National University of Lesotho

Tracking SDG7 Progress for Lesotho using Energy Indicators for Sustainable Development

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Acronyms

BAU	Business as Usual
BoS	Bureau of Statistics
CAD	Current Account Deficit
CAGR	Compound Annual Growth Rate
CSD	Commission on Sustainable Development
DoE	Department of Energy
ECO	Economic
EEA	European Economic Area
EISD	Energy Indicators for Sustainable Development
ENV	Environment
GDP	Gross Domestic Product
GHG	Greenhouse gas
IAEA	International Atomic Energy Agency
IDR	Import Dependency Ratio
IEA	International Energy Agency
IP	Illuminating Paraffin
ISD	Indicators for sustainable development
ISED	Indicators for Sustainable Energy Development
LEC	Lesotho Electricity Company
LEWA	Lesotho Electricity and Water Authority
LPG	Liquified Petroleum Gas
PEI	Primary Energy Intensity
SD	Sustainable Development
SDG	Sustainable Development Goals
SDG7	Sustainable Development Goal 7
SE4ALL	Sustainable Energy for All
SOC	Social
TFEC	Total Primary Energy Consumption
TFES	Total Primary Energy Supply
UN	United Nations
UNCSD	United Nations Commission on Sustainable Development
UNDESA	United Nations Department of Economic and Social Affairs

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ABSTRACT

Energy is regarded as a global variable in achieving sustainable development goals (SDGs). In Lesotho however, there are no traces of how far Lesotho's progress is regarding affordable and clean energy access status towards achieving the set SDG7 targets. There has never been any initiatives engaged for tracking the progress ever since the SDG7 targets were set globally. It is essential to know the country's current energy status, economic stability, what needs to be improved and at what pace should the improvement be done. This study therefore traces progress of Lesotho energy sector on the four targets of SDG7: energy access (electricity and technologies for clean cooking), renewable energy and energy efficiency. The study further monitors the overall progress of the energy system towards sustainable development and indicates progress with the latest available data up to 2019 against a baseline year of 2014. The five-year data from 2014 to 2019 is going to be projected from 2020 until 2030 to examine the possible progress that would be achieved through two scenarios; Business as Usual (BAU) and Sustainable Development (SD) scenario. It is with SD scenario that certain policies will be informed which will help accelerate the progress. The results from this study suggest that only 68.4% of population will have electricity access by 2030 under BAU scenario. This verifies the SDG gap of 31.6% to meet 100% access target. Moreover only 50% of population will have clean cooking access by 2030 leaving a gap of another 50% to have 100% access. On the other hand, by 2030 renewable energy share will only be 45.5% and still lacking 18.5% to double the renewable energy share of 2014 to 64%. Results further show that in 2030, the energy efficiency improvement will only be 14.3 MJ and still lacking 5.3 MJ to double the improvement to 19.6 MJ. In essence, all four SDG7 targets are not going to be achieved by 2030; hence more powerful policies are needed to make these targets a success.

CHAPTER 1 – INTRODUCTION

1.1 Study Background

The Brundtland Commission posits that sustainable development is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' [1]. According to the International Atomic Energy Agency (IAEA), sustainable development (SD) is aimed at improving the quality of life in a manner that can be economical, environmental, and sustained over a long period [2]. The United Nations (UN) General Assembly, however, stated that the current energy supply patterns are not sustainable; in which a large population around the world is dependent on non-commercial fuels, with people living without electricity and access to clean energy. This affects both socio-economic development and also degrades the environment and lays bare the need for a more sustained energy use pattern. It was then that the UN General Assembly recognized an urgent need for implementation of sustainable energy use patterns concerning production, distribution and use. This induced meetings regarding initiatives for sustainable development until the implementation of 17 Sustainable Development Goals (SDGs) in 2015 for 2030 Agenda.

The seventh SDG (SDG7), which is central to this study, calls for ensuring access to affordable, reliable, sustainable, and modern energy for all. It further aims to ensure universal access to electricity and clean energy for cooking and calls for a doubling of the rate of improvement of energy efficiency, plus a substantial increase in the share of renewable energy in the overall global energy mix by 2030 [3]. SDG7 is demonstrated as a very crucial factor in achieving many of the other SDGs including poverty eradication and improving human living standards amongst other issues [4]. Besides, Subramanian et al [5] see it as a primary driver towards the modern economy [5].

The Earth Summit 1992 realized the principal role that energy indicators can present in assisting countries in the formulation of sound decisions regarding sustainable development of which during this session were ; improving affordability and accessibility to modern energy services were presented as one of the major issues [2]. According to Dalia, energy indicators for sustainable development (EISD) is an analytical tool meant for measuring progress on energy as well as sustainable energy development [6]. Having seen the potential of EISD, the United Nations Department of Economic and Social Affairs (UNDESA) implemented the set of Indicators for Sustainable Development (ISD) to be utilized around the world with the purpose to track progress in achieving sustainable energy development targets.

1.2 Problem Statement

To facilitate the progress towards achievement of SDG7, the UN Secretary-General Ban Ki-Moon launched the Sustainable Energy for All (SE4ALL) framework in September 2011 intending to promote universal electricity access, double the share of renewable energy, and lastly double the global rate of improvement in energy efficiency by 2030 [7]. It was at this point that countries were requested to set country-specific targets that will help to accelerate SE4ALL, in responding to the need for achieving SDG7 by 2030. Lesotho, set the target to gradually increase access to electricity to 35% of total households in 2015 and 40% in 2020 however there were no specific targets being set concerning energy efficiency and renewable energy goals [8]. The year 2030 is a milestone for all countries including Lesotho since it marks the deadline for achieving the targets set within the framework of SE4ALL. The specified targets of SE4ALL should be tracked to gauge progress and hence improve strategies to speed up sustainable development goal 7 progress.

