



Dream Renewables End of Year Report 2019

Barnaby King

13/01/2020

DREAM RENEWABLES

4 WEEKS OF HANDS-ON LEARNING



SOLAR
POWER



WIND
ENERGY



HYDRO
POWER



MINI
PROJECT

15 students



100 % completion rate

Feedback survey

Skills and knowledge

92%

Rated good or excellent

Overall experience

83%

Rated good or excellent

IMPACT

Employment...



3 corporate sponsors
provided access to job opportunities

2 students
have since conducted paid work in
renewable energy

1 volunteer
employed as a full time engineer by a
programme sponsor

Spreading the word...



5 students

volunteered to teach a special lesson
on renewable energy at a local
school

25 school children

benefitted from this experience,
learning the importance of
renewable energy



Acknowledgements

This report was written by Barnaby King, the Founder of Dream Renewables, with contributions from Linda East and Chris Croudace from Dream Big Ghana Foundation, and Nadia Smith and Johanna Behaim from the Dream Renewables team. Jessica Went kindly provided pro bono copy editing services.

We are incredibly grateful to everyone who contributed to the 2019 programme. Our hardworking team of volunteers, advisory panel, commercial partners and funders all played a crucial part in ensuring that this project was a success, it achieved high ratings from the participants and had a demonstrable impact in the community.

Volunteer Team

Our volunteer team of renewable energy professionals and academics worked tirelessly for 9 months before the course - designing course materials, building local and international partnerships, raising funds and completing logistical planning. Many of our volunteers also taught classes and ran workshops on the programme. The volunteers on the 2019 programme were:

Ahenkorah Ferka — Alyazia Ahli — Enoch Akorno — George Marigold — Johanna Behaim — Mensah Florence Adzo — Nadia Smith — Raphael Sarpong — Yeboah Samuel — Yohanes Komla Getor

Advisory Panel

Our advisory panel was set up to provide senior guidance and direction to the project, building on their decades of experience in their fields. The advisory panel reviewed the project plan and learning resources periodically and provided feedback, guidance and direction. Members of the 2019 panel included:

- *Dr Peter Connor — Associate Professor in Sustainable Energy Policy at the University of Exeter*
- *Dr Eric Effah-Donyina — Head of Renewable Energy Unit at Northern Electricity Distribution Company (NEDCo), and Renewable Energy Lecturer at the University of Energy and Natural Resources*
- *Abdul W.Raa j— CEO at Suka Wind & Solar Energy Limited*
- *Samuel Owusu-Takyi — Director at Kumasi Institute of Tropical Agriculture*
- *Michael Avle — Group Marketing Manager at PEGAfrica*

Supporting organisations

Our project partners supported by providing equipment, learning resources, and delivering talks and workshops. Our 2019 project partners included:

- *The University of Energy and Natural Resources, Sunyani*
- *Suka Wind & Solar Energy Limited*
- *Kumasi Institute of Tropical Agriculture*
- *Atorkor Vocational Training Institute*
- *Dream Big Ghana Foundation*
- *Dream Big Ghana NGO*

Our Funders

Our funders appear below, in order of the size their donation

- *Dream Big Ghana foundation*
- *Individual donations from over 50 people*
- *ChargedUp*
- *UKPN*

Table of Contents

Background	4
Introduction to Dream Renewables	5
The team.....	7
The programme.....	8
The participants	8
Module 1: Energy Basics & the Energy System.....	9
Module 2: Solar Energy.....	10
Module 3: Wind Energy	11
Module 4: The Energy Challenge.....	12
Programme evaluation.....	13
Participant feedback questionnaire.....	13
Energy assessment of Meet Me There Lodge	15
Students become the teachers.....	15
Creating job opportunities	16
A national award for one of our volunteers.....	16
Project fundraising and cost	17
Fundraising 2019.....	17
Budget 2019.....	17
Dream Renewables 2020	18
Fundraising 2020	18
The 2020 programme	18
Appendix A: Qualitative data from the feedback survey	19

Background

'Energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive.'

Ban Ki-Moon, UN Secretary-General

In Ghana today, one in five people do not have access to electricity, often having to resort to using expensive and polluting fuels. Meanwhile, 70% of households in Ghana use heavily polluting solid fuels for cooking – undermining their health, productivity and quality of life. Those who do have electricity often find it unstable, unreliable and expensive, damaging equipment and stunting business growth.

