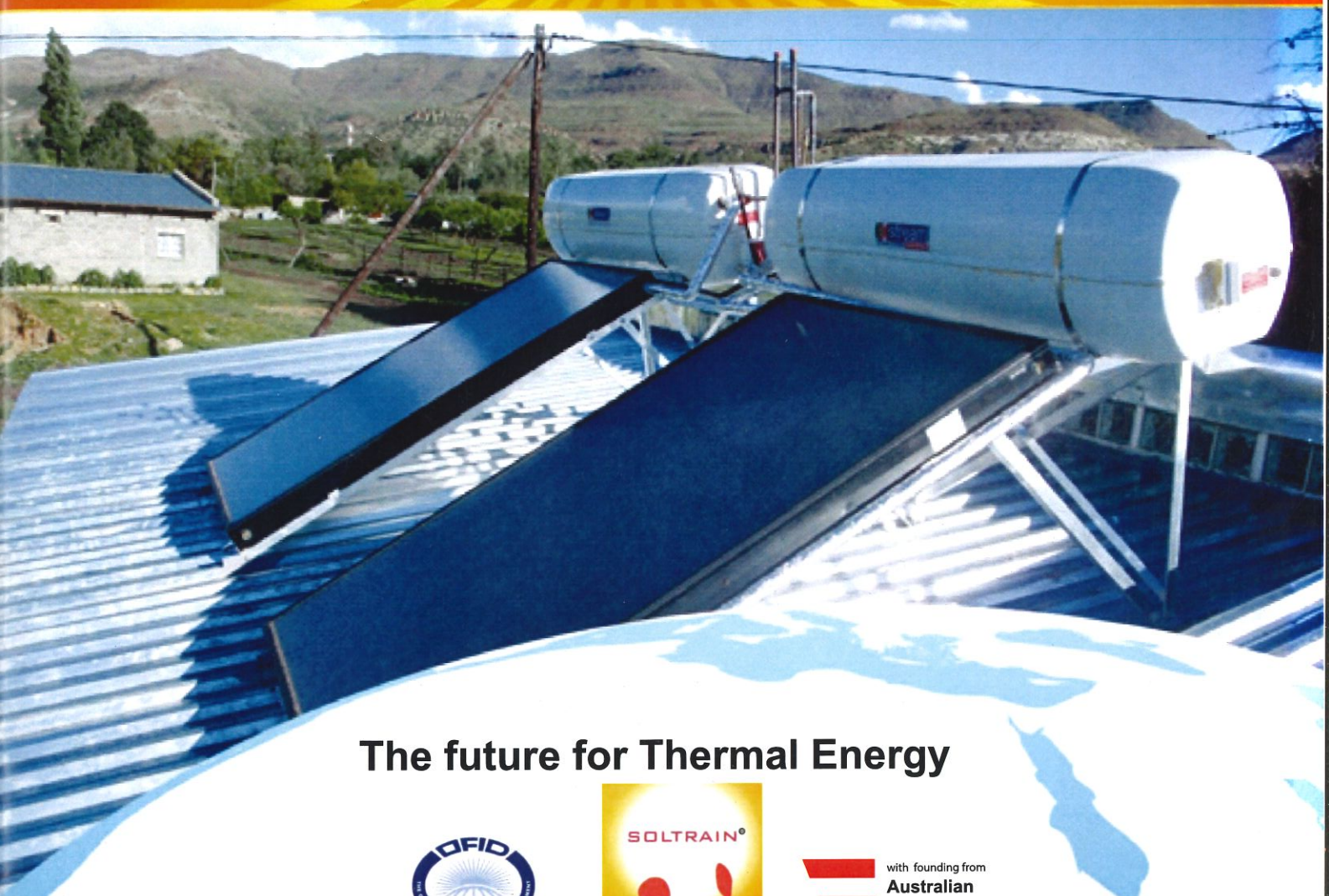
Solar Thermal Technology Roadmap and Implementation Plan



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Lesotho

Lesotho Solar Thermal Technology Roadmap

Prepared for

MINISTRY OF ENERGY AND METEOROLOGY

by

BBCDC

BETHEL BUSINESS AND COMMUNITY DEVELOPMENT CENTRE

in partnership with

National University of Lesotho
Department of Physics and Electronics

Sponsored by

SOLTRAIN

AUSTRIAN DEVELOPMENT AGENCY

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AEE INTEC

energy

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Abbreviations

DoE	Department: Energy
EE	Energy Efficiency
GW	Gigawatt
GWh	Gigawatt hour
kW	Kilowatt
kWh	Kilowatt hour
MWh	Megawatt hour
MW	Megawatt
PV	(Solar) Photovoltaic
R&D	Research and Development
RE	Renewable Energy
LSTTP	Lesotho Solar Thermal Technology Platform
LSTTRM	Lesotho Solar Thermal Technology Roadmap
NUL	National University of Lesotho
SWH	Solar Water Heater/Heating
BBCDC	Bethel Business and Community Development Centre

Foreword

The initiative of Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN Project) to enhance capacity building in Solar Thermal Technologies is highly appreciated. To this end, Lesotho has developed Solar Thermal Technology Roadmap 2018-2030, which is clear manifestation of Lesotho's unwavering commitment to contribute towards the global efforts to reverse the adverse effects and impacts of climate change. Lesotho's commitment to this end is also amply captured in its Energy Policy 2015-2025 which specifies reduction of reliance on fossil fuels and reduction of greenhouse gas emissions from the energy sector. The policy clearly articulates the country's strategies for attainment of the intended reductions, which include but not limited to:

- Phasing out the use of electric geysers in all existing public buildings and instead introduce solar water heating systems and heat pump systems;
- Compel all new Public buildings which require hot water to install solar water heaters; and
- Encourage the replacement of electric geysers with solar water heaters in industrial, commercial, residential and general purpose sectors.

It is my Ministry and Government's view that, the implementation of the recommendations highlighted in the Lesotho Solar Thermal Technology Roadmap, captured from the various sectors, will create conducive environment for the realization of the Sustainable Development Goals. Furthermore, it is the Government's expectation that the existing cooperation between Lesotho and SOLTRAIN shall result in a sustainable utilization and management of Lesotho's natural resources.

The SOLTRAIN Project was implemented in Lesotho in collaboration with various institutions like AEE - Institute for Sustainable Technology (Austria) and several regional partners in South African Development Community (SADC) Countries in an effort to narrow gaps encountered by solar thermal as well as government policy on renewable energy sources. The main aim of the project was to support the target countries in changing from a largely fossil fuel energy supply structure to the one based on renewable energy in general and on solar thermal in particular.

I further affirm that the Government of Lesotho will do its best to support the implementation of this roadmap. Inter alia, as Government, we will as much as possible encourage and facilitate initiative, innovative and standardization of technologies, processes and practices, in the view of reaching the targets for solar water heating in Lesotho and preparing a future in which solar thermal technology is deeply ingrained in Lesotho's overall technological portfolio.

Just to highlight the potential of solar power in Lesotho one may consider these two scenarios. Firstly, as expected, the industrial sector is the leading electricity consumer in the country. The sector accounts for nearly one third of country's total energy use. But, about one third of the country's industrial processes operate at below 100°C temperatures. Such levels of heat demands can easily be met by commercially available solar thermal collectors. In

principle the potential of solar thermal in this energy-intensive sector is huge. Secondly, the use of hot water for bathing and other cleaning purposes has become an integral part of the modern lifestyles; not to mention Lesotho's rather extremely low winter temperatures and prolonged winter seasons. Effectively, solar water heating is another area of great potential, if not just the natural solution to the country's energy challenges. Notably, research has established that an investment in solar water heaters pays itself back through saved electricity costs in 4 to 5 years; and thereafter the hot water becomes available almost for free through the rest of the equipment's lifespan of more than 15 years. In spite of these facts, the penetration of solar water heaters remains far below potential. One of the barriers that have been identified is the lack of organized information. Hence, potential users remain ignorant of the different technologies available, the selection and sizing of equipment as an evaluation of costs as well as issues concerning installation, maintenance and troubleshooting.

Finally on behalf of the Government of Lesotho, I would like to register my sincere appreciation to the Austrian Development Agency (ADA) and AEE - Institute for Sustainable Technologies (AEE INTEC) for their on-going support to the development and deployment of the solar thermal technology in Lesotho, and Bethel Business Development Community (BBCDC) and Energy Research Centre of the National University of Lesotho for efforts in developing the Lesotho Solar Thermal Technology Roadmap.

KHOTSO, PULA, NALA.

