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ENERGY AND PETROLEUM REGULATORY AUTHORITY

VIABILITY ASSESSMENT OF SOLAR WATER HEATING INDUSTRY IN KENYA

DRAFT REPORT

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The study has been undertaken by the Energy and Petroleum Regulatory Authority to assess the viability of the solar water heating industry in Kenya. The outputs of the study will inform the policy and regulatory developments of the industry in Kenya.

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Project Title

Study on Viability Assessment of Solar Water Heating Industry in Kenya

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The stakeholders indicated that regulating the sector is important for quality and safety of the sector. However, considerations should be made for different regions, existing buildings, circumstances for exemption, provision of back up conventional water heating system and the type of premises. Solar water heating has several benefits for Kenya and the end users. First, economic modelling showed that the systems could payback the investment costs in residential areas in about 4 years. Additionally, the growth of the sector create up to 5,000 jobs annually. On the environmental front, the sector could abate about 151,225 tCO2.

Given the potential the sector has on the economy, the recommendations that Kenya may consider in regulating and supporting the SWH industry in the country include; developing a national solar water heating guidelines, amending the Energy Act, 2019 to explicitly empower the Cabinet Secretary to make SWH regulations. The country should adhere to regulations making procedure set out in the Statutory Instrument Act, 2013. Further, the Energy (Solar Water Heating) Regulations, 2020 should be amended

to ensure consistency with the constitution and other laws of Kenya, as well as adopt the global best practice.

ABBREVIATIONS AND NOTATIONS

AAK	Architectural Association of Kenya
AEPEA	Association of Energy Professionals Eastern Africa
CDM	Clean development mechanisms
CO_2	Carbon dioxide
COC	Certificate of compliance
CoG	Council of Governors
DANIDA	Danish International Development Agency
ELCOS	Electricity Consumer Society
EPRA	Energy and Petroleum Regulatory Authority
IEK	Institution of Engineers of Kenya
ISK	Institution of Surveyors of Kenya
JKUAT	Jomo Kenyatta University of Agriculture & Technology
KAHC	Kenya Association of Hotelkeepers and Caterers
KAM	Kenya Association of Manufacturers
KARA	Kenya Alliance of Resident Associations
KCIC	Kenya Climate Innovation Center
KEBS	Kenya Bureau of Standards
KEPSA	Kenya Private Sector Alliance
KEREA	Kenya Renewable Energy Association
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KPRA	Kenya Professional Realtors Association
kW/m^2	Kilowatt per meter square
LPG	Liquefied petroleum gas
MoE	Ministry of Energy
NCA	National Construction Authority
NEMA	National Environment Management Authority
NGO	Non-Governmental Organisation
NITA	National Industrial Training Authority
RE	Renewable energy
RURA	Rwanda Utilities Regulatory Authority

SANS	South African National Standard
SED	Sustainable Energy Development
SPSS	Statistical Package for Social Sciences
SUNREF	Sustainable Use of Natural Resources and Energy Finance
SWH	Solar water heating
ToRs	Terms of Reference

CHAPTER 1 INTRODUCTION

1.1 Background

Among all the renewable energy (RE) sources, solar thermal energy, particularly solar water heating (SWH) technology, has one of the simplest harnessing pathways. This technology harnesses thermal energy from the sun to heat water or a working fluid for use in domestic, commercial, and industrial applications. With an average daily solar insolation of 4-6 kW/m^2 , Kenya is a good candidate for optimizing the use of SWH technologies in meeting her energy requirements.

Kenya has been actively pursuing ways of optimizing the use of SWH technologies. Use of legal instruments has been one of the options. On 25th May 2012, the country gazetted the Energy (Solar Water Heating) Regulations, 2012 (Regulations). The objective of the Regulations was to promote uptake of SWH technologies, specifically by guiding the incorporation of the low temperature SWH systems in industrial, commercial, and residential buildings.

To meet the objectives of the Regulations, premises within the jurisdiction of the Urban Areas and Cities Act with hot water requirements exceeding 100 litres per day were required to install and use SWH systems to cater for at least 60% of the hot water requirements. However, the Regulations faced challenges in their implementation and were set aside in 2018. The reasons for setting aside of the Regulations include:

i) The Regulations were not accompanied by an explanatory memorandum making it impossible to analyse the extent of public participation or the level of consultation conducted yet the Regulations affect a large proportion of the population as households.

ii) The fine of Ksh.1 million provided for in the Regulations was in excess of the amounts specified in the Statutory Instruments Act, 2013 that limits the fines payable to a maximum of Ksh.20,000/= or a prison term not exceeding 6 months in default.

iii) The Regulations imposed a fine, imprisonment or other penalty without express authority being provided for in the Energy Act 2006.

iv) The Regulations required regulatory impact statement as they would affect a significant number of households in urban areas and cities.

v) The implementation of the Regulations would be punitive to landlords, tenants, and people occupying their own premises as installation of solar water heaters was not a basic life requirement.

vi) Additional cost of solar water heaters was antithetical to the government objective of providing access to affordable housing.

vii) It was practically not possible to operationalize and monitor as installation of solar water heaters is not tantamount to the use of hot water, neither is the number of bedrooms in a house a reflection of the amount of cold or hot water used in the house.

viii) The Regulations made reference to the Local Government Act (Cap 265) that was repealed in 2011.

To solve these challenges and come up with revised draft regulations, the Authority sought to conduct an evidence-based assessment of the viability of adoption of low temperature SWH systems in industrial, commercial, and domestic facilities in Kenya. The assessment involved techno-socio-economic modelling of the systems in Kenya. The project entailed conducting data-based evaluation and modelling of Kenya's SWH industry.

1.2 Study Objectives

The main objective of this study is to assess the viability of low temperature solar water heating systems in Kenya and use the information to draft new regulations.The following were the study objectives:

i) To conduct a desktop review of policies, regulations, codes, practices and incentives in other jurisdictions promoting adoption of solar water heating systems, evolution of the frameworks overtime, successes and challenges thereof.

ii) To identify other legislations, codes and standards supporting the use of solar water heating systems in Kenya.

iii) To map out the different stakeholders of the solar water heating industry in Kenya and their roles in the growth of the industry during the regulation development process and during implementation.

iv) To identify the level of qualifications, skills, training, and experience required to install different types of solar water heating systems. This is to provide a basis for certification of solar water heating workers in different categories.

v) To conduct a comparative techno-economic modelling of the system building services costs associated with plumbing for premises (domestic, commercial, and institutional) with and without provisions for solar water heating, overall installation costs of solar water heating systems on the various categories of premises (domestic, commercial, and institutional) relative to the overall project development costs, load curve, payback period, among others.

vi) To conduct a techno-economic modelling of adoption of SWH systems for domestic, institutional, and commercial facilities and compare the outputs to the existing alternatives such as use of biomass, LPG, and electricity.

vii) To analyse possible environmental, social, and economic impacts of the solar water heating regulations including possible jobs that may be created through the industry, potential of the solar water heating in m^2 in the short, medium and long-term together with the expected CO_2 to be abated.

viii) To recommend a regulatory approach for the solar water heating industry taking into account the various industry stakeholders identified for the implementation including proposing changes to the Draft Energy (Solar Water Heating) Regulations, 2021. This includes a review of fines and penalties in the proposed regulations in compliance with existing laws.

1.3 Scope of work

The scope of the study was limited to review of reports on solar water heating published within the last decade. In addition, the policies, regulations, practices, and incentives that were reviewed were for countries that have embraced solar water heating. The participation of SWH systems end-users and promoters was limited to organised groups representing different interested parties like residential neighbourhood and

hotelkeepers' associations. Further, there were no technical measurements taken; the required data were obtained from published literature.

1.4 Organization of the report

This report comprises of seven chapters. The background information, study objectives, outputs, and scope are presented in Chapter One. The methodology employed to execute the study is outlined in Chapter Two. In Chapter Three, the a review of the mechanisms used for promoting solar water heating in other jurisdictions is presented whereas in Chapter Four,. the findings of the study and techno-economic evaluation of solar water heating in Kenya are presented. Chapter Five discusses the potential impacts of SWH regulations in Kenya while Chapter Six provides the legal requirements for regulations making. Finally, Chapter Seven provides the appropriate regulatory approach for promoting Kenya's SWH Industry.

CHAPTER 2 STUDY METHODOLOGY

2.1 Introduction

To address the objectives of this study, the project team carried out the following activities:

- Desktop study
- Stakeholders' identification and mapping
- Sample design
- Development of data and information gathering tools
- Data and information collection
- Techno-economic modelling
- Data analysis and reporting

The methodology set out in the following sections was employed in delivering the services.

2.2 Desktop Study

The project team reviewed the litigations on the Regulations, the committee on delegated regulations report, and exemption reports with the aim of establishing if the legal issues raised have been addressed in the Draft Regulations. In addition, the Draft Regulations were examined in light of the provisions of the Constitution of Kenya and the Energy Act 2019. Further, the existing legislations, codes and standards in Kenya were reviewed to identify the players with a jurisdiction in solar water heating promotion, their mandate and how they can complement each other. The policy review included the National Energy Policy, the Kenya National Energy Efficiency and Conservation Strategy, the Least Cost Power Development Plan and the National Climate Change Action Plan. The reviewed codes and standards included the Kenya National Building Code and the KS 1860:2008 Standard.

The team benchmarked with experiences, regulations and policies from selected jurisdictions to understand how they have managed to adopt SWH systems. The identified jurisdictions include Rwanda, South Africa, India, Brazil, and Barbados. The

study identified their success parameters, challenges and lessons in adoption of SWH systems. Stakeholders Identification and Mapping

The solar water heating stakeholders were identified and mapped. Preliminary review of the report on solar water heating in Kenya (EED Advisory Limited, 2017) was a good source of the stakeholders. The stakeholders were categorized into national government agencies, county governments, professional associations, development agencies, financial institutions, promoters, end users and training institutions.

2.3 The Population Size and Sampling Technique

2.3.1 Stakeholders Population

The technicians and contractors who were licensed by 2018 when the Regulations were annulled were identified from the Authority's database. The team also obtained information from literature, professional colleagues and knowledge of the market and identified other actors who may be involved in SWH. The population of the identified stakeholders is presented in Table 2.1.

Table 2.1: Stakeholders population

Targeted population category		*Population (N)*
Licensees	Technicians	232
	contractors	104
Unlicensed installers		Not known
Government Agencies		8
Professional Bodies/ Associations		5
Development Agencies		6
Financial Institutions		4
Promoters		6
End user associations		3
Training Institutions		5

2.3.2 Sampling Methods

The team chose stratified, purposive, and snowballing as the main sampling methods for the study. These choices were based on the nature of the survey and the categories of stakeholders identified. The rationale for each of the three sampling methods is presented in Table 2.2.

Table 2.2: Sampling Methods

Sampling Method	*Rationale*
Purposive sampling	Informed by the fact that the survey targeted respondents that are within the energy sub-sector, the survey employed the purposive sampling technique to identify key actors who may provide essential information to the survey. These mainly comprised of stakeholders in solar water heating including government agencies, professional bodies/ associations, development agencies, financiers, promoters, end-users, and training institutions as given in **Error! Reference source not found.**.
Stratified sampling	Based on the argument that the research targeted several respondent clusters who include the solar water heating systems importers and installers, policy makers, financiers, government agencies, professional associations, development agencies, promoters, end users and training institutions.
Snowball sampling	This method was included to ensure that the survey captured data from installers that were not within the EPRA database but who may have input and information that would be relevant and informative to the study. This specifically referred to unlicensed technicians and contractors and other actors who provide a range of services in the SWH sub-sector.

2.3.3 The Sample Sizes

For quality of information from the relatively large licensee stakeholders' category, an appropriate sample size of respondents that is adequate to bring out instructive and well-balanced output for the survey was determined. The team considered various logistical factors as follows:

- Distribution of stakeholders was widespread across the whole country (47 Counties)
- There was limited time and resources to conduct the study

- Majority of the stakeholders were confined in the major cities and towns.

The licensee stakeholders' population sizes involved in the study were finite. Thus, the study team used the following formula to determine the sample size for each of the two licensee stakeholder categories.

$$N_s = \frac{qN}{q + (N - 1)} \quad (1)$$

Such that

$$q = \frac{Z^2 p(1-p)}{E^2} \quad (2)$$

where

N_s - Sample size

N - Stakeholder population size

p - Population proportion

Z - Obtained from standard normal distribution tables.

E - Tolerance sampling error

The variables used for determining the sample sizes are given in Table 2.3.

Table 2.3: Variables used for determining sample size

Variable:	*Value:*	*Rationale:*
Confidence level	95%	Set at 95% because the survey is dealing with a finite population that is known and confirmed to be relevant to the study and thus, they represent a true population parameter.
Population proportion *(p)*	0.5	Sample of the population that is likely to have similar characteristics. Set to the conservative 0.5 the standard for finite populations.
Margin of Error (*E*)	0.05	A provision for the variance in results from a survey conducted using random sampling. Determined to be approximately 5% for a finite population and within a confidence level of 95%.
Alpha value (œ)	0.025	A statistical value used to determine the *Z*-score and is arrived at using the formulae œ *= (1 – Confidence level) x 0.5* œ *= (1-0.95) x 0.5*

Variable:	*Value:*	*Rationale:*
		$\alpha = 0.025$
Z-score (z)	1.96	The number of standard deviations from the mean score associated with the population size. Obtained using the formulae: *z= probability function*[1] *(1 – Alpha value)* = 1.96
Sample size (*n*)	Varied	Based on the database lists for the various stakeholder categories
Population size *(N)*	Varied	This is differentiated by the various respondent clusters as was obtained from the databases.

2.4 Development of Data and Information Gathering Tools

This research used questionnaires and interview guides to collect data from the respondents. Details of the contents of the questionnaires are presented in Appendix A. The questionnaires were administered to the licensed contractors and technicians, as well as the end-user associations. The information from the rest of the stakeholders was collected using the interview guide.

2.5 Data Collection Methods

Data was collected through a hybrid of methods. First, introduction letter was sent to all the respondents. This was followed by the administration of questionnaires and interviews. Some of this was through virtual platforms, while others were through face to face meeting.

2.6 Techno-economic Modelling

The team first sought to determine the cost of water heating in Kenya using conventional fuels such as biomass, LPG, and electricity. To model the cost, the team considered typical scenarios in residential, commercial and institutional sectors where typical hot water consumption was considered. The energy used to heat a certain volume of water, Q (J), from ambient temperature, θ_{amb} to the required temperature, θ_T was computed using the following equation.

[1] Probability function is a formula computed using weighted averages of the study variables and is used to validate the Z-score (z) value

$$Q = mc(\theta_T - \theta_{amb}) \quad (3)$$

Where m is the mass of the water (in kg) and c is the specific heat capacity kJ/kg/°C.

The energy input into the system was obtained considering the heating system's efficiency. Thereafter, the amount of fuel needed to heat the required amount of water was determined using the heat content of the various fuels. The cost of biomass, LPG, and electricity were obtained from the current market prices obtained in 2021. The cost of heating water was then modelled from the amount of fuel needed and the cost of each of these fuels in Kenya.

The team established the costs of installing and maintaining a SWH system from interviews with the players in the market, and through experience and expert judgement. The aforementioned scenarios were also modelled using SWH systems. The modelling included implementing solar water heating systems in different building categories to obtain:

i) the average costs associated with plumbing in different types of premises with and without provisions for SWH systems,
ii) the overall installation costs of SWH systems in various categories of premises.

The team used their experience and expert judgement to determine the cost associated with plumbing for various categories of facilities with and without provisions for SWH systems. These data were validated using the field data before the development of the techno-economic model.

Finally, the average energy savings accruing from installation of SWH systems in the various premises were modelled. This information was used to develop a techno-economic model for adoption of SWH systems for domestic, institutional and commercial facilities over their lifecycle. The techno-economic model was designed to give various outputs such as simple payback period, net present value and internal rate of return were calculated based on the methods in (Capehart, Kennedy, & Turner, 2016).

2.7 Identification of the Regulatory Impacts

During the interviews, the respondents were asked to give their views on the possible impacts of the solar water heating regulation from the environmental, social, and economic perspectives.

Further information was obtained through literature review on the potential market for solar water heating in Kenya. According to (EPRA, 2020) Energy and Petroleum Statistics Report, the demand for SWH systems was projected to be more than 800,000 by 2020. Additionally, the overall potential of solar water heating units in Kenya is estimated to be more than 2 million units (EED Advisory Limited, 2017).

The annual emissions reductions potential from solar water heating systems was estimated using the equation below.

$$\Delta CO_2eq = EF \times Q_{disp} \quad (4)$$

Where ΔCO_2eq was the reduction of emissions, EF was the emission factor of the fuel displaced by SWH system and Q_{disp} was the energy of the displaced fuel (UNFCC, 2018). The energy displaced by solar water heating was calculated as follows.

$$Q_{disp} = Q_{SWH} = 0.29 \times H0 \times A_a \quad (5)$$

Where Q_{SWH} was the annual SWH energy output, $H0$ was the Annual global solar irradiation on horizontal the given location in kWh/m² and A_a was the collector aperture area (IEA SHC, 2011).

Social impact was derived from the interview respondents, literature and expert judgement.

2.8 Data Analysis and Reporting

After collecting data from various stakeholders, a detailed analysis of the responses from the stakeholders was undertaken. Based on the analysis, inferences were drawn on:

i) skills and qualification requirements for solar water heating technicians;
ii) economic viability of solar water heating systems;
iii) social, economic, and environmental impacts of solar water heaters and;
iv) recommendations used to prepare the draft (Energy Solar Water Heating) Regulations 2022.

CHAPTER 3 SOLAR WATER HEATING IN OTHER JURISDICTIONS

3.1 Introduction

This chapter presents the findings of desktop review of the policies, regulations, codes, practices, and incentives in other jurisdictions promoting the use of solar water heating systems, as well as successes and challenges in the benchmarked countries. Specifically, the analysis focuses on Rwanda, South Africa, India, Brazil, and Barbados.

The parameters for review under each country include:

a) ***Legal framework*** - sets out the various legal instruments including regulations, codes, and practices that set up the legal framework for SWH systems specifically manufacturing, installation, use, and maintenance.
b) ***Scope of application*** - considers the type of premises and geographical spaces to which the legal framework for SWH systems is applicable.
c) ***Installations*** - reviews who is allowed to install the SWH system and how the installation is to be done.
d) ***Exemptions*** - considers the exemptions from compliance with the SWH systems requirements.
e) ***Standardization*** - delves into the standards applicable to the equipment used in assembling a SWH system.
f) ***Licencing*** - analyses the licences that an installer should obtain before they can install SWH systems and renewal of such licences.
g) ***Penalties*** - analyses any penalties for any failure to install and/or use SWH systems (if any).
h) ***Incentives*** - analysis of the nature and types of incentives that the jurisdictions under review have applied in promoting the use of SWH systems.
i) ***Successes*** - analysis of the successes in the respective jurisdictions and the factors leading to the success.
j) ***Challenges*** - delves into the obstacles that could have hindered or continue to hinder the uptake of SWH technologies in the select jurisdictions.

k) The chapter addresses objective i.

3.2 Rwanda

The development of the SWH sector in Rwanda had been enabled by laws and incentives, as highlighted in Table 3.1.