Ghana's rich array of renewable energy resources can address energy insecurity, help expand access to clean energy, and decarbonise Ghana's energy system whilst tackling global climate change. An increasing number of individuals and organisations across Ghana are focused on developing and scaling up renewable energy technologies to address this.

In response to the growing need for qualified engineers and technicians, higher education in renewable energy is becoming available at some of Ghana's leading institutions – such as the University of Energy & Natural Resources in Sunyani. However, renewable energy does not feature in the country's national curriculum, preventing widespread knowledge and understanding of renewable energy systems amongst Ghana's youth – and therefore reducing the uptake of such higher education programmes. Dream Renewables was founded to address this problem.



Seamstresses in West Africa often use hand powered sewing machines, access to electricity can significantly increase productivity.



Schools with access to electricity can provide crucial IT education

Introduction to Dream Renewables

Dream Renewables is a collective of experts from industry and academia working in the field of renewable energy and sustainability. The collective was founded by Barnaby King in 2018 with the mission of inspiring and informing young Ghanaians about renewable energy through practical, hands-on learning and helping to provide a springboard into the renewable energy sector.

In August 2019, Dream Renewables ran an intensive 4-week course for a group of 15 high school students from the Volta Region of Ghana. This was a pilot project designed to confirm the suitability of this type of renewable energy programme for the local community and to accrue key learnings to build-up future Dream Renewables programmes. The course was delivered at the Dream Big Community Learning Centre, based at Meet Me There Lodge near Keta. The course included a mixture of practical workshops, presentations and demonstrations, with an active exchange of views and opinions encouraged throughout.



As part of the course, the students built and tested prototype power generation systems – including a wind turbine and a small off-grid solar PV system, both of which were built from scratch. As well as getting a better understanding of the scientific principles involved, the students got a fantastic sense of achievement as they developed fully working systems from raw materials.

Towards the end of the course, the Dream Renewables team assisted the students in designing renewable energy systems to solve energy-related problems in the local area. The students also benefited from several influential guest speakers, including Mr Abdul

Raaj – a leading Ghanaian expert in wind and solar energy – who gave a motivational talk on employment opportunities in Ghana’s burgeoning renewable energy sector.

100% of participants said the programme met or exceeded their expectations in a post-course survey and the programme’s lasting impact is already evident. Just weeks after the course ended, a group of programme graduates visited a local school to design a renewable energy system that could power a new computer lab and science equipment—Dream Renewables is looking to secure funding to go ahead with this project in 2020. Whilst at the school the graduates taught a lesson on the importance of renewable energy and provided information on local training opportunities. Also, Florence – one of our wonderful local volunteers – has recently secured full-time employment with SUKA, one of our project sponsors, while Bright – a participant on the programme – received short term employment from Meet Me There Lodge to assist with the design of an off-grid solar energy system and is currently applying for job opportunities with our project sponsors.

Following the evaluation of the successful 2019 programme – which demonstrated the positive impact the course has had – Dream Renewables have decided to run a second programme at the same location in August 2020. The programme will be expanded to accommodate an intake of 25 students and will incorporate many improvements suggested through both verbal and written feedback from the participants and volunteers.



A group of students proudly show off their work after constructing a wind turbine rotor from wood and nails

The team

Dream Renewables core team of volunteers consists of young renewable energy professionals. They are united by a passion to educate people about renewable energy and the benefits it can bring to people's lives and the environment. Working as part of this culturally diverse team provided a great experience for the volunteers to develop their cultural intelligence and build strong relationships with people from different walks of life.

Each volunteer was responsible for designing and delivering teaching material centred around their field of expertise, ensuring the students had passionate and well-informed teachers. In addition to their full-time work or study commitments, the team worked tirelessly for 6 months before the programme to fundraise, prepare lessons plans, source equipment and advertise the opportunity. We can't thank the volunteers enough for all the hard work they put in.



