SOLAR THERMAL TRAINING INITIATIVES IN BOTSWANA – THE CASE OF SOLTRAIN IV PROJECT

2nd INTERNATIONAL SUSTAINABLE ENERGY CONFERENCE 2022 HELD IN GRAZ, AUSTRIA

PRESENTED 07 APRIL 2022

Prof Kevin N. Nwaigwe, PhD
Manager, SOLTRAIN IV Project
Clean Energy Research Centre (CERC)
University of Botswana

Prof Oboetswe S. Motsamai, PhD
Director, Clean Energy Research Centre (CERC)
University of Botswana

Presentation Layout

- Introduction
- Solar Thermal Activities in Botswana
- Impact Assessment of SOLTRAIN IV in Botswana
- Conclusion
- References

Introduction

- Globally, there is a growing interest in the use of solar water heaters in households and industries. This is also the case in Botswana.
- Water heating constitute about 23% of the total energy usage in most households (Taylor, et al, 1991).
- This underscores the importance of use of solar energy for heating.
- Unfortunately, end-user experience with solar water heaters is very negative, particularly in most developing countries.
- This is mostly attributable to poor quality installation materials and poor workmanship.

Introduction

- In Botswana, the state of solar water heating technology for hot water preparation is best described as reflecting the general trend in developing countries.
- The absence or insufficiency of skilled manpower to design and maintain solar water heaters has cast a dark shadow on the uptake of solar water heaters.
- Prior experience of lack of maintenance of installed solar water heaters and poor quality of installed systems has further worsened end-user confidence in the use of solar water heaters.
- These challenges are the current situation that needs to be addressed if the mass rollout of solar water heating technology is envisaged.

Introduction

- The Botswana solar thermal technology roadmap targets the installation of 910,000 m^2 of collector area by 2030.
- This represents 0.3 m^2 of installed collector area per resident of Botswana by 2030
- It represents an installed capacity of 637MW_{th} and annual electricity savings of 5,490.3 GWh (using the Botswana Power Corporation pricing model of 2021 [1 kWh = 0.99839 Pula for average domestic consumers])
- Avoiding 182,000 tons of CO_2 every year

(Matlotse & Opok, 2018; Botswana Power Corporation, 2022).

Introduction

Table 1: Targets for yearly solar collector installations in Botswana

Year	Targets for annual solar collector installations [m²]
Total estimated installed collector area by 2017	5,000
2018	500
2019	900
2020	1,500
2021	3,000
2022	5,000
2023	8,000
2024	14,000
2025	25,000
2026	44,000
2027	78,000
2028	137,000
2029	240,000
2030	348,000
Total installed collector area by 2030	**910,000**

Introduction

Table 2: Targets for Solar Thermal Systems by sector

Sector	Options of SWH and/or Cooling Technologies	Estimate of systems to be installed [units]	Projected levels of collector areas to be installed to meet target projection [m^2]	Projected Solar yields and electricity savings [MWh/year]	Estimated Cost [Mill. EURO]	CO_2 Emissions Avoided [10^6*kg]
Residential houses for single family (including replacement)	Thermo-syphon systems 2-4 m^2	181,000	450,000	360,000	135	90,000
Multi-story Residential houses and Tourism Sector	Pumped Solar thermal -systems 10-20 m^2	11,000	230,000	115,000	184	46,000
Government Institutions (Educational institutions and Hospitals)	Pumped SWH systems 20-100 m^2	3,000	140,000	112,000	70	28,000
Industrial Commercial and Mining Sector	Large pumped SWH systems 50-500 m^2	500	45,000	36,000	27	9,000
Solar Water Heating, Cooling and Air Conditioning for hotels & lodges, and large offices	Large Pumped Solar Water Heating, Cooling and Air-conditioning Systems 50-500 m^2	500	45,000	36,000	45	9,000
TOTALS		**196,000**	**910,000**	**659,000**	**461**	**182,000**

