + Accounting	Phone+accounting/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
			Phone+accounting/year	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**	**800 US$/year**
Total operation costs/year				**5351 US$/year**	**5351 US$/year**	**4839 US$/year**	**6874 US$/year**	**6874 US$/year**	**6450 US$/year**	**4005 US$/year**	**4005 US$/year**	**3513 US$/year**	**5021 US$/year**	**5021 US$/year**	**4587 US$/year**
Incomes			Time of Machinery operation/day	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours
			Diesel Generate the electric power	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day
		Batteries	Price for battery charging US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
			Number of Battery/day	38batteries	38batteries	38batteries	38batteries	38batteries	38batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries
			Electric for one battery charing kwh/day	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**	**0.60Kwh/day**
			Electric for all battery charing kwh/month	**675Kwh/month**	**675Kwh/month**	**675Kwh/month**	**675Kwh/month**	**675Kwh/month**	**675Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**	**450Kwh/month**
			Electricity price for all battery /month	**422 US$/month**	**422 US$/month**	**422 US$/month**	**422 US$/month**	**422 US$/month**	**422 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**	**281 US$/month**
			Sales revenue(US$/year)	**5063 US$/year**	**5063 US$/year**	**5063 US$/year**	**5063 US$/year**	**5063 US$/year**	**5063 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**	**3375 US$/year**
Own investment ($)				0	0	0	0	0	0	0	0	0	0	0	0
Vat ($)				0	0	0	0	0	0	0	0	0	0	0	0
Loan interest(%) /month				0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%	0.242%
Loan interest (%)/year				**2.90%**	**2.900%**	**2.900%**	**2.90%**	**2.900%**	**2.900%**	**2.90%**	**2.900%**	**2.900%**	**2.90%**	**2.900%**	**2.900%**
Loan form Bank($)				**500 US$/year**	**0 US$/year**	**77 US$/year**	**500 US$/year**	**0 US$/year**	**3123 US$/year**	**500 US$/year**	**0 US$/year**	**761 US$/year**	**500 US$/year**	**0 US$/year**	**2792 US$/year**
Total Gains				**5563 US$/year**	**5063 US$/year**	**5139 US$/year**	**5563 US$/year**	**5063 US$/year**	**8186 US$/year**	**3875 US$/year**	**3375 US$/year**	**4136 US$/year**	**3875 US$/year**	**3375 US$/year**	**6167 US$/year**
Net Annual Profit ($)				**212 US$/year**	**-288 US$/year**	**301 US$/year**	**-1312 US$/year**	**-1812 US$/year**	**1735 US$/year**	**-130 US$/year**	**-630 US$/year**	**623 US$/year**	**-1146 US$/year**	**-1646 US$/year**	**1579 US$/year**
Cumulative Earnings				**212 US$/year**	**-77 US$/year**	**224 US$/year**	**-1312 US$/year**	**-3123 US$/year**	**-1388 US$/year**	**-130 US$/year**	**-761 US$/year**	**-138 US$/year**	**-1146 US$/year**	**-2792 US$/year**	**-1212 US$/year**
Rank				1			7			3			5		

increase interest rate	25%		increase interest rate	25%		increase interest rate	25%		increase interest rate	25%	
increase comsumption	50%		increase comsumption	50%		increase comsumption	0%		increase comsumption	0%	
increase diesel price	0%	Case 5	increase diesel price	50%	Case 6	increase diesel price	0%	Case 7	increase diesel price	50%	Case 8
2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month	50 US$/month
2person	2person	2person	2person	2person	2person	1person	1person	1person	1person	1person	1person
900 US$/year	900 US$/year	900 US$/year	900 US$/year	900 US$/year	900 US$/year	600 US$/year	600 US$/year	600 US$/year	600 US$/year	600 US$/year	600 US$/year
8 US$/month	8 US$/month	8 US$/month	8 US$/month	8 US$/month	8 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month	5 US$/month
90 US$/year	90 US$/year	90 US$/year	90 US$/year	90 US$/year	90 US$/year	60 US$/year	60 US$/year	60 US$/year	60 US$/year	60 US$/year	60 US$/year
254 US$/month	254 US$/month	254 US$/month	381 US$/month	381 US$/month	381 US$/month	169 US$/month	169 US$/month	169 US$/month	254 US$/month	254 US$/month	254 US$/month
3046 US$/year	3046 US$/year	3046 US$/year	4570 US$/year	4570 US$/year	4570 US$/year	2031 US$/year	2031 US$/year	2031 US$/year	3046 US$/year	3046 US$/year	3046 US$/year
125 US$/year	125 US$/year	74 US$/year	125 US$/year	125 US$/year	836 US$/year	125 US$/year	125 US$/year	245 US$/year	125 US$/year	125 US$/year	753 US$/year
0 US$/year	500 US$/year	0 US$/year	0 US$/year	500 US$/year	0 US$/year	0 US$/year	500 US$/year	0 US$/year	0 US$/year	500 US$/year	0 US$/year
0 US$			0 US$			0 US$			0 US$		
500 US$			500 US$			500 US$			500 US$		
67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month	67 US$/month
800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year	800 US$/year
5461 US$/year	5461 US$/year	4911 US$/year	6985 US$/year	6985 US$/year	7196 US$/year	4116 US$/year	4116 US$/year	3736 US$/year	5131 US$/year	5131 US$/year	5260 US$/year
10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours	10hours
15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day	15.00Kwh/day
0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery	0.375 US$/battery
38batteries	38batteries	38batteries	38batteries	38batteries	38batteries	25batteries	25batteries	25batteries	25batteries	25batteries	25batteries
0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day	0.60Kwh/day
675Kwh/month	675Kwh/month	675Kwh/month	675Kwh/month	675Kwh/month	675Kwh/month	450Kwh/month	450Kwh/month	450Kwh/month	450Kwh/month	450Kwh/month	450Kwh/month
422 US$/month	422 US$/month	422 US$/month	422 US$/month	422 US$/month	422 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month	281 US$/month
5063 US$/year	5063 US$/year	5063 US$/year	5063 US$/year	5063 US$/year	5063 US$/year	3375 US$/year	3375 US$/year	3375 US$/year	3375 US$/year	3375 US$/year	3375 US$/year
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%	2.083%
25.00%	25.000%	25.000%	25.00%	25.000%	25.000%	25.00%	25.000%	25.000%	25.00%	25.000%	25.000%
500 US$/year	0 US$/year	298 US$/year	500 US$/year	0 US$/year	3344 US$/year	500 US$/year	0 US$/year	982 US$/year	500 US$/year	0 US$/year	3013 US$/year
5563 US$/year	5063 US$/year	5360 US$/year	5563 US$/year	5063 US$/year	8407 US$/year	3875 US$/year	3375 US$/year	4357 US$/year	3875 US$/year	3375 US$/year	6388 US$/year
101 US$/year	-399 US$/year	449 US$/year	-1422 US$/year	-1922 US$/year	1211 US$/year	-241 US$/year	-741 US$/year	620 US$/year	-1256 US$/year	-1756 US$/year	1128 US$/year
101 US$/year	-298 US$/year	152 US$/year	-1422 US$/year	-3344 US$/year	-2133 US$/year	-241 US$/year	-982 US$/year	-361 US$/year	-1256 US$/year	-3013 US$/year	-1885 US$/year

