CASINDO

Capacity development and strengthening for energy policy formulation and implementation of sustainable energy projects in Indonesia

Workshop on solar energy and biomass at Cenderawasih University

Final report

Project: Casindo

Details: Work package 4, fast-track of UNCEN

Venue: Fakultat Teknik, Cenderwasih University, new campus in Waena

Dates: 15th and 16th of June 2010

Lecturers: Dr. Han van Kasteren (biomass) and Ir. Jasper Frunt (Solar Energy)

Project leader: Ir. Mara Wijnker

Contents

Contents 2
1. Introduction 3
2. Day 1 of the workshop 4
2.1 Introduction 4
2.2 First day on solar energy 4
2.3 First day on biomass 5
3. Day 2 of the workshop 6
3.1 Studium generale on solar energy for the students 6
3.2 Second day on solar energy 6
3.3 Second day on biomass 8
4 Conclusions and recommendations 9
Appendix A: Program 10
Appendix B: Lists of participants 12

1. Introduction

This workshop was initiated as part of the fast track for UNCEN as part of the Casindo project. The fast track was initiated to offer UNCEN and UNDIP compared to the other universities the opportunity to co-operate in two more activities before starting the activities similar to the other universities. Reason for this is that UNCEN and UNDIP are only partners of TU/e since the beginning of the Casindo project in 2009 while the other three universities have already co-operated with TU/e for three years. UNCEN therefore decided to organize two additional workshops on selected topics. This workshop is the first one and chosen topics are energy of biomass and solar energy.

Dr. Han van Kasteren and Ir.Ing. Jasper Frunt agreed to give these workshops, each being expert on one of these topics. UNCEN requested if the workshop could be simultaneously given in two classes to give the lecturers of UNCEN the opportunity to learn in more details about the topic they are interested in. This was agreed on. Mr. Han and Mr. Jasper both prepared a presentation including an introduction, details on the technologies and calculations. Mr. Jasper also brought 4 small solar panels which were used for some practical measurements during the workshop.

This report includes a description of the workshop, contents and conclusions and recommendations for future workshops/meetings.

The objectives set before execution of the workshop are presented here:

- To provide the audience with basis theoretical knowledge on biomass/biofuels and solar energy
- To address given problems/questions on biomass/biofuels and solar energy
- To provide the audience with an understanding of the conversion of biomass/biofuels and solar energy

A program and list of participants can be found in the annexes.

2. Day 1 of the workshop

2.1 Introduction

The first day started with a speech by Mr. Apolo Safanpo, vice dean of the faculty of Engineering welcoming the participants. Afterwards the vice rector of UNCEN held a speech which was very motivating for the lecturers.
After this, a catholic prayer to request for a successful workshop was done.

Mr. Han van Kasteren started by giving half an hour presentation for a group of about 40 students being part of Studium Generale. A general introduction to students was given in the field of renewable energy. The role of renewable energy and its potential was enlightened for Indonesia. Especially solar energy, hydro power and biomass are important energy sources in this country.
This presentation was translated directly, per sentence, by Ms. Libertina. After the presentation, the students had the opportunity to pose questions to Mr. Han. They were very interested and asked whether they could also get training on bio energy. Mrs. Endang explained that a course on renewable energy sources will start from August 2010. The students will be able to take this course. Another question was posed on which location in Papua is best suitable for the installation of solar panels. This depends on the amount of solar radiation and a number of other factors.

After the break, the group of lecturers split up based on their interest and two classrooms were used; one devoted to the topic of solar energy and one to the topic of biomass. Mrs. Endang participated in the course on biomass and Ms. Libertina in solar energy. This ensured that translations could be done. Both lecturers were asked to speak slowly. The handouts were translated in Bahasa Indonesia, in combination with speaking slow; it was possible for the Indonesian lecturers to understand well. Some of the lecturers could understand easily and for others it was a bit of a challenge.

2.2 First day on solar energy

An introduction on solar energy was given, explaining the concept of irradiation. First the advantages of applying solar energy (renewable, environmentally friendly, reliability, silent, autonomous operation) were addressed in detail. The concept of solar energy, converting sunlight into electricity was discussed. Different types of cells were discussed; mono- and multi-crystalline, amorphous and organic cells and their advantages and disadvantages. Furthermore attention was paid to: semi-conductor functioning, p-n junctions, characteristics of the solar cell, diode functioning, connection of PV systems, maximum power point tracking, basic electrical properties of a panel (Peak power, open voltage, short circuit current, diode functioning), relation between voltage and current of a panel, etc. etc.