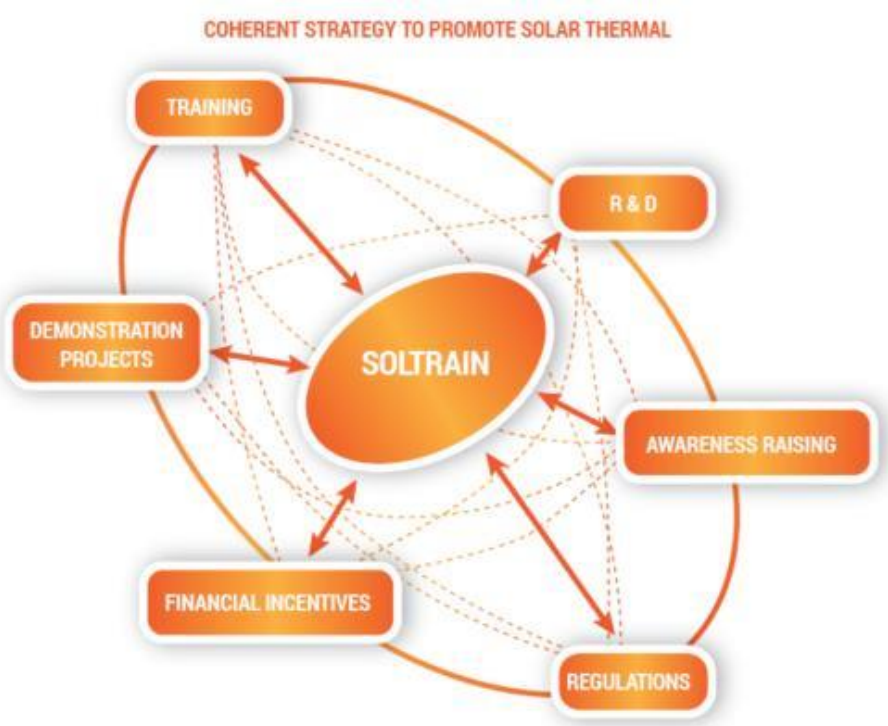
Introduction

- The Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) is a project funded by Austrian Development Agency (ADA).
- Implemented by AEE – Institute for Sustainable Technologies.
- In six Southern African countries – South Africa, Namibia, Lesotho, Botswana, Zimbabwe and Mozambique.
- The initiative started in 2009 and is currently in the fourth phase – SOLTRAIN IV (SOLTRAIN, 2019).
- Several activities have been implemented in partner countries under this project. This paper highlights activities of SOLTRAIN IV in Botswana.

SOLTRAIN

Southern African Solar Thermal Training and Demonstration Initiative

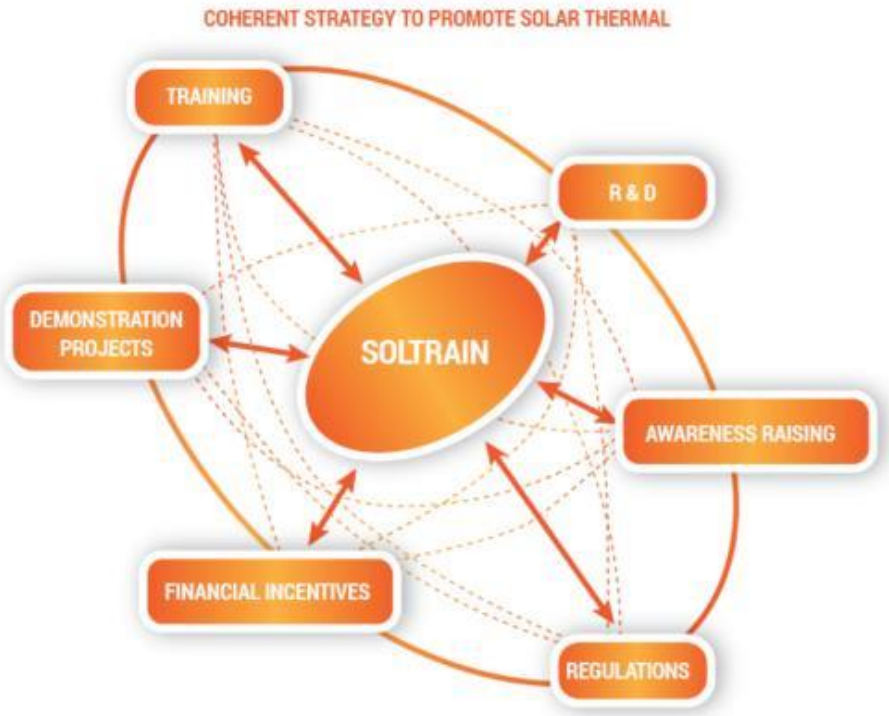
- Started in 2009
- Partner countries include South Africa, Namibia, Lesotho, Botswana, Zimbabwe, Mozambique
- Botswana joined in 2017 (phase 3)
- Phase 4 ending 2022 December



Solar Thermal Activities in Botswana

The activities of SOLTRAIN IV in Botswana are anchored under the following subsections:

- Training Programmes
- Research and Development
- Awareness Campaigns
- Policy/Regulations
- Demonstration Systems.