The problem to be addressed is the lack of sustainable energy progress tracking initiatives in Lesotho. This has led to complete ignorance of the energy sector concerning not having any information on the progress towards the achievement of SDG7. Amongst other issues, lack of tracking initiatives has demonstrated a setback to the development of the Lesotho energy sector. This is backed up by the fact that countries that have used the EISD tracking framework have indicated that the experience with EISD illustrated the potential applicability of the EISD methodology for energy policy development [9].

For this reason, therefore, Lesotho needs frequent monitoring of the impacts of selected policies and strategies to spot if they are furthering sustainable development or not. In a case where there is no considerable progress, both policies and strategies will have to be adjusted to a certain extend. It is not only important but also necessary to measure Lesotho's developmental state in addition to monitoring its progression or lack of progress towards sustainability. This would benefit the country to have a clear knowledge of the current status with regard to energy, environment, and socio-economic development. Secondly, policymakers appreciate the simplest methods to monitor and evaluate the current and future effects of energy use on human health, society, air, soil, and water. For these reasons, energy indicators for sustainable development (EISD) that are developed by IAEA, International Energy Agency (IEA), European Economic Area (EEA), etc can be used to fully address this purpose. The above-stated aspects will most probably enable Lesotho to make informed decisions about initiatives and policies to implement to facilitate the achievement of the set goals.

1.3 Objectives

This study aims to track and monitor progress in achieving SDG7 targets that are set globally and to further assess whether the desired targets will become a reality over a particular set time frame in the Lesotho context. To ultimately achieve this goal, the study is going to use globally applied energy indicators for sustainable development (EISD) which take into consideration the three primary dimensions of sustainable development: social, economic, and environmental dimensions. This core set of EISD is designed to supply information regarding energy trends in a manner that facilitates decision-making to assist countries to estimate successful and fruitful energy policies for action on sustainable development.

1.4 Motivation / Study Justification

The contribution of this study will assist the country to track the progress towards achieving SDG7 considering the use of renewable energy sources and access to modern energy sources. This in turn will lead to a cleaner environment and sustainable use of traditional biomass, which will further result in the recovering of the exploited forest cover nationwide. The country will have a clear picture of where it is with the progress to achieving SDG7 or how far it is from achieving the desired targets. This includes an assessment of the status of energy issues to make better-informed decisions on issues related to energy; the knowledge from this analysis will also be used to adopt or implement different strategies that will help accelerate the SDG7 progress. The evaluation will play a major role in the formulation of prospective energy policies and policy recommendations for the benefit of the policymakers not only on the shaping of development but also on the feasibility of making energy development sustainable.

Additionally, policymakers are forever seeking liable ways of measuring and assessing both the current and future effects of energy use on health, society, air, soil, and water. To successfully achieve this goal, they require the country's current energy status, economic sustainability, a place for improvement, and lastly how such improvements can be achieved. This emphasizes the need for policymakers to understand the implications of selected environment and economic programs, policies and plans, and their effects on the shaping of sustainable development goal 7 (SDG7).

1.5 Content / Structure

Chapter 1 of this study report entails the introduction which discusses in detail the study background, problem statement, objectives, and study justification. Chapter 2 discusses a literature review of similar studies around the globe where tracking studies of energy indicators for sustainable development have been undertaken including the methodologies used, with recommended policies. Chapter 3 entails the methodological guidelines that describe the core energy indicators for sustainable development that are going to be assessed depending on data availability. Chapter 4 explores the results and discussions of the assessed energy indicators, their projected trajectories, gaps identified, and lastly how they can be addressed to achieve the set goals. Chapter 5 as the last chapter gives the concluding remarks, recommendations, and summarizes the main results and recommends policies and strategies going forward.

CHAPTER 2 – LITERATURE REVIEW

2.1 Sustainable Development Goal 7 (SDG7)

Sustainable development goal 7 (SDG7) being the focus of this study and it aims at ensuring access to affordable, reliable, sustainable, and modern energy encouraging the objectives of the SE4ALL initiative [11]. Energy has been viewed as a very crucial factor in achieving many of the SDGs and to accelerate the progress towards the achievement of SDG7 in 2030, countries were requested to set country-specific SE4ALL targets such as ensuring universal access to modern energy services, doubling the global rate of improvement in energy efficiency, and doubling the share of renewable energy in the global energy mix. The accessibility of adequate and reliable energy services at affordable costs is recognized as a major element of sustainable development, especially when that happens in a safe and environmentally friendly manner in line with the social and economic development requirements. For this reason, energy is viewed as a major weapon in not only eradicating poverty but also in the improvement of human well-being and upgrading living standards [11].

Therefore there is a need to track the progress towards achieving these objectives to see how far coumtries are from achieving the set sustainability goals. Policymakers need methods that will help them evaluate the current and future effects of the energy system and they need to determine whether the current energy use is sustainable and the initiatives required to make it achievable and sustainable; this is the whole purpose of the energy indicators. For a successful assessment, countries were urged to use EISD to evaluate the sustainability of the energy system [2]. These energy indicators are declared very essential for monitoring the energy progress towards specific country goals. In short, EISD is declared as the proper tool for measuring progress in energy sustainability.

2.1.1 Energy Indicators as a Measure of Progress

Renewable energy integration, as well as improved energy efficiency, are seen as major influencers to achieve sustainable development [12] and a principal measure to ensuring energy security [13]. IAEA also added that the accessibility and affordability indicators are said to be the basic measures and determinants of progress towards sustainable development [2]. This is however coupled with their ability to encourage improvement in the situation of women as they bear the burden of fuel collection in poor countries as opposed to men. By right, energy use should not in any way or form, harm or deteriorate human health, but should enhance quality of human health by upgrading living conditions. On the contrary, energy production currently continuously causes accidents, injuries, and diseases through the generation of pollutants. It is therefore the purpose of the fourth social goal (SOC4) to mitigate these negative impacts. Besides, some of the indicators are very debatable in measuring progress, and this is where most of both environmental and social indicators, unfortunately, fall under. This encompasses the selected indicators like SOC4 (accident fatalities), ENV3 (air pollutant emissions from energy systems), and ENV6 (rate of deforestation attributed to energy use) [2]. This is a bit of a limitation on its own concerning these indicators.