Table 3.1: Laws and Incentives in Rwanda

Regulatory Element	*Highlights*
Legal Framework	The SWH Regulations, 2015
Objective	To provide a licensing and regulatory framework for the design, installations, operation, repair, maintenance, and upgrade of SWH systems in Rwanda[2]
The scope of application	The SWH Regulations 2015 apply to both commercial and residential buildings in Rwanda. The hot water capacity requirement is the use of 100 litres of hot water per day.
Installation	• Installation of SWH systems is done by technicians who must be licenced by the Rwanda Utilities Regulatory Authority (RURA). • Solar collectors are to be installed at an angle of between 10° and 20° from the horizontal plane.[3] • Upon installing the SWH systems, the contractor or technician is required to issue a certificate of installation which shall outline, among others, the date of installation, the capacity of the SWH system, details of the installer, and warranty. • The occupier or owner of the premises is responsible for ensuring that the installed SWH system is repaired and maintained throughout its lifetime.
Exemptions	• Where the hot water supplied to the premises is from a cogeneration plant; or • where the premises are using electricity generated from renewable energy and the excess is used to heat water as a dump load.[4]

2 Article 1 of the Regulations

3 Article 4 of the Regulations

4 Article 8 of the Regulations

Standardization	SWH systems are required to be designed and installed according to the Rwandan Standard as shall be developed by the National Bureau Standards.
Licencing	• SWH technicians need Permit and contractors need to License from RURA • An application for a permit/licence is made to RURA • Minimum Education Qualifications and Professional experience of SWH Technicians 1. Graduate Engineer (Mechanical Eng., Renewable Energy Eng. and other relevant fields) and 2 years of work experience involving plumbing works. 2. Higher National Diploma and 2 years of work experience involving plumbing works. 3. A_2 certificate with background in renewable energy technologies and 3 years of work experience involving plumbing works. 4. A_3 certificate with background in renewable energy technologies and 4 years of work experience involving plumbing works. 5. Certificate of a tailored training in SWH Technology and 4 years of work experience involving plumbing works. • The licences/permits are valid for three (3) years renewable • Transfer of licences is also allowed under the regulations.
Penalties	• Where a licence/permit holder violates the provisions of the licence/permit, the Authority shall send a warning to such persons giving them the period within which to comply with the terms of the licence/permit. • Where the violation persists, RURA may impose a monetary penalty not exceeding two million (2,000,000) Rwandan Francs (approximately USD. 1,955.00) or suspend/revoke the licence/permit altogether. • Where RURA had issued a compliance notice to the owner of the premises and they fail to correct the violation within the period specified in the order, RURA may on conviction require the person to pay a fine not exceeding ten thousand (10,000) Rwandan Francs (approximately USD. 9.78) for residential premises and thirty thousand (30,000) Rwandan Francs

	(approximately USD. 29.33) for all other premises for each day or part thereof that the contravention continues. • Failure to completely install SWH systems on-premises that require 100 litres or more of hot water daily shall be liable for a fine not exceeding one million (1,000,000) Rwandan Francs (approximately USD. 977.52). • For all other offenses without a specific penalty, provided for under the Regulations, the general penalty is 1,000,000 Rwandan Francs (approximately USD. 977.52).
Incentives	
• ***SolaRwanda program (2011-2015)*** - This program was founded to stimulate the usage of renewable energy and energy efficiency equipment in the country. The Government of Rwanda received a grant from the Global Environmental Facility Trust Fund (World Bank/GEF) amounting to about USD 4.5 Million for the Rwanda Sustainable Energy Development (SED) Project[5]. • In addition, the government obtained another grant from the Nordic Development Fund amounting to 4 million Euros to develop the solar water heaters market in Rwanda (SolaRwanda Program). • The objective of the SolaRwanda Program was to promote the use of solar water heaters in residential houses by providing financial incentives, and other support measures. • The program aimed at installing 12,000 SWH systems by the end of 2015. The program involved various stakeholders in the finance sector including I&M Bank, Umwalimu SACCO, and others who signed cooperation agreements to provide and manage credit to support the SolaRwanda Program.[6] • Another incentive that reduced the cost of installing SWH systems was the local manufacturing of SWH systems. Tumba College of Technology (Rwanda) started a solar water heater manufacturing project in 2010.[7] This has led to a reduction in the prices of SWH systems in the country making them affordable to citizens.	
Successes	
• A combination of both incentives and the regulations has led to a rise in the uptake of SWH technology in Rwanda compared to the uptake before the	

[5] See https://www.reg.rw/fileadmin/user_upload/Description_of_SolaRwanda_Program_Updated_2014_02_11.pdf

[6] See https://www.reg.rw/fileadmin/user_upload/Description_of_SolaRwanda_Program_Updated_2014_02_11.pdf

[7] Nshimyumuremyi, Esdras, and Wang Junqi. "Thermal efficiency and cost analysis of solar water heater made in Rwanda." *Energy exploration & exploitation* 37, no. 3 (2019): 1147-1161. https://doi.org/10.1177%2F0144598718815240

incentives and the regulations. Currently, slightly above 2,464 SWH systems have been installed in Rwanda even as the government continues to encourage people to install the systems.[8]

- Tumba College of Technology in Rwanda manufactures local solar water heaters, thus promoting the local investment in SWH systems production.

Challenges

- High cost of solar water heaters- a Solar water heater in Rwanda by Tumba College of Technology is $900 with 2.77 m^2 and 200 litres of tank capacity. This is a relatively high cost for domestic consumers of solar water heaters.[9]
- The SolaRwanda program aimed at having 12,000 SWH systems installed in Rwanda by end of the program in 2015. However, by 2017, only 2,464 systems had been installed throughout the country. The low uptake is partially due to the high cost of the systems, poverty levels in some parts of the country, and lack of awareness of the advantages of SWH technology.

3.3 South Africa

The South Africa's approach in promoting the uptake of solar water heaters involves programs and schemes to encourage the use of SWH systems. Regulations may, however, be enacted at the town levels as highlighted hereunder in Table 3.2.

Table 3.2: SWH regulations in South Africa

Regulatory Element	*Key Highlights*
Legal Framework	National Building Regulations and Building Regulations Standards Act No. 103 of 1977 and the Regulations proclaimed in 2008 apply. Local Government: Municipal Systems Act No. 32 of 2000
Objectives	The objective of the National Building Regulations and Building Regulations Standards Act is: • promotion of uniformity in the law relating to the erection of buildings in the areas of jurisdiction of local authorities; • prescribing of building standards; and • matters connected therewith. Local Government: Municipal Systems Act No.32 of 2000. This Act empowers local authorities to gazette by-laws to regulate standards and practices in their jurisdictions.

[8] https://www.ijstr.org/final-print/dec2020/Inventory-Analysis-Of-Power-Plants-In-Rwanda-And-Estimated-Generation-Capacities.pdf
[9] Ibid 13

The scope of application	**Hot water capacity requirement-** Part XA 2 of Extended South African National Standard (SANS) 10400 XA, Energy Usage in Buildings reads: "A minimum volume fraction of 50% of the annual average heating requirement for hot water shall be provided by means other than electric resistance heating or fossil fuels." This provision, however, is general and does not restrict a person from using SWH systems.
Installation	• The installation of SWH systems has to comply with the SANS 10106 • The National Buildings Regulations Act 103 of 1977 provides that the installation of SWH systems shall be by plumbers who have obtained a certificate of compliance (COC) from the South African Qualifications Authority. • The local authority shall ensure compliance with the standards and issue approval to that effect.

Exemptions	• SWH regulations enacted at the town levels allow for exemptions. For instance, under the Cape Town by-law on SWH systems, the following are exempted from SWH systems installation requirements:
	• Buildings used for industrial purposes only;
	• Any privately funded, residential building with less than 100 m², including garage space;
	• The city local authority could exclude buildings from the by-laws on the following grounds;
	  ○ Historical buildings; and
	  ○ Where the building is located in an area with permanent shading.

Installation and maintenance	• The installation and maintenance should comply with the SANS 10106 which requires only certified installers to install SWH systems. Towns should therefore ensure compliance with the said standard. • Under Section 6 of the SANS 10106, the installer is required to: Furnish the owner with an operation manual (written and schematic) containing operating, safety emergency shut down, and routine maintenance procedures and instructions.
Standardization	The SWH systems should comply with the SANS 1307.[10]

[10] See https://solarthermalworld.org/news/cape-town-draft-solar-water-heating-bye-law/

Licencing of installers	Installers/plumbers shall obtain a certificate of compliance (COC) from the South African Qualifications Authority
Local content requirement	• Under the National Solar Water program, there is a requirement for 70% local content whose purpose is to promote local manufacturers and industries. • However, the local content requirement applies only to the tank and collector components of the solar water heater configuration.

Incentives

SWH Communication Project (1978-1983) – during this period, the South African government promoted SWH systems.

- The Centre for Scientific and Industrial Research (CSIR) developed communication strategies and projects regarding SWH thus motivating homeowners to install them.
- Homeowners took a home improvement loan or made cash payments.
- As a result, the SWH market grew focusing on middle- to high-income customers.
- The cost of SWH was around R3500 for a 200 litres system, making it affordable for many houses to install.

SWH 500 project - this was launched in 2003 to create awareness through the media, SWH exhibitions, manufacturer consultations, municipalities, non-governmental organizations, and public and private entities among others.

Department of Energy (DoE) launched a solar water heater programme in 2008 aimed at houses without electrical hot water supply to equip 1 million homes with solar water heaters. The programme had installed 400,000 units by 2019.
The incentive used was a subsidy on the purchase price of installed SWHs, based on the reduction in peak power demand and energy achieved.
The programme was implemented in two ways:

- The subsidised installation of high-pressure SWHs in private and commercial buildings.
- The free installation of low-pressure SWHs on low-cost houses that are connected to the electricity network, low-income households, and permanent brick structures.

The programme is currently managed by municipalities subject to several criteria developed with the DoE.

Successes

- Increased installation of SWH systems in towns such as Cape Town that have by-laws on the installation of SWH systems in domestic and commercial premises. As of 2010.

• There is local manufacturing of solar water systems in South Africa assisted by the growing number of companies manufacturing SWH systems. In Cape-town only, there are about 12 SWH installation companies.
Challenges
• High cost of SWH technology limiting accessibility. • Lack of awareness on SWH resulting in low uptake of the technology. • Insufficient training of SWH systems installation officers which slows down installation rate. • Low electricity prices which makes people to prefer using electricity to meet their hot water demand instead of investing in the high-cost SWH technology.

3.4 India

India has made significant steps in having SWH systems installed in both residential and commercial buildings. Just like in South Africa, the use and installation of SWH systems in India rely on by-laws at the state and municipal levels, despite the existence of a requirement by the central government that new buildings shall install solar water heaters.

For purposes of this review, the state of Maharashtra is used as an example to illustrate the steps that India has made to promote the development of solar water heaters.

Table 3.3: India SWH regulatory framework

Regulatory Element	*Highlights*
Legal Framework	Energy Conservation Building Code ("Code"), 2017.
Objective/Purpose	It promotes the use of new and innovative technologies and methods in India.
The scope of application	• The Code targets (a) Buildings, (b) Non-Residential -sports complex, shopping malls (c) Residential -Hostels, Hospitals, Housing Complex. • State and municipal governments may choose to implement the Code or not, although they are urged to. • State governments are allowed to modify the code where necessary to consider the local climatic conditions. For instance, in the State of Maharashtra, the state government requires municipal co-operations to introduce by-laws on SWH providing for the installation of SWH systems on new buildings.

	• On this basis, municipal corporations including Thane, Greater Mumbai, Nagpur, and Malegaon have introduced by-laws requiring all new commercial and public houses to install a solar water heater of 2 m^2 per family.
Hot water requirement capacity	Section 5.2.9 of the Code provides: "*To comply with the Code, Hotels and Hospitals in all climatic zones and all buildings in a cold climate zone with a hot water system, shall have SWH equipment installed to provide for:* *(1) at least 20% of the total hot water design capacity if the above grade floor area of the building is less than 20,000 m^2.* *(2) at least 40% of the total hot water design capacity if the above grade floor area of the building is greater than or equal to 20,000 m^2"* Furthermore, the Code provides that hotels and hospitals in all climatic zones and all buildings in a cold climate zone with a hot water system shall have SWH equipment installed to provide at least 40% and 60% respectively of the total hot water design capacity.
Exemptions	Exemptions differ from one state to another and from one municipality to another.
Persons responsible for installation and maintenance	Generally, the duty is on developers or owners of premises to install solar water heaters.
Standardization	• The Bureau of Indian Standards (BIS) has established standards for flat place solar collectors. The standards provide for specifications, components, measuring instruments, and test methods for flat plate collectors. • Under the Energy Conservation Building Code of 2007, solar water heaters shall meet the minimum performance standards established under the Indian standards.
Incentives	
• Both the central government and the state governments offer incentives for promoting SWH. The Ministry of New and Renewable Energy (MNRE) provides the following subsidies which are passed onto consumers through specific companies dealing in solar water heaters: - 30% subsidy for general category states; and 60% subsidy for special category states. Special category states are those facing geographical and	

socio-economic disadvantages. These include states with hilly terrains, strategic international borders, economic, etc.

- One can take a loan on SWH systems at an interest of 2-5%. For some states such as hilly states and islands states, domestic users can access free-interest loans on SWH systems.
- Capital subsidies are also available to developers, builders, development authorities, housing societies an.d cooperatives, and housing boards to provide SWH systems in new buildings.
- State Electricity Regulatory Commissions (SERCs) are also encouraged to provide electricity tariffs to building owners or occupiers who have installed SWHs.

Successes

- As of 2010, about 0.7 million SWH systems had been installed within the residential sector.
- However, about 65% of these SWHs are in two states: Karnataka and Maharasthra.[11]
- The dominance of SWH in the two states is because of incentives that the states have introduced to encourage the uptake of SWH technology.

Challenges

- It is not mandatory to comply with the Energy Conservation Building Code ("Code"), 2017. Local governments may choose to comply with this Code or not thus reducing commitment by local governments to ensure SWH installation.
- Lack of consumer awareness on solar water heaters, which affects the installation, especially in remote and low-income communities.[12]
- Challenges relating to the accessibility of the SWH technologies as one has to meet certain criteria to benefit from the subsidies that the government offers.
- Limited skilled SWH installers due to few training centres in some parts of the country.
- Poor building designs that make the installation of SWH systems difficult.

3.5 Brazil

The approach taken by Brazil is similar to India where state and local governments are mainly involved in passing by-laws and regulations on SWH in the country. For instance, the state government of Rio de Janeiro approved a law (State Law 5184 of

[11] https://mnre.gov.in/img/documents/uploads/2cd570c26ddd4f54aacf840bdf388b5b.pdf
[12] https://www.99acres.com/articles/challenges-for-solar-heating-in-india.html

2008) requiring the installation of SWH systems for public buildings mandatory, as highlighted in Table 3.4.

Table 3.4: Brazil's SWH regulations

Regulatory Element	*Highlights*
Legal Framework	Law 9478 of 1997
Objective/Purpose	This law establishes the general principles of Brazil's national energy policy. It recognizes the use of renewable energy sources as a pillar of the country's energy policy.[13]
The scope of application	• The enactment of by-laws and regulations on SWH is mainly done by the state governments. An example is the state of Rio de Janeiro State Law 5184 of 2008. • All new and refurbished *public buildings* (buildings that are accessible to the public such as hotels) must install SWH systems in Rio de Janeiro.
Hot water requirement capacity	In Rio de Janeiro, at least 40% of the total hot water demand shall be acquired from solar energy for new and refurbished public buildings.
Exemptions	The exemption here is public buildings that, because of technicalities, cannot have SWH systems installed on them.
Persons responsible for installation and maintenance	The duty is on developers or owners of premises to install solar water heaters.
Standardization	• The equipment used in setting up the system must comply with the Brazilian norm NBR and the Brazilian Technical Standards Association
Incentives	
• There is a 0.5% levy on electricity bills for the users of SWH established by Law 9991 of 2000. • Some municipalities offer tax incentives for SWH through a discount of the ITPU local tax (as part of a Green ITPU package). • The Brazilian National Housing Program, also known as, Minha Casa, Minha Vida ("My House, My Life") program. Under this program, it is a requirement to install solar water heaters for new social housing projects. • Under this national program, the government seeks to build affordable and large-scale housing.	

13 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_RE_Latin_America_Policies/IRENA_RE_Latin_America_Policies_2015_Country_Brazil.pdf?la=en&hash=D645B3E7B7DF03BDDAF6EE4F35058B2669E132B1#:~:text=Law%209478%20of%201997%20established,setting%20energy%20policy%20in%20Brazil.

Success
• Through the Brazilian National Housing Program which emphasizes the installation of SWH systems in new government-sponsored houses, at least 400,000 SWH are to be installed by the end of the program.
Challenges
• According to an assessment that was done in 2021, about 43% of Brazilian households have water heating systems.[14] • Of the 43%, about 96.3% use electric showers and only 2.3 % use solar water heaters. This means that the SWH industry in Brazil is not much developed. Some of the causes of the low uptake include: - High up-front SWH system costs denying low-income populations access to SWH heaters [15] - Lack of awareness of the pros and cons of using SWH technology in some states - Limited access to financial support, especially in poor states forcing some local governments to rely on the national government SWH support programs.

3.6 Barbados

Barbados is one of the countries that have successfully developed the SWH systems industry globally. This development is attributed to several factors including the following highlights in Table 3.5.

Table 3.5: Barbados SWH legal framework

Regulatory Element	*Highlights*
Legal Framework	Barbados National Sustainable Energy Policy
Objective/Purpose	"To unlock economically viable investments in Renewable Energy and Energy Efficiency that will reduce Barbados' dependency on fossil fuels, and therefore • *reduce energy costs,* • *improve energy security, and* • *enhance environmental sustainability".*
The scope of application	Nation-wide application

[14] See ELETROBRAS - Centrais Eletricas Brasileiras S.A. (2019). National Program for Energy Preservation and Technical Efficiency (Procel) – Electrical Appliances Possession and Usage Habits Research for the Residential Sector– PPH Brazil 2019. Rio de Janeiro, Brazil, 2019.

[15] See https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/10304040_2.pdf

Incentives
Fiscal Incentives Act, 1974: through this law, the government of Barbados introduced a tax exemption for the materials used to produce SWH systems. This saved up to 20% of the production cost. • To discourage the use of electric water heaters, the government levied a 30% tax on electric water heaters making them very expensive for many people to afford. • Government Purchase of SWH for State Housing, 1977: • To support the SWH industry, the Government of Barbados mandated the installation of SWH systems in all buildings built under the government housing developments. **Homeowner Tax Benefits, 1980–1992**: In 1980, the Government of Barbados made the cost of installing SWH systems tax-deductible to a maximum of 1,750 USD. • As a result, there was a peak in SWH systems installations in 1989 leading to about 2,800 units being installed. This incentive ceased in 1992 due to the economic recession in the late 1980s. **Amended Homeowner Tax Benefit,** 1996: In 1996, the Homeowner Tax Benefit was reinstated. In the new setup, Barbadians were allowed an annual tax deduction of 1,750 USD for home improvements, which included repairs, renovation, energy- and water-saving measures, and SWHs.
Successes
• Two in every five households in Barbados have installed SWH system.[16] This is one of the highest number of SWH installations worldwide. • High growth of the local SWH systems manufacturing industry has boosted the uptake of SWH technology in the country.
Challenges
• Limited access to initial capital to install SWH systems especially among low-income populations. • Lack of awareness and confidence in solar technology among some consumers reducing the consumers' urge or interest to invest in SWH systems. In a study by Karakaya and Sriwannawit, it was discovered that many Barbadians were not taking up SWH technology because they did not have knowledge about it.[17] The government is however educating people on the technology creating possibilities of a high uptake in future. • Inconsistent financial incentives by the government, discouraging people to invest in a new system.

[16] See https://www.energy.gov/sites/prod/files/2015/03/f20/phase3-barbados.pdf
[17] See https://core.ac.uk/download/pdf/156784543.pdf

3.7 Lessons applicable for Kenya

3.7.1 Incentives

The development of SWH systems in most countries is mainly attributed to incentives that take different forms such as low-interest loans, tax rebates, and capital subsidies. The use of incentives in promoting the uptake of solar water heaters is due to the high initial costs of installing the systems which might hinder many people from accessing and installing them. In South Africa, the initial step was to create awareness among citizens about solar water heaters and how the use of these systems would impact their energy-related expenses. Over time, people started accepting SWH systems and installing them with the support of government incentives and in line with the country's building code.

In providing incentives, some governments work closely with financial institutions and other stakeholders within the energy sector. For instance, in Rwanda, under the SolaRwanda Program initiated in 2012, the Government of Rwanda partnered with local and foreign financial institutions including banks and SACCOS to offer low-interest loans for the acquisition of SWH systems. It is after the implementation of these and other incentives that Rwanda passed regulations in 2015 on SWH with penalties for failure to install SWH systems.