Solar Thermal Activities in Botswana

Training Activities

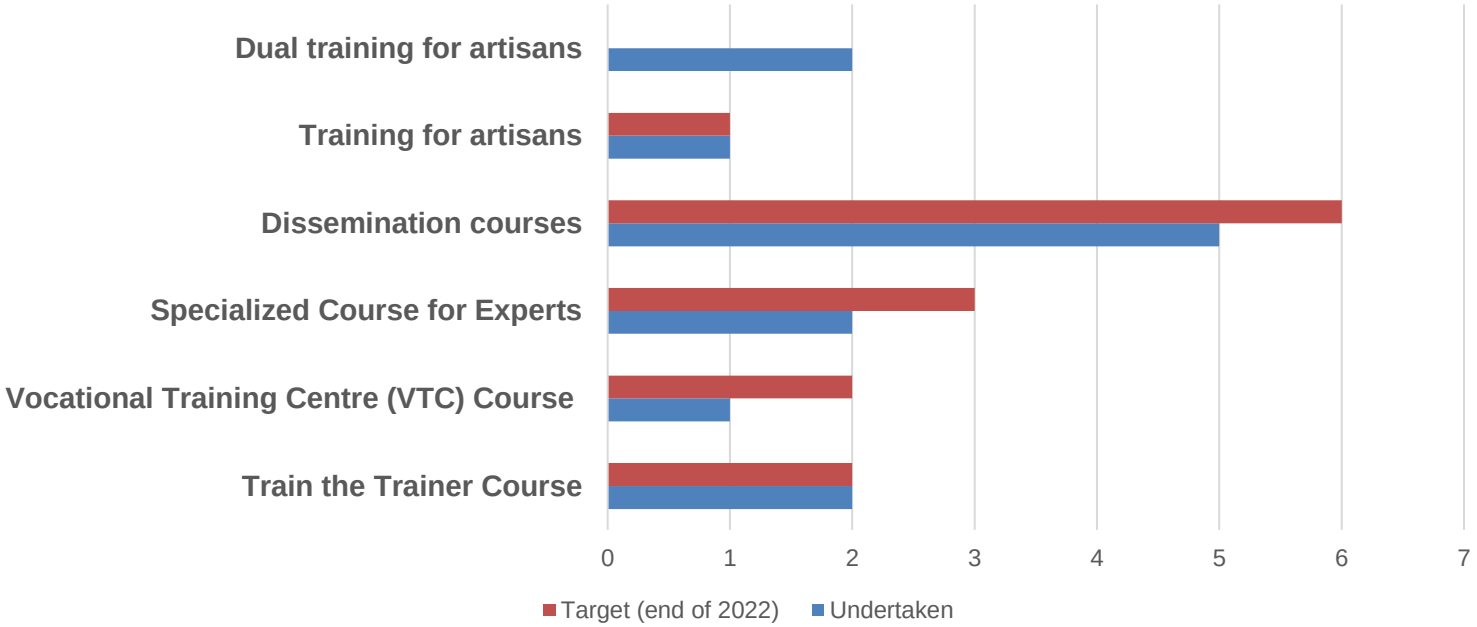


Figure 1: Number of organised training courses and number of targeted courses

Solar Thermal Activities in Botswana

Training Courses

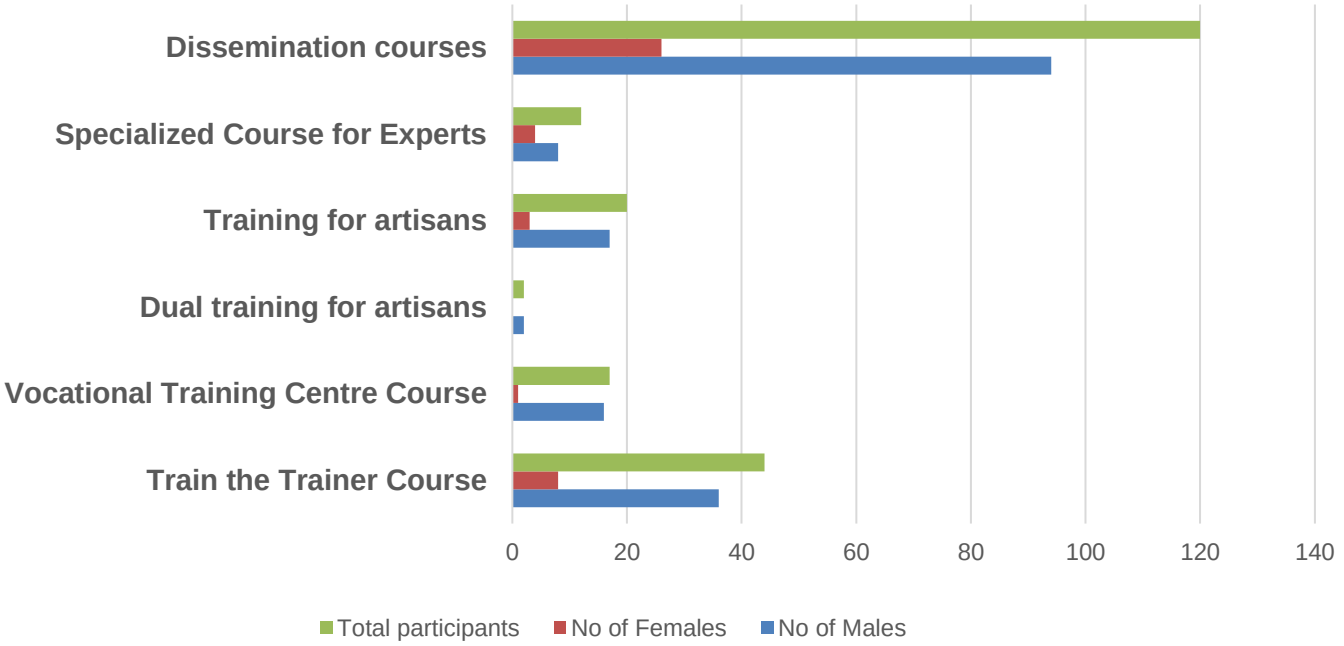


Figure 2: Number of participants to different training courses

Solar Thermal Activities in Botswana

Research and Development

- Through the graduate bursary program of SOLTRAIN, two graduate students have been assisted to undertake research in solar thermal technology.
- One of the bursary recipients undertook a study on potential analysis for solar thermal systems in the health sector.
- The work primarily aimed to document data on the state of hot water provision in hospitals.
- The work is a contribution to data availability and would be very useful to future researchers.
- The other recipient conducted applied research, developing a hybrid system for both water heating and water cooling using a shared collector.
- The study highlighted the possibility of using the solar thermal technology in a combination application that could be very useful for households in Botswana and elsewhere.
- The experimented concept could be prototyped and modified for possible roll-out as a solution in households.

