(Cooperative Agreement No. AID-OAA-L-11-00005
Leader With Associates- LWA)

Final Report

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Submitted to:

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Abbreviations

AA	Associate Award (USAID award)
ADB	Asian Development Bank
AECT	Association for Educational Communications and Technology
AOR	Agreement Officer's Representative (USAID)
ANU	Acharya Nagarjuna University (India)
ASEE	American Society for Engineering Education
ASU	Arizona State University
DANIDA	Danish International Development Agency
ECOWAS	Economic Community of West African States
EU	European Union
FNU	Fiji National University
FY	Fiscal Year
GEA	Guyana Energy Agency
GERMI	Gujarat Energy Research and Management Institute
GIZ	German Corporation for International Cooperation (English translation)
IRELP	IRENA's Renewable Energy Learning Partnership
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of nature
JICA	Japan International Cooperation Agency
LESSP	Liberia Energy Sector Support Project (Liberia)
LWA	Leader with Associates
MOU	Memorandum of Understanding
NAST	Nepal Academy of Science and Technology
NSF	National Science Foundation
NZMFAT	New Zealand Ministry of Foreign Affairs and Trade
PCC	Palau Community College
PEER	Partnership for Enhanced Engagement in Research
PI	Principal Investigator
PDM	Training for Policy and Decision Makers
PNGUT (UNITECH)	Papua New Guinea University of Technology
PV	Photovoltaic
RREA	Rural and Renewable Energy Agency (Liberia)
SINU	Solomon Islands National University
SME	Subject Matter Expert
SPC	Secretariat of the South Pacific
TCH	Technician and Operator Training
TIST	Tonga Institute of Science and Technology
TTT	Train-the-Trainer Training
USAID	United States Agency for International Development

USGLC	United States Global Leadership Coalition
USP	The University of the South Pacific
VAT	Value Added Tax
VIT	Vanuatu Institute of Technology
VLE	Virtual Learning Environment
VOCTEC	Vocational Training and Education for Clean Energy
WI	Winrock International

Contents

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Vocational Training and Education for Clean Energy (VOCTEC)

(Cooperative Agreement No. AID-OAA-L-11-00005
Leader With Associates- LWA)

I Executive Summary

Objectives of the Project

Developing countries routinely face problems of maintenance and operation for clean energy installations. Many projects fail because they lack personnel with the knowledge and skills to design, install and maintain clean energy systems. In developing countries, creating a trained workforce in the clean energy sector has remained a challenge due to inadequate training infrastructure and weak institutional capacity. Available trainings are often project based, which are not sustainable, and do not create sustainable local capacity in the communities.

The USAID-funded global Vocational Training and Education for Clean Energy (VOCTEC) Leader With Associates (LWA) program, under the leadership of Arizona State University (ASU) and its partners Green Empowerment and Appalachian State University, was designed to address the above problems, and improve sustainability of renewable energy infrastructure in developing countries.

The five-year program, which lasted from April 27, 2011 to April 26, 2016, contained the following six interconnected components:

1. Initial assessment, evaluation and project planning
2. Curriculum and training program development
3. Training equipment and facilities development
4. Accreditation support
5. On-line learning, collaboration and dissemination
6. Advancing gender-conscious programming

The actual implementation of the LWA project included all of these components, except providing accreditation support. Limited accreditation-related support was provided to partners in the Pacific through the Associate Award. Further, the LWA project had only limited

implementation of the on-line learning component mainly due to inadequate interest on the part of the training participants, and the lack of high speed, and widely available internet connections in countries in the Pacific, and in Liberia.

To achieve the objectives of the program, VOCTEC was designed as a multi-tier vocational training program that included three training levels: trainings for Technicians (TCH), Train-The-Trainer (TTT), and educational workshops for Policy and Decision Makers (PDM). The program's focus was on sustainable renewable energy systems, specifically solar photovoltaic (PV), micro-hydro, and wind energy systems, as well as hybrid systems utilizing any combinations of these technologies. VOCTEC training incorporated gender-awareness elements in the curriculum to promote access for and participation of women in vocational education for renewable energy technologies. The trainings also included an entrepreneurship module to provide basic knowledge about business practice to the trainees.

On August 10, 2012, affiliated to the LWA, VOCTEC received an Associate Award - Cooperative Agreement (AA) No. AID-492-LA-12-00002, titled "Pacific Islands Renewable Energy Technical and Vocational Education and Training Project," funded through the USAID Mission in the Philippines. The Pacific AA program also drew support from the LWA funds for the preparatory work in curriculum and for the delivery of some of the trainings.

The VOCTEC LWA program successfully implemented the trainings in all three technologies (solar PV, small wind and micro-hydro), and in all three training categories in the Pacific, Latin America, Africa and South Asia. During the course of the project period, VOCTEC implemented its programs in 15 countries: ten in the Pacific, four in Africa and South Asia, and one in Latin America.

Curricula and Training Center Development

VOCTEC developed baseline curricula in the three renewable energy technologies (off-grid solar PV, small wind, and micro-hydro). The curricula were built for three levels of training: policy and decision makers (PDM), train-the-trainer (TTT), and technician level (TCH). Whereas the PDM courses were lecture heavy with some hands-on modules, the course-work for the TTT and TCH trainings included classroom lectures and hand-on exercises, each taking about half of the total course duration.

The PDM program was directed at high level public and private administrators and business leaders, and was conducted in a workshop format lasting 2-3 days. The TTT trainings lasted about one and half to two weeks, and trained educators to drastically expand the training of

technicians. The TCH trainings lasted one week and trained the workforce, which actually designed, installed, operated, and maintained the clean energy systems. Most of the TCH trainings were performed by the educators trained under the TTT program.

VOCTEC developed training centers to facilitate local and regional training programs in a sustained manner, and equipped the centers with curriculum, equipment, manuals and other training materials.

As the solar TTT level course became the most popular program, VOCTEC designed and developed a portable laboratory kit for the solar PV training called the mobile training toolkit (MTT). It includes 31 components (e.g., solar panels, charge controller, inverter, battery, measuring tools, and wires) in a sturdy, rolling suitcase that can be fairly easily transported to remote locations. Each MTT provided a laboratory to train up to six TTT or TCH level trainees on solar PV system design, installation and maintenance. The ease of transportation and efficacy of this tool-kit made it possible for the program and its partners to not have to rely on local infrastructure (which is often limited). More importantly, it also considerably speeded up the implementation of the trainings. Key components in the MTT were selected after testing for their suitability for the specific climatic conditions in the region where trainings were planned.

VOCTEC also designed two short video games for solar technology trainings to help reinforce the knowledge the participants gained in the classroom and practical exercises. The solar training instructors and technicians played the games as a part of their TTT training. The games were provided on-line and on USB's to the participants, who used them to supplement their teaching of the technicians (TCH). The games are freely available on the VOCTEC website (http://voctec.asu.edu/gaming).

Many VOCTEC partners continue to use the curricula, and equipment provided by the VOCTEC program to train new generations of trainers and technicians. For example, Strathmore University in Nairobi uses the VOCTEC curriculum and MTTs to continue their solar trainings in Kenya. Many VOCTEC alumni have also succeeded in their professional and trade. For example, one alumnus from the first VOCTEC training in Kenya has been promoted to become a lead trainer, another alumnus has become the chief technical officer of a well-respected local private company, and yet a few more have organized to form a non-profit organization to continue the task of training women solar technicians and entrepreneurs in Kenya.

Accomplishments

Overall, the VOCTEC LWA and AA programs combined provided a total of 28,464 person-hours of training. The LWA program alone achieved 17,344 person-hours of training to individuals, out of which 7,662 person-hours (44% of the total) were to women. VOCTEC succeeded in the recruitment of a large number of women (total 150) in solar trainings by conducting specialized trainings for women with female instructors. The program conducted three all-women solar trainings in Kenya, and one each in Nepal and India (the latter with 83% women participation).