Also, in developing countries the availability of commercial fuels like kerosene give rise to the share of a household's income that is spent on energy (SOC2), from a socio-economical perspective however, this may not necessarily be representative of a negative development because even the collection of fuelwood is said to involve memorable losses of productive time in addition to obstructive health consequences from burning of the wood. In essence, these forms of fuel are seen to be deteriorating quality of human health although in a different manner.

SDG discussions have concluded that access to sustainable energy is primary to unlocking many areas of development including the ones just mentioned above. This is supported by the emphasis that some people globally still lack energy services and makes them prone to poverty hence staying behind on sustainable development. It was with this purpose that SDG7 proposed some targets to close this energy gap by ensuring access to affordable, sustainable, and modern energy services for all, universal access to energy and clean cooking, increasing the share of renewables in the global energy mix, and doubling the annual rate of improvement in energy efficiency.

The proposed targets to address these indicators should optimally and effectively bring about meaningful change towards energy sustainability. To successfully measure progress, these targets should therefore have robust energy indicators that fit their purpose of measuring what matters and ensuring that progress can be tracked through clear milestones. Below are these targets, indicators, and how to measure them as per the World Bank report [14].

2.1.2 The SDG7 Targets and Indicators

Target 7.1: By 2030, ensure universal access to affordable modern energy services. To measure the progress on this indicator will have to calculate the annual access rate using Equation 1. The annual change is calculated as the difference between the access rate experienced in year N and the access rate in the previous year (year M). The value is divided by the number of years to compute it into an annual value.

$$Change\ in\ electricity\ access = \frac{(Access\ rate\ year\ N - Access\ rate\ year\ M)}{(year\ N - year\ M)} \qquad \text{Equation 2}$$

Target 7.2: By 2030, the renewable energy share in the final energy consumption is expected to double the global energy mix. The proposed indicator in this target is the renewable energy share in the total final energy consumption (%), which is calculated as the difference between the rate of renewable energy share in the second year (year 2) and the rate in the first year (year 1), divided by the total number of years under study. This is done to annualize the value. The formula undertaken is representked in **Error! Reference source not found.**:

$$Share\ of\ renewable\ energy\ = \frac{(Access\ rate\ year\ N - Access\ rate\ year\ M)}{(year\ N - year\ M)} \qquad \textit{Equation 3}$$

Target 7.3: By 2030, the global rate of improvement in energy efficiency is expected to be doubled, with the proposed indicator to measure the rate of improvement in energy efficiency (%) which is measured in terms of primary energy and *GDP* as shown in **Error! Reference source not found.** and **Error! Reference source not found.**, where *TPES* is the total primary energy supply, *GDP* is the gross domestic product, *CAGR* is the compound annual growth rate, PEI_{tm} and PEI_{tn} is the primary energy intensity in year *tm* and year *tn* respectively.

$$Primary\ Energy\ Intensity = \frac{TPES}{GDP} \quad \text{Equation 4}$$

$$CAGR = (\frac{PEI_{tn}}{PEI_{tm}})(^{\frac{1}{tn-tm)}} - 1 \quad \text{Equation 5}$$

The composite Energy Efficiency Improvement of economic sub-indicators in transport, industrial, household, and agricultural energy efficiency as per Equation 6 to Equation 9 is also essential in improving the global energy efficiency, where TFEC is the sum of energy consumption or demand in all the sectors outlined in the respective equations. Depending on the type of sector, activities are calculated as either value-added, passenger-kilometers, or population. The value-added for one is the net output of different sectors after adding up all outputs and subtracting intermediate inputs.

$$Industry\ Energy\ Intensity = \frac{Industry\ TFEC}{Industry\ value\ added} \quad \text{Equation 6}$$

$$Agricultural\ Energy\ Intensity = \frac{Agriculture\ TFEC}{Agriculture\ value\ added} \quad \text{Equation 7}$$

$$Passenger\ Transport\ Energy\ Intensity = \frac{Passenger\ Transpoort\ TFEC}{Passenger-kilometers} \quad \text{Equation 8}$$

$$Residential\ Energy\ Intensity = \frac{Residential\ TFEC}{Residential\ floor\ area} \quad \text{Equation 9}$$

Net energy import dependency on the other hand is calculated as the ratio of imports over production plus imports minus energy exports divided by 100.

$$Import\ Dependency\ Ratio\ (IDR) = \frac{Imports}{(Production + imports - exports)} x\ 100 \qquad \textit{Equation 10}$$

End-use energy prices by fuel and by sector: under this indicator only the energy fuel prices are going to be analyzed due to lack of data on the fuel prices by sector. The considered equation for this assessment is shown below when the price increased from one year to the other:

$$Fuel\ price\ percentage\ change = \frac{(new\ price - old\ price)}{old\ price} x\ 100 \qquad \textit{Equation 11}$$

But when the price decreased, the equation is as follows:

$$Fuel\ price\ percentage\ change = \frac{(old\ price - new\ price)}{old\ price} x\ 100 \qquad \textit{Equation 12}$$

Energy use per unit of GDP (energy intensity of GDP): In the assessment for 2017 productivity, the total energy use for producing a unit of GDP was calculated using the following equation:

$$Energy\ intensity\ of\ GDP = \frac{Total\ energy}{GDP} \qquad \textit{Equation 13}$$

2.1.3 Related Studies Using Energy Indicators

In the process to gauge and track energy sustainability, different researchers around the globe have undertaken initiatives to measure energy sustainability progress in terms of affordability and access, clean energy for cooking, energy efficiency, and percentage share of renewable energy as outlined above. The knowledge about the energy progress of any country makes it easier for policymakers and relevant stakeholders to make informed decisions in implementing policies and measures to accelerate SDG7 achievement for the 2030 agenda.