Based on the above, Kenya should introduce a SWH incentives programme to support mass installation of SWH systems. For instance, the introduction of tax exemptions on the manufacturing of the systems would attract investors to the industry and cushion citizens from the burden of financing the installation. Tax incentives, tax exemptions, and subsidies on SWH products help lower the cost of importation and local manufacture of SWH systems to make them cheaper so that people can embrace SWH systems installation in their premises.[18]

[18] Urban, F., Geall, S., & Wang, Y. (2016). Solar PV and solar water heaters in China: Different pathways to low carbon energy. *Renewable and Sustainable Energy Reviews, 64,* 531-542. https://doi.org/10.1016/j.rser.2016.06.023

3.7.2 Decentralization of duties and responsibilities

The other common trend is the decentralization of the responsibility to ensure the installation of SWH systems. In countries with devolved systems of governance such as India, South Africa, and Brazil, the national governments have enacted general laws or building codes requiring the implementation of solar water heaters or clean energy projects at state or local government levels. However, the responsibility to develop by-laws on SWH is left to the local governments. This approach allows for flexibility in the development of SWH systems considering the unique needs of each local area.

This approach is critical because while the initiative to apply solar water heaters in residential and commercial entities is a good move towards reducing reliance on fossil fuels and other fuels, the implementation of programs, schemes, or laws on solar water heaters should accommodate the demographic capacities of local communities. It would be unreasonable to expect persons living in marginalized parts of the country to install SWH systems within the same period as people living in urban areas given the high initial costs of installing SWH systems.

Kenya has a devolved system of governance, meaning some functions are to be carried out by the National Government while others by the County Governments. However, some functions are shared between the two levels of government. Schedule (IV) of the Constitution classifies energy regulation as a function of the national government. However, under the Energy Act, 2019, County Governments have a role to play to ensure energy efficiency and conservation. Section 193 (a) of the Energy Act provides that the county government may,

"With the approval of the Authority, amend the energy conservation building codes to suit the local climatic conditions and may, by rules made by it, specify and notify energy efficiency and conservation building codes concerning the use of energy in the buildings"

Based on the above provisions, the Ministry of Energy should engage with and institute technical assistance programmes for County Governments to assist them amend their energy efficiency and conservation building codes to include requirements and guidelines on SWH systems within their respective jurisdictions. This is especially important as the Draft Regulations envision that the design, installation, testing,

commissioning, repair and maintenance of a SWH system shall be in accordance with the building code of a County,[19] and the selection of components for plumbing works in a SWH System shall also be in accordance with the planning and building code made under the County Government Act, 2012.[20]

3.7.3 Training and licencing solar water heating technicians

Effective and appropriate installation of solar water heaters is emphasized in almost all the benchmarked jurisdictions. In Rwanda for example, which is the only country under review that had a specific national level law on SWH, a technician must obtain certain academic requirements and a licence from the relevant authority to install SWH systems. Further, in Rwanda, a technician's licence obtained could be transferred to another person and is renewable after every three years. Essentially, this prevents the possibility of poor installation of solar water heaters which would pose a safety hazard to occupants of the premises and other persons nearby.

While the requirement for licencing is important, consideration should be given to creating the technical capacity for technicians to meet the expected demand for SWH installation in the country. There is a likelihood that the exceeding demand and a limited number of technicians may impede the installation of the solar water heaters within the prescribed period of five years.

SWH system installers' training institutions are equally important in promoting the installation of SWH systems, as evidenced in South Africa. The Institute of Plumbing South Africa (IOPSA) trains plumbers and installers for SWH systems to ensure that they possess the requisite knowledge with regards to the installation of SWH systems. This has also expanded the number of installers in the country. We propose that, Kenya could borrow from South Africa by introducing short courses on SWH systems in technical colleges and universities at affordable costs. This would address any shortages of technicians to install solar water heaters.

[19] Regulation 10 (2) of the Draft Regulations, 2020
[20] Regulation 8 (7) of the Draft Regulations, 2020

Additionally, the regulations should allow the transfer of licences from one technician to another as is the case in Rwanda so that qualified technicians can bypass the rigours of applying for licences before they can install SWH systems.

3.7.4 Scope of application of the Draft Regulations

The scope of application is equally an important element in promoting the use of solar water heaters. In Brazil, India, and South Africa, the regulations are specific on who they will apply to and exemptions, if any. For efficiency, the regulations are designed to apply within a small geographical space and to specific entities. This is important in tracking the implementation of programs or regulations on SWH.

It is ideal that for a first phase, the regulations provide for the geographical area within which they will apply for a particular period, before being rolled out to other parts of the country. An initial focus could be on cities -Nairobi, Mombasa, Kisumu, and Nakuru.

As currently designed, the scope of the Draft Regulations is general (save for the exemptions in Regulation 4 (3) and Regulation 5), and requires the installation of solar water heaters by all owners of buildings and premises in all parts of the country irrespective of the local conditions, availability of technical capacity, and financial capacity of the different demographics in Kenya.

3.7.5 Penalties

Penalties are not a major provision in most countries' laws, regulations, and building codes except in Rwanda. A majority of countries encourage the uptake of SWH technologies using incentives and government support programs instead of criminalizing failure to install SWH systems and providing timelines for compliance. Kenya may as such choose to do away with the penalties for SWH by developing national SWH guidelines instead of regulations.

CHAPTER 4 FIELD STUDY FINDINGS AND TECHNO-ECONOMIC EVALUATION OF SWH IN KENYA

This chapter presents the findings of the study based on the data gathered from stakeholders, desktop review as well as techno-economic modelling. These include the identified players, the interview response rate, current status of the SWH industry in Kenya, enhancing use and quality of SWH installations, weaknesses of the annulled regulations, matters that can be handled differently, need and impacts of regulating the SWH industry and the techno-economic evaluation of SWH in Kenya.

The chapter addresses objectives iii to vi.

4.1 Stakeholder Mapping

The stakeholders who were interviewed in this study included the technicians and contractors who had been licensed by 2018 as well as government and non-government organizations.

The sample sizes for the technicians and contractors had finite respondent populations in their respective clusters and are given in Table 4.1.

Table 4.1: Respondent clusters' sample size

Targeted stakeholder category	*Population (N)*	*Sample size (Ns)*	
		No.	% of *N*
Licensed technicians	232	124	53%
Licensed contractors/firms	104	56	54%
TOTAL	**336**	**180**	**54%**[21]

The government and non-governmental agencies (agencies) who participated in the survey were involved in various activities to promote SWH in the country. Some of the activities include:

- Design of environmentally friendly buildings, buildings service engineering, developing resources for design of green buildings, developing new building codes that promote energy efficiency and renewable energy, developing a green rating tool called Safari Green Building Index.

[21] Sample population as a percentage of the total population

- Development of building codes for the country
- Incubation of green projects as well as providing financing for climate change innovative projects of which some of the projects have SWH components
- Working closely with county governments to enforce regulations on use of SWH in residential, commercial , and industrial buildings before approval of drawings and implementing the 2012 SWH regulations before it was annulled in 2018.
- Supporting SWH technicians through capacity building and value chain addition in creation of market awareness and marketing
- Preparation of curriculum for training SWH technicians and capacity building
- Developing standards for SWH products
- Provision of building consultancy services for all government buildings

Advocacy for adoption of renewable energy including SWH systemsThe population of the government and non-government stakeholders was small. Thus, the study team sought to reach out to the entire population.

4.1 Response Rate

Table 4.2 presents a summary of the stakeholders' participation in the survey.

Table 4.2: Stakeholders participation in survey

Stakeholder category	*Sample size*	*No. of respondents*	*Response rate*
Technicians	124	76[22]	61%
Contractors	56	28[23]	50%
Government Agencies	8	8	100%
Professional Associations	5	5	100%
Development Agencies	6	3	50%
Financial Institutions	4	1	25%
Promoters	6	4	67%
End-user associations	3	3	100%
Training Institutions	5	5	100%

[22] Includes 5 unlicensed technicians
[23] Includes 3 unlicensed contractors

TOTAL	*217*	*133*	*61%*

It can be seen from **Error! Reference source not found.** that all the targeted government agencies, professional associations, end-user associations, and training institutions participated in the survey, which is very commendable. Some installers either wound up their businesses or moved away from the solar water heating field after the annulment of the regulations, and they were therefore not interested in participating in the survey. The lowest response rate was by the financial institutions at 25%. The low participation by this category of stakeholders may be attributable to the fact that they have other revenue streams and not just the SWH industry. Thus, they were not enthusiastic to participate in the survey.

The overall response rate was 61% which is acceptable based on (Baruch & Holtom, 2008) and (Mugenda & Mugenda, 2003) assertions that a response rate of 50% or more is acceptable for analyses and making inferences.

4.2 Current Status of the SWH Industry

4.2.1 Skills and Experience of SWH Installers

Prior to the annulment of the SWH Regulations, all SWH installers were required to be licensed. Most (92%) of the installers (both contractors and technicians) indicated that they had been licensed by 2018 and only 8% had not been licensed. Figure 4.1 shows the highest academic qualifications held by SWH installers.

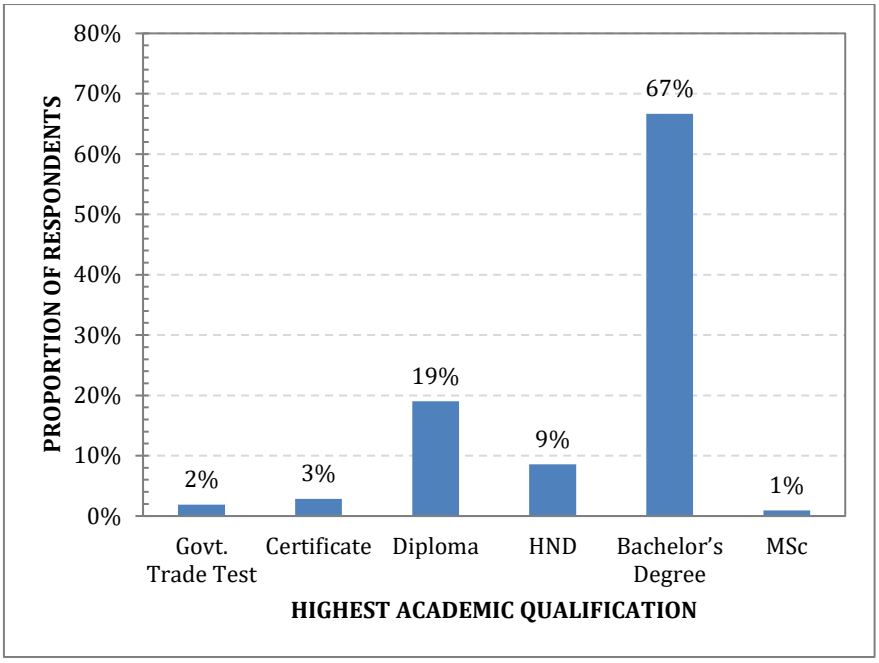


Figure 4.1: SWH installer's highest academic qualifications

It can be observed from **Error! Reference source not found.** that majority (67%) of the installers held a bachelor's degree as their highest qualification. In addition, only 2% of the respondents indicated that they had Government Trade Test as the highest qualification; 1% of the respondents had master's degree. The fields of training of the installers are given in Figure 4.2.

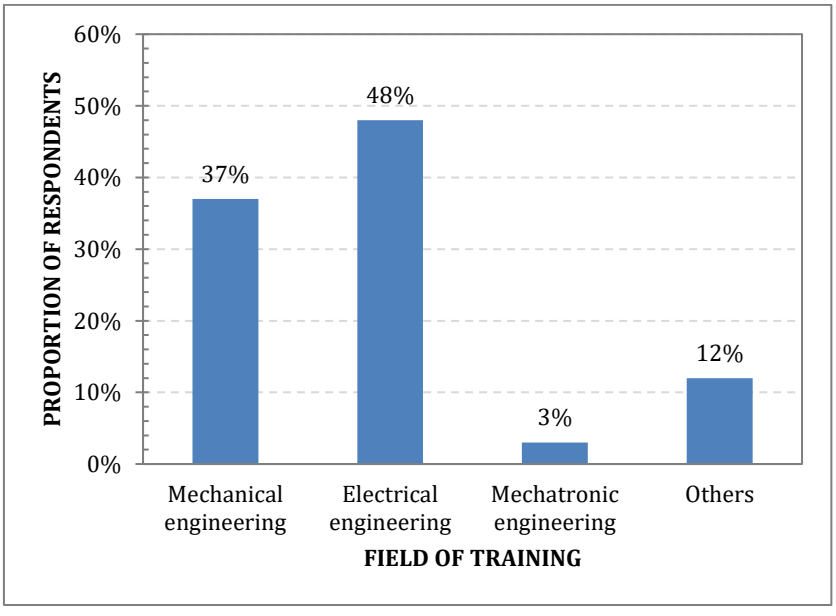


Figure 4.2: SWH installers field of training

Most of the respondents (48%) indicated they had Electrical Engineering background followed by 37% in Mechanical Engineering. Only 3% of the respondents had trained in Mechatronic Engineering. This may be attributed to the fact that this discipline of engineering is fairly new compared with the other traditional fields. In addition, it is not offered by many institutions in the country that offer other engineering courses. The respondents who were categorised as *Others* indicated they had trained in Agricultural Engineering/ Environmental and Biosystems Engineering, Civil engineering and Project management, Energy Engineering/ Renewable Energy Technology, Information Technology, or plumbing. So it can be observed that these fields are all in engineering and technology.

Most of the respondents did the courses locally and a few outside the country. It was also noted that some installers had attended trainings that had been organised by SWH systems suppliers like Davis & Shirtliff, Chloride Exide, Megasun, Honeywell, among others.

The study team sought to find out about the experience the installers had in plumbing works which was a licensing prerequisite in the annulled regulations. The findings are presented in Figure 4.3.

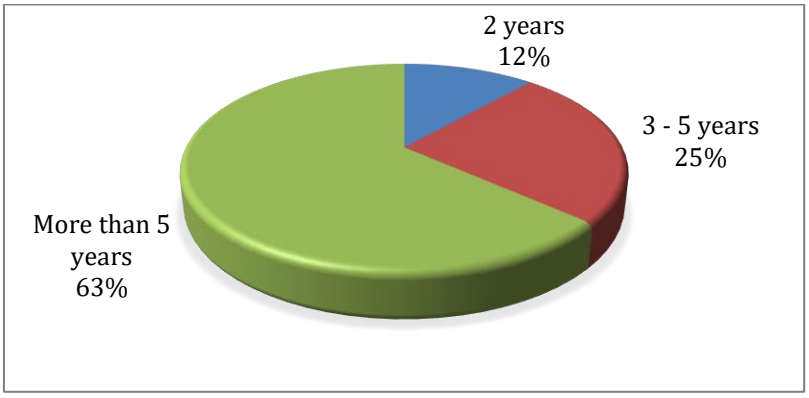


Figure 4.3: Plumbing work experience

It can be seen from Figure 4.3 that 63% of the installers had more than 5 years' experience in plumbing work whereas 25% and 12% had between 3 - 5 and 2 years of experience, respectively. Thus, the majority of the survey participants were people who had been in the industry long enough to understand it well.

Majority of the installers who participated in the survey had installed both passive (gravity flow) and active (with pump) SWH systems at 88% and 89%, respectively. Table 4.3 gives the proportions of installers who had installed the two types of systems in different types of premises.

Table 4.3: Installers experience installing SWH systems in different types of premises

Type of premises	*Proportion of installers with installation experience*	
	Passive SWH system	*Active SWH system*
Domestic	52%	44%
Institutional (schools, colleges, universities, hospitals)	14%	53%
Commercial (hotels, hostels, restaurants, laundries)	14%	61%
Industrial	4%	30%

The biggest proportion of installers had experience installing active SWH systems in commercial premises at 61% followed by institutional premises at 53% as seen from Table 4.3. These types of premises (hotels, hostels, restaurants, laundries, and schools, colleges, universities, hospitals) are heavy consumers of hot water and therefore, it makes business sense for them to install SWH systems to reduce their energy bills. Hence, there may be more installation opportunities in these types of premises than the other types. It is also notable that 52% of the installers had experience installing passive SWH systems in domestic premises. This is the only type of premises where a bigger proportion of installers had experience installing passive systems than the active ones. This is attributable to the smaller size of systems installed in domestic premises compared with the other types of premises and thus, gravity flow systems often suffice. Further, most domestic customers prefer to install the passive systems that are simple and easy to operate and maintain, and they are also cheaper than the active systems.

Some of the agencies were of the opinion that SWH technicians who had been licensed under the regulations had the requisite skills and competencies to handle the jobs they were mandated to. However, they highlighted that the Authority can improve by borrowing from solar PV where there are different categories of technician licenses (T1,

T2, T3) according to the complexity of the installations that they are mandated to handle. They also noted that despite the licensed technicians having the requisite skills and competencies, the quality of some SWH systems was poor and some could not meet consumer needs. They pointed out that the main challenge lay in weeding out unlicensed installers in the industry and ensuring those entrusted with the work are licensed.

4.2.2 SWH System Installations and Cost

According to the installers, the average cost and time taken to install different sizes of systems is given in Table 4.4.

Table 4.4: Average SWH system size, cost and installation time

Type of SWH system	*SWH system size (Litres per day)*	*Average system cost (Ksh)*	*Average installation time (days)*
Passive	100 - 300	146,000	2
	400 - 1000	421,000	4
	3,000	867,000	6
Active	100 - 300	274,000	3
	400 - 1,000	1,086,000	7
	3,000	3,000,000	7

It can be observed from Table 4.4 that the passive SWH systems are cheaper than a similar size of an active one. The higher cost of active SWH systems can be attributed to the additional cost of pumps and control elements required. In addition, the passive systems take a shorter time to install owing to their simplicity. Table 4.5 shows the proportion of installers who installed different numbers of SWH systems in the five years between 2016 and 2020. The percentages are based on the total number of respondents.

Table 4.5: SWH system installations 2016-2020

Year	*Proportion of SWH installers*					
	No. of passive SWH systems installed			*No. of active SWH systems installed*		
	<10	*10-20*	*>20*	*<10*	*10-20*	*>20*

2016	36%	15%	16%	22%	16%	12%
2017	28%	27%	17%	27%	12%	18%
2018	34%	21%	24%	28%	14%	19%
2019	35%	15%	24%	29%	13%	18%
2020	39%	14%	18%	30%	13%	13%

It can be observed that for the two types of SWH systems, throughout the five years under review, the highest proportion of installers each year installed less than ten systems.

4.2.3 Shortcomings Witnessed in the SWH Industry

The following were highlighted as shortcomings observed in SWH industry by the agencies.

- All the licensed technicians could handle simple systems but not institutional/commercial system which are more complex.
- Poorly trained technicians result in SWH installations that do not perform as expected.
- Inspection and revocation of SWH practitioners' licenses is not well implemented. This creates a gap/loophole as technicians do not take responsibility for the SWH installations that they undertake.
- Lack of professional plumbing skills and lack of tools of trade.
- Currently, the nation has few licensed installers and may not meet the demand for their services.
- The curriculum for SWH technicians needs to be standardized and included in TVET programs to enhance human resource capacity.
- The database on SWH technicians provided by EPRA does not include contact details and location of the SWH technicians.
- The public is oblivious of the competent technicians who can effectively install SWH systems.

Most of the shortcomings are related to installer skills and inadequate human resource capacity to service the market. Lack of public awareness on SWH matters is also highlighted.

4.2.4 Challenges and Growth of SWH Industry in Kenya

Some of the challenges that the SWH industry in Kenya faces that were highlighted by the installers and end-user associations are as follows.

1. Lack of proper regulations, proper framework of enforcing and implementing regulations by EPRA and other government agencies
2. Unfavourable taxation and lack of incentives for installing SWH systems e.g. VAT
3. Installation of SWH systems by unqualified personnel hence, sometimes leading to reduced performance of the systems and early failure
4. Knowledge gap in turn-key commercial projects
5. Poor quality and limited standardization of technical requirements for SWH systems in the market
6. Lack of customer awareness and public education on benefits and importance of SWH technology to the end-users
7. High cost of the buying and installing the SWH systems
8. Authorization of building architectural designs that do not support the installation of SWH systems
9. Inadequate and erratic piped water supply in many of parts of Kenya
10. Where borehole water is used the quality of the water is not guaranteed (hardness and saltiness) which can lead to extensive scaling in the SWH system
11. Complex importation procedures and corruption which encourages black market for substandard products
12. There are few licensed technicians who cannot adequately serve the market thus, creating room for unqualified people to engage in SWH installation.
13. County authorities who are the main enforcers of building laws have no reference of solar water heating systems within the building code. This means that during the building's approval process no reference is made on Solar Water Heating standards
14. Failure to involve consumers representatives in oversight mechanisms for transparency purposes.