Florence

BSc Renewable
Energy, Solar PV
Engineer



Enoch

BSc
Masters Student in
Renewable Energy



Johanna

MEng
Smart Grid Engineer



Yohanes

BSc
Masters Student in
Renewable Energy



Samuel

BSc
Renewable Energy
Teaching Assistant



Alyazia

BSc
Cloud Platform
Architect



Nadia

BA
Renewable Energy
Policy Analyst



Barnaby

MEng
Energy Systems
Engineer



Ferka

BSc
Masters Student in
Renewable Energy



Raphael

BSc
Energy Engineer

In addition to our volunteer team, Dream Renewables is supported by an advisory panel who proved to be instrumental in the success of our first programme. The panel provided useful contacts in the renewable energy industry as well as guidance on the design and planning of the learning modules. The panel will remain an integral part of Dream Renewables moving forward. It includes two senior academics working in the renewable energy field, Dr Eric Effah-Donyina of the University of Energy and Natural Resources, Sunyani, Ghana, and Dr Peter Connor of the University of Exeter, UK. The panel was further supported by representatives from our commercial partners including PEG Africa and Suka Wind & Solar Energy Ltd.

The programme

The 2019 programme was a pilot project designed to confirm the suitability of this type of renewable energy programme for the local community and to accrue key learnings to build into future Dream Renewables programmes. The programme covered four modules; each of which was led by a team member with specific expertise and knowledge in the area.

The participants

The programme was targeted at senior high school graduates and students aged 18-30 from the Southern Volta Region of Ghana. Students from various backgrounds expressed interest in the course.

The admission process was led by Christian Ganah, the Co-Director of Dream Big Ghana NGO, who collected CVs from interested participants, then followed up with a phone interview to confirm their suitability. The key criteria for participation were:

- Ability to communicate effectively in spoken English
- Academic background in science, mathematics or business
- A clear and well-demonstrated interest in renewable energy



Out of 20 applicants, 15 passed the selection criteria and were accepted onto the programme. The intake was diverse in academic background, with 3 Senior High School (SHS) students, 6 SHS graduates, 4 university graduates, and 2 entrepreneurs. However, gender diversity was low; only 2 women participated in the programme, making up 12.5% of the total intake, whilst women globally occupy 32% of the renewable energy workforce. We are currently in communications with Lady Volta Green Tech Academy (LVGTA) - a renewable energy training school for women in the Volta Region of Ghana. We plan to work with LVGTA to increase the Gender diversity of Dream Renewables 2020.

We were informed by Dream Big Ghana NGO that charging a small amount for educational programmes is important to ensure that the participants fully engage in the programme. While this could be a barrier to entry for some, we agreed on an amount (50 GHC or the equivalent of £8) that would be affordable for most of the local community with low-cost options available for those unable to afford this. The costs recovered through admission fees. were under 2% of the total programme cost.

Module 1: Energy Basics & the Energy System

The first module was designed to deliver three clear aims:

- 1) Provide the group with a basic understanding of energy systems, including simple scientific principles and basic energy calculations
- 2) Develop a healthy group dynamic by running team building activities
- 3) Contextualise the role of different stakeholders in an energy system and understand how they interact, including how energy systems are evolving to become decentralised.

We started the module with a brief introduction to the programme and teachers, followed by three team-building exercises designed to foster a culture of questioning, challenging and discussing. These exercises were a success and positively influenced the atmosphere within the group.

The rest of the week saw several other group exercises and challenges, introducing the students to the basic science behind energy systems and providing a key set of tools that were used throughout the programme. Activities included:

- Energy and power calculations, basic Microsoft Excel skills, electrical testing, and multimeter skills training
- Debating and negotiation skills, introduction to entrepreneurship and innovative business models to overcome local barriers to entry, and community energy



Module 2: Solar Energy

The Solar Energy module was designed to introduce the students to the basic theory behind solar energy systems and to build upon this through several practical workshops and demonstrations.

The week began with an intensive theory session which covered the key scientific and engineering principals governing the design of a solar photovoltaic system. We also demonstrated PEG Africa's innovative 'pay as you go' solar product that provides access to solar energy to those on lower incomes.

Following the introduction to the theory, the students completed four practical learning workshops, reinforcing the theory in a practical and hands-on way:

- 1) **Building a small solar panel** from solar cells (this helped students understand the IV relationship of a solar panel, and how to troubleshoot a solar system that is not performing as expected)
- 2) **Calculating panel efficiency** by measuring the power from the sun (irradiance) using an irradiance meter and calculating the efficiency of the system they built (this reinforced the effect of solar panel angle, shading and temperature on power output)
- 3) **Testing a commercial system** (students connected and tested a 150W, 100Wh solar and battery system, providing exposure to the connection and testing industry-standard components)
- 4) **Visiting a local 40kW rooftop solar array** and predicting its yearly power generation.