Solar Thermal Activities in Botswana

Awareness Campaigns

Technical Tours for decision makers (4):

- Directors of three disability centres – Mochudi Resource Centre, Pudulogong Rehabilitation and Motswedi Rehabilitation Centre.
- Parliamentary Portfolio Committee (PPC) on Education. The PPC was led by the Minister of Tertiary Education, Research, Science and Technology, Botswana and hosted by the Vice Chancellor of University of Botswana.
- Policy makers from Botswana Energy Regulatory Authority (BERA), Department of Energy (DoE) and Department of Meteorological Services (DMS).
- Proprietors and management staff of public and private hospitals within Gaborone. The biggest private and public hospitals were in attendance including Princess Marina Hospital, Sidilega Hospital, Bokamoso Hospital, and Gaborone Private Hospital.

Trade Fairs/Trailer Exhibition:

- Botswana Tourism Road Show held in 2019 at Grand Palm Hotel, Gaborone.
- STEM 2020 Show, held virtually.
- In all these fairs, SOLTRAIN trailer equipped with a pumped solar water heater and a thermosyphon solar water heater was displayed.
- Similarly, the solar trailer was exhibited at various public events including
  - within the University of Botswana,
  - SOS Village - a social home for the disabled,
  - Botswana Defense Force headquarters.