The framework used to conduct the assessment and evaluation of the VOCTEC training programs is adapted from Kirkpatrick model and consists of four focus areas:

1) Reaction, measures the participants' perception of and satisfaction with the design of the training program and delivery of content
2) Learning, measures the extent to which the participants acquire new knowledge and skills
3) Behavior, measures the participants' perceived preparedness and confidence in their ability to apply and perform the newly learned knowledge and skills following the training
4) Impact of results, looks at the long term impact of the training on the participants' ability to recall and apply the knowledge and skills learned six months to a year after the training delivery

The data used to assess measures was collected via different assessment instruments administered throughout the duration of the trainings. In general, results from the data analysis indicate a high degree of participant satisfaction with the trainings at all three levels (average score 4.60 on a 5-point scale, 5 being very satisfied). Likewise, in terms of learning, post training results show positive increase in understanding and information recall in the assessed content areas during different workshops. In the case of solar PV, educator's post-training scores on technical content increased an average of 39%, while technician scores increased 69%. The trainees' feedback, assessments results, and insights gained from each of the trainings have been used not only to examine the effectiveness of the training program but also to improve and modify future trainings.

The LWA project developed one regional training center at The University of the South Pacific (USP) in Fiji and five national clean energy training centers at: Fiji National University (FNU); Tonga Institute of Science and Technology (TIST); Strathmore University (SU) in Kenya; and

Gujarat Energy Research Management Institute (GERMI) in India; and Nepal Academy of Science and Technology (NAST).

VOCTEC was successful in leveraging approximately US $982,000 from non-U.S. government sources to expand and sustain the renewable energy capacity building programs during the life of the LWA project. In addition, with funding support from other partners, VOCTEC is already expanding its reach to West Africa and the Caribbean, thereby creating a much larger longitudinal impact from the USAID funding.

VOCTEC's successes were most pronounced in the recruitment of a large number of women in the trainings, leveraging significant non-US governmental funding to expand the program, crafting curriculums relevant to local situation, creating MTTs to ease the implementation of solar trainings, and building the capacity of local partners to conduct trainings on their own. In addition, VOCTEC carried out an extensive dissemination and experience sharing program through webinars, live seminars, website, printed brochure, publication and conference participation.

-End of executive summary-

1. Introduction

Clean energy provides employment and business opportunities and drives economic growth and helps societies prosper. In order to build and maintain clean energy infrastructure, a nation must ensure that its workforce possesses the skills and techniques necessary to design, install and maintain the energy systems and the ability to transfer those skills to future generations as technology progresses. Too many clean energy projects fail because they lack personnel with the knowledge and skills to design, install and maintain clean energy systems. In most developing countries, creating a trained workforce in the clean energy sector is a challenge, in part due to inadequate training infrastructure and weak institutional capacity. Any existing trainings are often project based, which are not sustained, and do not create sustainable local capacity in the communities.

The USAID-funded global Vocational Training and Education for Clean Energy (VOCTEC) Leader With Associates (LWA) program (April 2011 - April 2016), under the leadership of Arizona State University and its partners Green Empowerment and Appalachian State University, aimed to improve sustainability of renewable energy infrastructure in developing countries by increasing local awareness, knowledge and capacity via clean energy trainings.

In 2012, the USAID Regional Development Mission for Asia in the Philippines awarded ASU a two-year associate cooperative agreement entitled “Pacific Islands Renewable Energy Technical and Vocational Education and Training Project (Pacific Islands VOCTEC.)” The associate award working with the LWA was designed to help the Pacific nations overcome the barriers to clean energy development in the region.

In 2013, VOCTEC received an additional funding from the New Zealand Ministry of Foreign Affairs and Trade (NZ-MFAT) to support the VOCTEC Pacific program. This additional funding was blended into the Associate Award to expand the training program to a total of 10 Pacific nations.

2. Overall Summary of Implementation

The VOCTEC program successfully completed the development of training materials, and delivered trainings in all three VOCTEC technologies in 15 countries in the Pacific, South America, Africa and South Asia. Ten countries were in the Pacific—Fiji, Solomon Islands, Vanuatu, Tonga, Federation of Micronesia, Republic of Marshall Islands, Palau, Samoa, Kiribati, and Papua New Guinea)--and the others were Guyana in Latin America, Liberia and Kenya in Africa, and Nepal and India in South Asia.

A. Three Levels of Training

VOCTEC designed and developed three levels of trainings in three different clean energy technologies: solar photovoltaic, small wind and micro-hydro. The trainings were developed in three levels: Policy and Decision-Makers (PDM), Train-the-Trainer (TTT) and Technician (TCH).

The Policy-Makers trainings (PDM) were designed to provide decision makers better understanding of the technical aspects of the energy technologies (solar, wind or micro-hydro), and help them learn about design and siting needs, cost and economic viability issues, and socio-economic and environmental impacts related to renewable energy projects. The PDM participants also learned about the potential trade-offs in utilizing different types of renewable energy technologies, and factors related to utilizing multiple technologies that might be most suitable for their specific conditions. The PDM trainings lasted two to three days.

The Train-the-Trainer level (TTT) trainings were aimed at educators and provided them an in-depth knowledge of the energy technology, equipped them with the curriculum and participant assessment methodology, and highlighted the importance of gender inclusion and entrepreneurship in the trainings. The trainings aimed to ensure that the participants gained mastery of both the lecture and the hands-on sections of the course, so that they could later teach it to technicians. The length of these trainings varied between one and a half to two weeks, depending on the level of knowledge and skills of the participants.

The technician (TCH) level trainings were designed for the members of the workforce that would be directly involved in installing, operating and maintaining the renewable energy systems. The trainings spanned at least 40 hours of contact, which included lectures and hands-on lab exercises, divided almost equally.

Table 1 below gives the break-down of the number of trainings held and number of individuals trained by the VOCTEC program. For the TTT, number under LWA program includes the number of trainees who were also partially supported by the Associate Award.

Training Level	Total No. of Trainings (LWA +AA)	No. of Trainings for LWA program	Total Number Trained (LWA+AA)	Total number trained by LWA program
Policy Makers (PDM)	4	4	115	115
Train-The-Trainer (TTT)	9	9	200	200

Training Level	Total No. of Trainings (LWA +AA)	No. of Trainings for LWA program	Total Number Trained (LWA+AA)	Total number trained by LWA program
Technicians (TCH)	24	5	320	103
Total	**37**	**18**	**635**	**418**

Table 1: Number of trainings and participants by training levels

B. Training Locations and Years

Table 2 below shows the locations, types and dates of VOCTEC trainings implemented.

Training Level	Solar PV	Wind	Micro-hydro
Policy Makers (PDM)	Guyana – 2012	Fiji – 2014 Nepal – 2015	Fiji – 2014
Train-The-Trainer (TTT)	Fiji – 2013 & 2014 Palau - 2014 India – 2014 Kenya – 2014 Kenya – 2015 & 2016 (both **all women**) Nepal – 2015 India – 2016 (**83% women**)		
Technicians (TCH)	Tonga, Fiji, Vanuatu, Solomon Islands – 2013 Samoa, Kiribati, Marshall Islands, Federated States of Micronesia, Palau, PNG – 2014 Kenya – 2015 (**all women**) Nepal - 2015 (**all women**)		Liberia – 2014 Solomon Is. – 2015

Table 2. Location, types and dates of LWA trainings

C. Performance Indicators

Table 3 below shows the performance indicators for the VOCTEC project. It provides data on the number of courses developed, total person hours trained (split by males and females), number of institutions with improved capacity, and number of training centers established.

The number of courses developed includes the courses that were developed for the three different technologies, three different training levels and as they were customized for different regions.

The number of institutions with improved capacity denotes the approximate number of institutions which sent participants for the TTT trainings.