Maseru, Lesotho June 2019

Tsukutlane Au
Minister of Energy and Meteorology

Executive Summary: The Solar Thermal Technology Roadmap

The Lesotho Solar Thermal Technology Roadmap (LSTTR) is a project of the Solar Thermal Technology Platform (STTP), which forms part of the SOLTRAIN 2 project. STTP supports the switching from fossil fuels to sustainable solar energy sources for applications such as water heating, (solar) cooling, the provision of process heat and low temperature steam. STTP brings together all interested parties from academia, government, financiers, end-users and industry with the aims to:

Share information on technical and financial aspects of solar thermal energy use;

- Identify knowledge gaps and opportunities;
- Mobilise institutions or individuals to do the required research; and
- Disseminate the results and keep records of the roll-out of solar thermal energy technologies and systems in the country.

The purpose of the Lesotho Solar Thermal Technology Roadmap is to outline the path towards a national vision for solar thermal applications in the country, targeted at enhancing the quality of life of Basotho through the provision of a sustainable and quality-assured solar thermal technology value chain.

This vision document describes the goals and targets for solar thermal energy and provides an overview of the technological perspectives and needs of research and development to fully exploit the benefits of solar radiation as a major energy source in 2030. The document gives some ideas as to the sectors in which solar thermal energy will be used, to what extent, with which technology and in what types of applications.

In order to achieve the strategic goal this document presents the following issues:

- The concept of available technologies and present status;
- Identification of Strategic Focus Areas;
- Setting the targets and timelines; and
- Stakeholder roles.

To this end, the Solar Thermal Technology Platform has defined its mission, i.e., *to achieve a fully functional* 0.3 to 0.5 m^2 of solar collector area per inhabitant by 2030. By achieving the said penetration of solar thermal technologies, some 620,000 m^2 of collector area with a thermal output equivalence of approximately 220 MW would be available by 2030.

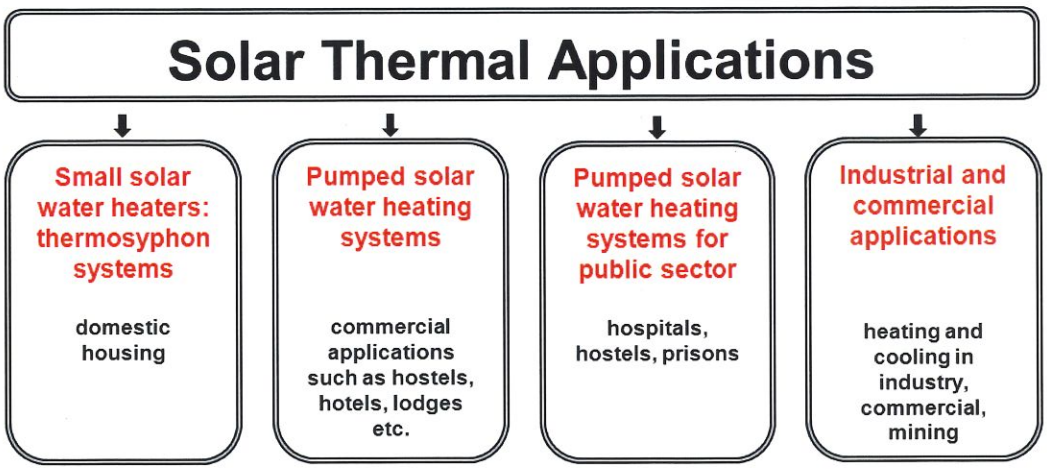
The purpose of the report is to present the Lesotho Solar Thermal Technology Roadmap (LSTTR). The LSTTR aims to identify the primary actions and tasks that must be addressed to accelerate the residential, institutional, industrial solar thermal development and deployment nationwide, where the majority of users have only just started to consider or become aware of the potential offered by solar heating and cooling technology for

applications. The LSTTP balances several diverse areas; namely policy, regulation and legal Issues; publicity, research, training and capacity development, standards quality and testing. Drawing from the foregoing synergies, the roadmap focuses on applications of thermal technology in the key areas of immediate attention to Lesotho, namely domestic and public sector applications; commercial and industrial applications; and mining applications.

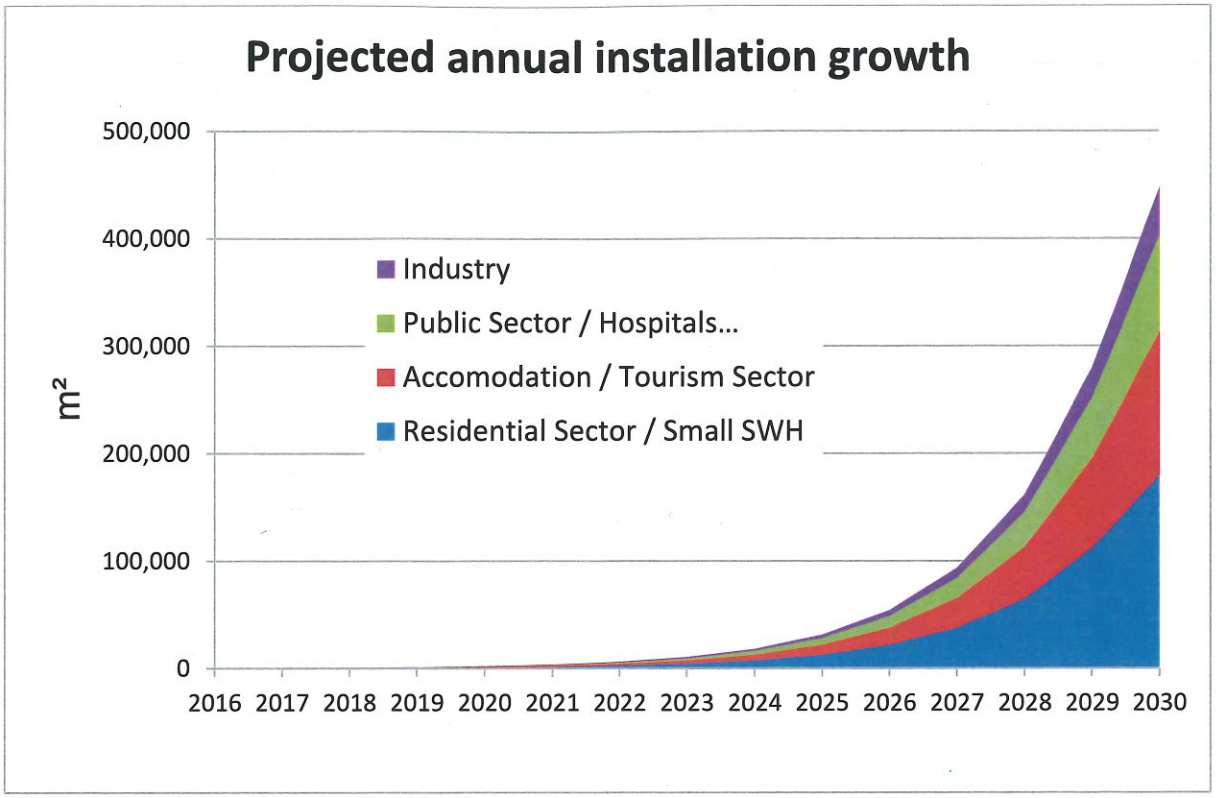
The population of Lesotho is estimated at 2 million with an annual population growth rate of 0.08%. Lesotho's solar thermal vision is to have installation of 0.3 to 0.5 m^2 of solar collector area per inhabitant by 2030. This translates into an overall collector area of 620,000 m^2 by 2030 for a projected population of 2.1 million persons nationwide. In order to achieve the envisaged target of 0.5 m^2 of solar thermal collector area per inhabitant by 2030, substantial growth in the number of installations is required

For the purposes of this roadmap, the solar thermal industry in Lesotho will focus on (though not limited) the following system types and sizes:

- Thermo-syphon systems for domestic houses (2 – 4 m^2 per system)
- Thermo-syphon systems for commercial operations, including tourist establishments and lodges (2 – 4 m^2 per system)
- Pumped systems for hotels, hospitals etc. (20 – 100 m^2 per system)
- Cooling and air-conditioning for hotels and larger offices (20 – 500 m^2 per system
- Commercial and industrial applications (50 – 500 m^2 per system)



As earlier noted, there is no baseline data regarding thee number, size and types of solar thermal systems that have been installed across country to date. Basing on anecdotal evidence, the current total collector area is estimated to be about 3,892 m^2. In order to achieve the envisaged minimum target of 0.3 m^2 of solar thermal collector area per inhabitant by 2030, substantial growth in the number of installations is required. Taking 3,892 m^2 as the initial collector area, the projected annual installation growth is given below showing two scenarios (0.3 m^2/inhabitant or 0.5 m^2/inhabitant):


Projected annual installation growth
500,000
400,000
300,000
200,000
100,000
0
m²
Industry
Public Sector / Hospitals...
Accomodation / Tourism Sector
Residential Sector / Small SWH
2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

1. Introduction and Rationale

The mission of Solar Thermal Technology (STT) Roadmap 2030 is to provide a practical, independent and objective analysis of pathways to achieve a low-carbon economy in Lesotho, in line with the universal energy access, energy security, environmental and economic goals of the Lesotho Government.