Solar Thermal Activities in Botswana

Awareness Campaigns - Sector Information Workshops

- Table 3: Sector Information Workshops held in Botswana in SOLTRAIN IV

Sector	Date/Place
Social Homes	15 December 2020 University of Botswana
Housing Sector	25 February 2021 Online
Hospitality Sector – hotels and lodges	29 June 2021 Pra Hotel by Marriot, Masa Square, Gaborone
Botswana Defense Force	27 October 2021 BDF HQ, Gaborone
Hospitals	2 February 2022 University of Botswana
Education Sector	25 February 2022 Botho University

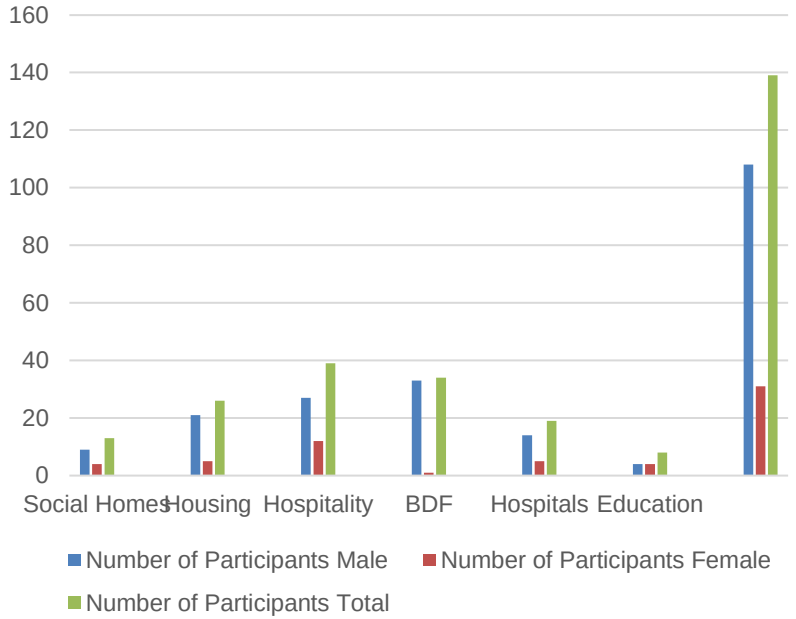


Figure 3: Participation distribution in sector information workshops

Solar Thermal Activities in Botswana

Policy Workshops

- A Botswana Solar Thermal Technology Roadmap (BSTTR) document was developed in phase 3 of the project.
- In phase 4, SOLTRAIN has undertaken to convert the developed roadmap into an implementable document – a bankable proposal.
- Towards achieving this aim, SOLTRAIN has solicited and attracted funding from United Nations Development Bank (UNDP) Botswana ($20K) for the procurement of a consultant.
- The consultant is currently working towards converting the roadmap into a bankable document.
- Additionally, four (4) policy workshops have been held towards mobilizing stakeholders for a successful implementation of the roadmap (see Table 4).