In Greece, Athanasios et al conducted a study in which they examined whether the energy system developed in a sustainable direction or not [15]. The results demonstrated that even though there is still a lot that needs to be done in achieving national and European policy objectives, there was development in the energy system that has been caused by social aspects more than any other pillar of sustainable development. About the social dimension, the accessibility was reported to have considerably improved. While on the other hand, inconsistencies between low and high-income households have been constricted. That being said, however, there was still a continuous increase in energy prices at a rate much higher than that of income. On economic aspects, productivity improvement was seen to be misleading, for the reason that it was rather caused by GDP increase instead of energy efficiency improvements.

The indicators were also used to evaluate the Indian development between 1983 and 2000 in which the results anticipated quicker economic growth especially in the late 1990s [16]. Energy efficiency was also reported to have increased, yet the increase was not ample enough for the complete satisfaction of the increasing energy demand. The situation as a result brewed a significant decline in renewable energy ratio to total primary energy. The increased energy demand on the other hand caused a noticeable increase in GHG emissions including other air pollutants. Surprisingly, there was a constant decrease in the share of people depending on low-quality fuels for cooking from about 90% to 75%. Conversely, the number of people without access to clean energy for cooking has inclined from 595 to 690 million.

Evidence lacking in both studies is an effort to at least give out the economic aspects or overview of the measures that are possible to be implemented to meet the SDG7 agenda in 2030. Without this effort, the work on its own feels incomplete or somehow unsatisfactory because it does not outline to which economically extend the countries can achieve the set goals. Also, Vera in the paper that he summarized, the paper used only one scenario to assess energy production and use patterns [3]. The policies that will be advised to implement will be highly based on the direction that will be dictated or pointed out by the individual indicators after the assessment. This is because there is a solid relationship between both energy policies and the energy indicators.

2.2 Overview of Sustainable Development Indicators

The concept of sustainable development is based on "the balance between economic development and the need to preserve the environment and unity between generations" as stated in Chapter 1 of the Brundtland Commission; in essence sustainable development is development that can accommodate the present needs without a limitation for future generations to meet their own needs [1]. Additionally, Streimikiene indicated that in achieving sustainable development, there should be a sensible use of resources, technology, economic incentives, and informed strategic planning taking place locally and nationally [6]. Streimikiene further stated that frequent monitoring of the strategies and policies will help countries see whether sustainability is progressing as expected or not. The concept of sustainable development must take into consideration the implications and consequences of the three dimensions of sustainable development; social, environmental, and economic, as shown in Figure 1 and recommended by Wuppertal Institute [17]. These include the inter-linked indicators under each dimension which can further be extended to more precise and measurable sub-indicators in the energy context as discussed in detail in the next section.

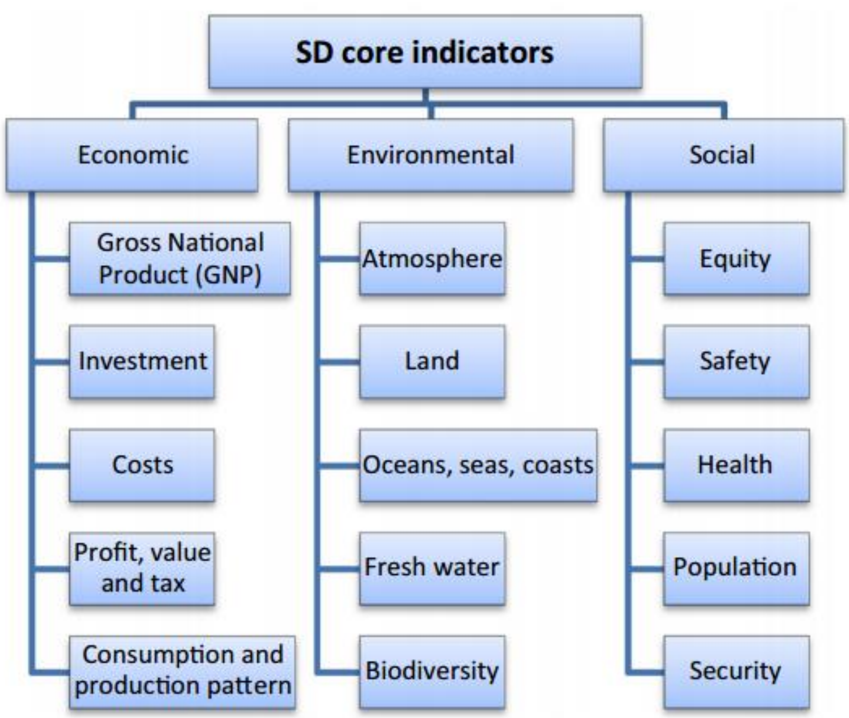

Figure 1: Sustainable development core indicators [17]

2.3 Energy Indicators for Sustainable Development (EISD)

The United Nations Commission on Sustainable Development (UNCSD) developed 58 indicators from a selected list of 134 indicators worldwide [17]. Neves and Leal also established a framework of 18 local energy indicators that can be used not only as an assessment but also as an action planning tool [18]. The work on the set of 30 energy indicators of sustainable development was proposed by the International Atomic Energy Agency's (IAEA) [4] in collaboration with various participating agencies that include UNDESA, the International Energy Agency (IEA), and other international and national organizations [19]. The work then introduced the name 'Indicators for Sustainable Energy Development' (ISED) at the ninth session of the Commission on Sustainable Development (CSD-9) in 2001, in which energy was the major theme [2]. This included the improvement in both affordability and accessibility to modern energy services. This name, ISED, was then later modified to Energy Indicators for Sustainable Development (EISD). Streimikiene also showed that the assessment can be performed using appropriate tools like EISD [9]. He further demonstrated EISD as an analytical tool developed specifically to aid in energy decision-making by policymakers.

The set of energy indicators considered in this study are listed in **Error! Reference source not found.**. Many of the national agencies and policymakers have been using EISD e.g. [20], [21]. The indicators do not only represent sectoral development but also suggest related policy actions that need to be adopted. Above all, they concentrate more on the conditions that are necessary for progress towards a more sustainable energy policy that mostly benefits the environment [3]. Additionally, EISD's were designed with the primary goal to provide information on current energy trends and progress. This was done in a manner that can assist in the decision making at the national level to help countries evaluate effective energy policies for action on sustainable development that include energy efficiency and advanced energy technologies to accommodate the growing energy demand, to increase renewable energy share and establish domestic programs on energy efficiency [3]. Energy indicators are further explained as primary tools meant for communicating energy issues that are specifically related to sustainable development, policymakers, and the public, and for promoting institutional dialogue [2]. There are specific energy indicators in every dimension of sustainable development.