2	8	4	6

Diesel fuel cost Calcula

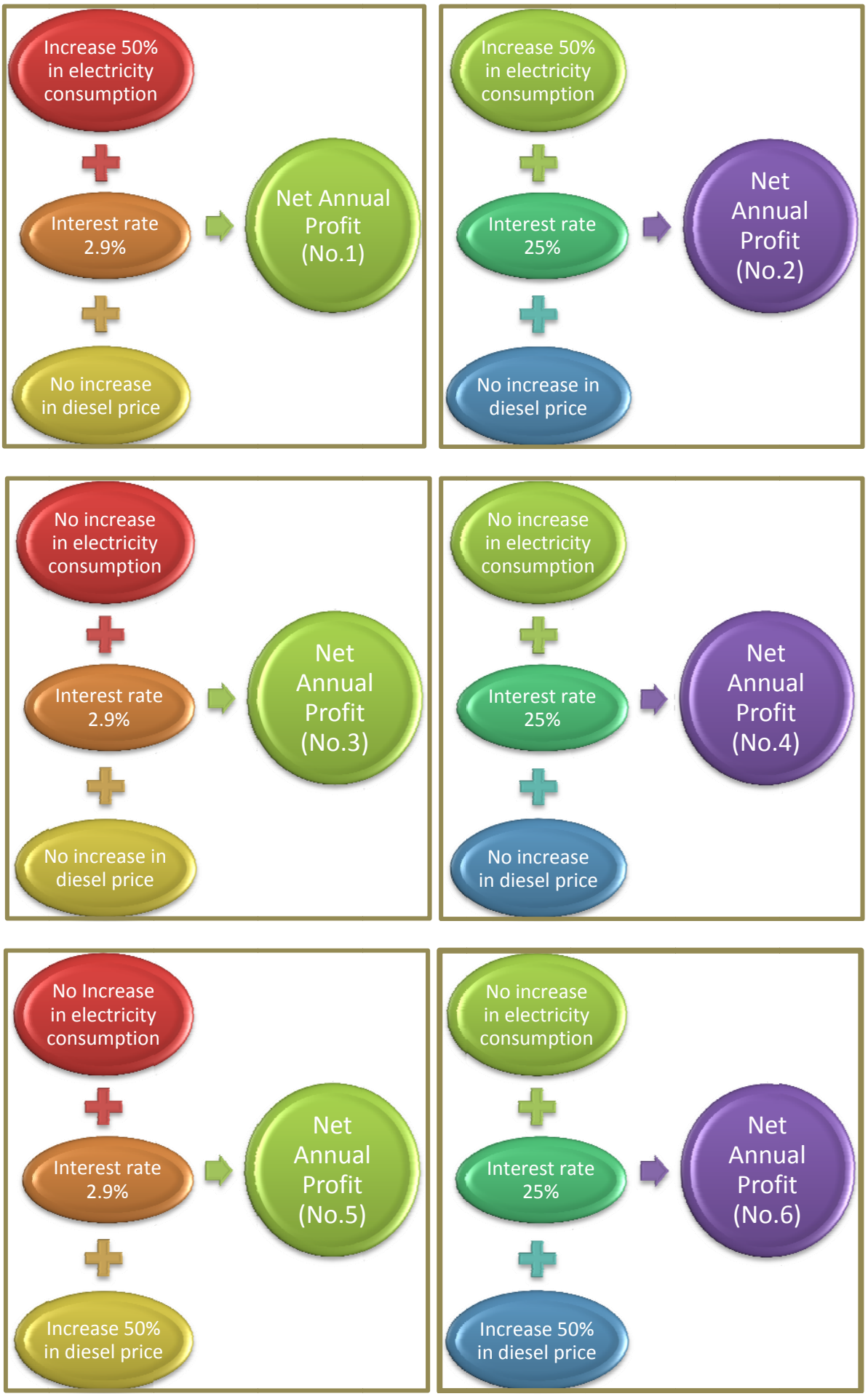
Energy contain(MWh/ton)	11.8
Desity of diesel(ton/m³)	0.845
Energy contain per litre MWh/m³=KWh/littre	9.971
Price per liter(US$/litter)	0.75
Diesel price per energy (US$/kWh)	0.075
Electricity price per energy (US$/KWh)	0.376

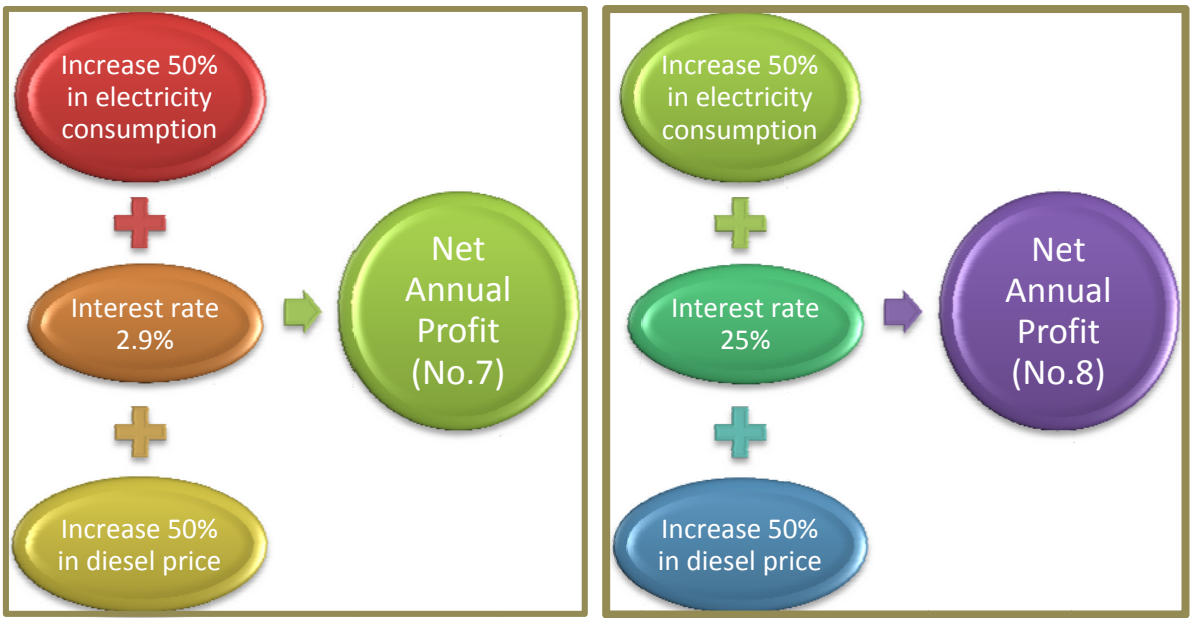
Machinary Feature

Capacity Of Machine(KWh)	5
Time Operation (hours)	12hours
Efficiecy of the diesel machine	20%
Electricity operation /day	60
Electricity operation price per day energy (US$/kwh/day)	22.56544