The number of training centers established lists the institutions that the LWA supported by providing equipment, course materials and other training resources.

Indicator No.	Indicator Description	FY11 Results	FY12 Results	FY13 Results	FY14 Results	FY15 Results	FY16 Results	Life of Project- **Actual**	Life of Project **Target**	Remarks
1.1	No of courses developed and delivered (by Technology)	0	1	2	4	2	6	15	11	Courses in different technologies, and training levels modified for different regions
1.2	Person-hours of training completed (Men/Women)	0	280 (210/70)	1,280 (1,040/240)	3,224 (2,992/232)	2,752 (1,280/1,472)	9,808 (4,160/5,648)	17,344 (9,682/7,662)	2,520 (1,966/554)	Person-hours of training provided under LWA greatly exceeded the initial target of 1,966 person-hours
1.4	No. of local institutions with improved capacity	0	5	10	30	30	50	125	19	Institutions sending participants (approx.)
3.1	No of clean energy training centers established	0	0	3	2	1	0	6	5	Including Associate Award funded training centers, the total is 14
2.2	Participation of women in L-2 and L-1 trainings (target)		17% (NA)	16% (20%)	6% (25%)	53% (30%)	65% (35%)	44% (average)	27.5% (average)	Average for total is calculated from person-hours of training

Table 3. Performance indicators: targets and actual results

3. Summary of Accomplishments

A. Development of Curriculum

For the VOCTEC LWA program, ASU and its partners, Green Empowerment and Appalachian State University, developed the baseline curriculum in the three renewable energy technologies (micro-hydro, solar PV and small wind). The curriculum was built for three levels of training: policy and decision makers (PDM), Train-the-trainer (TTT), and technician level (TCH). Whereas the PDM courses were lecture heavy with some hands-on modules, the course-work for the TTT and TCH trainings included classroom lectures and hand-on exercises, each taking about half of the total course duration. The curricula was developed by subject matter experts in the VOCTEC team, and were refined with the feedback from the people who regularly deliver such trainings internationally. Modules were customized to fit regional needs, and were revised based on the feedback from the training participants.

As solar became the most popular training program, VOCTEC developed curricula for all three tiers of solar training. For Micro-hydro curricula, courses were developed for policy makers (PDM) and technician (TCH) level trainings. Because of the limited demand for train-the-trainer (TTT) and technician level (TCH) training for small wind, the wind curriculum was developed only for the policy maker's (PDM) level.

The PDM curricula for all three technologies included introductions to the respective clean energy technologies, site selection criteria, environmental and social impacts, financial feasibility and a review of actual case studies. The delivery included lecture presentations by experts, and computer-based hands-on exercises for the participants. The curriculum also provided the participants concepts on the suitability of a particular type of clean energy system (solar, micro-hydro or wind, or hybrid forms) for any specific situation. Finally, a site visit to an actual installation of the relevant clean energy gave the participants an opportunity to see the application of the theories discussed in the workshop.

The solar TTT trainings lasted about one and a half to two weeks, and trained educators so that they could in turn deliver trainings to technicians. The TTT curriculum included theory and practical exercises in equal ratio. The curriculum had three main components: basic technical modules to include the engineering aspects of solar energy designed for the technicians, non-technical modules (gender awareness, entrepreneurship, communication), and advanced technical modules for the educators. The curriculum included the entire syllabus that the educators would teach to the technicians (TCH), while the advanced modules were designed to

deepen their knowledge of the solar energy systems. A sample schedule of training is attached in the appendix.

The one-week long solar TCH curriculum includes the basics of electricity, solar radiation, batteries, charge controllers, inverters, system sizing, trouble shooting, and gender awareness, entrepreneurship, and effective communication. The solar TCH curriculum is complemented by two video games related to off-grid solar PV systems: one on system sizing and one on trouble shooting. Participants found the video games effective in reinforcing their classroom and laboratory learning. The games can be found at http://voctec.asu.edu/gaming

For small wind, only PDM level courses were developed. The curriculum includes wind turbine types, wind tower heights and types, calculation of the feasibility of small wind projects on a given site, estimation of annual energy production, and use of high resolution wind data. For PDM courses in micro-hydro, a similar curriculum addressing the micro-hydro technologies is adopted.

The TCH micro-hydro curriculum included resource and demand assessments, micro-hydro systems components, economics and finance, feasibility, design, installation, operation and maintenance, environmental assessments, and comparison of micro-hydro systems with other forms of renewable energy. A sample training schedule is attached in the appendix.

Since the solar PV trainings were in high demand, the VOCTEC team devised a mobile training toolkit (MTT) to support the training. MTT is a portable laboratory fully sufficient to support the training of solar technicians in remote areas. The MTT weighs 65 Kilograms and has 31 elements neatly organized in a sturdy box fitted with rollers. It is accompanied by a user-friendly, outdoor suitable and visually rich training manual, which includes a step-by-step user guide for setting up the MTT and numerous detailed solar PV hands-on exercises organized by training topics, plus worksheets for the instructor and students. MTTs provide a platform to train around four to six technicians at a time, allowing the participants to gain practical experience in solar PV installations and operations.

B. Development of Training Centers

VOCTEC developed local training centers to facilitate local and regional training programs in a sustained manner, and equipped the centers with curriculum, equipment, manuals and other training materials. VOCTEC trained key educators from the training centers to help them run future trainings in their respective centers.

All LWA training partner institutions were developed as training centers, while The University of the South Pacific (USP) in Suva, Fiji was developed as a regional hub for trainings in the Pacific. USP is a regional university with its main campus in Suva, Fiji and satellite campuses in many countries, and has the reputation as one of the best universities in the region. On two different occasions, VOCTEC brought educators from other collaborating institutions in the Pacific to USP and trained them as trainers.

VOCTEC provided the training centers equipment, hardware and software to support lab infrastructure towards enhancing their training capacity. All partners who organized solar PV trainings received three or more mobile training toolkits (MTTs). In addition, as a part of ASU's cost-share obligations, VOCTEC shipped 30 solar panels to The University of the South Pacific (USP); 10 solar panels each to Fiji National University (FNU); Tonga Institute of Technology (TIST); University of Technology, Papua New Guinea; Strathmore University (SU) in Kenya; and Gujarat Energy Research and Management Institute (GERMI) in India. Through a separate agreement, all partners, who received the solar panels, agreed to utilize them for the solar training purposes only.

The MTT was popular with the VOCTEC trainers and trainees. With USAID LWA funding, ASU provided 16 MTTs to the partners in five countries, where we implemented solar trainings. Appendix II provides the list of institutions that received MTTs from the LWA program. Through the Associate Award, VOCTEC provided an additional 36 MTTs to the partners in the Pacific region. To date, with additional funding from other sponsors, we have provided a total of approximately 100 MTTs to various institutions. The institutions that have received the MTTs continue to use them for trainings of local technicians.

C. Partnerships and Training Implementation

VOCTEC LWA program developed partnerships with various educational institutions in the Pacific, Guyana, Liberia, Kenya, India and Nepal to help build clean energy capacity in the respective regions centers. Table 4 lists the LWA partners in respective countries.

Country	Name of the training partner Institution
Fiji	The University of the South Pacific; and Fiji National University
Tonga	Tonga Institute of Science and technology
Solomon Islands	IUCN Oceania Regional Office
Liberia	Rural and Renewable Energy Agency, and Liberia Energy Sector Support Project
Kenya	Strathmore University
India	Gujarat Energy Research and Management Institute, and Acharya Nagarjuna University
Nepal	Nepal Academy of Science and technology

Table 4: Training partner institutions by country

The training partners were selected on the basis of several criteria, including the following:

- Focus on renewable energy training, current and future interest.
- Convenient and central location that served the area, region and the country.
- Existence of at least some infrastructure for training, including educators with background in renewable energy or related technologies.
- Desire to partner with VOCTEC, and when possible, contribute in-kind or direct funding for trainings, and take ownership of the training program.
- Willingness to enter into MoU and agreement with VOCTEC to conduct collaborative and unassisted trainings.
- Commitment to conducting future trainings on their own after the VOCTEC-supported trainings were completed.