STT Roadmap 2030 is an initiative of the Solar Thermal Training and Demonstration Initiative (SOLTRAIN) Project and was developed and discussed through a consultative process involving key stakeholders during three workshops, which took place in January, March and June 2017 in Maseru. At these stakeholder workshops experts from the Ministry of Energy, Line Ministries, Academia, Private Sector, and NGOs participated. The Roadmap document was prepared and compiled by the Energy Research Centre of the National University of Lesotho.

There is a pressing need to accelerate the development and deployment of advanced clean energy technologies in order to address the global challenges of energy security, climate change and sustainable development. Solar heating technologies can have an important role to play in realising targets in energy security and economic development and in mitigating climate change, if effectively harnessed, since solar heating technologies have unique benefits. From a Lesotho perspective, increased use of solar water heaters (SWH) reduces dependency on imported electricity, increases the security of local supplies and in the long-run creates savings for end-users. They can increase resilience against rising energy prices as most costs are incurred at the initial capital investment, while on-going operating costs are generally minimal and not, in anyway, directly exposed to the volatility of oil, gas or electricity prices. Local energy supply leads to reduced energy transmission, which also enhances efficiency and cost effectiveness.

Moreover, the adoption of solar heating technologies at some significant scale will certainly create much need jobs for local communities. For instance, solar heating based on flat-plate or vacuum tube collectors are relatively simple (mainly using basic raw materials, including locally available metals) offering opportunities for local manufacturing and local economic development. In addition to replacing fossil fuels that are directly burned for heat production, solar heating technologies can replace electricity used for hot water and space heating. In fact, for Lesotho, electric water heating and cooling accounts for about a third of average household power consumption.

Generally, most industrial processes have not yet embraced existing solar thermal potentials. However, increasing prices of electricity and fossil fuels are likely to introduce rapid shift as soon as solar thermal technologies can be shown to be technically and financially viable alternatives. Arguably, solar heating and cooling as well as solar cooking, drying and related thermal applications are the most likely candidates that will easily replace traditional technologies in some foreseeable future.

2. Background: Current State of National Energy Supply and Demand

The current use of fossil fuels for most of Basotho's energy needs is economically, socially and environmentally unsustainable. Given that, a significant percentage of final energy used in Lesotho's industrial, commercial and residential sectors is for heat purpose and considering the country's unexploited higher than average solar resource, there cannot be any doubts that solar thermal energy can play a huge role in Lesotho's path to an independent, low carbon and sustainable energy future.

Lesotho does not possess any fossil fuel reserves. Hence it is totally dependent on imported fossil fuels (including, coal, natural gas, kerosene (paraffin) and gasoline) for its energy requirements in the transport and other industrial sectors. In fact, in its 2009-2011 Energy Balance Report issued in 2013, the Bureau of Statistics stated that the country imported an equivalent of 2,000 barrels (317,975 litres) of oil/day or 116.1 million litres of oil annually over the reported period. It was also observed that the demand for imported petroleum products has been on an increasing trend from 163.8 million litres in 2006 to 217.7 million litres in 2010, then to 225.3 million litres in 2014.

The industrial sector is the biggest electricity consumer at 35% followed by the domestic (households) sector at 32%. The country's annual per capita electricity consumption is 253 kWh, which below 50% of the African average of 579 kWh and approximately 11 times less than the world average of 2,777 kWh. Also, the national electricity access rate is currently estimated at 38%; with a huge access disparity between urban households (of which 65% have electricity access) and rural households (at only 10% access). Furthermore, electricity, only accounted for 10% of Lesotho's total energy consumption in 2014, and it is observably very unlikely that the scenario could have changed by any significant degree to date.

Notwithstanding its own limited supply, biomass remains the major energy source in the rural household sector. Approximately 60% of households in the country use biomass for heating and cooking, and 95% use paraffin or candles for lighting. Biomass accounts for 72% of the households' consumption and about three quarters of their total energy demand is met by biomass in the form of wood, shrubs, animal dung and agricultural residues. The total primary energy supply for Lesotho (40 *Petajoules* (PJ) in 2014) was dominated by traditional biomass (wood, crop waste and dung) with its share representing 66%. Modern forms of energy, such as petroleum products, coal, electricity and LPG, constitute the remaining 34%, but their demand continues to increase.

Notably, electricity demand has progressively increased over the years; and according to forecasts in the Second National Communication, the country's electricity demand for is expected to reach 294,900 *Terajoules* (TJ) by 2030. This is almost 10 times higher than the base year 2000 energy figures. The county's current installed capacity is 75 MW, and its peak demand of 161 MW (in winter) is met through extremely GHG-intensive energy imports

from the South African Power Pool (SAPP), which has a combined grid emissions factor of 0.9801 (77% of South Africa's electricity supply comes from coal).

Effectively, more than 50% of Lesotho's CO_2 emissions from the energy sector are the result of combustion of biomass and imported fossil fuels. Therefore, Lesotho's energy sector policies have accordingly put more emphasis on expanding renewable energy sources and implementing biomass development programmes that are cost effective as well impact on CO_2 emissions. The main objective of the sectoral policies is to provide energy to all sectors of the country at minimum social, economic and environmental cost.

2.1 About SOLTRAIN

The Austrian Development Agency (ADA) through AEE - INTEC (Institute for Sustainable Technologies from Austria), has initiated the support for development and deployment of solar thermal technology in cooperation with Southern African educational institutions, renewable energy institutions and companies in Lesotho, South Africa, Mozambique, Namibia and Zimbabwe as part of efforts to reduce dependence from fossil fuels. The project's aim is to support target countries in changing from largely fossil energy system to renewable energy system (Solar Thermal), to build capacity in the field of solar thermal technologies, and promote the use of solar thermal systems by ensuring the quality, performance and lifetime of solar thermal systems. In addition, the project is indirectly aimed at creating new jobs in small and medium enterprises, and strengthening the local support mechanisms for solar thermal systems. This roadmap is essentially market oriented to make Solar Heating more competitive and, thus, develop the full potential of social and environmental benefits inherent to solar thermal technologies. In this roadmap actions to significantly improve the competitiveness of solar heating are identified. The roadmap also describes the objectives to be achieved in response to prevailing societal challenges.

A number of renewable energy (RE) initiatives are currently on going in the country, including: feasibility study on Mini-grids, and Scaling-Up Renewable Energy Programme Investment Plan for Lesotho. However, none of those initiatives directly cover Solar Thermal Technology programmes. Therefore, there is need for the LSTTP to come up with a robust roadmap that will propel the country to high penetration of Solar Thermal Technology.

The preparation of Lesotho Solar Technology Roadmap (LSTR) follows similar exercises that have already been achieved in South Africa, Botswana, Mozambique and Namibia.

2.2 Climatic conditions: Solar Energy Resource Opportunity

The potential for effective utilization of the solar thermal energy depends primarily on the climate conditions of the specified area. It is therefore necessary to present an overview of the climate conditions of Lesotho for the purpose of a successful implementation of this roadmap.

One particular measure of relevance to most solar technologies is the level of insolation (i.e. the amount of direct normal irradiation), and global horizontal irradiation per square meter, as is shown in Figure 1. Lesotho experiences some of the highest levels of solar radiation in the world. The daily average solar radiation varies between 5 and 7 kW h/m^2 with maximum amount of radiation available in the months of December-January and minimum in June-July. Most parts of the country receive an average insolation in excess of 5 kWh/m^2/day with some parts in the South West averaging over 7 kWh/m^2/day. Lying between latitudes 28 and 31 in the south, it has the advantage of long hours of sunshine and more than 300 days of sunshine. Average sunshine hours range from 10.2 to 13.8 hours per day with more than 80% of solar radiation coming as direct radiation because of limited cloud coverage and clear sky.