1	2	3	4	5	6	7	8
11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
0.845	0.845	0.845	0.845	0.845	0.845	0.845	0.845
9.971	9.971	9.971	9.971	9.971	9.971	9.971	9.971
0.75	1.125	0.75	1.125	0.75	1.125	0.75	1.125
0.075	0.113	0.075	0.113	0.075	0.113	0.075	0.113
0.376	0.564	0.376	0.564	0.376	0.564	0.376	0.564

The change of Net Annual Profit (No.1: The best to No.8: The worst) is in the graphics below:





The cases of sensitivity analysis will be shown in the chart below from the Net Annual Profit No.1 (**Figure 43**) to the Net Annual Profit No.8 (**Figure 50**).

Net Annual Profit No. 1:

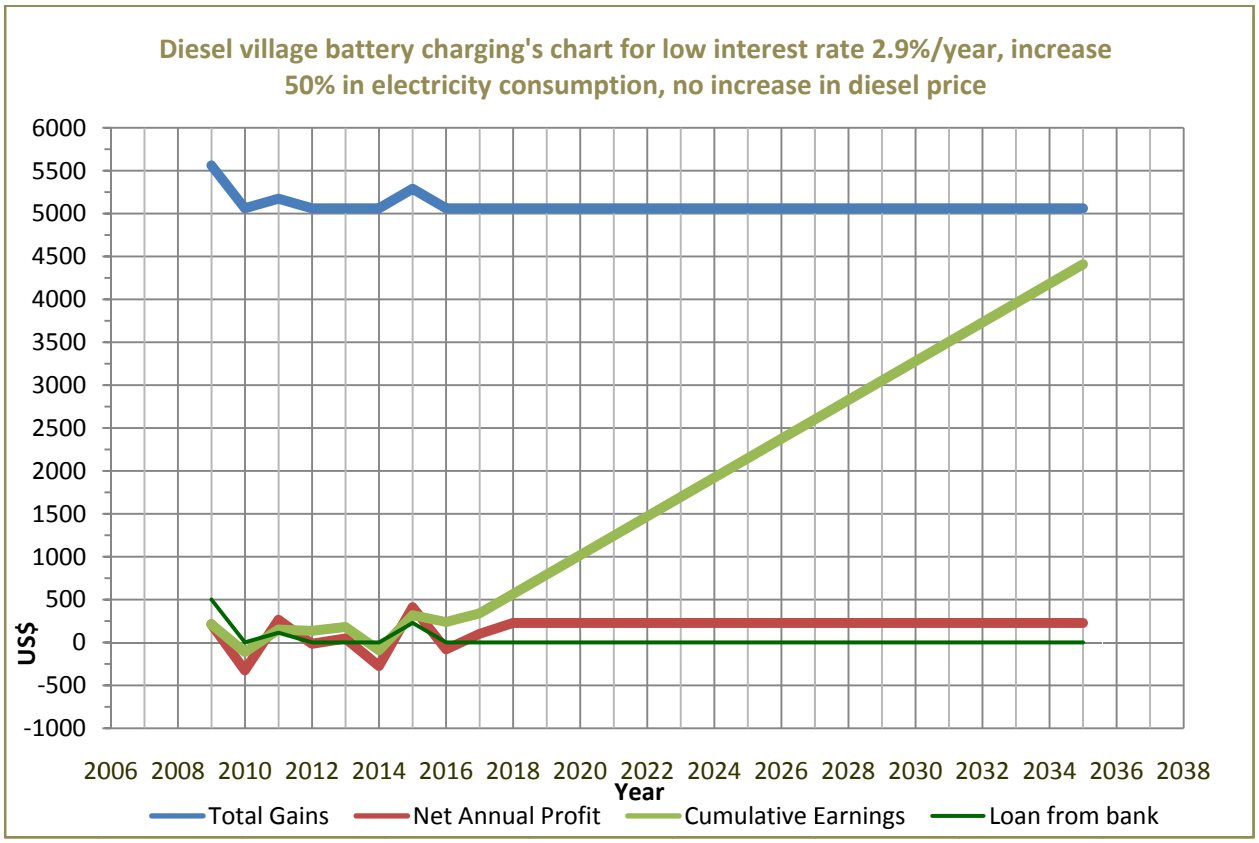


Figure 43: Diesel village battery charging's chart for low interest rate 2.9%/year, increase 50% in electricity consumption, no increase in diesel price

Net Annual Profit No. 2:

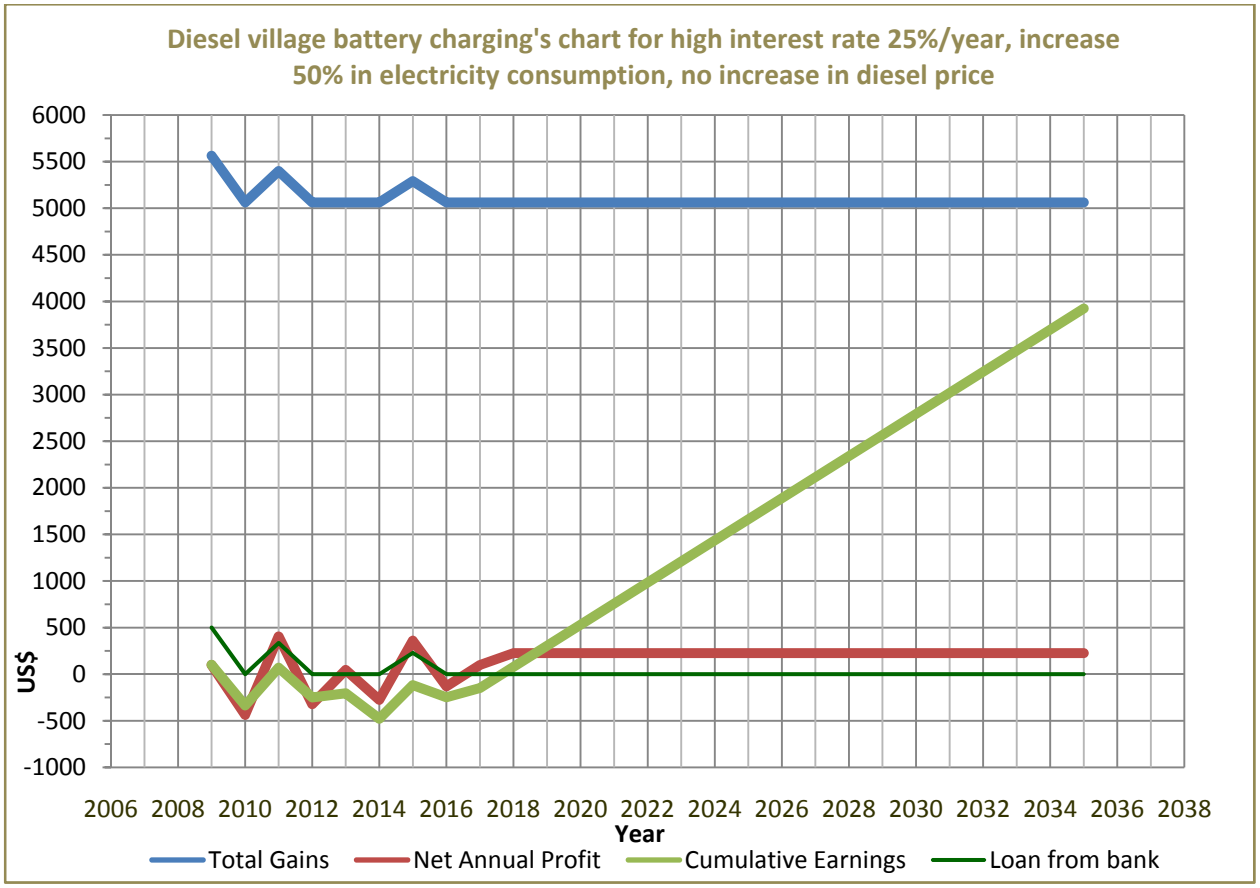


Figure 44: Diesel village battery charging's chart for high interest rate 25%/year, increase 50% in electricity consumption, no increase in diesel price

Net Annual Profit No. 3:

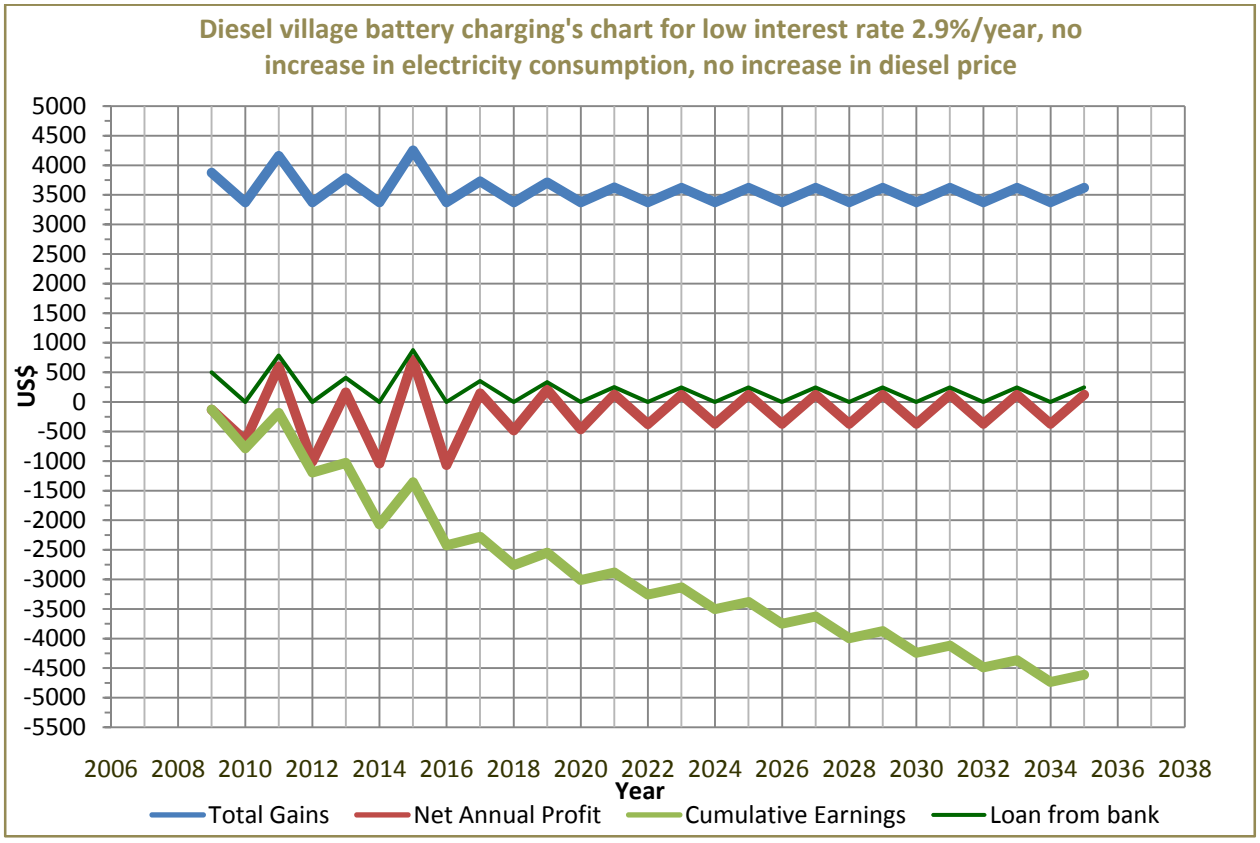


Figure 45: Diesel village battery charging's chart for low interest rate 2.9%/year, no increase in electricity consumption, no increase in diesel price

Net Annual Profit No. 4:

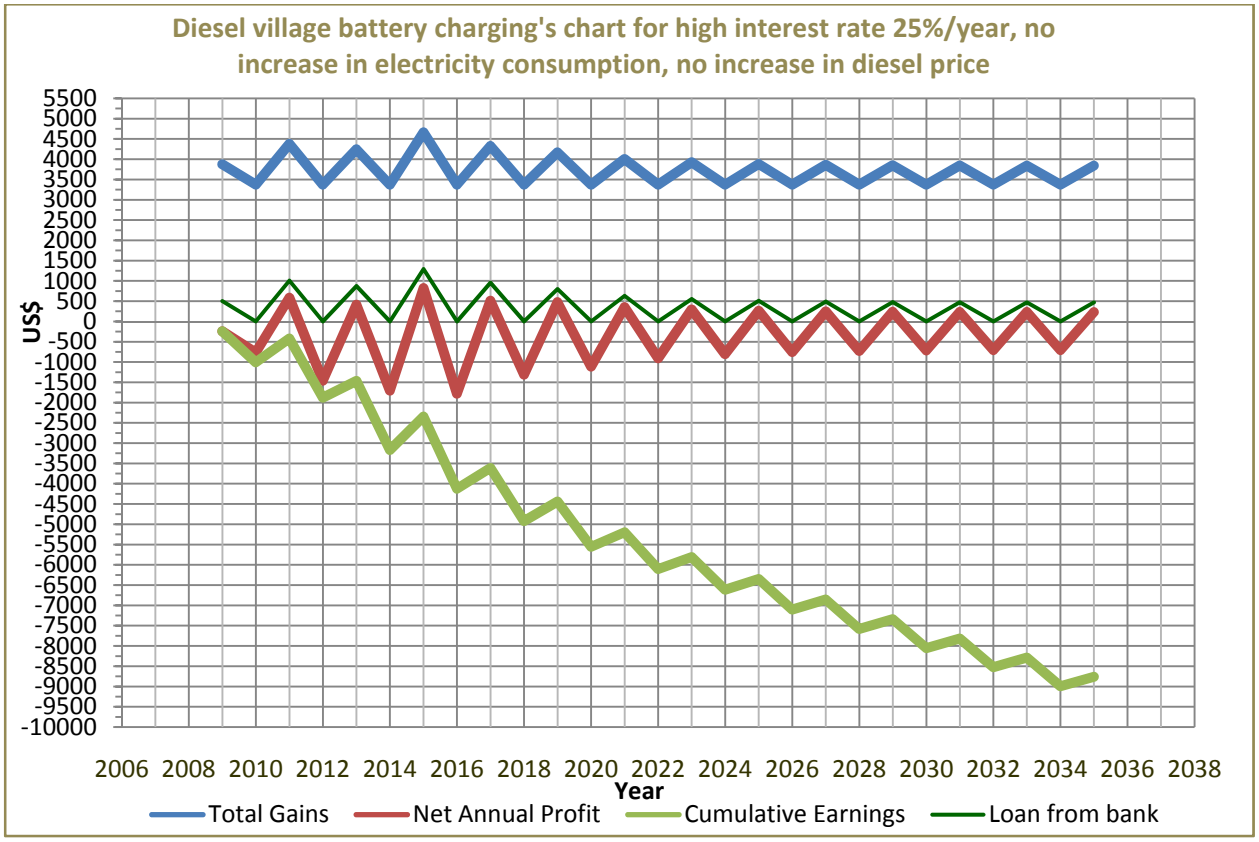


Figure 46: Diesel village battery charging's chart for high interest rate 25%/year, no increase in electricity consumption, no increase in diesel price

Net Annual Profit No. 5:

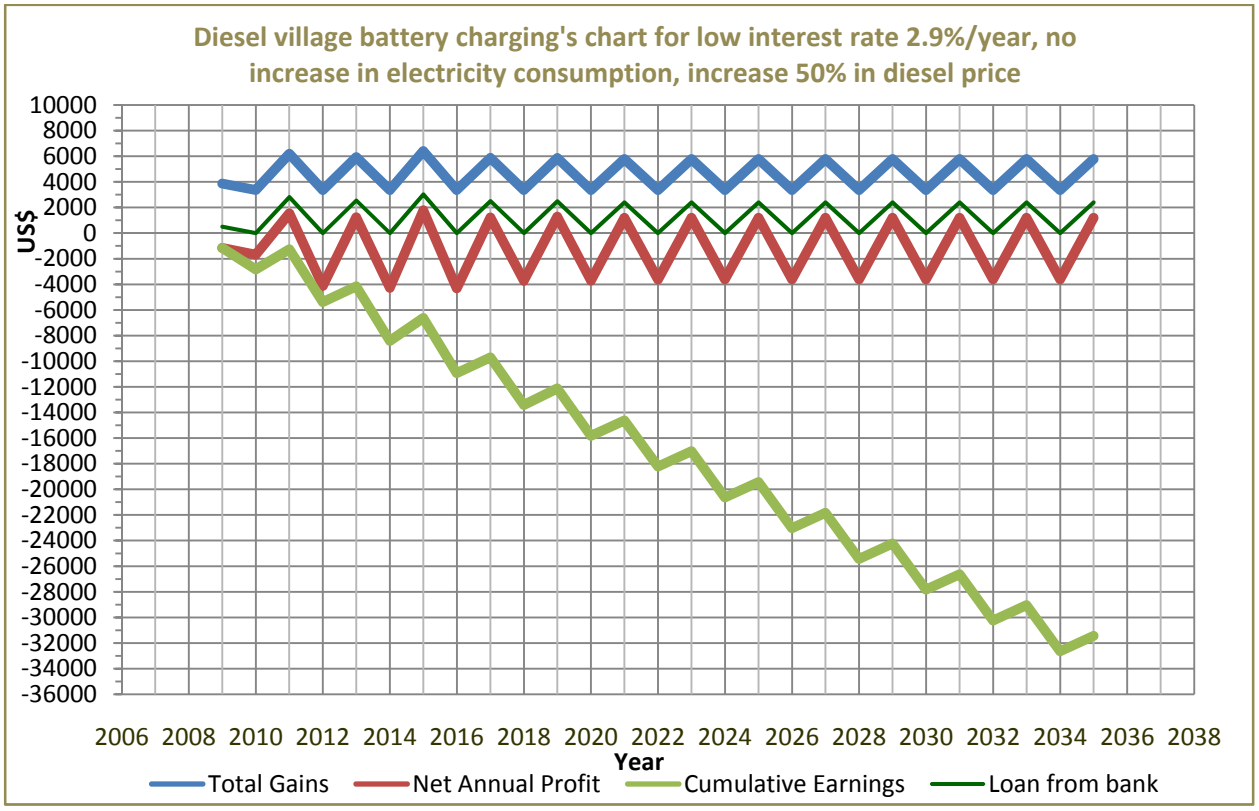


Figure 47: Diesel village battery charging's chart for low interest rate 2.9%/year, no increase in electricity consumption, increase 50% in diesel price

Net Annual Profit No. 6:

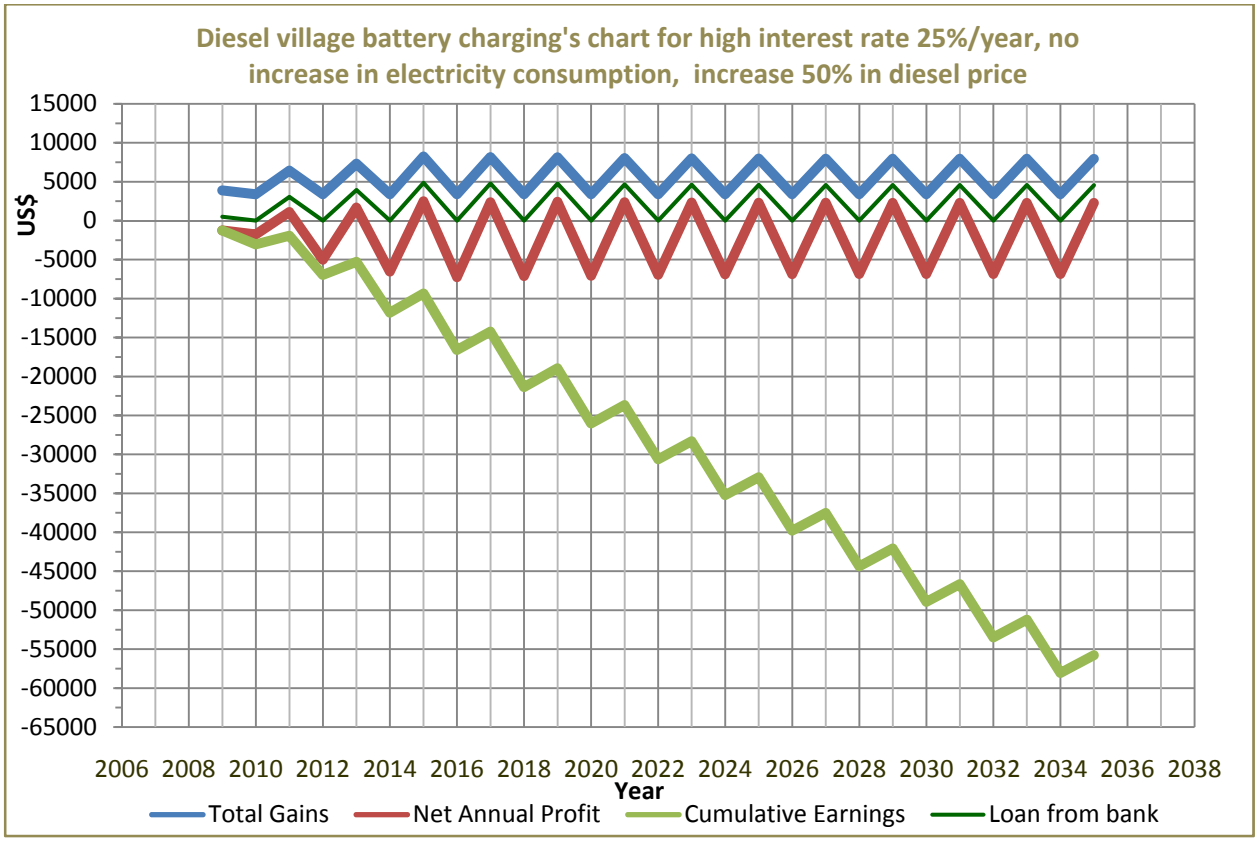


Figure 48: Diesel village battery charging's chart for high interest rate 25%/year, no increase in electricity consumption, increase 50% in diesel price

Net Annual Profit No. 7:

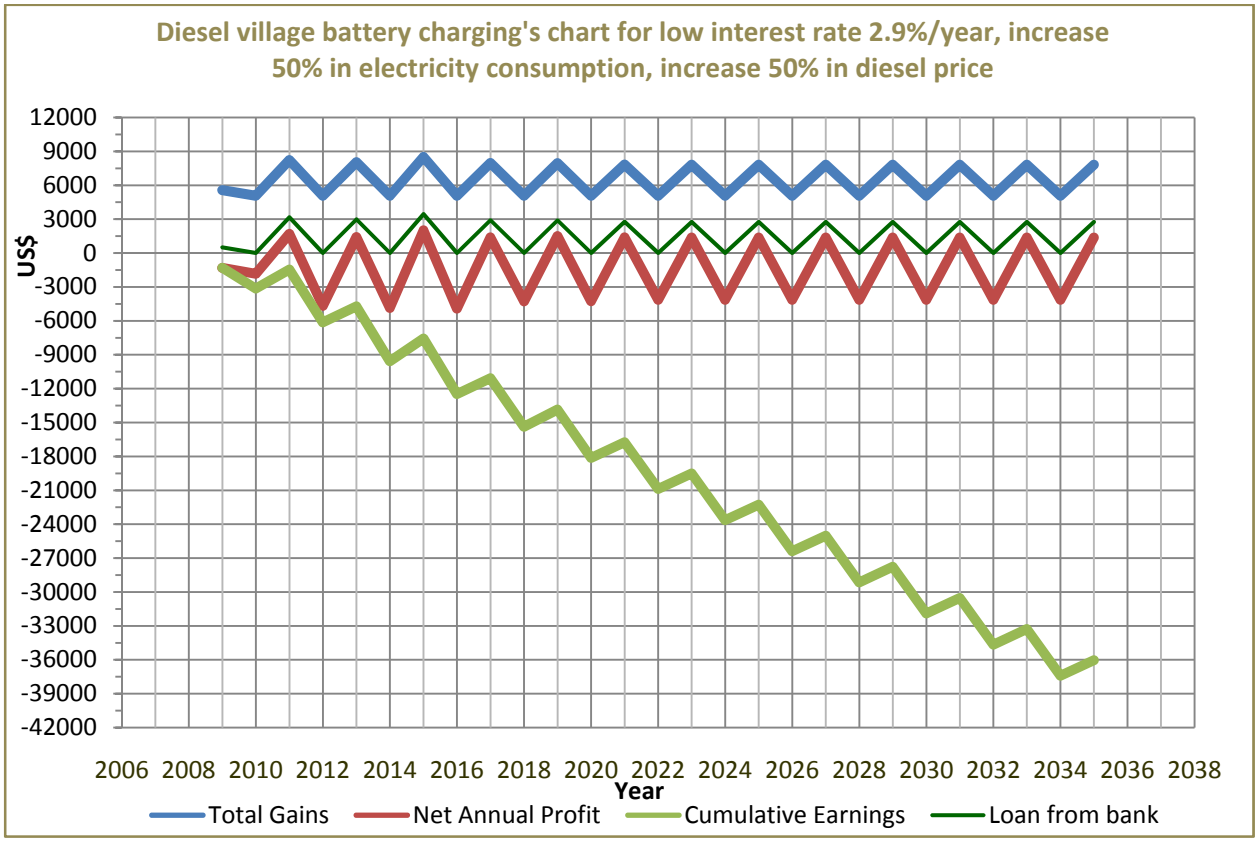


Figure 49: Diesel village battery charging's chart for low interest rate 2.9%/year, increase 50% in electricity consumption, increase 50% in diesel price