Table 1: 30 Energy Indicators for Sustainable Development (EISD)

Theme/Sub-theme	**Energy indicator**	
ECONOMIC		
Use and production patterns		
Overall use	ECO1	Energy use per capita
Overall productivity	ECO2	Energy use per unit of GDP
Supply efficiency	ECO3	The efficiency of energy conversion and distribution
Production	ECO4	Reserves-to-production ratio
	ECO5	Resources-to-production ratio
End-use	ECO6	Industrial energy intensities
	ECO7	Agricultural energy intensities
	ECO8	Service/ commercial energy intensities
	ECO9	Household energy intensities
	ECO10	Transport energy intensities
Diversification (fuel mix)	ECO11	Fuel shares in energy and electricity
	ECO12	Non-carbon energy share in energy and electricity
	ECO13	Renewable energy share in energy and electricity
Prices	ECO14	End-use energy prices by fuel and by sector
Security of supply		
Imports	ECO15	Net energy import dependency
Strategic fuel	ECO16	Stocks of critical fuels per corresponding fuel

stocks		consumption
ENVIRONMENTAL		
Atmosphere		
Climate change	ENV1	GHG emissions from energy production and use per capita and per unit of GDP
Air quality	ENV2	Ambient concentrations of air pollutants in urban areas
	ENV3	Air-pollutant emissions from energy systems
Water		
Water quality	ENV4	Contaminant discharges in liquid effluents from energy systems
Land		
Soil quality	ENV5	Soil area where acidification exceeds the critical load
Forest	ENV6	Rate of deforestation attributed to energy use
Solid-waste generation and management	ENV7	The ratio of solid-waste generation to units of energy produced
	ENV8	The ratio of solid waste properly disposed-off to the total generated solid waste
	ENV9	The ratio of solid radioactive waste to units of energy produced
	ENV10	The ratio of solid radioactive waste awaiting disposal to the total generated solid radioactive waste
SOCIAL		
Equity		
Accessibility	SOC1	Share of households (or population) without electricity or commercial energy, or heavily dependent on solid biofuels
Affordability	SOC2	Share of household income spent on fuel and electricity

Disparities	SOC3	Household energy use for each income group and corresponding fuel mix
Health		
Safety	SOC4	Accident fatalities per energy produced by fuel chain

2.3.1 Economic Dimension Indicators

The energy indicators in the economic dimension for one put into consideration two themes: use and production patterns, and security of supply. Under the use and production patterns, seven sub-themes are introduced: overall use (ECO1), overall productivity (ECO2), supply efficiency (ECO3), production (ECO4 and ECO5), end-use (ECO6, ECO7, ECO8, ECO9, and ECO10), fuel mix (ECO11, ECO12, ECO13) and prices (ECO14). The security part of the theme is inclusive of import dependency (ECO15) and strategic fuel stocks (ECO16) [4].

Modern economies are more dependent on reliable energy supply options. For this reason, modern energy services are in huge demand by all sectors of the economy; residential, commercial, transport, service, and agriculture. These energy services sequentially encourage both economic [22] and social development. This can be achieved by increasing productivity and hence enabling local income generation. With this in mind, energy supply affects a considerable number of issues that include jobs, productivity, and development [2].

Getting on to the issue of prices, prices of end-use energy by fuel and sector (ECO14) play a paramount role in the economy [2]. This is because efficient energy price is a crucial factor that leads to efficient energy supply and use, as well as efficient levels of pollution. ECO2 (energy use per unit of GDP) is one of the economic indicators that determine energy intensity. According to Vera and Langlois [4], per capita, energy consumption is a major indicator of the intensity of a society which in other ways may be utilized as a proper indicator for a successful economy. On the contrary, a higher value could be an indicator of excessive use of energy leading to negative consequences to the society and environment included [15].

2.3.2 Environmental Dimension Indicators

There are 10 energy indicators in the environmental dimension that are classified into three themes: Atmosphere, Water, and Land [2]. These include climate change (ENV1), air quality (ENV2 and ENV3), water quality (ENV4), soil quality (ENV5), forest (ENV6), and solid waste generation and management (ENV7, 8, 9, 10). And according to Cîrste [11], the environmental dimension is known for reducing the undesirable consequences of greenhouse gas (GHG) emissions, renewable energy footprints that resulted from generation, distribution, and use of energy as these stress the environment at all levels from household to global level.

The undesirable results on the environment as already posited above are largely dependent on how energy is produced and used, the fuel mix, the structure of the energy systems above all and the ruling energy regulations, and lastly, pricing structures [2]. Gas emissions from fossil fuels abundantly pollute the atmosphere with greenhouse gases resulting with amongst other effects climate change. The larger hydropower plants on the other hand lead to silting; the blockage from sand or other material coming with running water. The wood collection also leads to deforestation as well as desertification leaving the ground prone to soil erosion and extinction of natural flora and fauna. However, with the initiative to support the sustainable development goal of diminishing the environmental impact of energy systems, renewable energy technologies have proved to contribute a noticeable satisfaction as opposed to fossil fuels, particularly in terms of GHG emissions [2].

2.3.3 Social Dimension Indicators

Certain social issues are highly related to energy accessibility and how energy is utilized. These include among others poverty, quality of life, education, demographic transition, indoor pollution, health, gender, and age-related implications [4]. It is through these issues that the social dimension particularly demonstrates a need for people to access the basic energy services at affordable costs to accommodate all. Under this dimension, there exist 2 themes; equity and health. Equity for one involves the issues of energy systems and distributions, covering sub-themes of affordability (SOC1), accessibility (SOC2), and disparity (SOC3) [4]. The last theme is health, concentrating on safety (SOC4).