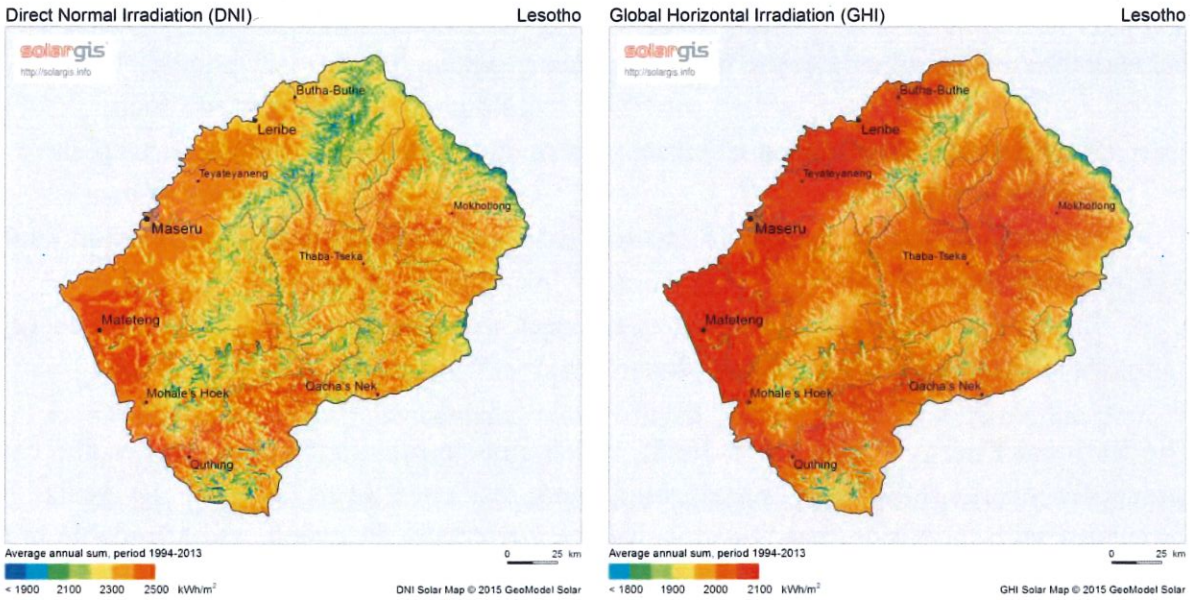


Figure 1: Annual Direct normal-, and Global horizontal solar radiation (Insolation)

The performance of solar systems also depends on other climatic conditions, such as the occurrence of wind and wind speeds, rainfall and humidity levels, as all these conditions have an indirect and/or direct impact on the ambient temperature. Lesotho has a continental temperate climate characterized by four distinct seasons: spring, summer, autumn and winter. The average temperature ranges between −10°C in winter and 30°C in summer. The country receives most of its rainfall between the months of October to April, with an average of 700 mm per annum. Precipitation patterns are determined by regional and local climate controls. The lowest average annual precipitation occurs in the Senqu River Valley (450 mm) and the highest in the north-eastern mountain zone (1,300 mm). Precipitation is highly variable both temporally and spatially. Snowfall occurs annually over the mountain tops and on average once every three years in the lowlands. The average annual relative humidity in Maseru is 34.9% and average monthly relative humidity ranges from 24% in September to 43% in March. Hail is occasionally experienced, with hailstones varying in size, but reliable records of the frequency of such events and associated hailstone sizes are not available.

2.3 Existing Legislation and Institutional Arrangements

The implementation of the roadmap will depend on current legal instruments, institutional arrangements, enabling policy, strategies, regulations and standards applicable to solar thermal technology in particular and renewable energy in general. Lesotho's development policies, plans and programmes are mainly guided by Lesotho Vision 2020, operationalized through the five-year National Strategic Development Plan (NSDP) 2012/13-2016/17 that is currently being updated to 2021/2022. The NSDP provides detailed guidance on priorities and on specific actions to be taken during the planning period, including actions that contribute to longer term development objectives beyond 2017. The document explicitly highlights the fact that there is a potential for energy generation based on renewable sources, provided financial resources are available. The energy sector is regarded as pivotal to the country's economic growth, climate change mitigation, and eventually export revenues. To that end, the strategy articulates the following three goals:

- Increase clean energy production capacity to attain self-sufficiency, export and have a greener economy.
- Expand electricity access to centres of economic activity, other sectors and households.
- Increase energy conservation, safety and access to alternative (non-electricity) energy products and efficient technologies.

The National Energy Policy (2015-2025), which aims to provide options that Lesotho can pursue for energy efficiency, sustainability and resilience over the next 10 years, is formulated with the vision that "Energy shall be universally accessible and affordable in a sustainable manner, with minimal negative impact on the environment". On renewable energy services and technologies, the policy aims at creating "a progressive, long-term policy framework to use locally available renewable energy sources" in the country. Among the key actions proposed in the field of renewable energies are:

- Phase out the use of electric geysers in all existing public buildings and introduce solar water heating systems and heat pump systems.
- Require all new public buildings with hot water demand to install solar water heaters.
- Encourage the replacement of electric geysers with solar water heaters in industrial, commercial, residential and general-purpose segments

The three objectives on renewable energy services and technologies are:

- To improve the energy security situation by reducing reliance on fossil fuels and imported electricity;
- To increase access to modern energy for rural and decentralized areas
- To reduce Greenhouse Gas (GHG) emissions from energy sector

Department of Standards and Quality Assurance (DSQA): Lesotho does not have a national standards body. THE DSQA, is located in the Ministry of Trade and Industry, functions as the focal point for standards and quality assurance. No national standards have

been developed to date and industries in Lesotho have traditionally relied on the South African Bureau of Standards and ISO for voluntary standards facilities and quality assurance schemes. Likewise, local exporters have developed their standards according to technical and quality requirements of importing countries or international standards. This is in line with its participation in the Southern African Development Community (SADC) regional programme on Standardisation, Quality, Accreditation and Metrology, a programme that aims to harmonise standards for adoption by all member states.

2.4 Barriers and Gaps in Accounting for Low Uptake of Thermal Energy Technology

The key gaps and barriers in thermal energy technology and applications in Lesotho are identifiable as follows:

- Clear policy for thermal energy technology uptake, energy efficiency and productive use of Thermal Energy Technology.
- Assessment of energy efficiency and renewable energy potential and capacities that can be achieved.
- Identification and costs and benefits of various Thermal Energy Technologies.
- Instituting appropriate regulatory frameworks e.g. for technology standards, incentives to reduce costs to consumers
- Having dedicated institutions that push for solar thermal technology and application
- Dedicated financing mechanisms with reduced cost of finance to enable the poor to afford Thermal Energy Technology
- Awareness of end users on Thermal Energy technologies and their costs and benefits
- Monitoring and evaluation of set targets for energy access, energy efficiency and renewable energy
- Capacity of technology developers, designers, installers and maintenance of Thermal Energy Technology
- The availability of local financing from commercial banks and financial intermediaries, which can play a decisive role in the development of local markets.

2.5 Solar thermal technology: Sector Potential

It is worth noting that, although there are many solar thermal systems that have been installed across the country - in government clinics, educational institutions, lodges, etc. -there is no baseline data regarding their number, size and types. However, potential solar thermal technologies in Lesotho can be divided into categories based on their system types and sizes or the specific sectors they serve, as follows:

Residential sector: This sector holds a greatest potential in Lesotho if appropriate financing schemes for the installation of the solar thermal technologies are put in place, together with other technology-promoting measures. Owing to the fact that the number of residential dwellings is larger than any sector in Lesotho, the formation of financial schemes,

introduction of early technology market development fund, introduction of tax rebates and donor investment on cheaper technology on life cycle basis could boost the deployment of the solar thermal technology in this sector by a significant amount by 2030.

Tourism sector: The tourism sector holds great potential for Lesotho because of the country's natural beauty and cultural heritage. This is crucial as a means of injecting wealth in Lesotho. In order to realize this injection of wealth, solar thermal energy infrastructure as a renewable energy will play an important role to achieve self-sufficiency and cut costs on imported electricity. To that end, the government of Lesotho intends to improve on the use of clean energy in the tourism sector as stipulated in the Lesotho National Strategic Development Plan (NSDP).

Public sector: The roadmap targets public establishments, including community centres, visitor centres, schools, hospitals, etc. The potential use of solar thermal heat in this target group rests on the fact that these establishments operate on public funds. The demand for hot water in these establishments is support-driven by establishment's/government policies and regulations.

Commercial and Industrial: There is no record of industrial applications of the solar thermal technology currently in Lesotho. However, there is a great potential for applications in the near future. Low (below 80 °C) and mid-range (80 °C to 250 °C) temperature solar thermal collectors are available in the market today. These collectors can be used to meet the heating requirements of the food, beverages and textiles industries among others. Processes like sterilizing, fruit drying, bleaching and dyeing (textiles), washing and cleaning, do not require high temperatures and can benefit from flat plate and evacuated tube collector technology.