Once the partnership was agreed upon in principle, VOCTEC and the respective partners signed MoUs to advance the collaboration. Subsequently, a consolidated agreement was signed which specified that the partners will use any MTT, hardware or equipment provided by VOCTEC for educational and training purposes only. The agreement further stipulated that the partner will provide support in the preparation, delivery and assessment of the training. VOCTEC provided all partners training curriculum, assessment materials, and support to conduct the VOCTEC-supported trainings. Where solar PV trainings were held, VOCTEC provided MTTs and accompanying manuals to the institutions, and to some, it provided additional equipment and solar panels for permanent keeping.

The partner institutions organized all the local logistics of the training including securing an appropriate venue, identifying field visit sites, providing support staff and co-instructors, advertising for and selecting participants, and organizing transportation, food and lodging arrangements for the participants.

VOCTEC provided training curricula to the partner institutions once VOCTEC staff had trained educators there (typically at least three from each institution). With the first-hand experience of VOCTEC training, the alumni were in a position to advance VOCTEC trainings in their respective institutions. The partners found that the structured VOCTEC curriculum offered the participants an ideal opportunity to link the theory and practice in a lab-like situation. We have received anecdotal feedback that some of our Pacific partners continue to use our curriculum and MTTs to train additional educators in the solar PV technology.

The collaborative trainings also drew participants from private sector businesses. We have learned that some of the VOCTEC training alumni have been promoted to important positions.

For example, in Nairobi, one of our training alumni became the chief technical officer of a reputed private solar company, and another became the lead trainer in the partner university itself. In India, some alumni from the first training in 2014 became the solar trainers for the subsequent TTT trainings, and were promoted within their organizations.

To promote sustainability of the program, VOCTEC encouraged all partners to integrate the VOCTEC curriculum into their own academic and training programs, and worked with the VOCTEC-trained educators and staff to help them organize their own trainings. In some instances, we also supported our partners' requests for competitive allied funding for training programs from other sources. For example, Strathmore University (SU), applied for the NSF PEER (National Science Foundation - Partnership for Enhanced Engagement in Research) funding, and with ASU's support, won an award for $120,000 for a two-year program. This funding allowed SU to greatly expand its training and outreach programs in solar energy. The objectives of the PEER project were consistent with the sustainability goals of VOCTEC, helping SU to build a stronger infrastructure for future solar trainings.

After attending the VOCTEC trainings, some educators have integrated the material and knowledge into additional short trainings and semester long university courses (e.g., Solomon Islands National University, University of the South Pacific, Tonga Institute for Science and Technology). These institutions have also used the improved institutional training infrastructure (e.g. mobile training toolkits) in their courses.

The list of VOCTEC LWA local partners and the trainings conducted by them is provided in Appendix I.

D. Dissemination

The VOCTEC team utilized several tools to disseminate the lessons learned from the implementation of the project. The tools included development of a website, provision of live seminars and webinars, presentation of papers in conferences, publications, creation of a virtual learning platform, and distribution of printed materials.

VOCTEC website

The VOCTEC team developed a website (http://voctec.asu.edu) to promote and provide information on the program's activities and to share images, videos, news items, and other pertinent information. The website was also designed to help market the VOCTEC program, ensuring its sustainability.

The VOCTEC website is continually updated to include information and data about current and future trainings. The site also includes stories and images related to the VOCTEC program, links to news items on our trainings, and interviews with VOCTEC managers and experts. It provides information on the MTT, links to the video games, and informs readers on the upcoming training programs. The website also has a link where visitors can reach the VOCTEC team to ask questions, and receive feedback.

The website enjoys a healthy visitorship. Besides the US, visitors come mainly from the countries where VOCTEC has organized trainings. As shown in table 5 below, most of the visitors are from the US followed by India, Kenya, Fiji, Australia, United Kingdom, Germany, Netherlands, Solomon Islands, and China. Table 5 shows the web traffic generated for the period of April 2011 to March 2016.

The average visit duration to the website was 4.04 minutes, which indicates that visitors not only just browsed, but also spent time reading the contents.

Country	No of Users
USA	3,208
India	409
Kenya	311
Fiji	245
Australia	119
United Kingdom	110
Germany	93
Netherlands	86
Solomon Islands	72
China	62
Unspecified, other	1,576
Total	**6,291**

Table 5: VOCTEC website visit by country

Virtual Learning Environment (VLE):

The VOCTEC team created the VLE (http://voctec.asu.edu/virtual-learning) site for graduates of the VOCTEC TTT programs so that they could have an online platform to access updated course materials, end-user posters and any new and relevant information related to the VOCTEC training programs. During the five years of the project, approximately 150 TTT training graduates utilized the platform for the advancement of their knowledge. ASU intends to maintain the site for some time even after the end of the USAID funding period.

The use of VLE in the Pacific was initially lower than expected due to the unavailability or slow speed of the internet. However, after the LWA-funded micro-hydro workshop in Nadi, Fiji several participants registered for the VLE. The VLE access in Kenya, India, and Nepal was more robust than in the Pacific. Kenya has 32 VLE registered users, India 14 and Nepal seven.

Videos, Pictures and Brochure

Pictures of trainings are interspersed on the VOCTEC website, and other media. These were also shared with the partners, USAID and VOCTEC team members. Some of the VOCTEC training pictures have been uploaded onto USAID and Power Africa websites. Please see the links below.

https://www.usaid.gov/powerafrica/photocontest
https://www.usaid.gov/powerafrica/gender

The VOCTEC program also prepared four videos related to the trainings and its impact. The training of the first TTT solar training in Suva, Fiji has been uploaded onto the voctec.asu.edu website. In addition, the following videos are available on the web.

USAID trains solar technicians in Pacific island nations, 2014
https://www.usaid.gov/energy/video/voctec/solar-technician-training-pacific-islands

VOCTEC Micro-Hydro Training - Liberia, January 2014
https://www.youtube.com/watch?v=rR320AUbam4

VOCTEC all-women technician training – Strathmore University, Nairobi, Kenya, 2015.
https://www.youtube.com/watch?v=mNbFkcAYkYQ

The VOCTEC program also printed hard copies of brochures providing a summary of the program, and distributed them widely. Brochures were handed out to individuals during the trainings, and at the meetings VOCTEC staff held with external agencies, such as potential donors, partners, government officials and private sector leaders.

Webinars, Exhibits, Conferences and Awards

VOCTEC was able to widely disseminate its experiences and lessons learned to stakeholders through different platforms such as webinars, conferences and exhibits. Some examples are given below.

- VOCTEC organized webinars in collaboration with several different organizations, including IRENA (International Renewable Energy Agency), WindAid, ASU and the United Nations Foundation.

- The VOCTEC program was presented at various conference paper/ presentations/exhibits, including at: Association for Educational Communications and Technology (AECT), American Society for Engineering Education (ASEE), and the United States Global Leadership Coalition (USGLC).
- VOCTEC participated in exhibits at ASU 2014, and the Pacific Energy Summit hosted by the government of New Zealand and the European Union in Auckland in 2013.
- VOCTEC won the ASEE conference best paper award from the Energy Conversion and Conservation Division (ECCD), and the paper was nominated for the best diversity paper award for 2015.
- VOCTEC received the Energy Globe National Award for the MTTs in the Federated States of Micronesia in 2015. The award was given to recognize the contribution of the MTT in solar PV trainings in the Pacific.