Bernard - our local entrepreneurship teacher - concluded the week with a lesson on the various business models that can be used to increase access to solar energy and introduced some companies in Ghana using these models.



Module 3: Wind Energy

The Wind Energy module introduced the basic theory behind wind energy and to build upon this by constructing a Hugh-Piggott wind turbine. The week commenced with a day-long theory session, covering the key engineering concepts. On day two, wind speed data from an anemometer installed at Meet Me There Lodge six months previously was used to conduct a basic resource assessment and feasibility study.

For the next two days, students were split into two groups based on their abilities and interests. The first group focused on the construction of the electrical generator and the second group on carving the blades. The two groups then worked together to assemble the turbine. Finally, each group was asked to explain what they had learned to the other group.

On the last day, the turbine was erected on a small stand in a windy location for a demonstration. A rectifier was attached to output DC power and a variable load was used to explore the relationship between the load, the current and the turbine's rotational speed. An electrical break was used to control the turbine and prevent it from spinning out of control. The students spent several hours testing the system, reinforcing the theory taught throughout the week.

To support their learning, the Dream Renewables team arranged for the students to visit the iconic Akosombo Hydroelectric Dam, which provides over 50% of Ghana's power requirements. They were shown around the site by a senior engineer with 40 years' experience in the sector. The tour lasted three hours, during which students visited the plant room, penstock and 70metre dam, whilst also benefitting from a detailed lesson about the history of the Ghanaian electricity system, and hydroelectric power.



Module 4: The Energy Challenge

This week aimed to bring together all the lessons learned in the previous weeks and to give students the chance to apply key concepts to a real-life problem. In groups, the students were asked to identify an application for renewable energy in the community, for which they would later produce an outline design. Chosen topics included water irrigation for a farm, refrigeration and lighting for a restaurant, and the powering of sewing machines for a seamstress business.

Once the students had identified a project, they conducted an energy assessment to determine how much energy is required. Students were then encouraged to think about which renewable energy technology would be best suited to meet their energy needs and whether energy storage might be required. Each group decided that solar energy was best suited to their situation. Next, students used a freely available modelling program, System Advisor Model (SAM), to determine the number of solar panels and batteries required for their situation.

Students were then guided through a financial appraisal of the project with the help of the local entrepreneurship teacher. The students researched the local prices of solar energy equipment and compared this to other forms of energy, including the grid and diesel generators.

Finally, all components were brought together to form a basic technical and financial feasibility study, which is a key document for any renewable energy project. Students also benefited from a workshop led by the director of Ghanaian renewable energy company, SUKA Wind and Solar Energy Ltd, which allowed them to further refine their designs.

The energy challenge gave students the chance to re-visit many of the concepts introduced in the previous weeks and motivated everyone to carry this newly gained knowledge forward in their lives.

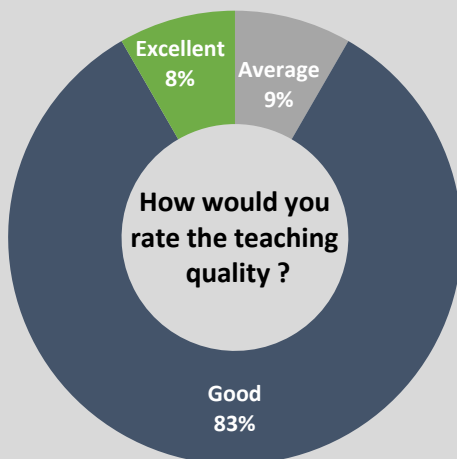
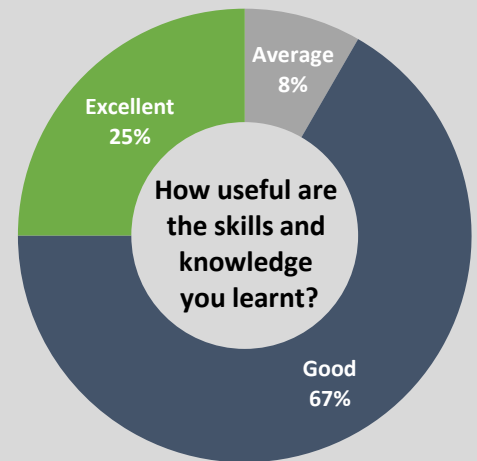
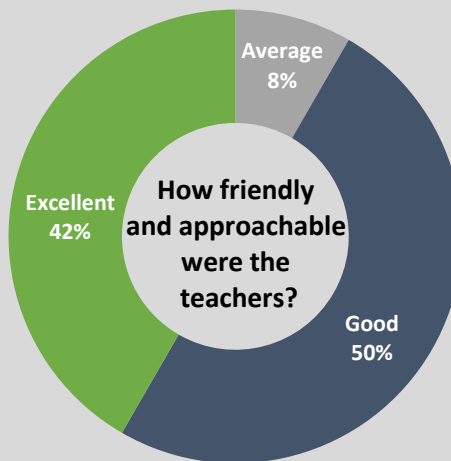