3. The Solar Thermal Technology Roadmap

The purpose of the report is to present the Lesotho Solar Thermal Technology Roadmap (LSTTR). The LSTTR aims to identify the primary actions and tasks that must be addressed to accelerate the residential, institutional, industrial solar thermal development and deployment nationwide, where the majority of users have only just started to consider or become aware of the potential offered by solar heating and cooling technology for applications. The LSTTP balances several diverse areas; namely policy, regulation and legal Issues; publicity, research, training and capacity development, standards quality and testing. Drawing from the foregoing synergies, the roadmap focuses on applications of thermal technology in the key areas of immediate attention to Lesotho, namely domestic and public sector applications; commercial and industrial applications; and mining applications.

The population of Lesotho is estimated at 2 million with an annual population growth rate of 0.08%. Lesotho's solar thermal vision is to have installation of 0.3 to 0.5 m^2 of solar collector area per inhabitant by 2030. This translates into an overall collector area of 620,000 m^2 by 2030 for a projected population of 2.1 million persons nationwide. In order to achieve the envisaged target of 0.5 m^2 of solar thermal collector area per inhabitant by 2030, substantial growth in the number of installations is required

For the purposes of this roadmap, the solar thermal industry in Lesotho will focus on (though not limited) the following system types and sizes:

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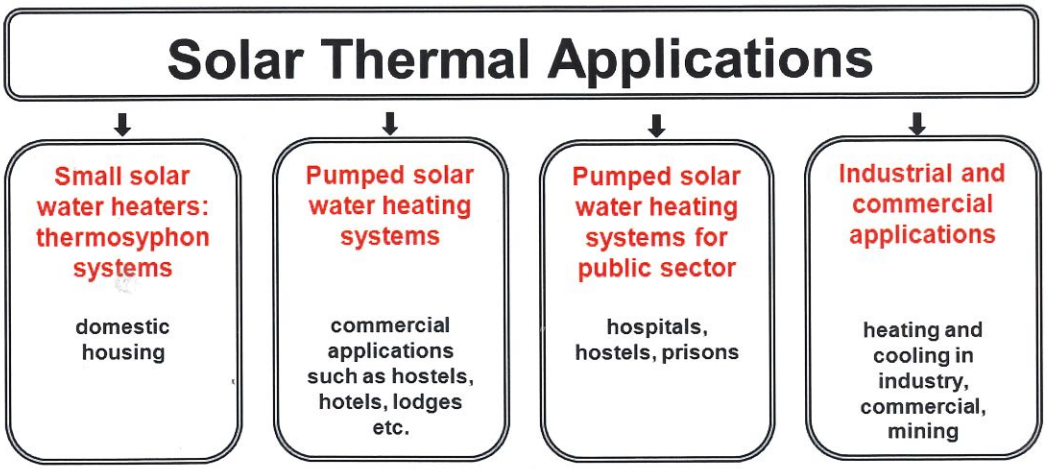

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evidence, the current total collector area is estimated to be about 3,892 m^2. In order to achieve the envisaged minimum target of 0.3 m^2 of solar thermal collector area per inhabitant by 2030, substantial growth in the number of installations is required. Taking 3,892 m^2 as the initial collector area, the projected annual installation growth is given below (Figure 2) showing two scenarios (0.3 m^2/inhabitant or 0.5 m^2/inhabitant):

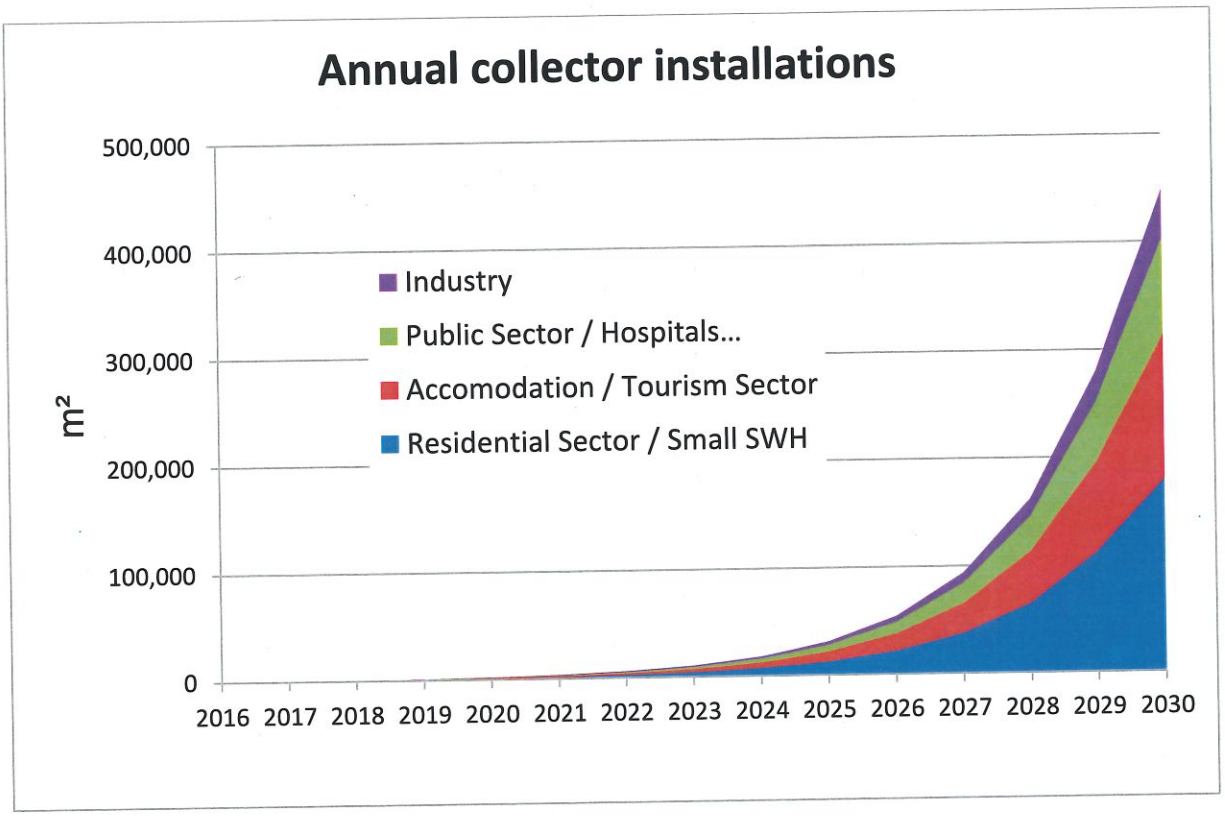

Figure 2: Projected annual installation growth

LESOTHO

Population (Million inhabitats)			Solar Water Heaters
Year	Projected by N.U.L.	DoBS Data	3,892 Upto the year 2014 New installations
2015	1,913,000.00	Estimates	
2016	1,932,130.00	1,932,814	225
2017	1,951,451.30	1,941,941	373
2018	1,970,965.81	1,951,688	619
2019	1,990,675.47	1,961,985	1,027
2020	2,010,582.23	1,972,790	1,704
2021	2,030,688.05	1,984,104	2,828
2022	2,050,994.93	1,996,214	4,691
2023	2,071,504.88	2,009,360	7,782
2024	2,092,219.93	2,023,500	12,911
2025	2,113,142.13	2,038,629	21,419
2026	2,134,273.55	2,054,542	35,534
2027	2,155,616.28	2,069,000	58,951
2028	2,177,172.45	2,083,483	97,800
2029	2,198,944.17	2,098,067	162,250
2030	2,220,933.61	2,112,754	270,147
			682,154 [m²]

RESULTS m2/inhab 0.3

LESOTHO

Population (Million inhabitats)			Solar Water Heaters
Year	Projected N.U.L.	DoBS Data	3,892 Upto the year 2014 New installations
2015	1,913,000.00	Estimates	
2016	1,932,130.00	1,932,814	225
2017	1,951,451.30	1,941,941	389
2018	1,970,965.81	1,951,688	673
2019	1,990,675.47	1,961,985	1,165
2020	2,010,582.23	1,972,790	2,015
2021	2,030,688.05	1,984,104	3,487
2022	2,050,994.93	1,996,214	6,032
2023	2,071,504.88	2,009,360	10,435
2024	2,092,219.93	2,023,500	18,053
2025	2,113,142.13	2,038,629	31,232
2026	2,134,273.55	2,054,542	54,031
2027	2,155,616.28	2,069,000	93,474
2028	2,177,172.45	2,083,483	161,710
2029	2,198,944.17	2,098,067	279,758
2030	2,220,933.61	2,112,754	447,612
			1,114,183 [m²]

RESULTS m2/inhab 0.5

3.1 Identification of Key Stakeholders and Stakeholder's Roles on Implementation of the Roadmap

Successful implementation of the roadmap can only be achieved by close collaboration of various stakeholders in a coordinated effort, under the leadership of the Department of Energy and guided by the Energy Policy.