4. Assessment, Evaluation and Indicators

A. Assessment and Evaluation Framework

The framework, illustrated in Figure 1, that was used to conduct the assessment and evaluation of the VOCTEC training programs, is based on the Kirkpatrick's Evaluation model. The model consists of four focus areas, namely:

1. ***Reaction:*** measures the participants' perception of and satisfaction with the design of the training program and delivery of content
2. ***Learning:*** measures the extent to which the participants acquire new knowledge and skills
3. ***Behavior:*** measures the participants' perceived preparedness and confidence in their ability to apply and perform the newly learned knowledge and skills following the training
4. ***Impact***: looks at the long term effect of the training on the participants' ability to recall and apply the knowledge and skills learned six months to a year after the training delivery

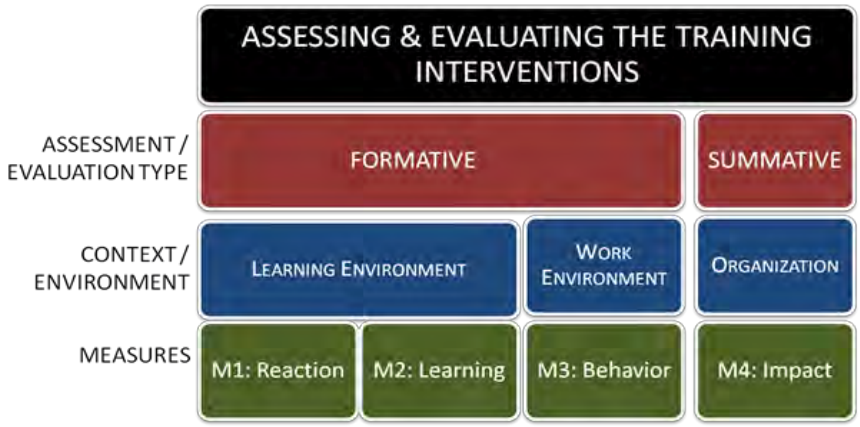

Figure 1: Assessment and Evaluation Framework

The first three measures, M1 - reaction, M2 - learning and M3 – behavior, were successfully applied during the training workshops (see tables below). However, even with all the attempts made, collecting assessment measures for M4 –longitudinal impact at institutional level, was challenging due to several reasons (e.g. participants relocating and changing contact addresses). Despite these challenges, we were able to analyze the impacts at some of the institutions, which are reported below.

Data throughout the trainings was collected using different assessment instruments based on the level of the training (i.e., train-the-trainer (TTT), technician (TCH), or policy makers (DPM)). Assessment instruments included knowledge and application assessments (e.g., pre- and post-assessments, hands-on evaluation) for different content areas (non-technical, technical, and advanced topics), and surveys (e.g., background, behavioral/attitudinal).

The tables below summarize the trainings by level and the results of their respective measures.

Solar PV TTT Trainings

For TTT trainings, M1-Reaction, M2-Learning, and M3-Behavior measures were applied. Overall, the increase in knowledge (M2) from before (pre-assessment) the trainings to after (post-assessment) the trainings was significant in the three content areas (non-technical, technical, and advanced topics) in all the regions. Results also indicate a very high degree of educators' satisfaction (M1) with the training workshop and a high level of preparedness (M3) to teach technician solar PV courses. Appendix III lists selected quotes from the training participants. Table 6 summarizes the results of the TTT trainings.

Training	No. of trainees	Mean Non-tech Level Pre-test Scores[a]	Mean Non-tech Level Post-test Scores	% increase from pre to post	Mean Tech Level Pre-test Scores	Mean Tech Level Post-test Scores	% increase from pre to post	Mean Adv-Level Pre-Test Scores	Mean Adv-Level Post-Test scores	% increase from pre to post	Overall Satisfaction[b]	Preparedness[c] to teach technician solar PV courses
Fiji 2013	16 (2F)	81.16	83.16	2.50	NA[d]	88.00	NA	70.00	87.00	24.30	4.67	2.75
Fiji 2014	14 (M)	61.00	71.00	16.40	53.00	84.00	58.50	73.00	86.00	17.80	4.77	2.82
Palau 2014	3 (M)	64.00	100	56.25	90.00	100	11.11	60.00	90.00	50.00	4.92	2.33
India 2014	26 (5F)	54.50	64.00	17.43	65.40	81.50	24.62	69.80	89.00	27.50	4.65	2.35
Kenya 2014	14 (1F)	57.61	70.65	22.63	68.63	85.30	24.30	54.93	85.20	55.11	4.75	2.87
Kenya 2015	18 (F)	69.44	73.00	5.00	65.19	78.25	20.01	58.02	80.86	39.36	4.64	2.61
Nepal 2015	23 (2F)	56.87	79.80	40.32	61.10	81.23	33.00	41.48	82.30	98.40	4.40	2.65
India 2016	23 (18F)	57.54	61.38	6.70	52.25	73.15	40.00	50.00	78.44	56.88	4.46	2.61
Kenya 2016	26 (F)	59.24	70.00	16.82	52.02	74.00	42.23	51.37	72.50	41.06	4.82	2.75

Table 6: Summary assessment results of TTT trainings

[a] All scores are in percentage
[b] Overall satisfaction is measured on a 5-point scale, 5 being the highest
[c] Preparedness is measured on a 3-point scale, 3 being the highest
[d] The pre-assessment for the technical content was not administered in Fiji 2013 training (i.e., first TTT training)

In some instances, VOCTEC was successful in collecting knowledge acquisition data 6-9 months post-training to measure trainees' ability to recall information and attainment of knowledge. In the cases where this data was collected (e.g., Fiji 2013, Fiji 2014, and Kenya 2014), results show that the trainees' knowledge level was maintained even after the passage of time (i.e., average score of the post-test and the long-term knowledge acquisition assessment were similar). Many attempts were made to collect this data for other train-the-trainer (TTT) graduates but with no success due to similar reasons to collecting the impact measures (M4).

TCH (Technician Trainings)

M1-Reaction, M2-Learning, and M3-Behavior measures were also applied for the TCH trainings. In terms of learning (M2) for the technician level trainings, pre- and post-knowledge were measured for the technical content only. Results show that there was a statistically significant change in the technicians' knowledge from before the training to after the training in all the training countries. By the end of the trainings, participants showed very high confidence (M3) in their abilities to apply the skills learned during the trainings and they were very satisfied (M1) with the overall training program. Table 7 shows the results of the technician level trainings.

Training	Type of training	No. of Trainees	Mean Tech Level Pre-test Scores[a]	Mean Tech Level Post-test Scores	% increase from pre to post	Overall Satisfaction[b]	Confidence[c] to apply the skills learned
Tonga 2013	Solar PV	15 (3F)	38.10	83.33	119	4.43	4.42
Liberia 2014	Micro-hydro	20 (1F)	45.66	85.00	86.16	4.66	4.53
Solomon Islands 2015	Micro-hydro	30 (M)	53.01	76.13	43.61	4.61	4.75
Kenya 2015	Solar PV	19 (F)	59.37	87.44	47.28	4.60	4.37
Nepal 2016	Solar PV	19 (F)	59.36	87.44	47.28	4.75	4.55

Table 7: Summary assessment results of technician level trainings

[a] All scores are in percentage
[b] Overall satisfaction is measured on a 5-point scale, 5 being the highest
[c] Confidence is measured on a 3-point scale, 3 being the highest

PDM (Policy-Maker Workshops)

For the PDM trainings, M1-Reaction and M2-Learning (for technical content) measures were applied. The overall results show that the increase in knowledge (M2) from the pre- to the post-assessment was significant for all the trainings. Results also indicate a very high degree of policy makers' satisfaction (M1) with the training workshop. Table 8 displays the results of the PDM trainings in different countries.