Solar Thermal Activities in Botswana

Policy Workshops

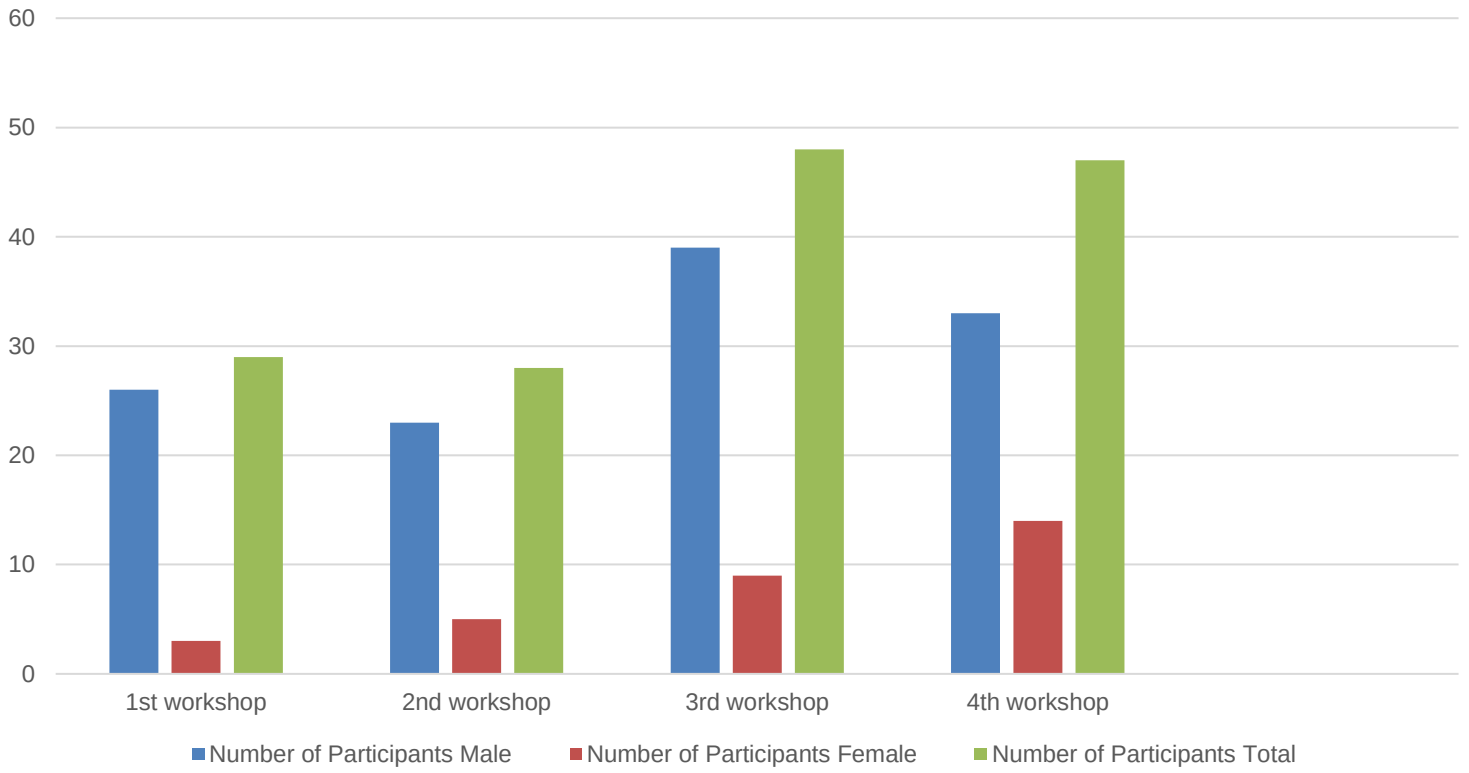
Table 4: Details of Policy Workshops held in SOLTRAIN IV

Workshop	Date	Venue	Major Highlight	Number of Participants		
				Male	Female	Total
1st Policy Workshop	9 September 2020	University of Botswana	Presentation of the BSTTR document to stakeholders	26	3	29
2nd Policy Workshop	8 February 2021	Online	Formation of steering committee to develop terms of reference (ToR) for development of bankable proposal	23	5	28
3rd Policy Workshop	8 September 2021	Online	Development of Terms of Reference (ToR) for bankable proposal and call for funding for a consultant	39	9	48
4th Policy Workshop	3 March 2022	University of Botswana	UNDP accepted call to fund a consultant. Consultant hired and already working; presented inception report.	33	14	47*
TOTAL				121	31	152

- *The 4th policy workshop was a hybrid (online/on-site) and some online participants were not captured in the attendance.

Solar Thermal Activities in Botswana

Policy Workshops



- Figure 4: Attendance pattern to policy workshops in SOLTRAIN IV

Solar Thermal Activities in Botswana

Demonstration Projects

- Like other partner countries, Botswana has benefitted from demonstration projects under the SOLTRAIN IV scheme.
- In this scheme, SOLTRAIN co-funds (to a maximum of 50%) the installation of solar water heaters within a defined flagship district – greater Gaborone.
- Beneficiaries could include social institutions, hospitals, clinics, communities as well as small enterprises located within greater Gaborone. Special focus is on institutions that support women (AEE INTEC, 2019).
- A total of 5 units have been installed within SOLTRAIN IV, totalling 14.2 m^2 collector area.
- Another 30 units totalling 76 m^2 collector area has been approved for installation.
- Similarly, another 20 units of 50 m^2 collector area has also been approved for installation.
- In SOLTRAIN III, 3 units totalling 122 m^2 collector area was installed in Botswana.
- By the completion of the installation of the approved systems so far, a total collector area of 262.2 m^2 representing 58 units would have been installed in Botswana.