The social outlook of the energy system is comparable to its capability to donate both commercial fuels and access to modern energy services to everyone at affordable prices [15]. Both affordability and accessibility issues are appraised in this assessment. The lack of access to energy services causes adverse effects on people's health through burning fuel indoors in open fires. This includes the use of inflammable fuels for lighting. Energy is very essential; hence it must be both accessible and obtainable to everyone at a fair price. The failure to accomplish this could marginalize poor people and hence cause social turbulence. Depending on the data availability and relevant qualities and strengths, the mentioned energy indicators are the ones that are going to assist in informing the policies to accelerate the gap left before achieving energy sustainability in 2030.

2.3.4 EISD Strengths and Limitations

EISD is viewed as an effective tool that can be used largely by different countries in the assessment of energy sustainability progress. This was concluded by Vera on the summarized paper that aimed to provide an analytical tool for current energy production assessment and use patterns at a national level [4]. It was further indicated that the energy indicators develop strategies to be implemented to accelerate the energy sector towards a more sustainable future. This includes the identification of those specific areas in which efforts, focused measures, and policies should be directed. Similarly, Streimikiene [9] also viewed EISD as an outstanding and beneficial tool as it allows the assessment of trends regarding targets of sustainable energy development.

On the assessment conducted for the Baltic States, the findings indicated that there is positive feedback from the considered indicators showing progress towards sustainability. However, Streimikiene reported that there were certain issues such as energy intensity, the security of supply, including the promotion of renewable energy sources, and energy efficiency improvements that were stressed to require special attention. To address this, the Baltic States had to implement specific measures and policies to back up a downfall caused by these specified indicators. Such policies include the enhancement of renewable energy sources and the reduction of energy transformation losses in the energy system that should be implemented [9].

EISD was also demonstrated in 1992 at the Earth Summit as vital in assisting countries to make sound decisions. This includes the strategic decisions that describe the approach towards sustainable development [4]. These energy indicators are designed in a manner that can be used with the least-cost data availability. However, it is encouraged that more efforts at data collection are exercised and there is also an effective interaction within relevant stakeholders and institutions at the country level. EISD further provides a better understanding of linkages and the relationship between energy-environment–economics nexus, the understanding that may not be visible from simple statistics. This understanding will then give a better picture of a whole energy system on interlinkages and trade-offs among the dimensions of sustainable development.

Even though EISD seems to be beneficial when it comes to informing the energy sector for different countries, there are unfortunately some limitations associated with it, which make them not 100% reliable or perfect for the mentioned purpose. To start with, the applicability and effectiveness of the EISD core set were tested in several countries like Brazil, Cuba, Lithuania, Mexico, Russian Federation, Slovak Republic, and Thailand [4]. On a considerable number of indicators tested, most of these selected countries encountered problems of both data availability and consistency. However, still with these limitations in place, the analysis drawn from the study was that Cuba, Brazil, and Mexico have reported some observable changes from the relevant energy indicators in their energy system. Vera [4] also added that the EISD tool is not enough for dictating long-term energy strategies due to the existence of certain issues that are difficult to quantify or are more qualitative by nature and that need to be deeply considered in the final formulation of energy policies. Unander [23] further stresses that a time series, consistent and high-quality data is critical if the aim is to reap the usefulness of indicators as analytical tools. And this data challenge with poor quality and inconsistencies is mostly seen in many non-OECD countries where the resulting factor can even be a lack of proper data collecting resources.

2.4 Link between selected indicators and relevant policies

The analysis undertaken in this study is based on the energy situation and policies in light of the EISD framework. There are links discovered among the selected EISD indicators and relevant policies as devoted by indicator.

As demonstrated in **Error! Not a valid bookmark self-reference.**, it is clear that both the energy sector and household energy indicators are the major influencers for energy intensity indicators. Also, the overall energy intensity indicators are considered as the authority of the overall economic-energy efficiency of a country or a region [20]. Economic energy efficiency comes as a result of emission and pollution indicators, while on the other hand the greenhouse gas (GHG) emissions (ENV1) are precisely determined by the energy mix (ECO11), and the indoor pollution (a constituent of ENV2) result from energy utilization from household level (Household energy indicators). This says therefore that, when informing policies that will reduce indoor air pollution as an example, consideration should also be taken as such policies will also affect other household energy indicators. Another visible example is that policies that increase reliable power and access productivity affect several energy intensity indicators that include ECO2, ECO6, ECO7, ECO8, etc. This is because of the link seen between different policies and energy indicators.

Equally, from the African context, it is clear that the issues that are addressed by household energy indicators also donate to deforestation issues (ENV6). In summary, the affordability indicator is in correlation with Energy intensity indicators while the Household energy-health indicator is a resultant of emission and pollution indicators and particularly of ENV2. Using relationships that seem to be running between these two parameters, the literature gap can easily be closed, which is now the purpose of this current study in the context of Lesotho.