Training	Type of training	No. of Trainees	Mean Tech Level Pre-test Scores[a]	Mean Tech Level Post-test Scores	% increase from pre to post	Overall Satisfaction[b]
Guyana 2012	Solar PV	35 (5F)	NA[c]	76.00	NA	4.40
Fiji 2014	Wind	24 (2F)	62.00	72.00	16.13	4.30
Fiji 2014	Micro-hydro	32 (2F)	63.58	76.20	19.90	4.33
Nepal 2015	Wind	27 (2F)	62.10	78.00	25.60	4.45

Table 8: Summary assessment results for policy-makers workshops

[a] All scores are in percentage
[b] Overall satisfaction is measured on a 5-point scale, 5 being the highest
[c] The pre-assessment for was not administered in Guyana 2012 training (i.e., first PDM training)

5. Successes and Challenges

A. Engaging and Leveraging Funding from Other Donors

The VOCTEC program developed collaborative opportunities with USAID country missions, and external donor agencies to provide improved training to operators and technicians in several countries. VOCTEC has expanded the scope of the training and geographical regions of implementation beyond those specified under USAID funding. This was done with the aid of other sponsors that allowed VOCTEC to build upon the strong foundation of the USAID-funded part of the program. Examples of agencies with whom VOCTEC collaborated include: International Union of Conservation of Nature (IUCN), Secretariat of the Pacific (SPC), European Union (EU), New Zealand Ministry of Foreign Affairs and Trade (NZ-MFAT), Inter-American Development Bank (IDB), Asian Development Bank (ADB), Danish Agency for International Development (DANIDA), European Union (EU), Government of Barbados, German Corporation for International Cooperation (GIZ), and International Renewable Energy Agency (IRENA).

The following provides example of some of VOCTEC's collaboration with external funding agencies.

VOCTEC's collaboration with the Abu Dhabi based International Renewable Energy Agency (IRENA) resulted in the completion of the following three programs.

- Entrepreneurship training in Vanuatu and Solomon Islands (2013). Majority of the participants in the trainings were women.
- Advisory service to IRENA to implement its IRELP (IRENA Renewable Energy Learning Partnership) program for its global activities in creating discussion groups for renewable energy enthusiasts, and for promoting renewable energy investments in developing countries (2014-15).
- Development of a solar technician certification program for the 15-member Economic Community of West African States (ECOWAS) member countries in West Africa (2014-16).

In 2014, the VOCTEC program secured a significant amount of funding from the IDB to implement a three-year renewable energy capacity building program in three countries in the Caribbean (Jamaica, Barbados, and Trinidad and Tobago). Additionally, in 2015, VOCTEC obtained IDB support through the Government of Barbados to develop a Competency Based Training Facility for renewable energy programs in the region. The Competency-Based Training Fund (CBTF) is a key component of the *Skills for the Future* initiative, which is sponsored by the Barbados Government with loan funding from the IDB designed to enhance the effectiveness of Technical and Vocational Education and Training (TVET).

In 2014, VOCTEC obtained supplemental funding from the ADB for supporting the solar training at GERMI in India. The ADB funds were used to defray the participants' local costs.

VOCTEC is currently conducting training assessments and delivery for clean energy systems in Cote d'Ivoire and Sierra Leone.

Table 9 below summarizes the amount of funds (approximated and rounded to thousands) leveraged for capacity building programs in clean energy in developing countries, which materialized directly as the result of our work from USAID's funding.

Project Name	FY 14	FY15	FY16	Total
IRENA IRELP		$20,000		$20,000
IRENA West Africa Solar Certification		$50,000	$50,000	$100,000
IRENA- Pacific entrepreneurship training	$45,000			$45,000
IDB Caribbean (BRIDGE Project)	$50,000	$150,000	$150,000	$350,000
IDB Funded- Competency Based Certification, Caribbean		$65,000	$60,000	$125,000
ADB Contribution to GERMI training		$10,000		$10,000
Value of Contribution by IUCN Oceania		$30,000	$30,000	$60,000
Value of Contribution by GERMI (Gujarat Energy Research and Management Institute)		$7,500	$7,500	$15,000
Value of Contribution by, Strathmore University, Kenya	$7,500	$7,500	$15,000	$30,000
Value of Contribution by NAST (Nepal Academy of Science and Technology), Kathmandu			$22,500	$22,500
PPG Global, Ivory Coast - solar training			65,000	65,000
IBIS-DANIDA, Sierra Leone solar training			140,000	140,000
Total (Approx.)	**$102,500**	**$340,000**	**$540,000**	**$982,500**

Table 9. Non-US government funds leveraged by the VOCTEC program

B. Recruitment of women in training

VOCTEC succeeded in recruiting women and creating some all-women's solar trainings in Kenya, Nepal and India. Our partners in these three countries were enthusiastic in implementing all-women trainings, and felt inspired to organize more trainings for women in the future. The all-women's trainings brought many benefits to the local communities.

The all-women trainings were created to drastically enhance the participation of women in clean technologies. We learned that mixed-gender trainings often made women feel intimidated to join the technology trainings. An all-women's training taught by female instructors was found to be much more conducive to attracting women to fully participate in the program, and motivated them to apply for available training slots.

Shown below are some of the impacts of the all-women's trainings in Kenya:

- The 2015 April training alumni formed a group called WISE (Women in Sustainable Energy and Entrepreneurship) to train women in Kenya. The objectives are:
  A. increase numbers of women entrepreneurs in renewable energy
  B. provide quality solar PV solutions to customers
  C. provide sustainable energy solutions that are particularly useful to women

D. build capacity of women in low-income communities in Kenya

- Three Kenyan female VOCTEC alumni, all members of WISE, have been certified as solar technicians, seven have passed oral exams, and several others were appointed in technical jobs since participating in VOCTEC training. Our partner Strathmore University has also promoted one of its female junior engineers to a full trainer.

C. Challenges, and Responses

The following paragraphs describe some of the challenges the VOCTEC program faced and how the program overcame the barriers:

- Recruiting women in some programs (especially in the Pacific): Because of the low ratio of women in academia related to energy technologies and in electrical trade and engineering fields, VOCTEC initially found it difficult to recruit women participants for its trainings. The VOCTEC program was able to surmount this problem in Kenya, India and Nepal by reaching out to women more widely, and by creating women-only trainings.

- Finding training candidates with appropriate background skills: VOCTEC responded to this problem by conducting a wider search and seeking help from local institutional partners to recruit qualified participants.

- Organizing training logistics in remote locations: VOCTEC was able to organize successful trainings by shipping equipment in time, asking local partners to clear the customs and book the training venue in advance. VOCTEC overcame these problems in the Pacific by hiring a local coordinator. In Kenya, India and Nepal, the VOCTEC team began the preparation with a very long lead time (typically, 4-6 months).

- Slow response and limited communication: Some partners in developing countries did not communicate swiftly, making it hard to organize the trainings in a timely fashion. Resolving this problem required creating a long lead time and following up regularly.

- Advanced availability of funds for operations: Some local partners were unable to mobilize funds in advance to prepare for the training. ASU was unable to advance funds to them because of its internal regulations disallowing disbursements of funds before the partners completed the trainings. ASU was able to overcome this barrier by awarding sub-grant funds in tranches: first tranche to be delivered upon completion of the training preparation, and second tranche, upon the completion of the training.

- Collecting long-term impact assessments: Although many attempts were made to collect the assessment measures for impact at institutional level, following up with institutions and graduates was challenging due to several reasons (e.g. participants relocating and changing contact addresses). Despite the challenges, VOCTEC was able to examine the impacts at some of the institutions as reported above. For future trainings, the host institutions should be responsible for conducting the impact assessments and following up with their graduates.

- The VOCTEC team made strong efforts to secure additional Associate Awards. We were not successful due to the changing needs of the USAID missions, and the evolving national markets for the VOCTEC-specific trainings. However, by successfully organizing three all-women solar trainings in Kenya, VOCTEC is well-poised to support possible future capacity building programs in East Africa. Some organizations and agencies based in Uganda and Kenya have indicated strong interest to utilize VOCTEC services in the future.