Net Annual Profit No.8:

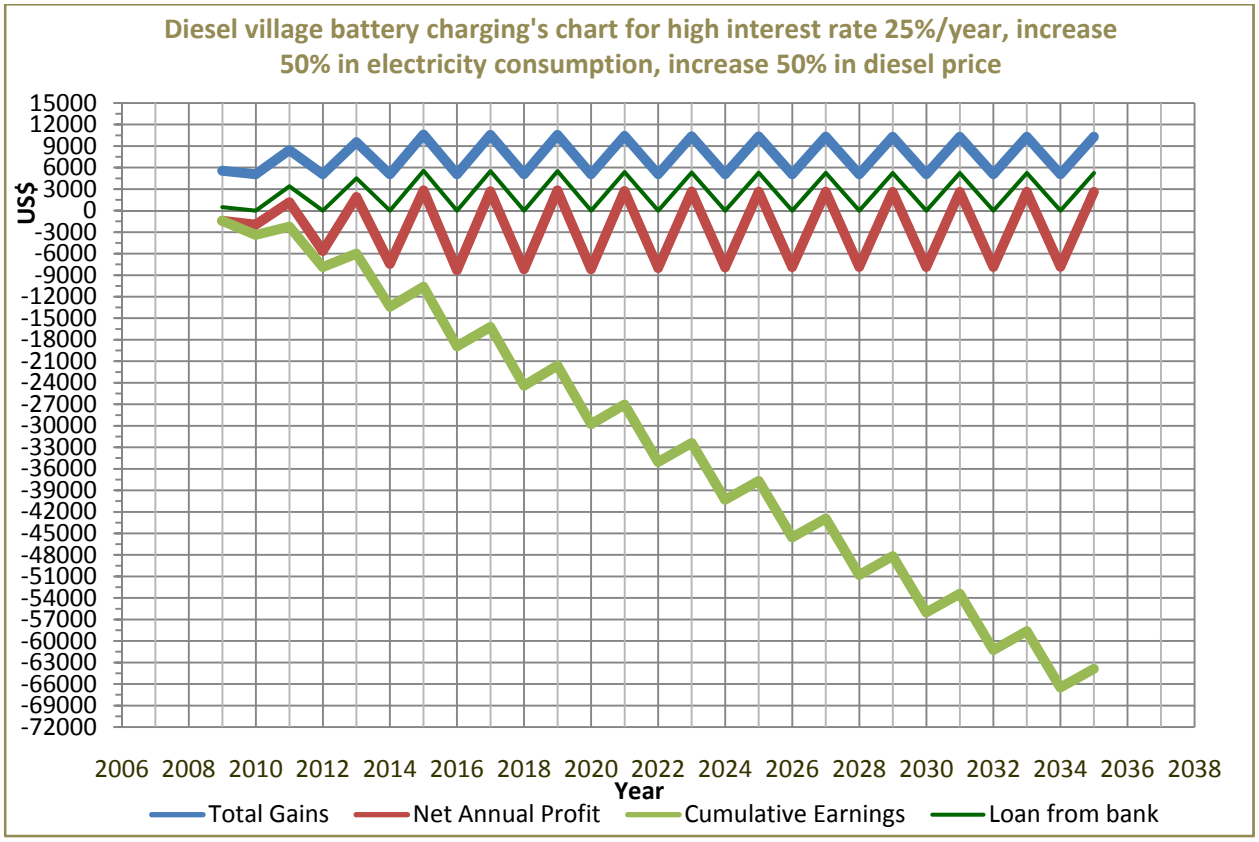


Figure 50: Diesel village battery charging's chart for high interest rate 25%/year, increase 50% in electricity consumption, increase 50% in diesel price

III. Conclusion

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.

The best case of sensitivity analysis which Loan from bank started to remain zero is in year 2010 which is the case of the best Net Annual Profit No.1: Increase 50% in electricity consumption, Low Interest rate 2.9%, no increase in diesel price. (**Figure 43**)

The worst case of sensitivity analysis which is the case of the worst Net Annual Profit No.8: No increase in electricity consumption, High Interest rate 25%, Increase 50% in diesel price. For this case (**Figure 50**), the year of Loan from bank is fluctuated gradually. It means that it is unacceptable investment for the cases of sensitivity analysis. Similarly, **Figure 45**, **Figure 46**, **Figure 47**, **Figure 48** and **Figure 49** are also unacceptable case of sensitivity.

CHAPTER 5

CONCLUSION

The best Net Annual Profit is the shortest period of payback loan, and the best choice of investment.

The result of sensitivity analysis during 3 years of village battery charging with different technologies is shown in **Table 23: Result of sensitivity analysis of village battery charging with different technologies** below.

According to Table 14, we can see that the best Net Annual Profit is Hydro village battery charging. The second is PV village battery charging. The third is Gasifier village battery charging and the last is Diesel village battery charging. Even though the Hydro village battery charging and PV village battery charging are better than Gasifier village battery charging, we still choose Gasifier village battery charging for our investment at the Anlong Tamey in Battambang province. The reason is that the SWOT for the Anlong Tamey gasifier in Battambang province gives a good result for our investment than the others.

SWOT Matrix - Anlong Thamey

SWOT analysis to identify strengths, weaknesses, opportunities and threats of bio gasifier

Strength (S)	Weakness (W)	Opportunity (O)	Threat (T)
• Community Energy Cooperative as a way of ownership and as functional structure (sense of working for a common cause) • The development of production and refining chain (growing Leuceana tree in the area) • The low price of grid electricity compared to using battery and kerosine lamps • The good quality of light • Environmentally friendly • A motivating way of producing electricity • Continuous controlling of the process possible because of labour force	• High initial investment cost • Productization of gasifiers not yet advanced • Relatively complex system, lack of local know-how • Gasifier unreliable which leads to need for additional energy supply (diesel is expensive) • Technology based on foreign equipment and components, difficult to have spare parts • Need for proactive maintenance (Filters need to be cleaned often) • The shortness of the grid • No electricity for the whole day • Not yet economically profitable • Demand is bigger than supply	• Opportunity to expand market, (mini)grids can be extended • The development of livelihood • Increase in consumption and improvement of the standard of living • More time for studying • Increase in information flow • In the future, the development of technology enables building of hybrids in which gas or diesel can be used in the same generator	• System failure due to mal operation or maintenance • Unreliability of electricity supply • Threats to the production of Leuceana • The extension of national grid will affect the local business and change livelihood • Changing Government policies