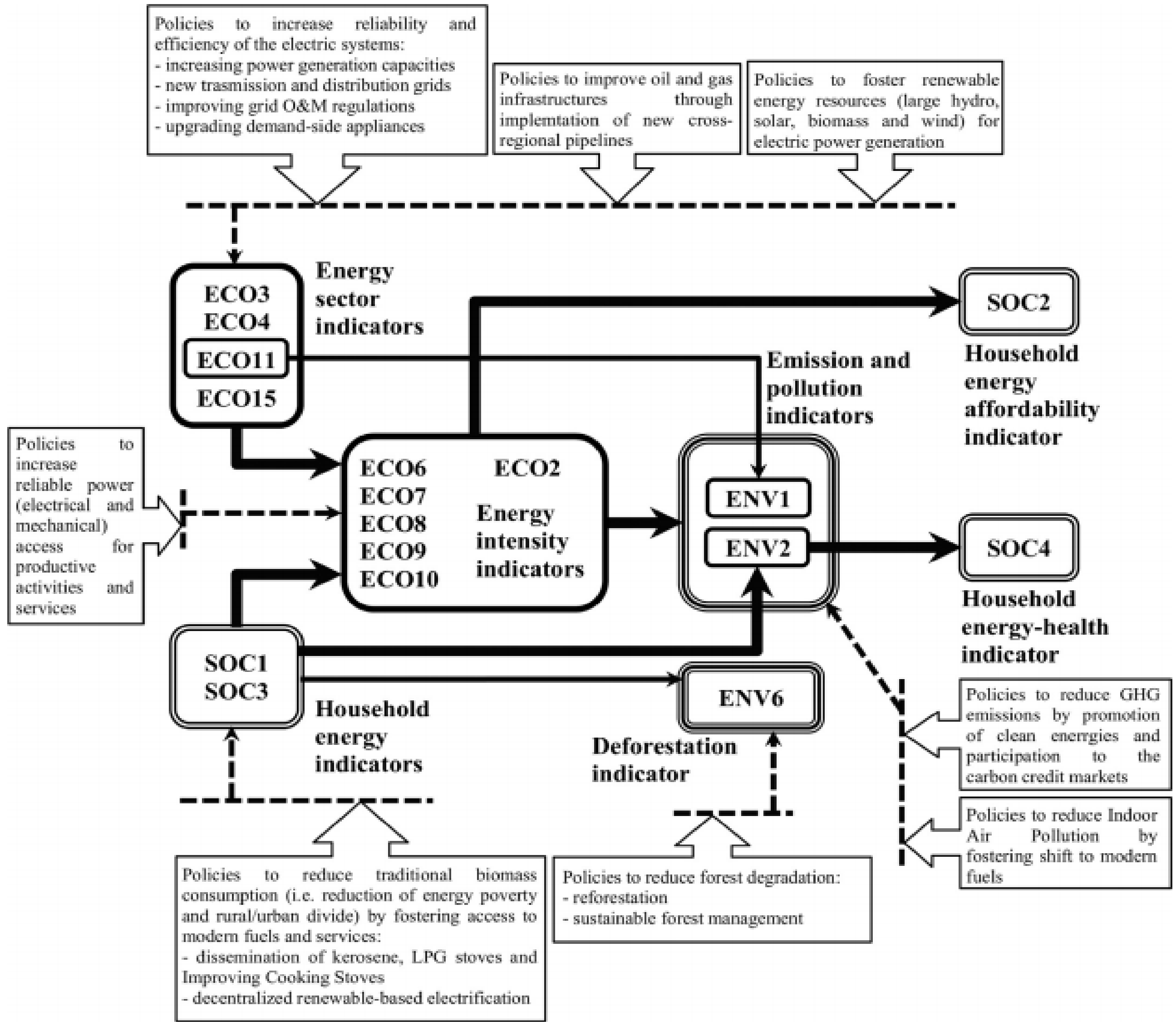

Figure 2: Relationship between selected indicators and relevant policies based on targeted indicators, [20]

2.5 Gap justification

In assessing the progress towards energy sustainability, researchers around the world have deployed far many different energy models intending to address energy policy and planning concerns of energy, economy, and the environment [24]. However, some studies in the literature have concentrated more on developing sets of indicators to measure and be used in the assessment of sustainable development aspects, tracking the progress of sustainable development goals including SDG7, the mitigation of GHG emissions by shifting the energy utilization in the demand side, while still increasing the potentials of diversifying energy supply mix, as well as diminishing GHG emissions by incorporating policies in both supply and demand side. The current study falls into a category where it intends to track SDG7 progress for Lesotho using EISD. This is done to support the sustainable development agenda that need to have been met by 2030.

EISD is very specific and beneficial in monitoring progress on achieving a specific country's developmental targets. There is a need for policymakers to know their country's energy situation and economic sustainability to make informed and fully researched energy policies [4]. This includes how to assess and measure the current energy situation and future impacts on more precise and measurable sub-indicators like water, soil, health, equity, safety, cost, and investment. Having concise knowledge of the current energy situation, they will then know the specific areas that need improvement, the kind of improvement required, and finally how to implement such and to what extent.

There are no previous studies conducted in Lesotho for tracking SDG7 progress as such the current study will use energy indicators for sustainable development to undergo the energy assessment that will benefit the Lesotho energy sector and researchers in the field by laying groundwork to information that remains uncaptured. The assessment of the selected energy indicators, those relevant to Lesotho will be useful for future energy planning as an initiative to achieving sustainable development by 2030. The main problem Lesotho is facing right now is the lack of knowledge about the progress towards SDG7 objectives. This further causes difficulty in implementing informed initiatives to accelerate the achievement of this goal. Through this study's conclusion and recommendations, there can derived some pointers for strategic plans, initiatives, and policies that can be engaged to assist in the accomplishment of SDG7 objectives in response to the sustainable development agenda in 2030 that include the adoption of green energies. These green energies have the greatest potential in both developed and developing countries [25] and [26], where electricity can be generated without imposing environmental pollution [27].

CHAPTER 3 – METHODOLOGY

3.1 Overview

The methodology undertaken in this study aims at tracking the progress of SDG7 to assess whether or not the targets set globally will become a reality over a particular planning horizon in the context of Lesotho. The set of energy indicators used represents a quantitative tool that is meant for monitoring progress and further defining long-term strategies. In this study, two different scenarios are used to accommodate different options that can gauge the achievement of the set targets. The proposed scenarios are Business as usual (BAU) and Sustainable Development (SD) Scenario.

Indicated by **Error! Reference source not found.** is a schematic diagram of the methodological approach undertaken in 7 simple steps. But due to data unavailability on environmental dimension, only two dimensions of sustainability (social and economic) are going to be assessed in this report. The data unavailability on the environmental indicators does not hide the fact that policy direction may be affected badly due to the inter-relation between these three dimensions. The steps to be followed are as follows:

1. Assess the energy indicators for their relevance to a policy as well as their relationship to SDG7 targets
2. Examine the selected indicators against the selection criteria as per Table 2.
3. Collect data from appropriate stakeholders required to cover the recognized priority areas and assess concerning data availability.
4. Sort dimensions and compile data in time series for each selected Energy Indicator (EI)
5. Analyze data and then establish specifically how the progress in those specified variables will be tracked using EISD
6. Calculate the growth rates on the necessary indicators, assess the data implications, and hence estimate the progress attained in the individual indicators as per the BAU scenario. This puts into consideration some different energy policies for the present time and the

future, looking at their possible effects towards achieving the set targets for different scenarios.