During the last part of the workshop, all lecturers were invited to go outside and in groups of 4 to 5 lecturers the open voltage and short circuit current of the credit card size multi crystalline solar panels were measured when receiving full sunlight (at this time of the day; around 16h00) and when pointed towards the other way. Afterwards, two panels were coupled, both in series and parallel to evaluate the effect of parallel and series connection on open voltage and short circuit currents.

During the day, among others, questions were posed on:
Q: Relation between wavelength and efficiency?

A: There is indeed a relation between wavelength and efficiency. Different panels absorb different parts of the solar spectrum.

Q: Where is the impedance located in the panel?
A: This is located in the cable; therefore the cable should be as short as possible to prevent from large losses. It is also located in the connection in the panel.

Q: How can the current of the panel be calculated?
A: It can be approximated by a formula, but normally it is presented at the back of the panel when purchasing a panel. This value is usually deterministic.

Q: Which kind of panel should be used for making an artificial mosquito using solar power for flying?
A: This should be a very efficient panel; so most like a mono-crystalline panel.

From the questions from the audience can be concluded that the information in the course was well understood by most of the Indonesian lecturers. Also during the practical exercise some of the lecturers were already able to explain the effect to others which indicates the level of understanding.

2.3 First day on biomass

After an introduction into the potential of biomass for Indonesia, the principle parameters concerning biomass were dealt with: organic content, water and ash. Based on an elemental analysis the energy content can be calculated of a biomass stream.

Biomass conversion technologies were discussed: physical methods: pressing oil out of seeds and transesterification; biochemical methods: digestion and fermentation; thermo chemical methods: pyrolysis, hydrothermal upgrading, gasification and incineration.

Examples were treated with concerning pyrolysis and gasification.
Also questions of the teacher were discussed:

1. Molecular adhesive catalyst preparation from clay for removal of water from ethanol / water streams.
2. Issues about the biodiesel production from a special fruit species from Papua as.

3. Day 2 of the workshop

3.1 Studium generale on solar energy for the students

Mr. Jasper Frunt gave an introduction to solar energy; solar energy is converting sunlight into electricity. Different types of panels were discussed with their advantages and disadvantages for usage in Papua. It was mentioned how people can easily recognize different types of panels. The working principle of solar panels was briefly discussed as well as their semi-conductor functioning because of the P-N junction.
Differences in efficiency and costs between panels were mentioned. Finally it was discussed how solar panels should be positioned (elevation and azimuth) to achieve maximum yield. Quick rules of thumb were given for this as well as more elaborate explanations. It was stressed that a solar home systems consists of more components than a solar panel (i.e. a solar battery, a battery charger, cables, appliances and sometimes and inverter if the appliances work on 230VAC). It was mentioned that a car battery should not be used for a solar home system. Local prices of components were mentioned. These local prices were determined by visiting a shop in Jayapura on June 14th.

Q: If in a region there is a lot of rain, how can you then get optimal power of a solar panel?
A: What always remains important is the angle of the panel towards the sun. Change the panel angle twice a year because of change of turning of the sun compared to equator (sometimes turning over south, sometimes of north). Keep the panel clean and ensure that no trees (or other objects) are blocking the sunlight. Furthermore, if it is raining a lot, the amount of power will be less, but the rain will not harm the panel. The clouds are just blocking the sun.

Q: How can we at Papua get this technology?
A: This is process that takes time. Part of this is knowledge transfer as we are currently experiencing in this workshop. After this, maybe some changes will be made on the number of solar panels being bought and then in some time maybe there will be other important factors influencing this change.

Q: What is cheaper; using a car battery or a solar cell battery in a solar home system?
A: Investments costs of a solar cell battery are higher (two to three times higher) but it is not recommendable to use a car battery in a solar home system since it will only last several months. A solar cell battery (if used in combination with a battery charger) can last for approximately five years, so if the investments costs are spread throughout the years of use, the solar battery is cheaper.

Q: Should a dry or wet battery be used?
A: Both systems exist for solar panels and both can be used well. The dry battery is more expensive, but the wet battery needs more maintenance: distilled water in the battery needs to be added sometimes and the battery should be placed top up, because else acid can flow out.