The key stakeholders comprise of:

- Department of Energy, who are responsible for policy and regulations.
- The Lesotho Electricity Company, National Power Utility, who can benefit from offsetting imports from SAPP
- Research institutions, which are responsible for innovation, and development of solar thermal systems. Additionally, they offer advanced professional and academic training in solar thermal systems.
- The private sector who can play different roles: market agents; promoters of solar thermal systems; development of demonstration systems; investment agents
- Banking institutions who can offer entrepreneurs investment funding
- Technical colleges who are responsible for training technicians and artisans to work in solar thermal field as maintenance personnel.

Government ministries and related entities: The energy policy is already in place and the government should develop the implementation strategy and regulation of the policy. This strategy should entail the following, among others: the development of curricula across all educational levels, public awareness campaigns, sensitising cabinet and parliament about the

technology and its implications, putting in place quality control measures to ensure customer satisfaction, and attract international potential funders of renewable energy.

In the residential sector, promotion of solar thermal technology installation can be achieved by introducing rebates programmes, encourage connection schemes similar to what is happening in electricity connection schemes and also adopting other various promotional incentives that been applied and proven to working elsewhere, especially in other SADC countries of comparable socio-economic status.

The Ministry responsible for Energy is already playing a leading role in overseeing the implementation of Energy Policy (2015), though there will be need for the Ministry to boost its efforts. In addition, Government will provide a significant proportion of the funding required for promotions, awareness programmes, and deployment of demonstration systems. Government will also have to provide funding for research and development (R&D) activities. Of course, Government will also work with development partners in co-financing the solar thermal systems.

The Department of Energy shall be the focal point and will coordinate all the solar thermal technology activities. It will disseminate information amongst relevant stakeholders, and collaborate with higher education institutions to provide relevant information. A database on solar thermal technologies and projects taking place in the country will be developed by the department.

Commercial and Industrial Sectors: The private sector will play a significant role in promoting and developing the solar thermal technologies as this roadmap is likely to lead to business opportunities, and result in income-generation. In particular, Lesotho Electricity Company (LEC) is expected to integrate solar thermal technologies into their demand side management programmes.

Academic and Vocational Institutions: It is expected that higher education institutions and technical institutions responsible for science, engineering and technology integrate solar thermal technology in their academic programmes and ensure that a well-qualified human resource base is created which is fully-equipped the relatively new labour market. In order to contribute meaningfully to knowledge generation such institutions are expected to engage in research and be able to offer postgraduate programmes in renewable energy, including the field of solar thermal.

Financial Institutions: This sector is critically for the success of this roadmap. It is expected that the financial institutions will come up with attractive financial packages to encourage more potential solar thermal technology users to apply for loans. It is crucial that all the relevant energy stakeholders work closely together in order to ensure that this roadmap is implemented successfully.

The following sections present a discussion for each of the solar thermal applications shown above, and elaborate stakeholder roles on how these could each be implemented.

3.2 Assumptions and Challenges of the Roadmap Vision

The development of the roadmap has been complicated by many challenges:

- At the national level there has been a lack of attention to strategy for development and deployment of Solar Thermal Systems. This is in contrast to Solar PV where the government has undertaken a number of studies as well development of strategies.
- The bulk of installations have been fragmented between government and the private sector, with eminent lack of coordination for effective development and deployment.
- The lack of database on statistics from which to make predictable and realistic projections for the roadmap targets.
- To a large extent, the target numbers for the vision, neglect significant a number of installations currently in use. Mainly because most of them are in a state of malfunction and at least need major repair or simply replacement.

The envisaged target of 0.3 m^2 per inhabitant of Lesotho is premised on the assumption that there will be concomitant increase in the number of connections to clean water countrywide. According to Renewable Policy (2013), Lesotho intends to require all new buildings which use more than 300 litres per day of hot water to install solar water heating systems (SWHS's). As stipulated in the policy it is assumed that commercial and industrial facilities will be provided with soft loans in order to accelerate installation of solar thermal systems. Therefore it is expected that commercial and industrial facilities will contribute significantly towards achieving the target figure of 0.3m^2 of collector area per inhabitant.

3.3 Solar Thermal Technology Systems

The strategy on achieving the installation target of 0.3 m^2 of solar collector area per inhabitant by 2030 is discussed below:

3.3.1 Thermo-syphon systems for residential sector (2 –4 m^2 per system)

Part of the roadmap will be to focus on electricity consumers who are connected to the electricity grid and use hot water. Target population groups will be prioritised based on the following criteria:

- Electricity Consumers who have electric geysers
- Urban and peri-urban electricity consumers
- Rural consumers and those that do not have access to electricity

Since about 40 – 50% of the electricity in the residential sector is used for heating water, solar water heaters constitute one of the major cost-effective and rapid options in order to reduce the electricity demand and thus the environmental effects like CO_2 emissions. Economic-wise, the current contribution of water heating to the households' monthly

electricity bill is roughly 40%, which can be reduced significantly by adoption of solar heating systems. Lesotho is blessed with abundant sunshine and switching to a solar water heater offers potential to save more than 60% of the electricity spend for hot water. Encouraging the replacement of electric geysers with solar water heaters in the residential sector will considerably reduce pressure on the electricity grid and thus resulting infrastructural investment and maintenance savings. Assuming that about 40% of the solar thermal collector area comes from residential water heating, this will translate to accumulated installed area of 444,116 m^2 by the year 2030 which will contribute significant energy saving of which could have been provided by electricity.

Like in other countries where solar water heating is promoted, Lesotho may have to introduce rebates and other appropriate incentives. These rebates may be structured such that they are based on the potential electricity savings, address the capital cost of the installation of the solar water heating systems and heat pump systems, and the cost of operating the electric geysers.

Strong government support coupled with the financial benefits from installation of solar water heaters, are anticipated to be an incentive to attract entrepreneurs to join the market and effectively grow the supply side. The achievement of the roadmap's objective will also be very much dependent on public awareness campaigns to sensitise households about the benefits of solar water heating.

Table 1: Industry and Government Roles in Supporting the Thermo-syphon System

Awareness and Marketing	
Industry Role	Promote uptake of thermos-syphoned systems: Production of technical brochures and other marketing material, providing information to the potential buyer/user, on procedures of O & M and installation, safety requirements of installations, on manufacturing quality standards, and on the benefits and ranges of hot water usage. Main types of promotional media are: mobile adverts; posters; print media; radio broadcasts and social media.
Government Role	The government should promote the use of the solar thermos-system in government institutions of the system where applicable. Government should develop clear strategy for improving access on solar thermo-syphon systems for domestic and government uptake. Government ministry responsible for energy/renewable energy should have a portfolio for showcasing the importance of the system at a national level. Use financial schemes to encourage the use of solar thermos-syphon systems.
Institutional Issues	
Industry Role	To prompt self-regulation on issues which the government regulations does not provide for clearly. Promote fair completion among suppliers regarding pricing, quality, and safety. Encourage ethical practice involving the application of the system.
Government Role	Establish regulations on the application of the system relating to standards, quality and safety in promotional activities for the system.
Research and Development	Monitor and publish results on system performance under local conditions which strengthens regulation. Identify areas where system performance can be improved under local operating conditions in terms of quality and environmental requirements.
Workforce Development	
Industry Role	Provide training programmes for their technicians, artisan, and professional engineers through accredited programmes relating to: maintenance and operations, design and installations of the system.

Government Role	Establish and support training programmes in technical institutions and Universities in SWH. Sponsor students to take courses in the area of SWH at training/academic institutions.
Research and Development	
Industry Role	Industry should have a network for collaborative research work with universities relating to field measuring and monitoring of system performance
Government Role	Provide research funding to research institutions for research on application and optimization of SWH.

3.3.2 Combined Solar Thermal and Heat Pump Systems

These are solar heating systems for combined residential hot water and space heating. They vary in size depending on the purpose for which they are installed. This ranges from those installed in individual properties to those serving several end-users in a block heating scheme. Usually, their collector area is larger than that of single purpose solar water heater. Because of their dual purpose use, it is expected that the demand for this kind of a system is likely to grow fast. In single family domestic settings its typical capacity ranges between 10 – 20 m².