6. Major Lessons Learned, and Recommendations

The following paragraphs summarize the major lessons learned from the program, and our recommendations for organizing future trainings.

A. Ship training equipment and materials early

The VOCTEC project staff organized shipping and freight requirements for the project. This primarily involved shipping the mobile training toolkits (MTTs) from the ASU campus to the recipient institutions in the Pacific, Africa and Asia. In several countries in the Pacific, Kenya, India and Nepal, the local customs often held the MTTs for a long period of time before releasing them.

We have learned that in order to arrive on time, any equipment needed for trainings should be shipped far in advance (preferably around three months in advance).

B. Require the local partner to clear customs and pay VAT

In many countries, even the equipment used for educational purposes can be taxed at the customs. Often, even if the local USAID mission wants to help in getting the customs waived for training equipment, the local customs office may not agree. We found that it is best to ask the local partner to pay and obtain the custom release for the equipment. The agreement with the local training partners must clearly indicate that the partner will be responsible for getting the equipment released from customs and will pay any applicable Value Added Tax (VAT) or excise taxes.

C. Create local partnerships and demarcate responsibilities

In order to have smooth institutional partnerships, VOCTEC delegated several tasks and responsibilities to its partners. The tasks delegated were based on discussions between VOCTEC and the partner institutions.

D. Select an appropriate season for training delivery

Most training dates were selected to ensure that they were held during summer, or breaks in the semester to allow participants from educational institutions to be able to attend the educator course (1.5) weeks without adversely impacting their teaching duties.

Some remote locations (especially for hydro trainings) are inaccessible in rainy seasons. The training times have to be organized in dry season because of this reason. For example, the VOCTEC micro-hydro training planned in May at Yandohun, Liberia was moved to January to avoid the rainy season. Yandohun is accessible only by a dirt road from Liberia's capital Monrovia.

E. Cast a wide net for recruiting women

After successful organization of all-women trainings in Kenya, Nepal and India, VOCTEC recommends the following steps to enhance female participation in technical training:

- Mobilizing partner networks
- Advertising widely, and target to women
- Make the program, venue and schedule workable and attractive to women
- Advertise the trainings as "women-only" training events--this helps the potential female trainee to feel more comfortable in joining the training
- Employ women trainers when feasible, as the women participants are often inspired by, and find it easier to relate to, female instructors.

F. Provide extensive opportunities for hands-on training

In technical trainings, employ about 50-50 percent time for lectures and hands-on activities. The hands-on exercises helped the attendees actually put what they have learned into practice. For example, in India, Nepal and Kenya, where we had many highly educated participants (including some PhDs), they told us that though they had studied the theory, they rarely had access to

equipment to gain practical knowledge and appreciated the opportunity to practice hands-on exercises.

VOCTEC recommends to provide equipment such as the MTTs to the partner institutions for future solar training efforts.

G. Include site visits in the training program

Training events should contain a dedicated time for site visits and walk through of nearby installations, so that the participants can see where the project is following best practices and where it can be improved.

Site visits were organized to see nearby solar PV installations in solar trainings, micro-hydro plants in the micro-hydro trainings, and small wind systems during the wind trainings conducted by VOCTEC. Participants enjoyed those visits and many remarked that it greatly helped them in understanding the theory of the renewable energy technologies.

7. Conclusions

The VOCTEC team successfully completed the implementation of this project designed to strengthen local capacity to operate and maintain renewable energy systems, thereby increasing sustainability of renewable energy investments. We exceeded most targets proposed at the initiation of the project. Among the highlights of the successes were the ability of the team to organize all-women trainings in the solar PV area, to leverage additional funding to expand and sustain the capacity building program, development of the MTT, and to successfully disseminate the lessons learned from the program to a wide variety of stakeholders.

We sincerely appreciate the constant guidance and help from our Agreement Officer's Representative (AOR), Ms. Pam Baldinger at USAID. The program would not have been successful without the collaboration and cooperation of educational partners, trainers, and sponsoring agencies, and the men and women who took time and made efforts to be trained and train others. We hope that the foundation laid by USAID and the VOCTEC program continues to grow and expand, and will have an exponential impact in the very near future.

-End of text-

Appendix I: List of VOCTEC LWA Partner Organizations and Trainings

1. Guyana – Guyana Energy Agency, Government of Guyana. The partnership was a two-day long policy level (PDM) training conducted in 2012.
2. Fiji -
    a. The University of the South Pacific (USP) - USP became VOCTEC's regional partner, where two regional TTT solar trainings and one TCH solar training was conducted.
    b. Fiji National University (FNU). FNU provided instructors for the TTT trainings held at USP. In addition, FNU also organized two TCH trainings in solar PV energy system.
3. Tonga - Tonga Institute of Science and Technology (TIST). TIST hosted two TCH level training.
4. Liberia - Rural and Renewable Energy Agency (RREA), and Liberia Energy Sector Support Program (LESSP), Monrovia. LESSP and RREA, organized one TCH micro-hydro training at Yandohun, Liberia.
5. Kenya - Strathmore University (SU), Nairobi. SU was one of the most enduring partners for VOCTEC. It hosted a total of four solar trainings (three TTT and one TCH), including three all-women trainings.
6. India – Gujarat Energy Research and Management Institute (GERMI), Gandhinagar. GERMI hosted two solar TTT trainings.
7. Nepal – Nepal Academy of Science and Technology (NAST). Kathmandu. NAST hosted three VOCTEC trainings. One PDM training on small wind energy systems, one TTT training in solar and a TCH all women solar technician training
8. Solomon Islands – International Union for Conservation of Nature (IUCN) Oceania Regional Office

Appendix II: MTT Inventory (LWA)

Partner Name	Number of MTTs	Any other equipment	Address
University of the South Pacific	4	Solar Panel donation	University of the South Pacific, Laucala Campus School of Engineering and Physics Laucala Bay Rd, Suva, Fiji Islands, FJ
Fiji National University (FNU)	3	Solar panel donation	Fiji National University Lot 1, Queens Road, Nadi, Fiji
Tonga Institute of Technology (TIST)	3	Solar panel donation	Tonga Institute of Technology (TIST) P.O. Box 750, 'Anana, Nuku'alofa Tongatapu, Tonga
Strathmore University	5	Solar Panel donation	Strathmore University Ole Sangale Rd Nairobi City, Kenya
Gujarat Energy Research and Management Institute (GERMI)	3	Solar Panel donation	GERMI 1st Floor, Energy Building, Pandit Deendayal Petroleum University Campus, Gandhinagar - 382007 Gujarat, India.
Nepal Academy of Science and Technology (NAST)	3		Nepal Academy of Science and Technology (NAST) GPO Box 3323 Khumaltar, Lalitpur Kathmandu, Nepal

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Appendix III: Sample Quotes from Participants

"Palau Community College is glad to be a part of the VOCTEC Program's advocacy and will continue to help achieve its goal by sustaining capacity building in the country."
- *Jerry Taroy, Electrical Trainer, Palau Community College, Palau.*

"Overall, the labs component was a huge success. The MTTs are a great resource and with the hard case and quality components will give us the best bet of surviving the conditions in the Islands."
- *Emeline Vakalahi, Head Electrical Trainer, Tonga Institute of Science and Technology, Tonga.*

"The way the program was conducted was so impressive, e.g., presenter very well informed, training material were available online and the new equipment for training were good and motivating."
- *Moses Ochieng Mitalo, Lecturer and Head of Electrical Engineering Department; Kenya Industrial Training Institute, Kenya.*

"As an energy engineer, I would like to thank the whole organization and training content providers. It was a very rich training to add on my profile and incorporate it much more practically in my field. Thank you very much for the organizers."
- *Tom Fred Ishugah, Energy Engineer, Kenyatta University, Kenya.*

"I found having a female instructor very motivating as it showed me even women can be professional installers and be the best in their field. Having fellow female participants created a less intimidating environment to share and get feedback."
- *Caroline Mwangi-Makenzi, Solar Engineer and Product Manager, David and Shirtliff, Ltd., Kenya.*

"Having lady instructors who were very good was encouraging to me and showed that it is possible for me to do the same. It was important to have an all women course in that we are able to share our challenges and we are about to form a women's group and in this network with all the many skills available we will be able to move forward stronger than just working individually"
- *Daisy Karimi Muthamia, Project Electrical Engineer; KETRACO, Kenya.*

"This micro-hydro workshop helped me very much to help build up our hydro. Similar trainings should be encouraged annually so that all operators and stakeholders can share their experiences and challenges."