4.3 Enhancing Use and Quality of SWH installations

4.3.1 How to Enhance Use of SWH Systems

The installers and stakeholders also suggested measures that can be used to enhance the use of SWH systems in the country. They are summarized as follows.

1. Ensuring good quality SWH system products are imported/ manufactured
2. Training more personnel on SWH systems to enhance capacity and hence, weed out unqualified personnel. This will in turn partly contribute to reduction in the failure arising from poor workmanship and thus, increase end-user confidence and hence, increase uptake of the technology.
3. Developing laws and regulations to promote the use of solar water heating systems
4. Promoting use of solar water heating systems through offering incentives, subsidies or tax exemption on importation of solar water heating systems.
5. Sensitization of the end-users (home and business owners) on the gains of installing solar water heating systems such as reduced electricity or other fuel bills which lowers cost of doing business.
6. Developing proper implementation policies in collaboration with County governments.
7. EPRA to engage with NCA and other stakeholders in the construction industry to encourage provision of hot water piping on new buildings.
8. Ensuring that SWH is integrated in the building design from inception to approval through defining clear standards that are enforceable and entrenching it in the building code.
9. Emphasize local manufacturing of SWH systems components that meet international acceptable standards. The environment should be friendly enough to make *Made in Kenya* competitive in terms of price and quality. Offer incentives for local manufacture/assembly of components including informal sector. Currently the country is facing a huge challenge with influx of cheap imported systems components. However, some components like water cylinders get corroded leading to leakages.
10. Licensing fees be made affordable and renewal period be longer than 5 years.

11. Only licenced technicians registered with EPRA should be allowed to carry out solar water heating installations
12. Enhance piped water supply reliability and access in the country
13. Create public awareness of the water heating bill saving as well as reduction in pollution to mitigate climate change which is affecting the globe.

4.3.2 How to Enhance Quality of SWH Installations

According to the agencies, the quality of SWH installations can be enhanced through the following means.

- Quality of the installation depends on design and training of technicians. There is a need to develop a SWH training curriculum to enhance the skills and competencies of the technicians.
- Maintenance of the systems can be enforced by having periodic reports to show that the systems have been maintained.
- Enforcement of KEBS standards to ensure SWH system accessories comply with the set standards.
- Technicians should be re-certified regularly (after 2 years or so) as they renew their licenses.
- Enforcement of quality check and inspections of installations to be done by county governments to ensure that the products that reach the end-users meet the set standards.
- Categorisation/classification of the installers depending on skills set.
- The SWH systems should be locally manufactured to meet the local demand. Imported systems may not meet the unique consumer needs in the country.
- KPLC should also invest in solar. The solar energy can then be linked to electricity bills to motivate consumers.
- There should be clear guidelines on accessory and safety guidelines.
- Provide a list of approved/recommended designers and installers that have been certified by EPRA. These should be trained persons and quality of their work monitored.

Most of the suggestions are related to enhancing the skills and competencies of the technicians, and the quality of the SWH systems. There is also the unique one on lack of awareness by the end-users on how to engage a qualified and licensed installer. In Kenya, end-users often rely on referrals from colleagues and friends who have previously engaged the services of an installer. Most end-users are not aware of the obligations and responsibilities of the installer for as long as the system works. For example, as per the annulled regulations, upon commissioning the SWH system, the installer was obliged to issue an installation certificate indicating the date of installation, capacity of the system, details of the installer and warranty, for the premises. Hence, the Authority needs to put deliberate effort to educate the end-users on how they can identify the licensed installers. Such efforts should be sustained until the masses are well educated.

The following section presents the qualifications proposed for SWH technicians by the stakeholders.

4.3.3 Proposed Fields of Training for SWH Technicians

The study sought to find out from the installers the engineering disciplines that should be admissible for licensing of SWH technicians. The responses are as shown in Figure 4.4.

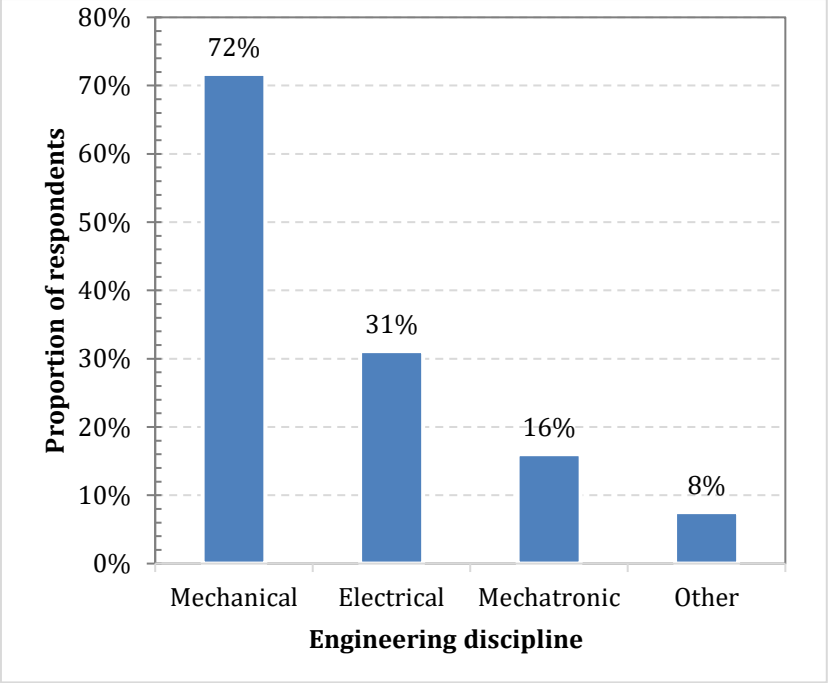


Figure 4.4: Proposed admissible engineering disciplines for SWH licensing

Mechanical engineering background was favoured by majority (72%) of the installers as can be seen from **Error! Reference source not found.**. It is important to remember that only 37% of the respondents had training in mechanical engineering. Most (48%) of the installers interviewed had trained in electrical engineering yet only 31% of all respondents were of the view that license applicants with electrical engineering background should be admissible for licensing. The SWH skills possessed by most installers with electrical engineering background are self-taught. These results are intriguing. Is this an indication of the practitioners with electrical engineering background trying to correct an error that they think they might have made by choosing to go into SWH industry? Or, have the current practitioners realised there are more opportunities in their line of training like solar PV and therefore, one does not need to cross over to the jobs that are more inclined towards mechanical engineering? These results bear some weight and need to be interrogated further when making the decision on what disciplines are admissible for licensing.

Other proposed admissible disciplines included renewable energy technology, energy engineering, water engineering, agricultural and biosystems engineering, building and construction, plumbing, and basic knowledge on SWH installations.

4.3.4 Proposed License Classification

Majority of the stakeholders indicated that one categorization for SWH technicians provided in the 2012 regulations was not appropriate. Technicians' licenses therefore, should be classified based on their capabilities, level of education and project size they can handle.

Majority (51%) of the installers were of the view that there is need for different classes of SWH technician licenses. This was corroborated by the agencies who highlighted the need for different classes as system complexity varies a lot. Some of the agencies were of the view that there ought to be a structured way of recognizing competency which should borrow a leaf from the categorization done in licensing of solar PV technicians.

Further, 54% of the installers who were of the opinion that there is need for license classification did not favour license classification based on the type of systems (Passive or Active); only 41% deemed the classification to be appropriate. Thus, the following is a summary of the proposed classification criteria.

- Based on type of premises; commercial, residential, and possibly limitation on capacity
- Type of premises; Domestic buildings with maisonettes up to 1st floor, multi-storeyed buildings, and industrial premises
- Application i.e., Domestic (not more than 2 SWH systems), commercial, institutional, or industrial systems
- Size/capacity of SWH system
- Design (Basic and advanced)
- Complexity of the system
- SWH system type (Combined active & passive).

Most (55%) of the installers who were of the view that there should be different classes of licenses favoured creation of two license classes whereas the remaining 45% were of the opinion that three classes would be appropriate.

4.3.5 Proposed Academic and Professional Qualifications

The installers were asked to propose the minimum admissible academic qualifications for three categories of SWH license applicants; Class 1, 2, and 3 with Class 1 as the lowest. The responses are given in Table 4.6.

Table 4.6: Proposed minimum academic qualifications

Minimum Academic qualification		*Proportion of respondents*		
		Class 1	*Class 2*	*Class 3*
Basic Education	KCPE	28%	6%	2%
	KCSE	72%	94%	98%
Higher Education	Trade Test 1	38%	5%	0%
	Trade Test 2	6%	5%	0%
	Certificate	30%	21%	4%
	Diploma	19%	45%	24%
	HND	0%	9%	13%
	Bachelor's Degree	6%	13%	58%

Majority of the respondents proposed that for all license classes, the minimum basic education should be KCSE as can be seen from **Error! Reference source not found.**. Additionally, most installers were of the view that minimum higher education qualification for Class 1 (lowest class), 2 and 3 should be Trade Test 1, Diploma, and Bachelor's Degree, respectively.

The installers were also asked to propose the minimum professional training for each category of SWH technicians. Their responses are presented in Table 4.7.

Table 4.7: Proposed minimum professional training for SWH technicians

License classification	*Proportion of respondents*		
	Minimum required professional training		
	Basic	*Intermediate*	*Advanced*
Class 1	72%	22%	6%
Class 2	10%	74%	15%
Class 3	4%	10%	86%

It can be observed that most installers propose Basic, Intermediate, and Advanced professional training for Class 1, 2, and 3, respectively. Therefore, during the curriculum development, careful consideration of the needs of each class of technicians will go a long way in making the trainings successful.

Normally, license holders undertake the work that they are mandated to do without supervision. Therefore, it is necessary that license applicants gain some experience working under the supervision of a licensed technician before seeking to be licensed. The SWH technicians are mandated to design and install SWH systems. Thus, the installers were asked to propose the minimum number of design projects and installations that license applicants should have done to be eligible for licensing. The results are presented in Table 4.8.

Table 4.8: Proposed minimum professional experience for SWH technicians

Nature of work	*No. of Projects*	*Proportion of respondents*		
		Class 1	*Class 2*	*Class 3*
Design	Two	66%	28%	23%
	Three	27%	60%	61%
	Other	7%	12%	16%
Installation	Two	67%	22%	14%
	Three	27%	66%	72%
	Other	6%	12%	14%

Majority of the respondents were of the view that Class 1 license applicants should have designed and installed at least two SWH systems each prior to being licensed as can be observed from **Error! Reference source not found.**. In addition, Class 2 and 3 license applicants should have design and installation experience of at least three projects each.

Besides the academic qualifications, 83% of the respondents indicated that there should be other relevant skills that SWH technicians should have which can be enhanced through training. They proposed skills include:

1. Plumbing system and fluid flow techniques
2. Basic fluid mechanics to understand water flow

3. Electrical wiring craft
4. Personal Safety Training (basic working at heights training) and First Aid
5. Ethics and professionalism
6. Water management, recycling, and sewage management
7. Trouble shooting and problem solving
8. Emerging technologies and best practice
9. Control and automation
10. Pipe utility by use of the PVR machine
11. Plan interpretation, site management
12. Preparation of bills of quantity and project management
13. Basic structural analysis
14. Heat exchangers
15. Customer experience
16. SWH system orientation and sizing
17. Maintenance/flush-out
18. Computerised design of centralised systems.

Majority (96%) of the installers acknowledged that continuous professional development (CPD) through participation in relevant trainings, seminars, workshops, paper publication, and work experience is important for SWH technicians. CPD is important for the technicians to keep abreast with the happenings in their field not only locally, but globally too.

4.4 Weaknesses of the Annulled Energy (SWH) Regulations 2012

The views of the agencies on the weaknesses of the annulled regulations were sought. Some agencies noted that the regulations were good for the country because the intention was to accelerate the penetration of the clean technology. However, they highlighted that the main problem was with the existing buildings which required retrofitting since the building code had not included the aspects of SWH provisions prior to the enforcement of these regulations. The agencies pinpointed the following weaknesses:

- There were not enough technicians available to do retrofitting needs resulting from the implementation of the regulations. There was a need to upscale the number of technicians.
- Some of the plumbing works were not regulated by EPRA; they work under NCA, and the trades were not aligning
- There were no incentives in SWH like the ones in solar PV
- Retrofitting in existing buildings was costly thus, becoming unaffordable
- The price of solar collectors was too high with the cheapest one ranging between Ksh.120,000 – 150,000 which was out of reach for most people. They noted that Kenya is a very price sensitive market; the SWH systems had a payback period of up to 10 years, which is rather long compared to solar PV systems' payback period of 4 years.
- The regulations did not consider the different roles of the county and national government
- The regulations referenced to an outdated building code that was supposed to be implemented through Municipal Councils instead of County Governments
- There were no provisions on SWH systems in the building code prior to enforcement of the SWH regulation
- The fines indicated in the regulations of Ksh.1milion was too high.
- The regulator chose Kenya Power as an enforcement agency at the point of electricity connection, yet Kenya Power had different mandate
- Only one category of licenses for all technicians (domestic/simple systems and institutional/complex systems) was a weakness. This was a big oversight and there ought to have been a differentiation with regard to level of education attained as well as experience for licensing categorization. The ideal scenario would be various tiers of technical classes depending on the complexity of the systems.
- The government failed to consider financing gaps in the industry. Most consumers did not have the funds to install SWH systems or modify their homes to meet the regulatory requirement. The clients did not feel supported and there was insufficient partnership with financial institutions.
- The regulations did not have a mechanism for enforcement.

- The blanket requirement for all residential premises both new and existing with a hot water demand of 100 litres per day to install SWH system was not right. It should have been made optional.
- The availability of quality solar water heating systems in the country was also a challenge. Some of the installed systems did not work
- Some of the statements were ambiguous, with some information missing e.g., equation for temperature adjustments in the second schedule.

From the foregoing, it is clear that there are several issues that need to be addressed with any subsequent SWH regulations.

4.5 What Can Be Done Differently?

4.5.1 Water Heating Requirement by Region

The annulled regulations targeted premises within the jurisdiction of the Urban Areas and Cities Act. The views of the installers and end-user associations were sought on whether water heating is necessary in all parts of Kenya. Majority of both the installers (85%) and end-user associations (67%) responded in the affirmative. However, it is worth noting that only three end-user associations participated in the survey and thus, their results should be treated with caution. The respondents who were of a different opinion indicated that the following regions do not need water heating: Coast, Northern, North Eastern and Southern areas that are normally hot and have high ambient temperatures, and arid and semi-arid areas that do not have enough water. In addition, cold areas such as Nyeri, Limuru and Nanyuki may not be well suited since they experience low temperatures between 20 - 25° C which is insufficient to provide adequate hot water supply.

4.5.2 Existing Buildings

The study sought the views of end-user associations on whether existing buildings should be obliged to install SWH systems. Majority (67%) of them were of the opinion that they should not be obliged to install the systems. In addition, those who answered in the affirmative indicated that the existing premises should be given 5 years to comply.

The agencies were of the view that existing premises should be given alternatives in addition to SWH to avoid regulations being prescriptive. Existing buildings need to have guidelines given that different buildings have different plumbing systems, technologies, lease agreement, mixed users such as hotels and apartments, property management arrangements etc. In addition, the existing buildings should be given the incentive or the government to subsidize the high cost of installing SWH systems. The agencies also noted that the existing buildings were designed without the consideration of SWH systems. Hence, there would be need to carry out audits of existing buildings to assess if they can structurally accommodate the SWH systems so that the owners can make informed decisions.

Additionally, County governments working with EPRA can pass regularization rules and give an implementation timeline. Owners of existing buildings should be given an option to install the SWH systems. If structural provisions for SWH were made they should be able to decide whether to install. Engage owners of the building and support them through sustainable partnerships with the financial institutions.

EPRA should collaborate with other regulatory bodies such as Kenya Bureau of Standards (KEBS), National Construction Authority (NCA), National Environment Management Authority (NEMA), and consumers in harmonizing provisions for SWH regulations. Modification to existing premises require licences to do so, and these are extra costs which should be waived. Extra costs are also incurred through the masons/electricians engaged to carry out the modifications.

Existing premises should be given a minimum of 7 years to work towards compliance, since this will take time, money, and modification approvals. Centralised SWH systems can be recommended for communities such as estates and apartments. Sensitisation on suitable options can be done, which may result in cost savings.

4.5.3 Solar Water Heating Requirement by Type of Premises

The opinion of both the installers and end-user associations was sought on the type(s) of premises that should install SWH systems. The results are as given in Figure 4.5.

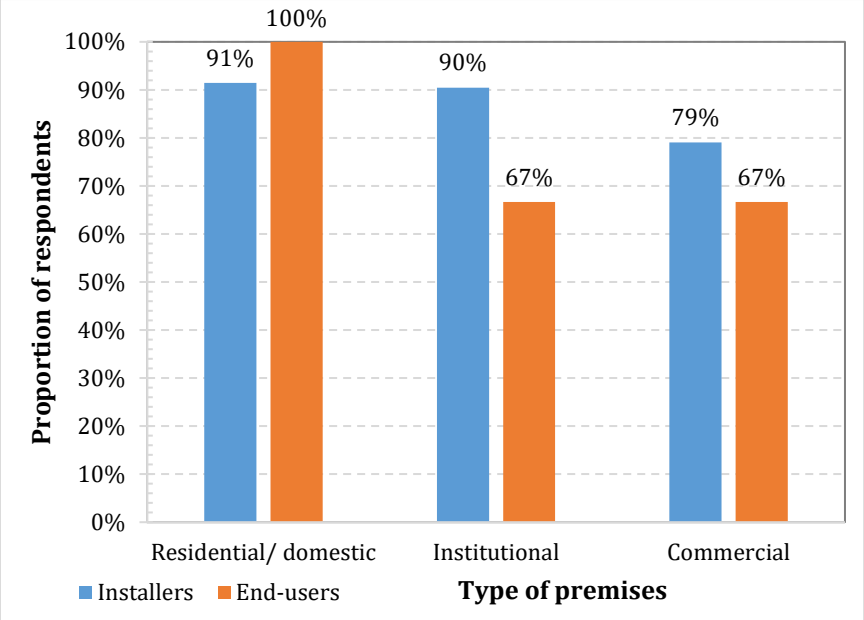


Figure 4.5: Proposed types of premises required to install SWH system

As observed from **Error! Reference source not found.**, majority (more than 50%) of both the installers and end-user associations were of the opinion that residential/domestic, institutional[24], and commercial[25] premises should all install SWH systems.

There were very varied opinions by the agencies on the type of premises that are best suited to be obliged to install SWH systems. Some of the agencies were of the view that all commercial, institutional, and residential premises should be obliged to install SWH systems. However, they added that the end-users should be supported financially to meet the requirements and there should be incentives. Other agencies were of the view that the determination of the premises that should be obliged to install the systems should be based on the hot water demand.

Others were of the opinion that SWH provisions should be made a requirement for all buildings under the building code so that compliance is enhanced at the design stage. This was corroborated by the majority of the installers (87%) and end-user associations (100%) who agreed that all new premises or alterations and extensions to existing premises should have provision for installing SWH system. This would ensure that

[24] health institutions including hospitals, health centres and clinics and similar medical facilities; educational institutions including universities, colleges, boarding schools and similar institutions
[25] hotels, lodges, clubs, restaurants, cafeterias, laundries, eating places and similar premises

structural consideration for the system is made right from the beginning. The agencies also highlighted that the interactions/co-ordination of National Construction Authority (NCA), county governments, engineers and other professionals should be enhanced to ensure compliance.

The installers who were of the opinion that all new premises or alterations and extensions to existing premises do not have to make provision for installing SWH system gave the following reasons for their views.

- Only assessment of hot water demand on each premises, ascertaining the minimum threshold is met, can be used as a guide on whether it is viable to instal a solar system.
- Activities in some buildings e.g., office block do not require hot water.
- The design of roof i.e., orientation and pitch gradient should be considered to allow maximum exposure to sun.
- Inadequate finance may limit individuals to equip their houses to the required standard
- Most domestic housing clients do not consider having SWH cost included during design phase - they are not willing to invest in SWH
- Water shortages is experienced in some parts of the country (e.g., Nairobi residentials have water 2-3 days a week) waters down making the requirement compulsory for all premises since the systems will not be in use
- People should not be regulated on their preferences. A consumer chooses what suits them and what they can afford. SWH should never be mandatory especially for domestic users.
- All institutional and commercial premises must have such provisions. Altering institutional and commercial premises to include such provisions later (when the premises are in use) poses greater danger than in domestic premises.
- The cost of installing solar system is quite high and in the long run the savings are low for residential houses as compared to institution and other commercial sets ups.
- This should be linked to a lot of things e.g., previous source of energy for heating, some national goal, rebates, government scheme for adoption, gradual rollout - can start with government housing etc.