Table 23: Result of sensitivity analysis of village battery charging with different technologies

1

Change interest rate	2.9%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	50%	Gasifier 3			Diesel 1			Hydro 1			PV 1		
Change Diesel cost	0%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		1392	1392	1366	15	15	2	9	9	0	261	261	205
Total operation costs (US$/year)		53552	53552	5526	5351	5351	4839	2189	2189	1880	10997	10997	1941
Sales revenue(US$/year)		6000	6000	6000	5063	5063	5063	5063	5063	5063	2970	2970	2970
Loan form Bank (US$)		48000	0	47104	500	0	77	300	0	0	9000	0	7054
Total Gains (US$)		54000	6000	53104	5563	5063	5139	5363	5063	5063	11970	2970	10024
Net Annual Profit (US$)		448	-47552	47578	212	-288	301	3174	2874	3183	973	-8027	8083
Cumulative Earnings (US$)		448	-47104	474	212	-77	224	3174	6048	9230	973	-7054	1029

2

Change interest rate	2.9%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	50%	Gasifier 4			Diesel 7			Hydro			PV		
Change Diesel cost	50%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		1392	1392	1372	15	15	91						
Total operation costs (US$/year)		53652	53652	5632	6874	6874	6450						
Sales revenue(US$/year)		6000	6000	6000	5063	5063	5063						
Loan form Bank (US$)		48000	0	47304	500	0	3123						
Total Gains (US$)		54000	6000	53304	5563	5063	8186						
Net Annual Profit (US$)		348	-47652	47672	-1312	-1812	1735						
Cumulative Earnings (US$)		348	-47304	368	-1312	-3123	-1388						

3

Change interest rate	2.9%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	0%	Gasifier 1			Diesel 3			Hydro 3			PV 2		
Change Diesel cost	0%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		1392	1392	1301	15	15	22	9	9	0	261	261	249
Total operation costs (US$/year)		52432	52432	4341	4005	4005	3513	1829	1829	1520	10685	10685	1673
Sales revenue(US$/year)		6000	6000	6000	3375	3375	3375	3375	3375	3375	1890	1890	1890
Loan form Bank (US$)		48000	0	44864	500	0	761	300	0	0	9000	0	8590
Total Gains (US$)		54000	6000	50864	3875	3375	4136	3675	3375	3375	10890	1890	10480
Net Annual Profit (US$)		1568	-46432	46523	-130	-630	623	1846	1546	1855	205	-8795	8807
Cumulative Earnings (US$)		1568	-44864	1659	-130	-761	-138	1846	3393	5248	205	-8590	217

4

Change interest rate	2.9%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	0%	Gasifier 2			Diesel 5			Hydro			PV		
Change Diesel cost	50%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		1392	1392	1307	15	15	81						
Total operation costs (US$/year)		52532	52532	4447	5021	5021	4587						
Sales revenue(US$/year)		6000	6000	6000	3375	3375	3375						
Loan form Bank (US$)		48000	0	45064	500	0	2792						
Total Gains (US$)		54000	6000	51064	3875	3375	6167						
Net Annual Profit (US$)		1468	-46532	46617	-1146	-1646	1579						
Cumulative Earnings (US$)		1468	-45064	1553	-1146	-2792	-1212						

5

Change interest rate	25.0%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	50%	Gasifier 7			Diesel 2			Hydro 2			PV 3		
Change Diesel cost	0%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		12000	12000	17080	125	125	74	75	75	0	2250	2250	2758
Total operation costs (US$/year)		64160	64160	21240	5461	5461	4911	2255	2255	1880	12986	12986	4494
Sales revenue(US$/year)		6000	6000	6000	5063	5063	5063	5063	5063	5063	2970	2970	2970
Loan form Bank (US$)		48000	0	68320	500	0	298	300	0	0	9000	0	11032
Total Gains (US$)		54000	6000	74320	5563	5063	5360	5363	5063	5063	11970	2970	14002
Net Annual Profit (US$)		-10160	-58160	53080	101	-399	449	3108	2808	3183	-1016	-10016	9508
Cumulative Earnings (US$)		-10160	-68320	-15240	101	-298	152	3108	5915	9098	-1016	-11032	-1524

6

Change interest rate	25.0%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	50%	Gasifier 8			Diesel 8			Hydro			PV		
Change Diesel cost	50%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		12000	12000	17130	125	125	836						
Total operation costs (US$/year)		64260	64260	21390	6985	6985	7196						
Sales revenue(US$/year)		6000	6000	6000	5063	5063	5063						
Loan form Bank (US$)		48000	0	68520	500	0	3344						
Total Gains (US$)		54000	6000	74520	5563	5063	8407						
Net Annual Profit (US$)		-10260	-58260	53130	-1422	-1922	1211						
Cumulative Earnings (US$)		-10260	-68520	-15390	-1422	-3344	-2133						

7

Change interest rate	25.0%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	0%	Gasifier 5			Diesel 4			Hydro 4			PV 4		
Change Diesel cost	0%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		12000	12000	16520	125	125	245	75	75	0	2250	2250	3142
Total operation costs (US$/year)		63040	63040	19560	4116	4116	3736	1895	1895	1520	12674	12674	4566
Sales revenue(US$/year)		6000	6000	6000	3375	3375	3375	3375	3375	3375	1890	1890	1890
Loan form Bank (US$)		48000	0	66080	500	0	982	300	0	0	9000	0	12568
Total Gains (US$)		54000	6000	72080	3875	3375	4357	3675	3375	3375	10890	1890	14458
Net Annual Profit (US$)		-9040	-57040	52520	-241	-741	620	1780	1480	1855	-1784	-10784	9892
Cumulative Earnings (US$)		-9040	-66080	-13560	-241	-982	-361	1780	3260	5115	-1784	-12568	-2676

8

Change interest rate	25.0%	Investment calculation for the Anlong Tamey gasifier in Battambang province											
Change Cosumption	0%	Gasifier 6			Diesel 6			Hydro			PV		
Change Diesel cost	50%	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Interest of loan (US$/year)		12000	12000	16570	125	125	753						
Total operation costs (US$/year)		63140	63140	19710	5131	5131	5260						
Sales revenue(US$/year)		6000	6000	6000	3375	3375	3375						
Loan form Bank (US$)		48000	0	66280	500	0	3013						
Total Gains (US$)		54000	6000	72280	3875	3375	6388						
Net Annual Profit (US$)		-9140	-57140	52570	-1256	-1756	1128						
Cumulative Earnings (US$)		-9140	-66280	-13710	-1256	-3013	-1885						