- *Paul Hurutarau, Hydro Chairman, Solomon Islands.*

"The workshop was effective. The instructors were well-prepared and the materials were interesting. I enjoyed the training and it met my expectations."
- *Suraj Thapa, Director; Wind Energy Nepal PUT Ltd., Nepal.*

"The workshop is modeled very well for two days and to those who can't spend a week or a month in the training/workshop due to regular jobs. I am satisfied with the workshop organization as well."
- *Santosh Rai, Active Manager (Wind Energy); Alternative Energy Promotion Centre (AEPC), Nepal.*

"The training was very helpful to understand solar PV systems. All the content areas were interesting and trainers also worked hard to teach us how we operate our system for individual and industrial purposes. In the training, the practical exercises were very important and effective to understand the PV system in full. This training was useful."
- *Jaydeep Pandya, Electrical Engineer, Gujarat Energy Development Agency (GEDA), India.*

Appendix IV: Solar Train-the-Trainer sample curriculum

Sample: Solar PV Train-the-Trainer Workshop Schedule for Kenya (March 7 - 16, 2016)
Week 1

	Monday	Tuesday	Wednesday	Thursday	Friday
TIME	Day 1	Day 2	Day 3	Day 4	Day 5
8:30 AM	Welcome, introductions, Objectives and Agenda	Recap and Review of Day 1	Recap and Review of Day 2	Recap and Review of Day 3	Recap and Review of Day 4
9:00 AM		A. Social/Gender Inclusion B. Tools for Effective Teaching	5. System Components (PV modules)	8. Site Survey and shading Assessment	11. Inspection and Commissioning
9:50 AM	Background Survey				
10:00	Break	Break	Break	Break	Break
10:15 AM	VOCTEC Pre-Assessment	C. Solar Entreprenership D. Preparing for Technician Training (includes VOCTEC VLE module)	6. System Components (Batteries)	9. Energy Efficiency and PV System Sizing	12. Operations and Maintenance
11:00 AM	1. PV Markets and Applications	4. Solar Resources and Orientation	7. System Components (Controllers & Inverters)	10. Installation of Electrical and Mechanical Components	13. Common Failures and Troubleshooting
12:30	Lunch	Lunch	Lunch	Lunch	Lunch
13:30 - 15:30	2. Electricity Basics 3. PV Safety Basics Mobile Training Toolkit (MTT)	Hands-on Exercises	Hands-on Exercises	Sizing Game Hands-on Exercises	Troubleshooting Game Games' survey Hands-on Exercises
15:30	Break	Break	Break	Break	Break
15:45 - 17:30	MTT Set-up Hands-on Exercises	Hands-on Exercises (cont.)	Hands-on Exercises (cont.)	Hands-on Exercises (cont.)	Hands-on Exercises (cont.) Hands-on Assessment

Legend: Classroom (Technical) | Classroom (Non-Technical) | Lab/Field/Hands-on | Assessments/Quizzes | Review and Discussions | Games

Week 2

	Monday	Tuesday	Wednesday	Thursday	Friday
TIME	Day 6	Day 7	Day 8	Day 9	Day 10
8:30 AM	Recap of Week 1 Goals for Week 2	Recap and Review of Day 6			
9:00 AM	1. Advanced PV (Solar Radiation)	5. Advanced PV (Integration of Stand_Alone PV System)			
9:30 AM	2. Advanced PV (PV Modules)	6. Advanced PV (Energy Efficiency)			
10:00	Break	Break			
10:15 AM	3. Advanced PV (Batteries)	7. Advanced PV (Stand_Alone & Hybrid PV System Sizing)			
11:00 AM	4. Advanced PV (Controller & Inverter)	8. Advanced PV (Reliability and Standards)	Stand-alone Solar PV Site visit (t.b.c.)		
12:30	Lunch	Lunch			
13:30 - 15:15	Advanced PV Lab Exercises	Advanced PV Lab Exercises			
		Next Steps & future support by Strathmore (brief presentation)			
15:15	Break	Break			
15:30 - 17:30	Advanced PV Lab Exercises (cont.)	VOCTEC Post-Workshop Survey, instructor's Eval survey, Post-Assessment, and Certificate distribution			

Legend:	Classroom (Technical)	Classroom (Non-Technical)	Lab/Field/Hands-on	Assessments/Quizzes	Review and Discussions	Games

Appendix V: Micro-hydro Technician Training Sample Curriculum

Training Schedule Sample: Micro-Hydro Training for Technicians in Solomon Islands (Nov. 04-13, 2015)

	Wed day 1	Thu day 2	Fri day 3	Sat day 4	Sun	Mon day 5	Tue day 6	Wed day 7	Thu day 8	Fri day 9
8:30 - 9:00	Breakfast	Breakfast	Breakfast	Breakfast		Breakfast	Breakfast	Breakfast	Breakfast	Breakfast
9:00 - 9:30	M1 Introductions, Training Objectives, and Agenda	M4 catchment, M5 Weir, M6 channel & Forebay	Recap previous day	Recap previous day		40' MID POINT ASSESSMENT	Recap previous day	Recap previous day	Recap previous day	Open recap & discussion of the class - remaining Q&A
9:30 - 10:00			M11 turbines	M14 generators & 3 phase AC		M16 electrical layout of powerhouse	M17 Transmission & Distribution	M19 testing plant	M21 maintenance daily, monthly	
10:00-10:45	Pre-assessment	M7 penstock								40' FINAL/ POST ASSESSMENT
10:45-11:00	break	break	break	break		break	break	break	break	break
11:00 - 11:30	M2 social & gender implications of electricity projects	M8 powerhouse	M12 drives	M15 load controllers & ballast loads		M16 cont'd - switchboard	M17 Transmission & Distribution cont'd	M20 fault finding = troubleshooting	M22 operation of the MH plant	Evaluation by students
11:30 - 12:00		M9 powerhouse valve								Certificate distribution
12:00 - 13:00	lunch	lunch	lunch	lunch				lunch		lunch
13:00 - 13:30	M3 introduction to microhydro plant, power production, and demand	M10 pressure gauge	Tour of powerhouse turbine & drive, in-depth examination	Powerhouse generator, controller, ballast		Powerhouse electrical in-depth examination, measurements, wiring	Transmission & Distribution Practice	fault finding tour/ demo	Walking Tour for Testing, fault finding, maintenance planning practice	Dismantle class equipment
13:30 - 14:00		Tour of civil works, hands-on practice of flow measurement, monitoring and cleaning								
14:00 - 14:30							Tour of house & community building wiring		Walking Tour for maintenance plan pracice	Travel
14:30 - 15:00										
15:00 - 15:15	break	break	break	break		break	break	break	break	
15:15 -16:00	M3 continued, discussion	Tour of powerhouse, introduction to valves, gauge, etc.	Tour of powerhouse E-M, in-depth examination	Powerhouse generator, controller, ballast		Powerhouse electrical measurements, wiring	M18 House wiring good & bad	fault finding tour/ demo	practice operation of the plant	
16:00 - 16:30							House wiring Practice			
16:30 - 17:00	Daily discussion	Daily discussion	Daily discussion	Daily discussion		Daily discussion	Daily discussion	Daily discussion	Daily discussion	

color coding: classroom work: lectures /discussion/ practice | field work