Some agencies were also of the view that there should be no obligation to install SWH systems across board. Once people are educated on the benefits of installing the systems, they should be allowed to make a choice whether to install or not.

4.5.4 Criteria for Identifying Premises Obliged to Install SWH Systems

The views of installers and end-user associations were sought on the criteria that would be appropriate for identifying the premises that would be required to install SWH systems. The results are presented in Figure 4.6.

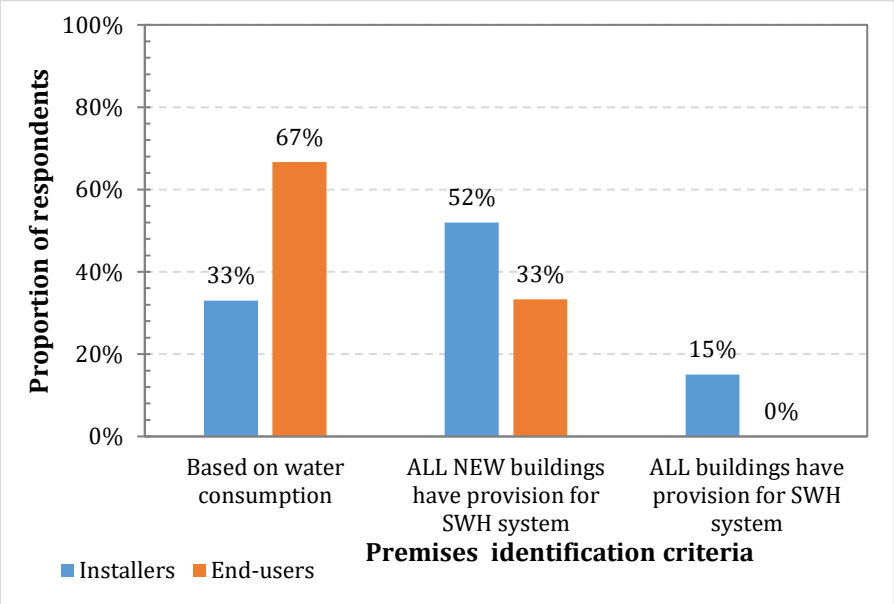


Figure 4.6: Criteria for identifying premises required to install SWH systems

It can be seen from **Error! Reference source not found.** that the criteria favoured by most end-user associations is based on water consumption whereas the installers prefer that all new buildings should have provision of SWH. Only 15% of the installers were of the view that all buildings should have provision for SWH. Further, 67% each of both the installers and end-user associations proposed that the appropriate minimum daily hot water requirement for installation of SWH system is 200 litres whereas 33% suggested 300 litres.

Some respondents proposed other parameters that can be used to determine the threshold for installation of SWH system as follows:

- Number of occupants - with caution that it cannot be used across the country since the demand for hot water varies significantly depending on the region

- Size of building i.e., consider number of bedrooms. The size of the building is proportional to the amount of water consumed
- Total consumption per occupied floor area to accommodate the variation on occupancy and design with maximum capacity
- Average periodic (annual/monthly) electricity consumption. This way, the electricity bills are used to determine need for SWH.

Some of the proposed parameters tie in with the guidelines in the annulled regulations for calculating the hot water demand. For example, once the size of building is known, an assumption is made on the number of occupants for a typical house of the same size. Each occupant is assumed to use a certain amount of hot water per day and thus, the total demand is estimated. Using the occupied floor area may be applicable to residences like hotel accommodation and hostels. This goes back to the level of occupancy and the computation of hot water demand would be similar to the one in the annulled regulations.

It would be difficult to know what proportion of the electricity units consumed goes to water heating. To be able to apportion, it would require that an electrical energy audit of the premises be conducted first to come up with an estimate of the energy used for water heating. This may neither be a feasible nor a worthwhile exercise to undertake as it makes the identification criteria expensive in terms of the resources (time and human) required.

4.5.5 Minimum Annual Solar Contribution

The annulled regulations required all premises to have a minimum annual solar contribution of sixty per cent to the premises' hot water demand. We sought the installers and end-user associations' views on the provision and the results are given in Figure 4.7.

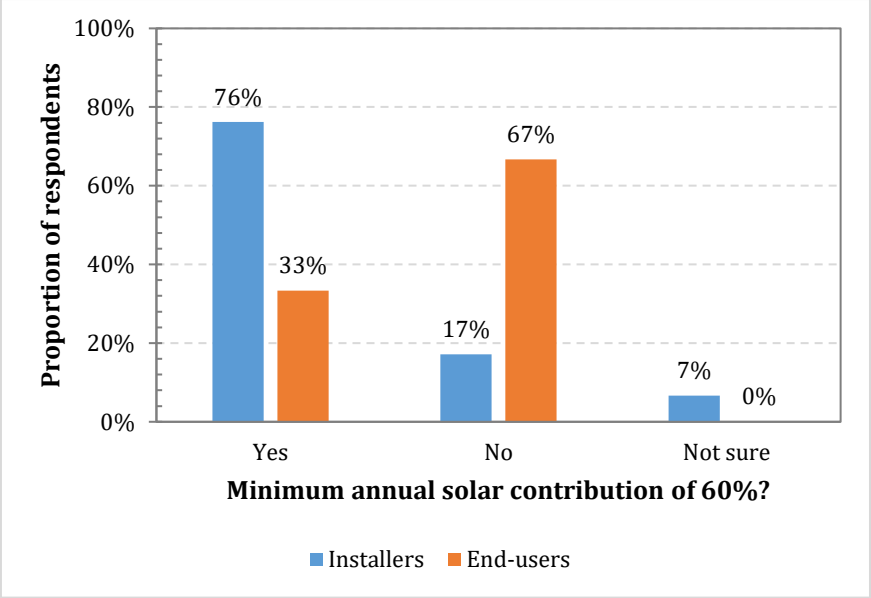


Figure 4.7: Minimum annual solar contribution

It is clear that the installers were pulling in opposite directions with the end-user associations. Majority (76%) of the installers agreed with the provision whereas majority (67%) of the end-users disagreed with it. Most (75%) of the installers and 50% of the end-users who did not agree with the provision of minimum annual solar contribution to the premises hot water demand suggested that it should be lowered from to 50%. Further, the remaining installers suggested that it ought to be raised to 70%. Some end-users were of the opinion that there should be a gradual approach with no specific limit.

It is not clear how the 60% was arrived at. In most parts of the country, the rainy seasons are April to mid-May and November through December, and the cold season from June to mid-August during which time the solar irradiation dips to minimum which impacts on water heating. These periods account for about six months. Increasing the limit to 70% may require the end-users to increase the number of panels so that they can increase hot water production during the seasons of low irradiation. This would be a waste since there would be over production during the hot seasons and it would be an additional cost and thus, not desirable.

4.5.6 Circumstances for Exemption

Both the installers and end-user associations were asked to give their views on the circumstances that would require some buildings to be exempted from installing SWH systems. The results are presented in Table 4.9

Table 4.9: Exemption situations

Exemption situation	*Proportion of respondents*	
	Installers	*End-users*
Premises with technical limitations	77%	100%
Premises that are incapable of incorporating solar heating systems due to their special circumstances	73%	67%
Premises supplied with hot water from a cogeneration plant in or proximate to the premises	71%	67%
Premises utilizing electricity generated from renewable energy and the excess is used to heat water as a dump load	84%	67%
Others	4%	-

Majority of the installers and end-user associations agreed that all the four circumstances given warranted exemption. The other situations highlighted by the installers include:

- Buildings in shaded areas, apartments (more than three storeys) without hot water line provision, areas with extremely salty water, buildings which have installed heat pumps
- Premises whose electricity consumption associated to water heating is too small to give a realistic ROI
- Premises without reliable water supply in consideration of water quality and pressure requirements.

The proposal to exempt buildings that have heat pumps is valid but only if they are used for heating water. It is worth noting that this technology is currently not widely used in the country.

4.5.7 SWH System Incorporation and Maintenance Responsibility

The study sought to find out the views of installers and end-users on who should be responsible for incorporating SWH systems in all new buildings. The responses are as shown in Table 4.10.

Table 4.10: Responsibility of incorporating SWH systems

Responsibility for incorporating SWH systems	*Proportion of respondents*	
	Installers	End-users
Developer of a housing estate	80%	67%
Promoter of the construction	30%	0%
Owner of premises	75%	100%
Architect	63%	33%
Engineer	63%	33%
County government	50%	0%

Majority (more than 50%) of the installers were of the view that developers of housing estates, owners of premises, project architect and engineer should be responsible for incorporating SWH systems in all new premises designs and extensions or alterations to existing premises; majority of the end-users thought only the developers and owners of premises should take responsibility.

Some agencies were of the opinion that the project engineers (civil and mechanical) should be the ones to ensure that the structures can accommodate the SWH systems and the provisions for plumbing works have been made at the design stage. Others were of the opinion that everyone involved in the project should bear responsibility; architects and engineers to ensure there is provision in the design drawings and developer/ owner of the premise to ensure they conform since they are the project financier. In addition, some were of the view that NCA and county governments who approve the design of the buildings need to bear responsibility. Others were of the opinion that there should be joint responsibility between the owners of the premises and the technical team in charge of the design and supervision of the construction of the buildings.

The responsibility needs to be addressed at the design stage and the actual implementation. It would be futile effort for the technical team to make all provisions on paper, get the necessary approvals but the plans are not implemented. Hence, all in the delivery chain ought to be held responsible with very clear demarcation of their roles. For example, after design and approvals, if the developer or owner of the premise does not provide funds for installation of the system, the technical team is absolved from any blame.

Once the SWH systems have been installed, 83% of the installers and 67% of the end-user associations suggested that the owner of the premise should be responsible for carrying out the necessary operational maintenance and repairs required to keep a SWH system installation in good and efficient working condition. Only 17% of the installers and 33% of the end users think that the occupier should be responsible.

The agencies indicated that the requirement to install SWH systems, use them and carry out the necessary operational maintenance and repairs to keep the installation in good and efficient working condition can be enhanced through the following means:

- End-users should be well informed about the maintenance required at the point of installation through training and provision of manuals for basic troubleshooting.
- Develop operation and maintenance manual which should be left with the owner of premise where installation has been done and commissioned.
- Training the premise caretakers on how to detect faults resulting from using different types of water, etc and including some quick fixes.
- Regular inspections by external inspectors to be enforced especially for the large (commercial & Institutional systems) as is the case with commercial boilers and firefighting equipment.
- Smart technologies for monitoring SWH systems.
- EPRA needs to first conduct extensive public awareness on the benefits of SWH to the public to create demand for the service.
- Regulator to sample some installations on a regular basis to check on the quality and confirm that the systems are in good working conditions.

- Use external agents to implement the monitoring of systems at the county level and ensure that regional EPRA officials have authority to check on compliance.
- The government should ensure that the quality of SWH systems in the market meet consumer needs. Consumers should be cushioned from unethical business people who import substandard products into the country by conducting market surveillance.

The major highlight is the need for end-user education to demystify SWH. Most members of the public do not know the obligations of the installers after commissioning the system. In addition, some installers do not inform the end-users that the system needs to be serviced at regular intervals and thus, the end-users only call them for breakdown maintenance. If SWH is actively promoted in a way that would convince the end-users to voluntarily install the systems, there would be no need for enforcing maintenance; the users already understand they are the biggest losers if the system does not work efficiently.

4.5.8 Provision for Conventional Back-up Water Heating System

When asked about the provision of conventional back water heating systems in buildings, 89% of the installers and 100% of the end-user associations agreed that the conventional back-up water heater systems that utilize traditional fuels, including electricity, gas, or similar fuels, may be separately installed in buildings, or be integrated into the SWH system to ensure that there is always an adequate supply of hot water. Further, 98% of the installers and 100% of the end-user associations agreed that the back-up system should be designed to supplement a SWH system by operating when necessary to supply the energy deficit from solar collectors due to adverse weather conditions or a SWH system defect.

Again, if the end-users buy into the adoption of SWH technology, they will be self-driven to maximise the use of solar and avoid other means of water heating. This would be purely from a point of knowledge of the benefits offered by SWH.

4.6 Regulating the SWH sector

4.6.1 Is it Necessary to Regulate SWH Industry in Kenya?

The respondents were asked if they thought it was necessary to regulate the solar water heating industry in Kenya. Majority of the installers (97%) and all (100%) end-user associations were of the opinion that it is important to regulate the SWH industry. It is worth noting the feedback of the end-users to have the industry regulated. This is an indication that they probably understand the benefits of having the industry streamlined through regulation.

Further, the respondents were given three main areas of the SWH industry and they were asked to point out which ones they thought should be regulated. Their responses are given in Table 4.11.

Table 4.11: Aspects of the SWH industry that should be regulated

SWH industry regulation aspect	*Proportion of respondents*	
	Installers	End-users
Technical personnel involved in installation of SWH systems	89%	67%
Quality of the solar water heating system components	86%	100%
Premises that need to install SWH systems	69%	100%
Others	4%	-

Majority (over 50%) of both the installer and end-user associations respondents were of the view that all the areas of the industry -installers, system components, premises- should be regulated.

In similar veins, the agencies indicated that the SWH industry in Kenya should be regulated both on the supply and demand side to ascertain the quality of the SWH systems to ensure compliance with the standards. They noted that EPRA needs to partner with KEBS to license all importers/manufacturers of SWH systems to ensure only quality products that meet consumer needs are sold in the local market. With quality

SWHs that can meet the local demands at an affordable cost, most consumers would install the system without coercion.

On the demand side, the regulation should focus on ensuring that the technicians are well trained and capable of handling all types of SWH systems. Additionally, the quality of installations should be subject to inspection before commissioning. Although regulations are essential, the respondents indicated that the Kenyan market is mature and therefore, the public must be engaged in the process instead of being coerced to implement the provisions. Demand side regulations are desirable in driving market forces and encouraging the public to embrace SWH systems.

Some respondents were of the view that there is a need for *hot water heating regulations* and not solar water heating regulations. They indicated that EPRA should take into consideration the use of other renewable and sustainable energy in providing hot water. Additionally, the revised national building code is promoting green buildings for lighting, heating etc. Ideally, all new buildings should take into consideration green building requirements and hence, make provisions for SWH without being obliged.

4.7 Techno-economic evaluation

4.7.1 Desktop Research

The desktop study revealed that the estimated potential market size for domestic SWH systems in Kenya at the time was 140,000 m^2 in collector area, translating to around 50,000 Solar Unit installations (EED Advisory Limited, 2017). Additionally, various parameters of SWH systems were determined as shown in Table 4.7.

Table 4.12: Parameters used for techno-economic evaluation of SWH

Description	*Data*	*Source*
Lifetime of SWH	10 to 20 years	(Energy Star, 2021)
Average Capacity of a SWH system	300 Litres per day	(Ulaginoli Energy Solutions, 2018)
Average cost of a 300l SWH system	Kshs.212,500	(Ulaginoli Energy Solutions, 2018)
Cost of using electricity per kWh in Kenya for domestic consumer	25	(Stima Tracker, 2021)

SWH system efficiency	60%	(Ulaginoli Energy Solutions, 2018)
Estimated growth rate of SWH installations	11%	(EED Advisory Limited, 2017)

An analysis of a standard solar water heater in Kenya was performed to determine the initial cost outlay over the future cost savings of using SWH over other means. Upon identifying the benefit of installing one unit of the SWH, these can be projected benefits that households , industrial or commercial will have since it is noted that most solar water heaters come at standard sizes of 300 litres to 500 litres and households, commercials and industrial use integrate the units to suit their demand for hot water e.g one hospital may install five of the standard water heaters in the market for their demand compared with another that will install three based on their demand. The analysis has thus been restricted to the cost benefit of one SWH.

4.7.2 Input data and Plausible Assumptions

Various solar water heating systems parameters such as average size, cost, and length of time required for installation were determined from the survey as shown in Table 4.13.

Table 4.13: Parameters for a typical SWH installation in Kenya

Parameter	*End-user category*		
	Domestic	*Commercial*	*Industrial*
1. The average size (in liters) SWH that is installed in various buildings (litres).	300	600	1,500
2. The average cost of the SWH system (Kes)	212,500	550,834	753,286
3. The average charge out rate per hour for installations (Kes)	50,000	120,000	200,000
4. Time (in hours) it takes to install SWH systems	2.5 days	6 days	9 days

During the development of the model, the assumptions shown in Table 4.14 were made.

Table 4.14: Plausible assumptions

Data		Source

Inflation rate	5.65	(KNBS, 2020)
Local Solar energy generation in Kenya (million kWh)	13.06	(KNBS, 2020)
Cost of 13kg LPG cylinder (Kes)	2,394.18	(KNBS, 2020)
Cost of 1kg biomass (Kes)	30	World Economic Forum
Average Amount of hot water consumed by Domestic set up in liters per day	300	Survey results
Average Amount of hot water consumed by Commercial set up in liters per day	600	Survey results
Average Amount of hot water consumed by Industrial set up liters per day	1000-1500	Survey results

4.7.3 Economic analysis

The techno -economic model analysed the savings that the consumer would make by installing a SWHT from paying electricity to the retailer. The benefits were discounted at a rate of 10 % over the life of the SWHT and the savings compared with the initial costs of procuring the SWHT to identify if there are any positive net savings.

The net cashflows being :

$$R_t = \sum_{t=1}^{N} \frac{E_B \times UB_t}{(1+i)^{t-1}} - COM \quad (3)$$

With R_t being the net savings, E_B being the solar power (KW) used to heat the SWHT while UB_t is the cost charged had the water been heated by the retailer. COM is the cost of installing the Solar water heater. Similar models of heating the same amount of water with other sources of energy namely biomass or LPG were analysed and the net present values of these models derived to identify whether they generated a positive NPV which would indicate that there is a benefit with using these sources of energy than using electricity from the grid. Table 4.15 summarizes the findings.

Table 4.15: Economic analysis results

Sector	Metric	Solar vs KPLC	Solar vs LPG	Solar vs Biomass

Residential	Payback period	4 years	5 years	-ve
	NPV	545,414	510,575	<0
	IRR	34%	30%	-ve
Commercial	Payback period	3years	4 years	-ve
	NPV	248,898	453,893	<530.58
	IRR	33%	35%	-ve
Industrial	Payback period	5 years	6 Years	-ve
	NPV	275,774	803,262	<0
	IRR	22%	27%	-ve

It was observed that there are significant savings using SWH systems over electricity and LPG for all sectors namely residential, commercial and industrial. The comparison of SWH systems with biomass indicates that biomass would be more cost effective. However, this does not account for the effects of biomass on deforestation and health issues. These social and environmental factors have not been factored in the model due to the limited study on quantifying these costs. This essentially indicates that the costs for biomass is understated.

The techno-economic model contains five worksheets namely summary of assumptions, Heating Load Calculation (HLC), Cost Analysis (CA), Financial Analysis (FA), and Project appraisal sheet. The model with all these sheets has been submitted as a different document together with this report.

The economic analysis will be beneficial for making the framework of government policies for specific sectors namely residential, commercial, and industrial. The economic analysis has taken a comparative approach where comparisons were made between heating a comparable water tank with the alternative sources of energy namely electricity, biomass and LPG and deriving the savings if any from using solar as opposed to the existing alternatives.

CHAPTER 5 POTENTIAL IMPACTS OF SWH REGULATIONS

This chapter presents the potential impacts of SWH regulations obtained from modelling and feedback given by the stakeholders. The impacts considered include the environmental, social and economic.

5.1 Economic Impact

The demand for SWH systems in Kenya was projected to have risen by more than 800,000 units in 2020 (EPRA, 2020). Additionally, studies have shown that about 84.5% of the systems installed in Kenya would be domestic with a collector area of 2.9 m^2, while 15.5% of the systems covering about 22.5 m^2 (EED Advisory Limited, 2017). Therefore, the total potential for Kenya would be about 475,040 m^2 of collector area. Kenya's solar irradiance is 4-6 kWh/m^2/day[26] which would translate to 1,642.5 kWh/m^2 annually. From equation (5), the energy produced by the SWH systems annually could be 458,257.50 MWh. This is energy that could have been provided using the available conventional forms and would lead to money not spent by the end users.