Table 2: Industry and Government Roles in Supporting the Solar (pumped) combi-systems

Awareness and Marketing	
Industry Role	Promote uptake of thermos-syphoned systems: Production of technical brochures and other marketing material, providing information to the potential buyer/user, on procedures of O&M and installation, safety requirements of installations, on manufacturing quality standards, and on the benefits and ranges of hot water usage. Main types of promotional media are: mobile adverts; posters; print media; radio broadcasts and social media.
Government Role	The government should promote the use of the Solar (pumped) combi-systems in Multi-story residential houses and lodges as applicable.
Institutional Issues	
Industry Role	To prompt self-regulation on issues which the government regulations does not provide for clearly. Promote fair completion among suppliers regarding pricing, quality, and safety. Encourage ethical practice involving the application of the system.
Government Role	Establish regulations on the application of the system relating to standards, quality and safety in promotional activities for the system.
Research and development	Monitor and publish results on system performance under local conditions which strengthens regulation. Identify areas where system performance can be improved under local operating conditions in terms of quality and environmental requirements.
Workforce Development	
Industry Role	Provide training programmes for their technicians, artisan, and professional engineers through accredited programmes relating to: maintenance and operations, design and installations of the system.
Government Role	Establish and support training programmes in government technical institutions and Universities in SWH. Sponsor students to take courses in the area of SWH at training/academic institutions.
Research and Development	Advanced training should be offered to Research class workforce at research in research organizations and Universities,
Research and Development	
Industry Role	Industry should have a network for collaborative research work with local universities relating to field measuring and monitoring of system performance
Government Role	Provide research funding to research institutions and Universities for research on application and optimization of SWH.

3.3.3 Pumped systems for tourism sector (10 – 30 m² per system)

Part of the roadmap will be to focus on electricity consumers who are connected to the electricity grid and use hot water. Target population groups will be prioritised based on the following criteria:

- Hotels, guest houses and similar institutions

Pumped solar water heaters are indirect systems and they work in such a way that they use heat exchanger to transfer heat from the collector to the water in the storage tank. After the heat transfer fluid is heated in the solar collectors, it is pumped to a storage tank, where a heat-exchanger transfers the heat from the transfer fluid to the stored water. This transfer fluid is usually a mixture of water and antifreeze.

The electricity consumption in the tourism sector is projected and estimated to be in Megawatts. There is potential savings by installing the pumped systems for this sector of which are estimated to accumulate installed area of 333,087 m^2 by the year 2030, if allocated 30% of the projected installations.

Table 3: Industry and Government Roles in supporting the pumped system

Awareness and Marketing	
Industry Role	Promote the use of pumped thermal systems for industry, commercial enterprises, government, and residential houses. Develop manufacturing capacity for the systems locally. Use media to publicize availability and application of the system. Promote the use of large scale systems for Industries.
Government Role	Establish tax incentives, and rebates to make the system affordable and competitive.
	Establish a revolving funding mechanism to promote uptake of the system.
Research and Development.	Monitor and publish operating characteristics of the system. Develop and publish models for increasing uptake of the system- particularly in the areas of funding, technology, and application.
Institutional Issues	
Industry Role	Develop mechanisms for maintaining ethical business models for design quality, procurement, installation and commissioning of the systems. Establish businesses for supply, maintenance, and servicing and operations business nation-wide. Establish industry association to support regulations for the system.
Government Role	Establish standards for testing and the quality of the product through Department of Standards and Quality Assurance (DSQA): Provide policy, strategy and regulations for application of the system.
Research and Development	Monitor results of field operation and publish results. Build test plants for the system to evaluate and develop technical standards.
Workforce Development	
Industry Role	Train artisans, technicians, and professional engineers who can design, install, commission and operate through short course training programmes. Employ qualified artisan, technicians and engineers to work on the systems. Collaborate with University and research institution in performance measurements and monitoring of systems installed.
Government Role	Establish training programmes in tertiary technical institutions for training for SWH. Fund students taking courses in SWH at all levels.
Research and Development	Research funding should be established for capacity development in SWH for training technicians, and engineers. The funding can be sourced from different institutions: government, international development partners, foreign donors and research institutions themselves.
Research and Development	

Industry Role	Collaborate with research institutions and Universities on monitoring and evaluating system performance from installations. Fund research in areas where they encounter problems in their systems. Design and develop home grown adaptation of large-scale pumped thermal to meet local needs.
Government Role	Provide funding for research and development activities in SWH at local Universities and research institutions- in areas of optimization of operating system, design to meet local conditions.
Research and Development	Develop new components and systems well adapted to local. Undertake field tests and monitoring of current installations to support improved designs. Build research and testing facilities for development of larger systems.

3.3.4 Pumped systems for the public sector (30 – 60 m² per system)

Part of the roadmap will be to focus on institutions with centralised hot water supply. The target groups are:

- Hospitals, schools, student residences and similar institutions

According to the Lesotho Energy Policy (2015), the country intends to phase out the use of electric geysers in all existing public buildings and introduce solar water heating systems and heat pump systems. It aims to compel all new public buildings which require hot water to install solar water heaters and encourage the replacement of electric geysers with solar water heaters in general purpose sectors. With these initiatives the country will experience significant savings in energy by 2030.

Table 4: Industry and Government Roles in supporting the Large pumped system

Awareness and Marketing	
Industry Role	Promote the use of pumped thermal systems for industry, commercial enterprises, government, and Multi-residential buildings. Develop manufacturing capacity for the systems locally. Use media to publicize availability and application of the systems. Promote the use of large scale systems for Industries.
Government Role	Establish tax incentives, and rebates to make large pumped system affordable and competitive. Establish a revolving funding mechanism to promote uptake of large pumped systems.
Research and Development.	Monitor and publish operating characteristics of the large pumped systems.
	Develop and publish models & methods for increasing uptake of the large pumped systems- particularly in the areas of funding, technology, and application.
Institutional Issues	
Industry Role	Develop mechanisms for maintaining ethical business models for design quality, procurement, installation and commissioning of the large pumped systems. Establish businesses for supply, maintenance, and servicing and operations business nation-wide. Establish industry association to support regulations for large pumped systems.
Government Role	Establish standards for testing and the quality of the produc for large pumped systems. Provide policy, strategy and regulations for application of large pumped systems.
Research and Development	Monitor results of field operation and publish results of large pumped systems. Build test plants for large pumped systems to evaluate to support development of technical standards.
Workforce Development	
Industry Role	Support employees on short courses (artisans, technicians, and professional engineers) to design, install, and commission and operate large pumped systems. Employ qualified artisan, technicians and engineers to work on large pumped systems. Collaborate with University and research institution in performance measurements and monitoring of large pumped systems installed.
Government Role	Establish training programmes in tertiary technical institutions for training in large pumped systems.

	Fund students taking courses in large pumped systems at all levels.
Research and Development	Research funding should be established for capacity development in large pumped systems for training technicians, and engineers. The funding can be sourced from different institutions: government, international development partners, foreign donors and research institutions themselves.
Research and Development	
Industry Role	Collaborate with research institutions and Universities on monitoring and evaluating large pumped systems performance from installations. Fund research in areas where they encounter problems in their large pumped systems. Design and develop home grown adaptation of large-scale pumped thermal to meet local needs.
Government Role	Provide funding research and development activities in large pumped systems at local Universities and research institutions- in areas of optimization of operating system, design to meet local conditions.
Research and Development	Develop new components and systems well adapted to local. Undertake field tests and monitoring of current installations to support improved designs. Build research and testing facilities for development of larger systems.

3.3.5 Pumped systems for Industrial and Commercial Sector (50 - 500m² per system)

For industrial and commercial sectors, heat requirements range widely depending on individual end-use specifications and needs. Important industrial sectors which may require solar thermal systems include the food processing and beverages industries, the textile and chemical industries and in washing processes.

It is important that the installation of solar thermal systems enjoy a strong support from government coupled with financial benefits. This support will act as an incentive to attract entrepreneurs to join the market and thus significantly grow the supply side.

Table 5: Industry and Government Roles in supporting Industrial and commercial systems.