Q: We have a panel at home, but don't have a battery charger. Can we still use it well?
A: You can use it for several months, but you will overcharge the battery which reduces the lifetime of the battery dramatically. So, you should actually add a charger in between.

3.2 Second day on solar energy

During the second day of the solar workshop the following topics were addressed.

- Relation between voltage and current of solar panels (IV curves)

- Relation between output voltage and power of solar panels
- Systems with multiple PV panels
- Information on grid connected systems with inverters. Parallel and series (and combinations of both) connections. Different connections for different system sizes.
- Information on autonomous system (e.g. solar home systems are autonomous systems as well as systems for water pumping stations)
- Information on how to position the panel (azimuth and elevation) was discussed. Different systems to track the sun during the day / year were mentioned and discussed.
- How to install and maintain a panel
- Discussion of the experimental results
- Different batteries, the effect and use of battery chargers, costs and lifetime of battery systems, different battery connections
- Calculating system size, panel capacity, battery capacity, cable dimensions, charger capacity, and inverter capacity.
- Effect of cloudy (rainy) days on a solar home system
- Design of larger systems (clinics)
- Fluctuation of irradiation during the day
- Fluctuation of irradiation during the year
- Costs of PV systems and comparison with current diesel generator solutions
- Possibilities for research at the university

Directly after lunch more experiments were performed using the available credit card size panels. Using available multi-meters (2 per setup) and variable resistances the IV curve and power output were determined with different irradiation by two groups (each consisting of 10 people). Afterwards the results from the measurements were discussed in detail. The experiments took about 45 minutes. Conclusions were:

- High yield during the day, more than the previous day
- Difficult to achieve good measurement results in a relatively brief period
- Nice experiments to do with students as well

During the experimental phase different pictures were taken to give an impression.

3.3 Second day on biomass

The second day digestion was treated in detail in the morning. What is the potential and what are the parameters to be handled for a good process and maximization of gas production.
Some examples of topics: functioning of digester; adding of feedstock, micro organisms producing enzymes, methane and CO_2 (and some other particles); production methane can be used for cooking. Percentage of methane produced out of dry material is 55-70%

The temperature of the digester can be between 30 and 55 C. Higher temperature increases the speed of the process, but energy needs to be added. At low temperature, this is a slow process.

Furthermore, digestate is produced which can be used for example as a fertilizer.
Types of biomass that can be used are discussed.
In the afternoon calculations were dealt with concerning when a biomass stream can be incinerated auto thermal.

Finally the energy efficiency of digestion is compared to direct incineration, pyrolysis and/or gasification. This was done via calculation of examples.

Questions were posed on:
What is the heat inside of the digester? If digestion is carried out at high temperature (55℃); heat should be added. Low temperature digesters (< 40℃) can be installed without heating in countries like Indonesia

Do you have any suggestions on waste treatment? It turned out there are two landfills in which plastics and other waste is collected and another in which organic materials of toilets are collected. The plastic can be burned or gasified, but it would be even better to separate the waste and recycle it.
The organic material if gathered like this will produce a lot of methane. This methane could be collected and used as energy resource.

4 Conclusions and recommendations

Did the lecturers understand?
The presentations were given in English but at a slow pace and the presentation slides on solar energy had been translated beforehand. The handouts were presented to the participants. This made understanding the presentation very easy. Furthermore the presentation was given in a way which allowed for immediate questions. An open atmosphere was created which allowed interruptions by the audience in case of any questions/difficulties.

What was the level of the questions?
The lecturers of UNCEN paid very well attention and some of them understood very well and posed many questions. Often the level was good and quite high. This high level of questions indicates that most of the members of the audience understood the matter very well. At the end of the session sometimes some members were even able to answer and explain matter to other members which is an even stronger signal about the high level of understanding.

Did they think about ideas for research or application?
Yes, because already some research proposals have been submitted. Also in the solar course research proposals were discussed in great detail. Some ideas for further research were given by Jasper Frunt and the audience showed great interest in this.

What kind of additional material/information is demanded?
The attendees of the solar energy course would like to have more of the experimental solar panels (credit card size). The price of these panels is approximately 5 euro a piece. In case of experiments by students the ideal number of panels is 1 per 2 students. Furthermore the attendees of the solar course had interest in literature (papers and books) about solar energy.