Benefits of SOLTRAIN Demonstration System

SOLTRAIN INSTALLATIONS

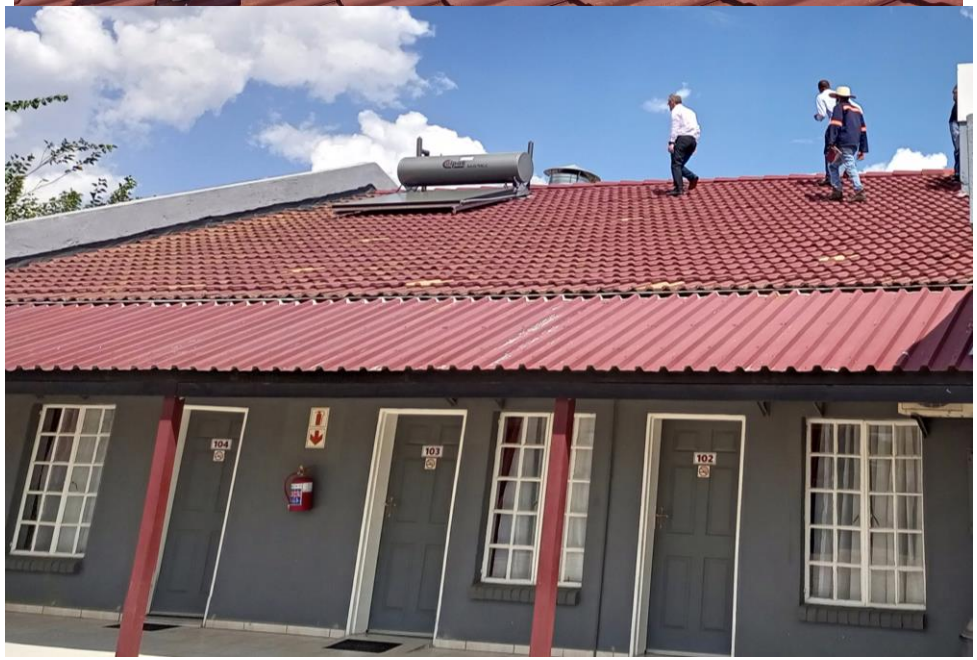
- Maru-a-Pula School
  - Girls hostel with installed collector area of 24 square metres, with a 2000L storage tank.
  - Boys hostel with installed collector area of 30 square metres, with a 2000L storage tank.

SOLTRAIN INSTALLATIONS

- Laundry Africa
  - A 4000L indirect pumped system and collector area of 63 square metres

SOLTRAIN INSTALLATIONS

- Platinum Hotel
  - five indirect thermosyphon system consisting of 3 x 300 litre and 2 x 200 litre units.



Impact Assessment of SOLTRAIN IV in Botswana

- Using training activities, at least 215 experts (80.5% males; 19.5% females) have so far been trained in solar water heating technology within SOLTRAIN IV.

- Decision makers from the public sector and the private sector have been sensitized about the importance and applications of the solar thermal technology.

- At least 139 people (77.7% males and 22.3% females) have attended an information workshop organised by SOLTRAIN IV. Additionally, an uncountable number of residents have been reached through fairs, exhibitions, and publications.

- A direct offshoot of awareness drive in the maintenance of quality is the current activity of Botswana Bureau of Standards (BOBS) towards developing standards to guide the solar thermal sector.

- SOLTRAIN IV has provided training for a significant membership of the task team towards this activity, including the Technical Secretary.

Impact Assessment of SOLTRAIN IV in Botswana

- A total of 262.2 m^2 collector area have been approved in SOLTRAIN IV, an increase of **115%** compared to SOLTRAIN III.

- This is a marked improvement in the impact of the advocacy of SOLTRAIN IV. It also reflects a significant positive shift of perception by the end-users.