Programme evaluation

Participant feedback questionnaire

After the four weeks, each student filled out an evaluation questionnaire, providing Dream Renewables with invaluable feedback which will be used to improve next year's programme. Overall, the results were overwhelmingly positive. The first six questions were designed to assess how successful the programme had been overall. The students had the option of responding in the following ways; 'very poor', 'poor', 'average', 'good' or 'excellent'.

93% of responses were either 'good' or 'excellent', and every response was 'average' or better. 42% of respondents rated their teacher as being excellent (and 50% as good) in terms of their friendliness and approachability, and 100% of students felt that the course met or exceeded their expectations.



The survey also asked a set of open questions to obtain qualitative data. A full list of the questions and the key answers can be found in appendix A. The key themes from these questions are summarized below:

Things the program did well:

- 1) The majority of students have the ambition to further their education in renewable energy and to educate the community about its importance
- 2) The students saw the skills and knowledge they learnt as valuable and relevant to their lives, with 100% of respondents stating they will use the skills in the following year
- 3) The students enjoyed the practical workshops and projects, especially learning how to design renewable energy systems
- 4) The students found the Solar Energy Module particularly useful and relevant.

Things the program needs to improve on:

- 1) The theory sessions could have been shorter and backed up with more practical examples
- 2) The learning hours should have been shorter to allow the students to tend to their personal and professional obligations outside of the programme. This was a particular issue for local farmers as they can only work on their farms during daylight hours.
- 3) The Wind Module and particularly the Solar Module would have benefited from being longer, to allow for more detailed practical work and prolonged testing
- 4) The IT workshops were too complicated for some respondents, and to ensure all students benefit equally from these sessions they should have been longer and started at a more basic level
- 5) Ensuring equal access to the course for people of all financial backgrounds and genders whilst also ensuring engagement levels are high.

The Dream Renewables team are currently discussing how best to respond to this feedback and adapt the 2020 Programme accordingly.

Energy assessment of Meet Me There

Lodge

One of the students, Bright Mensah, excelled in the programme. He was recently contracted by Meet Me There Lodge to conduct an energy assessment of the entire complex, which includes a library, community learning centre, bar, kitchen and guest house. This energy assessment was passed on to a local renewable energy company who have designed and quoted for a solar panel and battery system to cover all the electricity needs of the complex.

An anemometer was installed at the learning centre as part of the programme. Data from this anemometer can now be used to assess the potential for a small wind turbine, which could provide electricity for Meet Me There Lodge during cloudy days of the year.

We hope to keep Bright and other students involved in this project as it develops.

Students become the teachers

Just one month after the completion of the programme a group of students started passing on their knowledge. On October 16th 2019 they took it upon themselves to teach a lesson about renewable energy at a local school. During this time, they carried out an energy assessment of the school, aiming to design a renewable energy system to supply the school with much-needed electricity. Dream Renewables are currently awaiting their designs and hope to assist the group in raising funding to build the system in 2020.



Meet Me There African Home Lodge, which is soon to be powered by a renewable energy system



Bright, Denis, Theophilus and Promise teaching renewable energy at a local school

Creating job opportunities

In November 2019 we were thrilled to learn that Florence, one of the volunteer teaching assistants who helped to deliver our Dream Renewables programme, has found employment with SUKA Wind & Solar Energy Ltd (Ghana) as a solar project engineer. SUKA was one of the sponsors for Dream Renewables and met Florence when they gave a presentation to course participants at the Meet Me There Community Learning Centre.

She is undergoing an 'on the job' training programme in the installation and design of Solar PV systems, including engineering design, health and safety, and electrical installation. We are so proud of Florence and look forward to having a solar design engineer teach on the 2020 programme.

In addition, we are currently supporting two participants of the programme in finding internships within the industry.