It was concluded that photovoltaic generation could play a big role in West-Papua due to the available solar irradiation. Furthermore PV can be used to set up autonomous systems (solar home systems). During the experiments it was concluded that it is difficult to set up a good experiment but that very basic results can be achieved with the currently available material.

At the end of the second day research proposals were discussed for research in photovoltaic. It was concluded that the first research should focus on the availability of solar irradiation in Jayapura. Furthermore research on how to position (or how to change the position during the year) should be performed. Also research into how to set up solar home systems would be very useful.

Recommendations for future courses:
For future courses on photovoltaic generation the following aspects should be taken into account:

- Bring experimental (4) solar panels
- Bring literature for the lecturers (perhaps e-books can be found)
- Bring more information on prices of systems (in Africa and in Europe) as a reference. The price information should be for panels but also for batteries and chargers.

Appendix A: Program

Proposal Program Solar and Biomass Workshop

Location : Jayapura, Papua
Venue : Engineering Faculty, University of Cenderawasih (Uncen)
Date : 15th and 16th June 2010

Lecturers : Dr. Han van Kasteren and Ir. Jasper Frunt

Tuesday 15th June

Time	Topic/lecturer	Remark
8h30-9h00	Registration	Committee
9h00-9h30	Opening ceremony	By Vice of Rector 1
9h30-10h30	Stadium general to Biomass	For students Half an hour introduction/lecture by Dr. Han van Kasteren; half an hour questions
10h30-11h00	Short break	Committee
11h00-12h00	Introduction to Biomass	By Dr. Han van Kasteren
	Introduction to Solar Energy	By Ir. Jasper Frunt
12h00-13h00	First assignments/calculations & discussion Biomass	By Dr. Han van Kasteren
	First assignments/calculations & discussion Solar Energy	By Ir. Jasper Frunt
13h00-14h00	Lunch and prayers	Committee
14h00-15h00	Assignments/calculations & working out of assignments Biomass	By Dr. Han van Kasteren
	Assignments & discussion Solar Energy	By Ir. Jasper Frunt
15h00-15h30	Coffee break	Committee
15h30-17h00	Discussion of calculations/assignments and summary of first day	By Dr. Han van Kasteren & By Ir. Jasper Frunt

Wednesday 16th June

Time	Topic/lecturer	Remark
8h30-9h00	Registration	Committee
9h00-10h00	Stadium general to Solar Energy	For students Half an hour introduction/lecture by Ir. Jasper Frunt; half an hour questions
10h00-10h30	Short break	Committee
10h30-11h30	Second lecture Biomass	By Dr. Han van Kasteren
	Second lecture Solar Energy	By Ir. Jasper Frunt
11h30-13h00	Assignments/calculations & discussion Biomass	By Dr. Han van Kasteren
	Assignments/calculations & discussion Solar Energy	By Ir. Jasper Frunt
13h00-14h00	Lunch and prayers	Committee
14h00-15h00	Third lecture Solar Energy	By Dr. Han van Kasteren
	Third lecture Solar Energy	By Ir. Jasper Frunt
15h00-15h30	Coffee Break	Committee
15h30-16h30	Discussion on outcomes/assignments and Wrap up of the workshop; summary of second day	By Dr. Han van Kasteren & Ir. Jasper Frunt
16h30-17h00	Closure of the Workshop and handing out certificates & take group picture	Committee

Appendix B: Lists of participants

List of participants in Biomass Workshop

Dates: 15th and 16th of June 2010

Name of participants on biomass workshop

1. Endang H
2. Agustinus
3. Samuel B.M
4. I Gusti Ngurah
5. Allo Sarira
6. Dewi A R
7. Sriyanto
8. Darwanta
9. Suwito
10. Florida D
11. Daniel A
12. Jaingot P

List of participants in Solar Energy Workshop

Dates: 15th and 16th of June 201

Solar Energy participants

1. Enos Tambing
2. Manus S
3. Prihananto
4. Enos R
5. Parlindungan D
6. Rombe A
7. Yakobus K
8. Theresia Wuri
9. Djoko Triwahyono
10. Handoko
11. Herman K
12. Sony W
13. Ekawati Ohee
14. Selyus Rantepulung
15. Yosef Lefaan
16. Lia Medy Tandi
17. Libertina
18. Duha A