Other economic impacts identified during the field work include.

1) Job creation - SWH technicians and businesses in supply of the systems
2) Cost savings in homes, hotels, and institutions
3) If enforced, regulation of the industry would ensure professionalism in design, installation, and quality of SWH system installations hence,
4) There will be order in the industry as trained technicians will be used to carry out design and installation
5) Increased consumer satisfaction and confidence in SWH
6) Less usage of main power supply thus, freeing extra power that can be used more productively
7) The regulations have a potential to spur local capacity for production of high efficiency SWH solutions and related components.
8) Increased construction costs and as a result, increased house rent.

[26] See https://renewableenergy.go.ke/technologies/solar-energy/

9) Possibility of registering a SWH system under the carbon finance mechanism (CFM) may be established.

5.2 Environmental Impact

Assuming that the SWH systems would replace electricity for heating water, Kenya's grid emission factor has been estimated as 0.33 $kgCO_2$ per kWh (MoE-Kenya, 2020). Hence, from equation (4), the potential CO2 abatement could be up to 151,225 tCO2. Other potential impacts obtained from the analysis of field data included

1. Reduction in greenhouse gas emissions results in better carbon footprint for the country
2. Help the country achieve its renewable energy goals
3. Enhanced sustainability of the country's resources
4. Forest conservation as people switch from using wood/biomass to SWH systems and reduce GHG emissions to the environment.
5. Improved environment from reduced indoor air pollution resulting in better hygiene especially in institutions
6. The solar panels used for the SWH systems can be an environmental hazard. There is need to put measures in place for waste disposal.

5.3 Social Impact

Globally, around 20 million jobs will be created in solar energy by 2050, with 15% (about 3 million) of these being in solar water heating (IRENA and ILO, 2021). According to (IRENA, 2021), the distribution of human resources across the solar water heating value chain is as given in Figure 6.1. Most of the jobs in the SWH value chain in Kenya would be created in operations and maintenance, especially given that the country relies more on importation of the systems. The country is projected to install about 135,096 SWH units in 2022 which would create about 2,000 direct jobs.

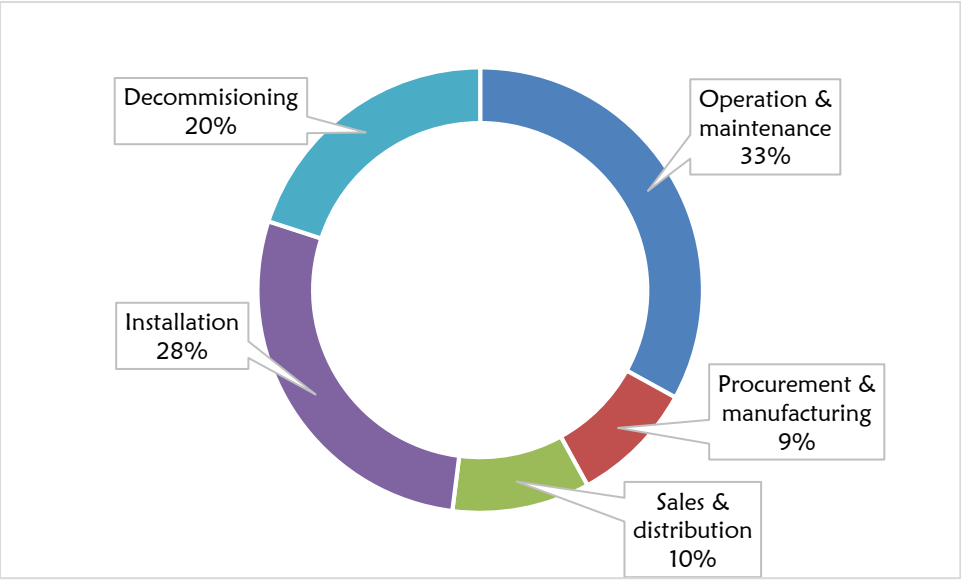


Figure 6.5.1: Distribution of human resources along the SWH value chain (IRENA, 2021)

The inclusion of indirect jobs would increase the job numbers by at least 50% while induced jobs, that is, jobs resulting from spending wages earned in the SWH industry would increase the job numbers by at least 100%. Therefore, with the expected SWH installation, over 5,000 jobs could be created.

From the field work analysis, the following social impacts were also identified.

1. Access to hot water leads to general social improvements in health and translates to savings in health care.
2. Use of solar also improves the relationships between institutions and community as institutions would maintain a clean environment.
3. Decreased dependency on public utilities e.g., KPLC

CHAPTER 6 LEGAL REQUIREMENTS AND REVIEW OF DRAFT REGULATIONS

6.1 Introduction

The legal review analysed Kenya's enabling legal framework for solar water heating systems ("SWH systems"), the annulled Energy (Solar Water Heating) Regulations, 2012, and the Draft Energy (Solar Water Heating) Regulations, 2020. In particular, the review sought to establish:

a) Whether the Energy and Petroleum Regulatory Authority (the "Authority") is possessed of the statutory authority to make the regulations under the enabling legislation i.e., the Energy Act, 2019.
b) Whether the specific rules made under the proposed regulations have the effect of limiting or otherwise infringing upon the rights granted to persons under the Constitution of Kenya.
c) Whether the specific rules made under the proposed regulations are each consistent with specific powers donated to the Authority under the Energy Act, 2019.
d) To the extent that the proposed regulations interact and overlap with existing regulations under the Energy Act or any other law, the proposed regulations are not in conflict or contradiction.
e) That the process employed in making the proposed regulations complies with the process under the Statutory Instruments Act, 2013.
f) That proposed regulations meet the regulatory objectives established by the Authority while at the same time answering legitimate concerns raised by stakeholders during the engagement process.

The chapter addresses objectives (i) and (viii) of the Study.

6.1 The Enabling Policy and Legal Framework

6.1.1 Policies, Plans, and Strategies enabling SWH

Kenya's policy, legal and regulatory framework largely recognizes SWH implicitly. This is through laws and policies supporting climate change mitigation, renewable energy technologies, energy conservation and green buildings.

The policies, plans and strategies enabling solar water heating in Kenya are discussed in the following sub-sections.

6.1.1.1 The National Energy Policy, 2018

The National Energy Policy, 2018 (the "Energy Policy") is the national policy on energy and was developed to provide a roadmap towards achieving affordable, competitive, sustainable and reliable supply of energy at the least cost to achieve the national and county development needs, while protecting and conserving the environment (GoK,2018).

The Policyidentifies solar energy as one of the possible sources of clean energy in the country. It recognizes that despite the high solar insolation in the country, only a small percentage is harnessed for both domestic and industrial use and aims to create an enabling environment for the increased adoption of affordable, competitive, sustainable and reliable energy sources.

Specifically with regards to SWH, the Policy states that the demand for SWH systems in the country was to increase to 800,000 SWH units by 2020. The growth was expected to be catalysed by the operationalization of the now annulled SWH Regulations of 2012. However, the Policy does not provide any strategies to overcome the challenges related to the adoption of solar other than "enforcing regulations on building codes regarding water heating and lighting".

6.1.1.2 The Kenya National Energy Efficiency and Conservation Strategy, 2020

The Ministry of Energy developed the Kenya National Energy Efficiency and Conservation Strategy, 2020 (the "Energy Efficiency Strategy") as the national strategy highlighting steps Kenya seeks to take towards achieving energy efficiency goals with the aim of having an overall positive impact on Kenya's economy (GoK, 2020). The

document explains how Kenya is to avoid energy wastage to benefit the present and future generations by providing for measures that could be used to achieve this goal. .

According to the Energy Efficiency Strategy, one of the ways to enhance energy conservation is by adopting solar water technology. The Strategy has economy-wide and sectoral targets. For economy-wide targets, the Strategy seeks to help Kenya achieve its international commitments to promote cleaner energy and meet its commitments under the NDC. For the household sector, the Strategy targets to increase energy efficiency of electrical appliances in households by 3% by 2025 and efficiency of household thermal energy such that by 2025, 50% of the households in Kenya would be using clean energy. In the building sector, the Strategy targets to improve the energy performance of new buildings.

6.1.1.3 The Least Cost Power Development Plan (LCPDP) 2020-2040

The Least Cost Power Development Plan (LCPDP) for the period 2020-2040 is Kenya's national power sector plan highlighting efforts towards achieving cost-effectiveness in energy generation and consumption (GoK, 2021). The LCPDP was developed with the aim of articulating the Government's commitment to the power sector recovery through a national long term power generation expansion plan. Although the LCPDP does not directly refer to SWH, it calls upon the promotion of renewable energy technologies through measures such as financial and tax incentives. It also highlights essential principles that emphasize the adoption of technology in the production and use of renewable energy in the country.

6.1.1.4 National Climate Change Action Plan 2018-2022

The National Climate Change Action Plan 2018-2022 (the "Action Plan") is a national plan that sets outs Kenya's commitment to reducing the emission of greenhouse gases and enhancement of adaptation to climate change over the period 2018-2022 (GoK, 2018). The Action Plan is a required national plan under the Climate Change Act and is to be reviewed and updated every five years. Related to SWH, the purpose of the Action Plan is provided for under section 13 (3) of the Climate Change Act, to include:

> *"to enhance energy conservation, efficiency and use of renewable energy in industrial, commercial, transport, domestic and other uses."*

Notably, the Action Plan identifies the promotion of climate technologies and innovation in the private sector as one of the ways to combat climate change, implicitly enabling the adoption of SWH systems as among the technologies for low carbon climate-resilient development.

6.1.2 Laws Enabling Solar Water Heating

4.7.3.1 The Constitution of Kenya, 2010

The Constitution of Kenya, 2010 ("the Constitution") is the supreme law of the land (GoK, 2010). It guarantees the right to a clean and healthy environment and places the obligation to promote and protect this right on the State, with all persons having a responsibility to co-operate with the State for the protection of the environment. Under Article 42, the right to a clean and healthy environment encompasses having the environment protected *"through legislative and other measures"*, enabling the use of law and regulation-making as a tool to support the adoption of clean technologies such as those on SWH.

4.7.3.2 The Energy Act, 2019

The Energy Act, 2019 (the " Act") is the main statute regulating the energy sector in Kenya (GoK, 2019). The Act was enacted following recommendations by the National Energy Policy 2018 to create an appropriate legal framework for the various types and sources of energy. In its preamble, the Energy Act provides:

"An Act of Parliament to consolidate the laws relating to energy…[for] ***promotion of renewable energy****… and for connected purposes." [Emphasis ours]*

From the above preamble, one of the Energy Act's main objectives is to promote the development and uptake of renewable energy. The Energy Act requires the Cabinet Secretary responsible for matters related to energy (the "Cabinet Secretary") to support the achievement of this goal. Specifically, section 75 (1) provides that:

"The Cabinet Secretary shall promote the development and use of renewable energy technologies, including but not limited to biomass, biodiesel, bioethanol, charcoal, fuelwood, solar, wind, tidal waves, hydropower, biogas, and municipal waste."

The Energy Act allows the Cabinet Secretary to engage the Authority in performing such functions or exercise such powers as may be necessary to promote renewable energy in the country.[27] The powers include providing an enabling environment for the sustainable production, distribution, and marketing of solar and promoting the development of appropriate local capacity for the manufacture, installation, maintenance, and operation of basic renewable technologies such as solar systems.

The above provisions illustrate Kenya's commitment to promoting renewable and clean sources of energy such as solar for domestic and industrial use and also highlight a goal to build a solar market and build local capacity in the entire SWH value chain.

4.7.3.3 Climate Change Act, 2016

In 2016, Kenya enacted the Climate Change Act as the national legislation on climate change. The objective of the Act is the provision of a regulatory framework for enhanced response to climate change; to provide for mechanism and measures to achieve low carbon climate development, and for connected purposes (GoK, 2016). The Act aims to meet low carbon climate-resilient development in Kenya, and this is reliant on clean technologies such as SWH systems. Specifically, section 3 (2) (g) of the Climate Change Act provides that the Climate Change Act shall be applied by both the national and county governments in all sectors of the economy to-

> *"Promote low carbon technologies, improve efficiency and reduce emissions intensity by facilitating approaches and uptake of technologies that support a low carbon, and climate-resilient development."*

The Cabinet Secretary responsible for matters climate change is also empowered under the Climate Change Act to make regulations that place climate duties on both public and private entities. Although these are not yet enacted, such regulations once in place have the potential to increase demand for clean technologies such as SWH systems.

27 Section 75 (2) of the Energy Act, 2019

6.1.3 Codes and Standards Regulating Solar Water Heating

In addition to the policies and laws presented in the preceding sub-sections, SWH systems are regulated by codes and standards as highlighted below:

6.1.4 Kenya National Building Code 2009

The Kenya National Building Code, 2009 promotes SWH by providing explicitly that:

> *"All new housing developments or alterations and extensions to existing buildings should have solar hot water heating installations for bathroom use. No new housing development should be allowed to use the national grid electricity for hot water heating in bathrooms." (GoK, 2009*

SWH systems incorporated into buildings must comply with this Code in as far as they affect such matters as the materials of construction, roof loading, weather tightness, fire resistance, and insulation, among others.

It is important to note that Kenya is currently developing updated National Building Code and Regulations which will address the role of the National Construction Authority and county governments in the construction sector and have a bearing on the role of these entities in promoting SWH.

6.1.5 Standards on Solar Water Heating

The Kenya Bureau of Standards (KEBS) has established Standards that apply to the design, installation, repair, and maintenance of SWH systems. The standard sets out components and methods for minimum operation, safety, and effectiveness of SWH systems to be used in Kenya. Details of the standards are provided in the Annex 2.

6.2 The Law-Making Power of the Authority to Make SWH Regulations

From the review in Section 6.1, it is evident that Kenya has a relatively developed enabling environment policy and legal framework for SWH. However, the existing foundation does not provide for installation requirements, qualification of installers, licencing of installers, and inspection of installed SWH systems, among other core requirements for enhanced uptake of SWH technology in the country. To remedy this,

the Authority has developed the Draft Energy (SWH) Regulations, 2020 (Draft Regulations).

6.2.1 Law-Making Authority under the Constitution

The Constitution provides the overarching framework for law-making power setting out requirements on the law-making process by Parliament or any authority exercising delegated law-making powers. Article 94 (5) of the Constitution provides,

> "*No person or body, other than Parliament, has the power to make provision having the force of law in Kenya except under authority conferred by this Constitution or by legislation.*"

As provided under Article 94 (5) above, a body, such as the Authority, has the power to make laws provided this authority is conferred by legislation, being in the present case, the Energy Act

However, the Constitution under Article 94 (6) makes further clarification on the parameters for the grant of law-making power by providing thus,

> *"An Act of Parliament, or legislation of a county, that confers on any State organ, State officer or person the authority to make provision having the force of law in Kenya, as contemplated in clause (5), shall expressly specify:*
>
> - *the purpose and objectives for which that authority is conferred,*
> - *the limits of the authority,*
> - *the nature and scope of the law that may be made, and*
> - *the principles and standards applicable to the law made under the authority."*

This means that an Act of Parliament such as the Energy Act must comply with the requirements of Article 95 (6) of the Constitution in granting any law-making powers.

Whereas the provisions of the Energy Act that the Authority is relying on to make the SWH regulations do not explicitly meet all the constitutional parameters above In line with the foregoing Constitutional requirements, sections 93 (1), 167, and 208 of the Energy Act, 2019, although not explicitly mentioning solar water heating, it may be

possible to infer that the power to make these regulations is within the law-making power of the Authority as set out in Table 6.1

Table 6.1: Constitutional parameters to be met by the SWH enabling legislation

Constitutional Parameter	*Section implicitly demonstrating meeting of this parameter*
Purpose and objectives for which that authority is conferred	Section 208 (1) of the Energy Act requires the Cabinet Secretary to consider Section 167 while making regulations under it. Section 167 (1) provides "The Cabinet Secretary may upon recommendation of the Authority make such regulations as may be *necessary or expedient for the achievement of the objectives and purposes of this Act* and in particular, for all or any of the following purposes". Therefore, the purpose of the SWH regulations would be to achieve the objectives and purposes of the Energy Act which is to promote renewable energy production and use and energy efficiency and conservation.
Limits of the authority	Section 208 (2), (3), and (5) limits the law-making power under this section as follows," *(2): The regulations to be made under this Act may be formulated by the Authority on its own motion or may be proposed to the Authority by any licensee or person.* *(3): Before making recommendation of any regulations to the Cabinet Secretary under this Act, the Authority shall publish the proposed regulations for purposes of inviting proposals from the public, in such manner as it may deem fit, at least thirty days before the regulations are submitted to the Cabinet Secretary.* *(5): The regulations made under this Act may be made for a limited period or without limit of period, and may be made subject to such conditions as the Cabinet Secretary deems fit, and may contain such supplemental and consequential provisions as the Cabinet Secretary considers necessary for giving full effect to the regulations."*
Nature and scope of the law that may be made	Section 208 (4) provides the scope and nature of the regulations the authority may make as follows: *"The regulations made by the Cabinet Secretary in accordance with this section may, impose conditions, requiring acts or things to be performed or done to the satisfaction of the Authority, prohibiting acts or things from being performed or done and may prescribe periods or dates upon, within or before which such acts*

	or things shall be performed or done or within which such conditions shall be fulfilled."
Principles and standards applicable to the law made under the authority	Although the Act does not provide for principles and standards expressly, section 167 (1) outlines the general principles and standards that the regulations must comply with. This section provides, *"The Cabinet Secretary may upon recommendation of the Authority make such regulations as may be necessary or expedient for the achievement of the objectives and purposes of this Act and in particular, for all or any of the following purpose".* As per this, the regulations must comply with the principle of objectivity of the Act.

The importance of Article 94 (6) parameters is evidenced by recent court decisions. In ***SDV Transami Kenya Limited and 19 Others vs. Attorney General & 2 Others & Another [2016] EKLR,*** *the court analysed the legality and constitutionality of regulations made under* section 8 (1) of the Merchant Shipping Act, Cap 389 Laws of Kenya. This Section *grants powers to the Minister to make regulations* generally for the better carrying out into effect the provisions of the Act. Pursuant to the above section, the Minister made the Merchant Shipping (Maritime Service Providers) Regulations, 2011.

While emphasizing that a provision granting law-making powers shall meet all the constitutional requirements under Article 94 (6), the court stated, *"While the purpose and objectives for which the authority is given and the nature and scope of the law may be deduced from the provisions of section 8 (1) (2), respectively, there is nothing on the requirement of the limits of the authority and the principles and standards applicable to the law to be made by the Minister."* In other words, a provision granting authority to make laws to anyone must meet all the elements under Article 94 (6) of the Constitution.

6.2.2 Law-Making Authority under the Energy Act, 2019

The Energy Act grants the Cabinet Secretary in charge of Energy powers to make regulations to further the objectives of the Act. The SWH regulations are made pursuant to sections 93 (1), 167 and 208 of the Act. Below is a summary of these provisions and a highlight of the law-making authority granted thereunder in Table 6.2.

Table 6.2: Law making authority

Section of the Energy Act	*Explanation*	*Detailed Provision*
93 (1)	*The section grants the Cabinet Secretary powers to make regulations giving effect to Part IV of the Act which covers matters concerning renewable energy.*	*Section 93 (1) specifically provides that "the Cabinet Secretary may upon recommendation of the Authority make regulations necessary for carrying out or giving effect to the provisions of this Part."*
167	*Grants the Cabinet Secretary powers to make regulations to achieve the objectives of the Energy Act, 2019. The SWH regulations will be seeking to achieve one of the main objectives of the Act which is to promote renewable energy uptake and energy efficiency.*	*According to section 167, "The Cabinet Secretary may upon recommendation of the Authority make such regulations as may be necessary or expedient for the achievement of the objectives and purposes of this Act..."*
208	*Outlines the general power of the Cabinet Secretary to make regulations.* *It highlights that:* *a) Regulations may be made on the Authority's recommendation for any matter permitted to be prescribed in the Act.*	*According to section 208: "Cabinet Secretary may make regulations generally* *(1) The Cabinet Secretary may, on the recommendation of the Authority and subject to section 167, make regulations for or with respect to any matter that by this Act is required or permitted to be prescribed, or that is necessary or expedient to be prescribed for carrying out or giving effect to this Act.*

	b) *Regulations may be formulated by the Authority on its own motion or may be proposed to the Authority by any licensee or person.* c) *Public participation is a requirement in regulation-making.* d) *Regulations may impose conditions.* e) *Regulations may be made for a limited period or without time limit.*	*(2) The regulations to be made under this Act may be formulated by the Authority on its own motion or may be proposed to the Authority by any licensee or person.* *(3) Before making recommendation of any regulations to the Cabinet Secretary under this Act, the Authority shall publish the proposed regulations for purposes of inviting proposals from the public, in such manner as it may deem fit, at least thirty days before the regulations are submitted to the Cabinet Secretary.* *(4) The regulations made by the Cabinet Secretary in accordance with this section may, impose conditions, requiring acts or things to be performed or done to the satisfaction of the Authority, prohibiting acts or things from being performed or done and may prescribe periods or dates upon, within or before which such acts or things shall be performed or done or within which such conditions shall be fulfilled.* *(5) The regulations made under this Act may be made for a limited period or without limit of period, and may be made subject to such conditions as the Cabinet Secretary deems fit, and may contain such supplemental and consequential*

		provisions as the Cabinet Secretary considers necessary for giving full effect to the regulations."