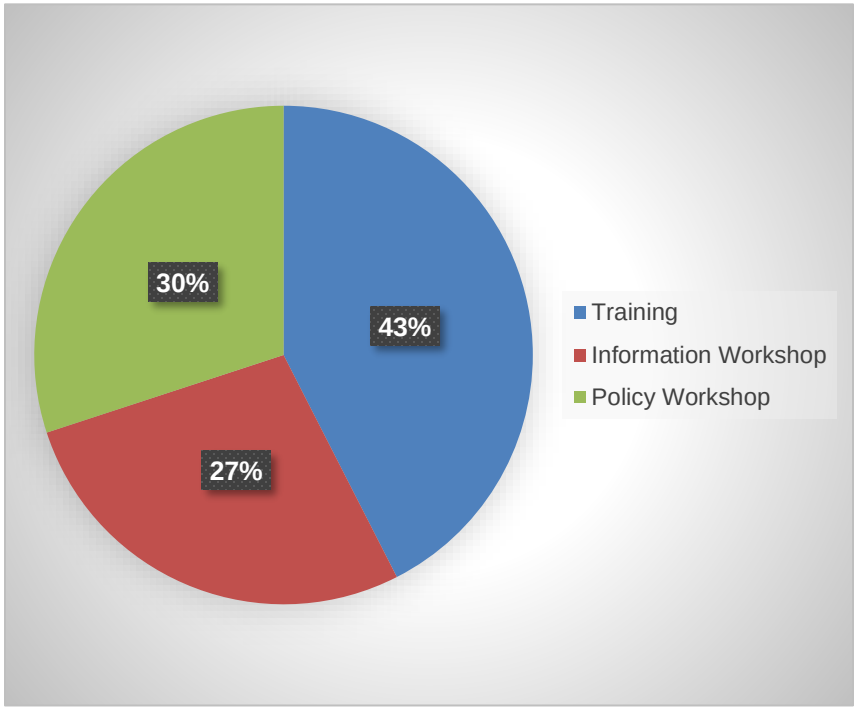
- Botswana has improved immensely in policy and knowledge advancement. This is evident in the number of experts who participated in SOLTRAIN policy workshops.

- A total of 152 experts (79.6% male and 20.4% female) have participated in advancing policy issues.

- Overall, at least 506 residents (79.4% males and 20.6 females) have been impacted directly by the activities of SOLTRAIN IV in Botswana.

Impact Assessment of SOLTRAIN IV in Botswana

Figure 5 shows percentage participation in SOLTRAIN IV activities under selected programmes.



- Figure 5: Percentage participation in training courses, information, and policy workshops

Conclusion

- A core mandate of SOLTRAIN IV in Botswana, as implemented by the Clean Energy Research Centre (CERC) University of Botswana, is training of experts in solar thermal technology.
- So far, 43% of direct engagement with residents have been for training activities.
- 27% of direct engagement has been in dissemination of information on the possibilities that exist in the solar thermal sector.
- This has included sensitisation on quality requirements for design and installation of solar water heaters.
- 30% of direct engagement has been in advancing policy implementation towards achieving the target of 0.3 m^2 collector area per resident of Botswana by the year 2030.
- SOLTRAIN IV has been a tremendous success in Botswana, leading to an increased uptake of demonstration systems by at least 115%.

References

AEE INTEC. (2019). *Project Document - Southern African Solar Thermal Training and Demonstration Initiative.* Feldgasse, Austria: AEE - INSTITUTE FOR SUSTAINABE TECHNOLOGIES.

Botswana Power Corporation. (18. February 2022). *BPC.* Von BPC: https://www.bpc.bw/customer-service/tariffs abgerufen

Matlotse, E., & Opok, A. O. (2018). *Solar Thermal Technology Roadmap and Implementation Plan for Botswana.* www.soltrain.org.

SOLTRAIN. (2019). *SOLTRAIN.* Von www.soltrain.org abgerufen

Taylor, M. E., Ritland, K. G., & Pratt, R. G. (1991). *Hot Water Electric Energy Use in Single-Family Residences in the Pacific NorthWest.* Portland, Oregon: US Department of Energy, Bonneville Power Administration.

THANK YOU!

2nd INTERNATIONAL SUSTAINABLE ENERGY CONFERENCE 2022 HELD IN GRAZ, AUSTRIA

07 April 2022

Presented by

Prof Kevin N. Nwaigwe
Manager, SOLTRAIN IV Project
Clean Energy Research Centre (CERC)
University of Botswana