A national award for one of our volunteers

We are very happy for Nadia Smith, who was awarded the 2019 Community Energy Young Champion Award at the Community Energy England annual awards ceremony. The award recognised her volunteering work for Dream Renewables and a local community energy NGO.

We are delighted that we have been able to support Nadia in achieving this award, and appreciate the publicity generated for Dream Renewables as a result of this award.



Florence taking a selfie in her new job as solar design and installation engineer



Nadia with a group of students

Project fundraising and cost

Fundraising 2019

Funding came from four sources; corporate sponsorship, sponsored events, volunteer contributions and the UK charity, Dream Big Ghana Foundation.

Corporate sponsorship (ChargedUp)	£500
Sponsored Event 1	£443
Sponsored Event 2	£2027
Volunteer Contributions	£1,725
Dream Big Ghana Foundation	£3170

Budget 2019

The project came in under budget thanks to a significant reduction in teaching and volunteer costs. This was due to reduced flight costs for UK volunteers, a favourable exchange rate, and a discount on food and accommodation for Ghanaian volunteers from Meet Me There Lodge. The budget for equipment and running costs ran £700 over budget due to additional travel costs and volunteer team building sessions that were not built into the initial budget.

	Actual expenditure	Budget
Total	£7,865.10	£8,822
Total materials, equipment and running costs	£3,547	£2,670
Volunteer team building activities	£148.75	£0
Materials	£2,841.07	£2,719.07
Transport and logistics	£557.03	£0
Total teacher and volunteer expenses	£4317	£6,152
Ghanaian volunteers' accommodation	£1,406.25	
UK volunteers' expenses	£2,911.00	

Dream Renewables 2020

Fundraising 2020

The 2020 programme is not yet finalised and fully budgeted. However, the team are confident that we can run our second programme for 25 students at a similar cost. We are hoping to generate a higher percentage of funds through corporate sponsorship from existing and new relationships. Our target fundraising for 2020 is shown below:

Corporate sponsorship (various)	£5,000
Sponsored events	£1,500
Volunteer Contributions	£1,200
Dream Big Ghana Foundation	£1,000

The 2020 programme

Dream Renewables will be running its second programme at Meet Me There African Home Lodge in 2020. The team have held two meetings to determine what the 2020 programme should look like and will be holding further meetings in January 2020 to finalise the plans.

We currently plan to run 2 programmes in parallel:

- 1) A 4-week solar energy programme aimed at scientific SHS graduates and University Students, including:
 - At least 4 practical workshops
 - More in-depth solar theory lessons
 - A solar energy case study, including detailed demand assessment and solar PV system design
 - We are considering whether to include a week-long IT skills module.
- 2) We also plan to work with the alumni from the 2019 programme to help install a renewable energy system in the community. This will help to further build the skills and experience of the alumni and refresh their knowledge.

Responding to feedback

We have made the following changes responding directly to feedback from students:

- To finish at 2 pm to allow the farmers crucial time to tend to their crops
- To allow more time for the solar module
- To allow more time for the Energy Challenge week
- Should the IT workshops be included, to make them a more significant part of the programme and to provide booster sessions and foundation courses for those who are less computer literate.

Appendix A: Qualitative data from the feedback survey

Q1: Will you use any of the skills and knowledge learnt on this course in the coming year, if yes, how?

All participants answered yes to this question and the following ideas were highlighted:

- educating the community in renewables
- attending further training
- setting up demonstration solar PV system
- research and advocate for fuel efficient stoves

Q2: After completion of the programme what impact would you like to have on the community?

- educate the community on solar energy
- start a small solar energy business in the village
- set up a solar panel demonstration site in the village

Q3: Which parts of the programme went the best?

- solar PV module, system design
- wind turbine workshop
- all the practical work
- electrical workshops and theory
- demand profile calculation

Q4: Which aspects of the course could have been longer or shorter?

- theory sessions could have been shorter
- practical sessions could have been longer
- wind and solar Modules should be longer
- Excel workshops should have been longer

Q5: Do you have any general comments about the course?

'in all, the experience was terrific and we hope to cruise more into renewable energy world'

- some material started running out in the last week

Q6: What could we do better next time?

- more practical work
- shorter learning hours (to accommodate farmers schedules)
- advertise the programme early to allow time to prepare
- more business and entrepreneurship classes
- spend more time teaching IT skills