CHAPTER 7 APPROPRIATE REGULATORY APPROACH FOR PROMOTING KENYA'S SWH INDUSTRY

The analysis of the enabling policy and legal framework for SWH in Kenya highlighted in Chapter 3 demonstrates that Kenya does not have an overarching SWH policy, law or regulation. However, the national policy, legal and regulatory framework largely recognizes SWH implicitly. This is through laws and policies supporting climate change mitigation, renewable energy technologies, energy conservation and green buildings, among others.

One of the explicit SWH instruments is the National Building Code which refers to SWH directly by requiring all new housing developments or alterations and extensions to existing buildings to have solar hot water heating installations for bathroom use. Based on this, county governments who are mandated to enforce the code should ensure that new buildings install SWH systems to enhance uptake of clean energy while at the same time minimizing power costs. It is however unclear the extent to which this is ongoing.

Kenya's fiscal regime has also in the past specifically made provision for SWH. However, the inconsistency in the fiscal environment may hinder the development of solar water heating systems in the country. In 2014 for example, solar water heater equipment was exempted from VAT, but this exemption was removed in 2020. The Finance Act, 2021 restored tax relief for solar by exempting specialized equipment for the development and generation of solar energy, including photovoltaic modules, direct current charge controllers, direct current inverters and deep cycle batteries that use or store solar power from VAT, however there was no direct mention of SWH.

Our review of law- making authority shows that the law-making power for SWH is not explicit but subject to inference. A broad reading of sections 167 and 208 of the Energy Act impliedly grant mandate the Cabinet Secretary to make SWH regulations. To avoid

a situation where this inference is challenged, it may be beneficial to amend the Energy Act to expressly grant SWH regulation making power and align this express authority with the parameters set out in Article 94 (6) of the Constitution.

Additionally, the comparative analysis of SWH in different jurisdictions reveals common practices in promoting the use of SWH systems. For instance, the use of incentives has been a key factor in promoting the uptake of solar water heaters in all countries reviewed herein. Standardization and training of technicians to install the SWH systems are equally commonly practiced, among others.

In most benchmarked countries, the duty to enact laws on SWH systems has been assigned to the state or local government levels. While in some countries, the SWH systems are regulated under national energy legislation, in others, the regulation is done under the building and planning laws and codes. In addition, some countries such as Brazil and South Africa, utilize their national bureau standards in the installation of SWH systems which extends to monitoring the quality of the SWH systems.

From the comparative review, the overarching lesson for Kenya is that SWH Regulations are unlikely to alone increase the uptake of SWH systems. Kenya should consider introducing various incentive programmes to encourage the installation of solar water heaters at an affordable cost, as well as ensure awareness is high and participation of key players and stakeholders is clear, including both at the national and county level.

7.1 Recommendations

From the findings of this legal review, we set out recommendations that Kenya may consider in regulating and supporting the SWH industry in the country. These include;

i) Develop National SWH Guidelines

As an alternative to SWH Regulations that are binding and require penalties to deal with issues of non-compliance, Kenya may be best served by SWH guidelines that give owners the discretion to implement, and use a carrot i.e., incentives approach, as opposed to sticks i.e., penalties, to advance the SWH industry. This approach will also

ensure that the human right infringements and instances of exercise of ultra vires power by the Authority will not arise as they currently do under the Draft Regulations, as highlighted in our analysis.

ii) Amend the Energy Act, 2019

As currently provided under the Energy Act, the Cabinet Secretary does not have express powers and authority to make regulations on SWH. Such powers can only be implied in sections 167, 198 (2), and 208 of the Energy Act. For the avoidance of any doubts, we recommend that Parliament amends the Energy Act to explicitly empower the Cabinet Secretary to make SWH regulations. The provision granting such powers should provide for all the elements under Article 94 (6) of the Constitution.

iii) Adhere to the regulations-making procedure set out in the Statutory Instruments Act, 2013

The Draft Energy (Solar Water Heating) Regulations, 2022 should be taken through the procedural requirements under the Statutory Instruments Act, 2013. Under this Act, Regulations are to be subjected to public participation and tabled in Parliament for Parliamentary scrutiny before Gazettement. The main steps in public participation under the Act are summarized below.

- **Consultation Stage**

Section 5 of the Statutory Instruments Act requires the Authority to consult persons who are likely to be affected by the proposed regulations as well as persons who have expertise in fields relevant to the Draft Regulations prior to the making of the Draft Regulations. This process of public participation should be inclusive to involve stakeholders mapped out that includes the public. The stakeholders should be notified of the participation process through direct communication where contacts are available as well as through, public notices in the local dailies or, social media, among other possible media.

- **Notification of the regulatory impact statement stage**

The making of the Draft Regulations should be accompanied by an explanatory memorandum which explains the purpose and operation of the proposed regulations. In addition, the Authority is required to prepare a regulatory impact statement about the Draft Regulations, if it is determined that the Draft Regulations are likely to impose significant costs on the community or a part of the community. It is required under section 8 of the Statutory Instruments Act that the regulatory impact statement is notified in the gazette and in a newspaper likely to be read by people particularly affected by the proposed legislation. It should be published in a way likely to ensure members of the group particularly affected understand the purpose and content of the notice and should allow at least fourteen days from publication of the notice for the making of comments. It must also be clear as to where interested parties can access the draft of the proposed regulation and the regulatory impact statement for inspection.

- **Parliamentary scrutiny stage**

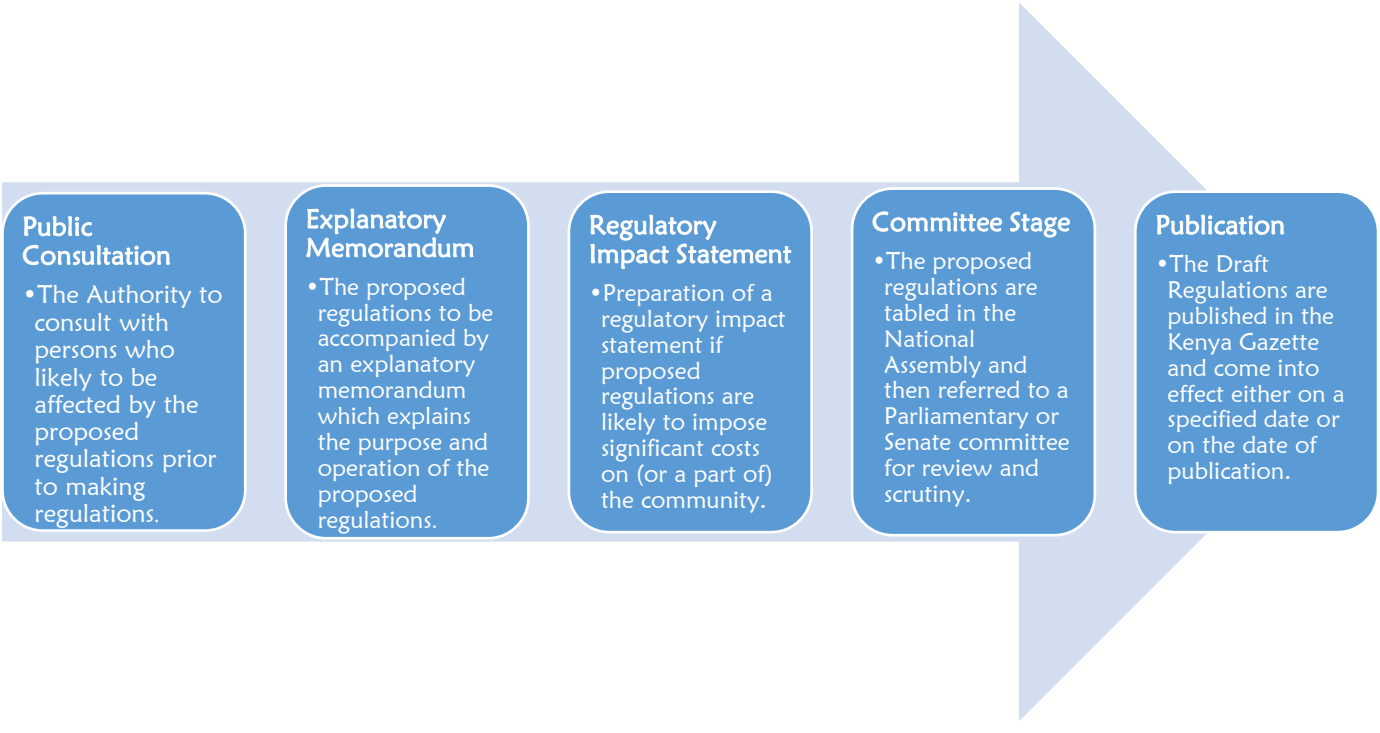
According to section 11 of the Statutory Instruments Act , the Cabinet Secretary in charge of matters related to energy shall within seven (7) sitting days after the publication of the Draft Regulations, ensure that a copy of the proposed regulations together with the regulatory impact statement is tabled before the relevant House of Parliament. Once tabled, the Draft Regulations shall be referred to a committee for the purpose of reviewing and scrutinizing statutory instruments. The Departmental Committee to which a Bill is committed is required to facilitate public participation on the Bill through an appropriate mechanism. This includes by including inviting submission of memoranda, holding public hearings, consulting relevant stakeholders in a sector and consulting experts on technical subjects. The committee then tables the Draft Regulations before Parliament for passing or annulment upon consideration of public views. The Draft Regulations are then published in the Kenya Gazette and shall operate either from the date of publication in the Kenya Gazette or a date specified in the Draft Regulations.

It is important to ensure that all steps required under the Statutory Instruments Act are followed keenly to avoid the resultant regulations being challenged and potentially invalidated by the courts. Public participation is particularly critical and for the Draft

Regulations at hand, Kenya's court decisions are instructive. The courts have for example highlighted that the threshold of public participation is dependent on the particular regulation and the circumstances surrounding the legislation, the concerned State Agency or officer should provide a reasonable opportunity for public participation, any person concerned or affected by the intended legislation should be given an opportunity to be heard, the representatives should be of diverse interests, the approach to engaging the public should account for the variations that exist e.g. population density, literacy trends, media use and distance from the centre, and the citizens must have the capacity to understand the issue(s) at hand.

Currently, the Authority has complied with the consultation stage requirements, whereby the proposal of the Draft Regulations has undergone public consultation as exemplified by the stakeholder engagement process highlighted in this report. What is pending is for the finalization of the regulatory impact statement and the Draft Regulations, their notification in the Kenya Gazette, tabling before Parliament and subsequent publication as law in the Kenya Gazette.

The Figure below provides a summary of the procedure under the Statutory Instruments Act,2013



iv) Amend the Energy (SWH) Regulations, 2020

We recommend the correction of errors, inconsistencies and gaps in the Draft Regulations to ensure consistency with the Constitution, Energy Act and other laws in force in Kenya, as well as reflect best practice examples globally as relates to the Kenyan context. These amendments are set out in Annexure 2 and 3.

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ANNEXURE

Annexure 1: List of Standards Applying to Solar Water Heating in Kenya

1. **KS1860:2009:** Solar Heating Systems for Domestic Hot Water – Design, Installation, Repair and Maintenance – Code of Practice. Kenya Bureau of Standards.
2. **KS 1851-1:2009** Kenya Standard — Thermal solar systems and components — Solar collectors Part 1: General requirements, First Edition
3. **KS 1851-2:2009** Kenya Standard — Thermal solar systems and components — Solar collectors Part 2: Test methods, First Edition
4. **KS 1852-1:2009** Kenya Standard — Thermal solar systems and components — Factory made systems Part 1: General requirements, First Edition
5. **KS 1852-2:2009** Kenya Standard — Thermal solar systems components — Factory made systems Part 2: Test methods, First Edition
6. **KS 1855-1:2009** Kenya Standard — Thermal solar systems and components — Custom built systems Part 3: General requirements, First Edition
7. **KS 1855-2:2009** Kenya Standard — Thermal solar systems and components — Custom built systems Part 2: Test methods, First Edition
8. **KS 1855-3:2009** Kenya Standard — Thermal solar systems and components — Custom built systems Part 3: Performance characterization of stores for solar heating systems, First Edition
9. **KS 1895:2009** Kenya Standard — Code of practice — Solar heating systems for swimming pools, First Edition
10. **KS 1892:2009** Kenya Standard — Standard practice for generating all-day thermal performance data for solar collectors, First Edition
11. **KS 1891:2009** Kenya Standard — Standard practice for evaluating absorptive solar receiver materials when exposed to conditions simulating stagnation in solar collectors with cover plates, First Edition
12. **KS 1898:2009** Kenya Standard — Standard guide for on-site inspection and verification of operation of solar domestic hot water systems, First Edition

13. **KS 1873:2009** Kenya Standard — Standard practice for exposure of cover materials for solar collectors to natural weathering under conditions simulating operational mode, First Edition
14. **KS 1871:2009** Kenya Standard — Standard practice for determining resistance of solar collector covers to hail by impact with propelled ice balls, First Edition
15. **KS 1872:2009** Kenya Standard — Standard practice for non-operational exposure and inspection of a solar collector, First Edition
16. **KS 1870:2009** Kenya Standard — Method of test — Exposure of solar collector cover materials to natural weathering under conditions simulating stagnation mode, First Edition.

Annexure 2: Proposed Amendments Schedule

Clause	Current clause	Proposed amendment	Reason for the proposed amendment
Preamble	IN EXERCISE of the powers conferred by sections 93 (1), 167 and 208 of the Energy Act, 2019, the Cabinet Secretary makes the following Regulations: —	IN EXERCISE of the powers conferred by section 93 (1), 167, 198 (2) and 208 of the Energy Act, 2019, the Cabinet Secretary makes the following Regulations: —	Section 198 also grants law making and penalty imposing power. Specifically see 198 (1) and 198 (2) (s) and (y) on steps and procedures necessary for the application of energy-efficient technologies and procedures; and penalties and sanctions to be imposed by the Authority, respectively.

3 (definition of local content)	No definition of "local content"	"Local Content" means the added value brought to the Kenyan economy from energy related activities through systematic development of national capacity and capabilities and investment in developing and procuring locally available work force, services and supplies, for the sharing of accruing benefits as defined under Section 2 of the Energy Act, 2019.	Although the term *local content* is used under clause 25, the same is not defined in the regulations.
3 (definition of premises)	"**Premises** " means existing new alterations and extensions to the existing residential or commercial buildings or structures, including (i) small domestic houses as defined in the building code made under the Local Government Act;	**Premises** " means existing new alterations and extensions to the existing residential or commercial buildings or structures in urban areas and cities as defined under the Urban Areas and Cities (Amendment Act, 2019), including (i) small domestic houses as defined in the planning and building code made under the County Government Act, 2012	The Local Government Act is now repealed. Including the Urban Areas and Cities (Amendment Act, 2019 means that the regulations would apply

			in towns and cities only at least in the early stages of the regulation since it might be impractical to implement the regulations countrywide given the high initial capital /technical capacity required.
7 (4) (Responsibility for compliance)	An electric power distributor or retail supply licensee shall not provide electricity supply to premises where the provision of these Regulations shall have not been complied with.	Delete this provision	The provision contravenes section 7 of the Energy Act, 2019 which obliges the government to provide energy in all areas. The provision could also be considered a

			human rights violation as it is discriminatory
13 (1)	A person shall not undertake any SWH system installation work unless the person is licensed and or certified by the Authority as a SWH system worker or contractor.	A person shall not undertake any SWH system installation work unless the person is licensed or certified by the Authority as a SWH system worker or contractor.	Regulations should be clear and unambiguous
Part X (offences and penalties)	Section 26 and 27	Amend all penalties to ensure the fine set out does not exceed the limit set by the Statutory Instruments Act, 2013.	In line with the Statutory Instruments Act, maximum penalties are a fine of Kshs.20,000 and/or a fine of six months.
Other provisions for consideration			
Consider adding provisions setting out: • programs on the training of solar water heaters installation technicians • awareness raising on SWH programs among members of the public.			

- That the licencee or certified technician may transfer the licence or certificate to another person upon the Authority's approval of such transfer.
- The set-up of financial incentive and technical support programs by the Authority, and the role County Governments and Private Sector
- Checks on the use of the word "licence and License"- The two words are used in the Draft Regulations interchangeably. For consistency, either should be used but not both.

Annexure 3: Amended Solar Water Heating Regulations, 2022

AMENDED DRAFT SOLAR WATER HEATING REGULATIONS, 2022

APPENDIX A: INFORMATION GATHERING TOOLS

A.1. RESPONDENTS PROFILE

LICENSED FIRM/TECHNICIAN

Technician/Firm Name	
Physical Location	
County	
Telephone contact	
E-mail Address	
Website	
Contact Person	
Title of Contact Person	
Date of visit	

END-USER PROFILE

Name of association	
Telephone contact	
E-mail Address	
Website	
Contact Person	
Title of Contact Person	
Date of visit	

A.2. QUESTIONNAIRE

VIABILITY ASSESSMENT OF SOLAR WATER HEATING INDUSTRY IN KENYA

A. BACKGROUND

Among all the renewable energy (RE) sources, solar thermal energy, particularly solar water heating (SWH) technology, has one of the simplest harnessing pathways. This technology harnesses thermal energy from the sun to heat water or a working fluid for use in domestic, commercial and industrial applications. Kenya receives an average solar insolation of 4-6 kW/m2 and this makes the country a good candidate for optimizing use of SWH technology, to meet her energy requirements.

Kenya has been actively pursuing ways of optimizing the use of SWH technology. Use of legal instruments has been one of the options explored by the Energy and Petroleum Regulatory Authority (the Authority). The Authority is established under section 9(1) of the Energy Act, 2019 with the responsibility of technical and economic regulation of electric power, renewable energy, and petroleum subsectors in Kenya.

On 25th May 2012, the country gazetted the Energy (Solar Water Heating) Regulations, 2012. The objective of the regulations was to promote uptake of SWH technology, specifically by guiding the incorporation of the low temperature SWH systems in industrial, commercial, and residential buildings. To meet the objectives of the Regulations, premises within the jurisdiction of the Urban Areas and Cities Act with hot water requirements exceeding 100 litres per day were required to install and use solar heating systems to cater for at least 60% of the hot water requirements. They were implemented by the Authority. However, the regulations faced challenges in their implementation and were annulled in 2018.

To solve these challenges, the Authority intends to conduct an evidence-based assessment of the viability of adoption of low temperature SWH systems in industrial, commercial, and domestic facilities in Kenya. The assessment will involve techno-socio-economic modelling of the systems in Kenya. This questionnaire has been designed by EPRA to assist in getting the stakeholder's input on the provisions of the developed Draft Energy (Solar Water Heating) Regulations, 2021.

JKUATES has been contracted by EPRA to undertake the survey. Your firm/you have been identified to participate in the survey as a stakeholder affected by the Energy (Solar Water Heating) Regulations, 2012. Your participation in this survey is of paramount importance.

The data and information provided shall be treated as STRICTLY CONFIDENTIAL and shall only be used for the purposes of the study. Further, it shall NOT be disclosed to any other parties other than EPRA.