Awareness and Marketing	
Industry Role	Promote air cooling technology as an option to enhance solar, which when used with Solar PV system leads to a solution approach which is wholly clean and solar based. Identify and prioritize areas of application of great benefit in reducing electricity usage through passive solar cooling/energy efficient buildings. Private Architects should be motivated to design passive solar cooling/energy efficient buildings. An industry association needs to be set up to promote passive solar cooling/energy efficient buildings. Hotels should encourage use of passive solar cooling/energy efficient building technology.
Government Role	Apply passive solar cooling/energy efficient building technology for improvements to government buildings and offices Establish a mechanism to increase uptake of passive solar cooling through building regulations. This could be in the form of a revolving fund. Government architects should be empowered to publicise the uptake of passive solar cooling
Research and Development.	Monitor and publish the benefits of passive solar cooling/energy efficient buildings.
Institutional Issues	
Industry Role	Develop mechanisms for maintaining ethical business models for design quality, procurement, installation and commissioning passive solar cooling/energy efficient buildings. Establish businesses for supply, maintenance, and servicing and operations business

	nation-wide. Establish industry association to support regulations passive solar cooling /energy efficient buildings.
Government Role	Prepare strategies for increasing passive solar cooling Establish standards for testing and the quality of passive solar cooling/energy efficient buildings Provide policy, strategy and regulations for passive solar cooling/energy efficient buildings. Empower government architects to implement building designs incorporating passive solar cooling.
Research and Development	Monitor and report results of field operation of passive solar cooling/ energy efficient buildings and publish results. In particular energy efficiency of the buildings.
Workforce Development	
Industry Role	Train artisans, technicians, and professional engineers who can design, install, commission and operate systems for passive solar cooling/energy efficient buildings through short course training programmes. Train technicians and engineers in energy efficiency and energy audit and monitoring of systems installed. Employ trained technicians in operations and maintenance of passive solar cooling/energy efficient buildings
Government Role	Establish training programmes in tertiary technical institutions for training for passive solar cooling / energy efficiency and energy audit Fund students taking courses in passive solar cooling/ energy efficiency and energy audit at all levels.
Research and Development	Evaluate how current governments buildings can be upgraded or altered to cater for passive solar cooling /energy efficiency and advise stakeholders
Research and Development	
Industry Role	Collaborate with research institutions and Universities on monitoring passive solar cooling/energy efficient buildings. Design passive solar cooling/energy efficient buildings. Design and develop home grown adaptation of passive solar cooling/energy efficient buildings to meet local needs.
Government Role	Provide funding research and development activities in passive solar cooling/energy efficient buildings at local Universities and research institutions- in areas of optimization of operating system, design to meet local climatic conditions.
Research and Development	Develop models to quantify the benefits of passive solar cooling/energy efficient buildings in relation to energy savings, impact on carbon emission, economic and financial savings. Develop plans for converting the current stock of buildings to passive solar cooling/energy efficient buildings.

3.4 Solar Thermal Road Map Implementation Plan: 5 Years (2017 - 2021)

Policy framework: Lesotho government has developed an energy policy framework which supports energy access within the dimensions of reliability and affordability to drive the economy and improve livelihoods of the people of Lesotho. This policy, among others, emphasises the phasing out of electric geysers in all existing public buildings and introduce solar water heating systems. It also requires all new public buildings, which require hot water, to have solar water heaters installed; and that the electric in industrial, commercial, residential and general purpose sectors geysers be replaced with solar water heaters. It is therefore clear that the government will ensure the successful implementation of the road map as indicated by its commitment as outlined in the energy policy of Lesotho.

Solar Thermal installations in the upcoming 5 years

Figure 3 below the projected new installations required to reach 0.5m^2 collector area per inhabitant.

PROJECTED NEW INSTALLATIONS REQUIRED TO REACH 0.5m2 collector area per inhabitant

	Distribution percentage per sector						
	Schemes/Grid expansion	SOLTRAIN /UN funding	Policy driven	Energy Management			
	0.4	0.3	0.2	0.1			
Year	Residential Sector / Small SWH	Accommodation / Tourism Sector	Public Sector / Hospitals...	Industry	Annual installations [m²]	Cumulated [m²]	Cumulated [MWth]
		[m²]	[m²]	[m²]	3,892	3,892	3
2016	90	68	45	23	225	4,117	3
2017	156	117	78	39	389	614	0
2018	269	202	135	67	673	1,063	1
2019	466	349	233	116	1,165	1,838	1
2020	806	605	403	202	2,015	3,180	2
2021	1,395	1,046	697	349	3,487	5,502	4
2022	2,413	1,810	1,206	603	6,032	9,519	7
2023	4,174	3,131	2,087	1,044	10,435	16,467	12
2024	7,221	5,416	3,611	1,805	18,053	28,488	20
2025	12,493	9,370	6,246	3,123	31,232	49,285	34
2026	21,612	16,209	10,806	5,403	54,031	85,263	60
2027	37,389	28,042	18,695	9,347	93,474	147,505	103
2028	64,684	48,513	32,342	16,171	161,710	255,183	179
2029	111,903	83,927	55,952	27,976	279,758	441,467	309
2030	179,045	134,284	89,522	44,761	447,612	727,370	509
Total	**444,116**	**333,087**	**222,058**	**111,029**	**1,114,183**	1,114,183	780
Size(m2)	2.5	20	50	100			
Nb. of systems	**177,647**	**16,654**	**4,441**	**1,110**	Total installations	**199,852**	

Figure 3: projected new installations required to reach 0.5m^2 collector area per inhabitant.

3.5 Awareness, Marketing, Market Development and Support

By 2030, solar thermal technologies are envisaged to play a considerable role in the national economy. In order to achieve this aspiration, a consistent and stable support environment is a prerequisite. This support needs to target, inter alia, activities such as research and development (R&D), prototypes development, project-specific support as well as awareness campaigns and training.

Technological development in solar thermal technology systems needs market development. Since currently these systems are more expensive than the conventional fossil fuel based systems, there is a need to institute market deployment measures. Some countries like Germany and France provide grants and tax reductions for installation of solar thermal system as forms of subsidy, respectively. The most important aspect of a successful subsidy

scheme is that it should work continuously over a reasonably prolonged period of time. If the scheme is in the form of grants, the budget has to grow every year in order to cover the expected growth of the market and therefore the growing numbers of applications. In this regard it is the responsibility of the government to ensure that there are incentives and rebates. A tax reduction scheme may be put in place for solar thermal systems, and maintained at a more or less fixed level. In line with the Renewable Energy policy, the country will have to put a marketing strategy in place to increase the installation of renewable energy systems so that they contribute to the countries energy balance. The development of a marketing plan should involve all stakeholders and the role for each stakeholder should be clearly spelt out.

Government: Government, through the Department of Energy, should play a critical role in the handling of all fiscal aspects in the initial development of the renewable energy sector. The government will be required to create conducive environment for solar thermal technologies. For the technology to compete favourably with other low-cost options, the initial costs should be addressed both at policy level and financial level (particularly the introduction attractive and sustainable financing strategies). It is therefore important that government engages financial institutions to come up with attractive financing programmes and loans. The promotion of any programme supporting solar thermal technologies should focus on the long-term benefit to individual consumers, and to the nation at large. A general public campaign to sensitise prospective consumers or users, and promotion of solar thermal technologies must be led and driven by the government. Working with industry, tertiary institutions and other stakeholders, government should ensure that there is adequately trained and equipped human resource to support the sector.

Private Sector: Private sector is encouraged to propose appropriate, affordable and tailor-made solutions that are appropriate to the local market and conditions. Innovation should be central for coming up with solutions appropriate to the local market and needs. To ensure long-term sustainability, the private sector should work with the tertiary institutions such as National University of Lesotho (NUL), Lerotholi Polytechnic (LP) and BBCDC to generate and evaluate a wide spectrum of potential solutions and disseminate the solutions and technologies to all stakeholders. Workable business plans and promotion strategies for various solar thermal technologies should be developed. The private sector should participate in curriculum development in tertiary institutions and should support them to produce personnel with relevant skills and competencies.

Academic Institutions: Academic institutions are expected to provide a strong leadership by embarking on R&D activities in the solar thermal technologies sector. This will help spearhead the creation of an innovative environment in this sector. In order to ensure the long-term sustainability of the initiative it is important that government and private sector support and adequately budget for R&D and demonstration programmes.

3.6 Long term Plan (2022 - 2030): Supporting policy strategies

The government of Lesotho should facilitate the creation of properly regulated and efficient financing schemes for the installation of the solar thermal technologies in the urban residential areas where there is already piped water to ease the burden on expanding rural electrification, taking into consideration the country's socio-economic context. To be fully functional, these schemes should involve the government of Lesotho, the private sector and the international financial institutions. In addition to this, the early market development of this technology could be supported by creating a solar thermal energy technology fund. Different agencies (donors, bilateral and multilateral) should explicitly consider solar thermal technologies for development projects and prioritise them, especially when they are potentially the least cost options on a life-cycle basis. Dedicated loan facilities with low interest rates can be established to provide microfinance for solar thermal technology on preferential terms can also be part of the strategic mix.

4. Conclusion

The rationale for the LSTTP is underpinned by a number of critical considerations, namely, the:

- abundance solar resources that Lesotho enjoys;
- need for Lesotho to contribute to global warming by increasing its proportion of renewable component of its energy supply mix;
- need to reduce the country's sustained gap between supply and demand for electricity; and
- growing unemployment and poverty levels in the country, and particularly among rural communities whose access to electricity remains minimal.

Share of renewable energy in the primary energy supply is still very low and almost insignificant despite the effort done to overcame this situation

To implement this SWH Roadmap, there is need to build up internal capabilities in design, installs and servicing SWH installations of various types, through the creation or resourcing of local plumbing companies, which will need to acquire quality certification before their services can be offered confidently to grand hotels and industry

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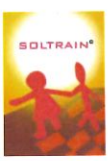

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