Please send the completed questionnaire to murimi.evan@eng.jkuat.ac.ke

CONTRACTORS/TECHNICIANS

This questionnaire should be completed by solar water heating system installers (CONTRACTORS and TECHNICIANS)

1. Were you a licensed solar water heating system technician/contractor by 2018?

1. Yes ☐	2. No ☐

2. If your response in (1) is ***Yes***, which year were you first licensed as a technician/contractor?

_____

3. What is your highest academic qualification?

1 Govt. Trade Test ☐	2 Certificate ☐	3 Diploma ☐
4 HND ☐	5 Bachelor's Degree ☐	

4. Which is your field of training?

1. Mechanical engineering ☐	2. Electrical engineering ☐	3. Mechatronic engineering ☐
4. Other (Please specify		

5. How long have you been involved in plumbing works?

(1) 2 years ☐	(2) 3 - 5 years ☐	(3) More than 5 years ☐

6. Please give the courses/trainings relevant to SWH that you have attended

1	
2	
3	
4	
5	

7. What type of solar water heating systems have you installed in the past?

(1) Passive (Gravity flow) ☐	(2) Active (with pump) ☐

8. In what type of premises have you installed solar water heating systems?

(1) Domestic ☐	Passive ☐	Active ☐
(2) Institutional (schools/ colleges/ universities/ hospitals) ☐	Passive ☐	Active ☐
(3) Commercial (hotels/ hostels/ restaurants/ laundries) ☐	Passive ☐	Active ☐
(4) Industrial ☐	Passive ☐	Active ☐

9. What is the average size of SWH systems that you install in litres per day (LPD)?

a. **Passive**

Size (LPD)	*Average system cost (Ksh)*	*Installation time (days)*
(1) 100 -300 litres ☐		
(2) 400 – 1000 litres ☐		
(3) Other (Specify)		

b. **Active**

Size	*Average system cost (Ksh)*	*Installation time (days)*
(1) 100 -300 litres ☐		
(2) 400 – 1000 litres ☐		
(3) Other (Specify)		

10. Give the ***number*** of solar water heating systems that you installed in the last 5 years?

Year	*Passive*			*Active*		
2016	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐
2017	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐
2018	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐
2019	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐

2020	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐	(1) <10 ☐	(2) 10-20 ☐	(3) >20 ☐

11. What is your average daily rate for installation of a 300 litres SWH systems?

Passive	Ksh.
Active	Ksh.

12. In your opinion, is water heating necessary in all parts of Kenya?

1. Yes ☐	2. No ☐

13. If your response in (12) is ***No***, which regions of the country do you think may not require water heating?

_____

_____

_____

14. In your opinion, which ***type(s) of premises*** should install solar water heating systems? (You may choose more one)

1) Residential/ domestic ☐	2) Institutional[28] ☐	3) Commercial[29] ☐

15. In your opinion, should all new premises or alterations and extensions to existing premises have ***provision*** for installing solar water heating system for use?

1. Yes ☐	2. No ☐

16. If your response in (15) is ***No***, please give reason(s)

_____

_____

[28] health institutions including hospitals, health centres and clinics and similar medical facilities; educational institutions including universities, colleges, boarding schools and similar institutions

[29] hotels, lodges, clubs, restaurants, cafeterias, laundries, eating places and similar premises

17. What ***criteria*** should be used to identify premises to be required to install solar water heating system?

1. Based on ***water consumption***	☐
2. ***ALL NEW*** buildings have provision for solar water heating system	☐
3. ***ALL*** buildings have provision for solar water heating system	☐

18. If your response in (17) is ***1***, suggest the appropriate ***minimum daily*** hot water requirement for installation of solar water heating system. More than:

1) 200 litres ☐	2) 300 litres ☐	3) Other (Please specify)

19. Please choose the circumstances that in your view would warrant ***exemption*** from installing solar water heating system

Existing situation	
1. Premises with technical limitations	☐
2. Premises that are incapable of incorporating solar heating systems due to their special circumstances	☐
3. Premises supplied with hot water from a cogeneration plant in or proximate to the premises	☐
4. Premises utilizing electricity generated from renewable energy and the excess is used to heat water as a dump load	☐
5. Other (please specify)	

20. Do you agree with the provision in the regulations that all premises shall have a ***minimum annual solar contribution of 60%*** to the premises' hot water demand?

1. Yes ☐	2. No ☐	3. Not sure ☐

21. If your response in (20) is ***No***, please suggest the appropriate minimum annual contribution of solar to the premises' hot water demand.

1) 50% ☐	2) 70% ☐	3) Other (Please specify)

22. Who among the following do you think should take responsibility for incorporation of SWH systems in all new premises designs and extensions or alterations to existing premises? (You may choose more than one)

1. Developer of a housing estate	☐
2. Promoter of the construction	☐
3. Owner of premises	☐
4. Architect	☐
5. Engineer	☐
6. County government	☐
7. Other (please specify)	

23. In your opinion, who should be responsible for carrying out the necessary operational maintenance and repairs required to keep a SWH system installation in good and efficient working condition?

1. Owner ☐	2. Occupier ☐	3. Not sure ☐

24. Please state if you agree or disagree with each of the following provisions for conventional backup water heating system.

	Backup water heating system	*Agree*	*Disagree*	*Not sure*
1	The conventional back-up water heater systems that utilize traditional fuels, including electricity, gas, or similar fuels, may be separately installed in buildings or be integrated into the solar water heating system to ensure that there is an adequate supply of hot water at all times	☐	☐	☐
2	The back-up system shall be designed to supplement a solar water heating system by operating when absolutely necessary to supply the energy deficit from solar collectors due to adverse weather conditions or a solar water heating system defect	☐	☐	☐
3	Propose any other relevant provision			

25. In your opinion, which ***disciplines*** of engineering or other fields should be admissible for licensing of solar water heating system technicians?

1. Mechanical ☐	2. Electrical ☐	3. Mechatronic ☐
4. Other (Please specify		

26. In your opinion, is there need for different ***classes*** of solar water heating system technician licenses?

1. Yes ☐	2. No ☐	3. Not sure ☐

27. If your response in (26) is ***Yes***, do you think license classification on the basis of the type of systems (Passive or Active) that the licensee can handle is appropriate?

1. Yes ☐	2. No ☐	3. Not sure ☐

28. If your response in (27) is ***No***, what should the classification be based on?

_____

29. How many classes do you think would be appropriate?

(1) Two ☐	(2) Three ☐	(3) Other (Please specify)

30. For each class of solar water heating system technicians, suggest the ***minimum academic qualifications*** (Choose one for each class to match the number of classes that you propose)

a. Basic Education:

Class 1 (lowest)	1. KCPE ☐	2. KCSE ☐
Class 2	1. KCPE ☐	2. KCSE ☐
Class 3	1. KCPE ☐	2. KCSE ☐

b. Higher Education:

Class 1 (lowest)	1 Trade Test 1 ☐	2 Trade Test 2 ☐	3 Certificate ☐
	4 Diploma ☐	5 HND ☐	6 Bachelor's Degree ☐
Class 2	1 Trade Test 1 ☐	2 Trade Test 2 ☐	3 Certificate ☐
	4 Diploma ☐	5 HND ☐	6 Bachelor's Degree ☐

Class 3	1 Trade Test 1 ☐ 4 Diploma ☐	2 Trade Test 2 ☐ 5 HND ☐	3 Certificate ☐ 6 Bachelor's Degree ☐

31. Are there other relevant skills that SWH technicians should have which can be enhanced through training?

1. Yes ☐	2. No ☐	3. Not sure ☐

32. If your response in (31) is ***Yes***, please specify the other relevant skills that can be obtained through training and experience

_____

_____

_____

33. For each class of solar water heating system technicians, suggest the ***minimum professional training*** (Choose one for each class to match the number of classes that you propose)

Class 1 (lowest)	1. Basic ☐	2. Intermediate ☐	3. Advanced ☐
Class 2	1. Basic ☐	2. Intermediate ☐	3. Advanced ☐
Class 3	1. Basic ☐	2. Intermediate ☐	3. Advanced ☐

34. For each class of solar water heating system technicians, suggest the ***minimum professional experience*** (Choose one for each class to match the number of classes that you propose)

a. Number of systems installed

Class 1 (lowest)	1. Two ☐	2. Three ☐	3. Other (Please specify)
Class 2	1. Two ☐	2. Three ☐	3. Other (Please specify)
Class 3	1. Two ☐	2. Three ☐	3. Other (Please specify)

b. Number of systems designed

Class 1 (lowest)	1. Two ☐	2. Three ☐	3. Other (Please specify)
Class 2	1. Two ☐	2. Three ☐	3. Other (Please specify)
Class 3	1. Two ☐	2. Three ☐	3. Other (Please specify)

35. Do you think continuous professional development through participation in relevant trainings, seminars, workshops, paper publication, and work experience is important for solar water heating system technicians?

1. Yes ☐	2. No ☐

36. In your opinion, is there need for regulation of the solar water heating industry in Kenya?

1. Yes ☐	2. No ☐	3. Not sure ☐

37. If your response in (36) is ***Yes***, what aspects of the industry do you think should be regulated?

1	Technical personnel involved in installation of SWH systems	☐
2	Quality of the solar water heating system components	☐
3	Premises that need to install SWH systems	☐
4	Other (Please specify)	

38. In your view, which are the challenges hindering the growth of solar water heating in the country?

_____

_____

_____

_____

_____

39. How can the use of solar water heating systems be enhanced in the country?

_____

_____

_____

_____

_____

40. Which are the possible impacts of the solar water heating regulation?

_____

_____

_____

_____

_____

THANK YOU FOR YOUR COOPERATION IN COMPLETING THIS QUESTIONNAIRE

END-USER REPRESENTATIVES

This questionnaire should be completed by solar water heating systems end-user associations

1. In your opinion, is water heating necessary in all parts of Kenya?

1. Yes ☐	2. No ☐

2. If your response in (*1*) is ***No***, which regions of the country do you think may not require water heating?

_____

_____

_____

3. In your opinion, should all new premises or alterations and extensions to existing premises have ***provision*** for installing solar water heating system for use?

1. Yes ☐	2. No ☐

4. If your response in (3) is ***No***, please give reason(s)

_____

_____

_____

5. In your opinion, which ***type(s) of premises*** should install solar water heating systems? (You may choose more one)

1) Residential/ domestic ☐	2) Institutional[30] ☐	3) Commercial[31] ☐

6. What ***criteria*** should be used to identify premises to be required to install solar water heaters?

[30] health institutions including hospitals, health centres and clinics and similar medical facilities; educational institutions including universities, colleges, boarding schools and similar institutions
[31] hotels, lodges, clubs, restaurants, cafeterias, laundries, eating places and similar premises

1. Based on ***water consumption***	☐
2. ***ALL NEW*** buildings have provision for solar water heating system	☐
3. ***ALL*** buildings have provision for solar water heating system	☐

7. If your response in (6) is ***1***, suggest the appropriate ***minimum daily*** hot water requirement for installation of solar water heating system. **More than:**

1) 200 litres ☐	2) 300 litres ☐	3) Other (Please specify)

8. In your opinion, should existing premises be obliged to install solar water heating systems?

1. Yes ☐	2. No ☐	3. Not sure ☐

9. If your response in (8) is ***Yes***, what period should they be given to comply with such a requirement?

1) 3 years ☐	2) 5 years ☐	3) Other (Please specify)

10. Please choose the circumstances that in your view would warrant ***exemption*** from installing solar water heating system

Existing situation	
1. Premises with technical limitations	☐
2. Premises that are incapable of incorporating solar heating systems due to their special circumstances	☐
3. Premises supplied with hot water from a cogeneration plant in or proximate to the premises	☐
4. Premises utilizing electricity generated from renewable energy and the excess is used to heat water as a dump load	☐
5. Other (please specify)	

11. Do you agree with the provision in the regulations that all premises shall have a ***minimum annual solar contribution of 60%*** to the premises' hot water demand?

1. Yes ☐	2. No ☐	3. Not sure ☐

12. If your response in (11) is *No*, please suggest the appropriate minimum annual contribution of solar to the premises' hot water demand.

1) 50% ☐	2) 70% ☐	3) Other (Please specify)

13. Who among the following do you think should take responsibility for incorporation of SWH systems in all new premises designs and extensions or alterations to existing premises? (You may tick more than one)

1. Developer of a housing estate	☐
2. Promoter of the construction	☐
3. Owner of premises	☐
4. Architect	☐
5. Engineer	☐
6. County government	☐
7. Other (please specify)	

14. In your opinion, who should be responsible for carrying out the necessary operational maintenance and repairs required to keep a SWH system installation in good and efficient working condition?

1. Owner ☐	2. Occupier ☐	3. Not sure ☐

15. Please state if you agree or disagree with each of the following provisions for conventional backup water heating system in the regulations.

	Backup water heating system	*Agree*	*Disagree*	*Not sure*
1	The conventional back-up water heater systems that utilize traditional fuels, including electricity, gas, or similar fuels, may be separately installed in buildings or be integrated into the solar water heating system to ensure that there is an adequate supply of hot water at all times.	☐	☐	☐
2	The back-up system shall be designed to supplement a solar water heating system by operating when absolutely necessary to supply the	☐	☐	☐

	energy deficit from solar collectors due to adverse weather conditions or a solar water heating system defect			
3	Propose any other relevant provision			

16. In your opinion, is there need for regulation of the solar water heating industry in Kenya?

1. Yes ☐	2. No ☐	3. Not sure ☐

17. If your response in (16) is ***Yes***, what aspects of the industry do you think should be regulated?

1	Technical personnel involved in installation of SWH systems	☐
2	Quality of the solar water heating system components	☐
3	Premises that need to install SWH systems	☐
4	Other (Please specify)	

18. In your view, which are the challenges hindering the growth of solar water heating in the country?

_____

_____

_____

_____

_____

19. In your opinion, how can the use of solar water heating systems be enhanced in the country?

_____

_____

_____

_____

_____

20. In your opinion, which are the possible impacts of the solar water heating regulations?

_____

_____

_____

_____

_____

THANK YOU FOR YOUR COOPERATION IN COMPLETING THIS QUESTIONNAIRE

A.3. DIRECT INTERVIEW QUESTIONS

QUESTIONS TO GOVERNMENT AND NON-GOVERNMENTAL ORGANISATIONS OFFICERS

1. Kindly provide a brief overview on how your organization has been involved in the solar water heating industry in the last five (5) years?
   - As a promoter of solar water heating
   - As a Policy Administrator
   - Professional body
   - Other
2. The Energy and Petroleum Regulatory Authority (EPRA) was implementing the Energy (Solar Water Heating) Regulations gazetted in 2012 to promote the use of solar water heating in Kenya that were annulled in 2018. What were the weaknesses of the regulations? Discuss.
3. In your opinion, how should existing premises be handled in relation to installing solar water heating systems? Discuss.
4. In your opinion, which premises (commercial, institutional and residential) do you think are best suited to be obliged to install solar water heating systems?
5. In your opinion, how best can the threshold for installation of solar water heating system be defined e.g., number of premises users/occupants, premises floor area etc.?
6. How can the quality of the solar water heating system installations be enhanced?

7. Do you think the solar water heating system technicians who had been licensed under the regulations had the requisite skills and competencies to handle the jobs they were mandated to?

8. What shortcomings have you witnessed/observed in the solar water heating system technicians?
9. Is one categorisation of the technician licenses provided for in the 2012 regulations appropriate? Please elaborate.
10. What academic and professional qualifications do you deem necessary for licensing the technicians?

11. How can the requirement to install SWH systems, ***use*** them and ***carry out*** the necessary ***operational maintenance and repairs*** to keep the installation in good and efficient working condition be enforced?

12. Should developers of housing estates, promoters of construction, an owner of the premises or an Architect or an Engineer engaged in the design or construction of premises bear responsibility for installation of SWH systems?

13. To what extent should the solar water heating industry in Kenya be regulated (Supply/ demand side)?

14. Are there other ways that members of the public can be encouraged to install solar water heating systems without necessarily effecting regulation?

15. Which are the possible environmental, social and economic impacts of the solar water heating regulations?

Government and Non-Governmental organisations to be interviewed

Category	*Stakeholders*
Government Agencies	Ministry of Energy, Ministry of Transport, Infrastructure, Housing and Urban Development, County Governments through the Council of Governors, National Construction Authority (NCA), EPRA, Kenya Bureau of Standards (KEBS),
Professional Bodies/ Associations	Institution of Engineers of Kenya (IEK), Architectural Association of Kenya (AAK), Association of Energy Professionals Eastern Africa (AEPEA), Kenya Renewable Energy Association (KEREA)
Development Agencies	World Bank, World Vision, Oxfam, UN Habitat
Financial Institutions	Banks (Equity, KCB, Bank of Africa), Housing Finance Group
Promoters	Kenya Green Building Society, Kenya Property Developers Association, Institution of Surveyors of Kenya (ISK), Kenya Professional Realtors Association (KPRA)
Training Institutions	Strathmore Energy Research Centre, National Industrial Training Authority (NITA), Nairobi Technical Training Institute, Kenya Water Institute, JKUAT

APPENDIX B: LIST OF RESPONDENTS

B.1. TECHNICIANS

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B.2. CONTRACTORS

No	Name	Contact person	Email	Phone
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4.	Kastom Energy	Joseph Mwangi	Info@kastom.co.ke	
5.	Suntransfer	Clinton Njeru		
6.	Scandinavian Solar Systems	Ville Paakkari		
7.	Go Solar Systems Ltd	Joe Mwangi	jmwangi@gosolar.co.ke	0721207949
8.	Plenser Limited	Geoffrey Matu	matu@plenser.com	0706602394
9.	Ljos (Eos) Company Limited			
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17.	Eenovators Limited	Ruth Carol Atieno	ruth@eenovators.com	0791839959
18.	Eco Desh Power Solutions	Mark Njenga		
19.	Ezex Engineering Company Limited	Samuel Kongo		
20.	Delta Energy Systems Limited			
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B.3. GOVERNMENT & NON-GOVERNMENT STAKEHOLDERS

Category	Stakeholder
Government Agencies	Ministry of Energy,
	Ministry of Transport, Infrastructure, Housing and Urban Development,
	County Governments through the Council of Governors,
	National Construction Authority (NCA),
	Kenya Bureau of Standards (KEBS),
	EPRA
	National Environment Management Authority (NEMA)
	Kenya Institute for Public Policy Research and Analysis (KIPPRA)
Professional Bodies/ Associations	Institution of Engineers of Kenya (IEK),
	Architectural Association of Kenya (AAK),
	Association of Energy Professionals Eastern Africa (AEPEA),
	Kenya Renewable Energy Association (KEREA)
	Kenya Association of Manufacturers
Development Agencies	World Vision,
	UN Habitat
	GIZ Kenya
Financial Institutions	Banks (Equity,),
Promoters	Kenya Green Building Society,
	Kenya Property Developers Association,
	Institution of Surveyors of Kenya (ISK),
	Kenya Private Sector Alliance (KEPSA)
	Kenya Climate Innovation Center (KCIC)
End users	Kenya Alliance of Resident Associations (KARA),
	Kenya Association of Hotelkeepers and Caterers (KAHC)
	Electricity Consumer Society (ELCOS) Kenya
Training Institutions	Strathmore Energy Research Centre,
	National Industrial Training Authority (NITA),
	Nairobi Technical Training Institute,
	Kenya Water Institute,
	JKUAT

APPENDIX C: SWH TRAINING COURSES

The following courses and trainings relevant to SWH were reported to have been pursued by the installers.

- *Plumbing grade 3, 2 and 1*
- *Policy in Solar water heating*
- *Certificate in Plumbing*
- *Megasun Solar Heating online workshop*
- *Installation of solar water heater*
- *Basic plumbing works*
- *Hot water training by Davis & Shirtliff Academy*
- *Renewable Energy: Solar PV and Solar Water Heating (SWH) Systems*
- *Solar Energy Systems*
- *Solar Thermal Technology Training*
- *Plumbing and solar plumbing-trade test-NITA*
- *Solar Hot Water Training on Commercial and Industrial Solar Hot Water Systems Design and Installations - Davis & Shirtliff*
- *Basic pump course, Design, sizing and installation of SWH systems*
- *Solar Water Heater Training – ERC*
- *Solar Water Heating Installations at Strathmore University*
- *Honeywell SWH system installation training*
- *In house training- Chloride Exide solar technologies training*
- *Plumbing Control and instrumentation systems for solar water heating*
- *Solar Hot water system sizing*
- *Solar hot water auditing*
- *Solar water system design*