7. Develop an SD scenario to explore future policy, different options, and growth trajectories that may be required to achieve the set targets.

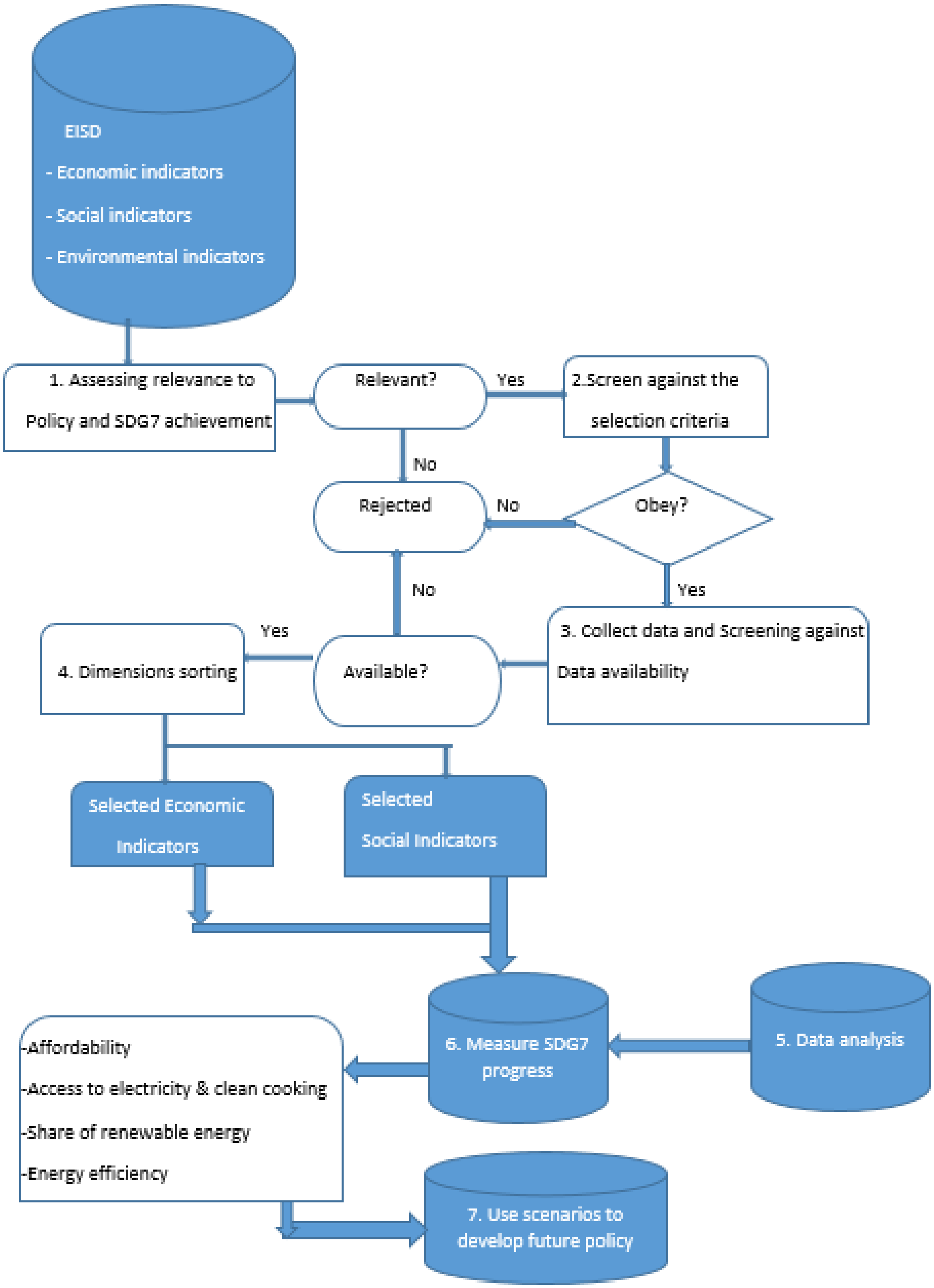

Figure 3: A schematic diagram explaining research method (structural overview)

Table 2: Selection criteria for indicators considered

Selection criterion	Description
1. Data availability	Availability or possibility of data collection
2. Measurability	Should be measurable either in qualitative or quantitative terms
3. Simplicity	Practicability and easily understood by decision-makers
4. Sensitivity	Ability to accommodate trend evaluation
5. Reliability	The capability of capturing both positive and negative aspects
6. Relevance to SDG7	Should ensure high relevance to SDG7 achievement

3.2 Selection of relevant energy indicators

The relevant EISDs were selected from the EISD core set of 30 to address and cover the priority energy concerns of the Lesotho energy sector about SDG7 primary targets. The selected EISDs are shown in Table 3. Even though a large indicator set has the advantage of covering almost all issues concerned with sustainability and additionally contributes a comprehensive insight into the energy system, their complexity conversely makes their interpretation to be most difficult [15], hence it is not suitable for sound decision-making purposes [28]. For this reason, to successfully carry out this analysis, a smaller set of indicators need to be selected. Kemmler [16] also indicates that a smaller set of representative indicators are more appropriate to use as opposed to a larger set.

Also, the scope of this current study is to propose a small set of energy indicators for sustainable development to track SDG7 progress. It is with these justifications that certain energy indicators were selected from the 30 EISD frameworks. And this selection is highly based on considerations regarding data availability and their relevance to SDG7 and other aspects as depicted in Table 2. However, the formula to select these indicators is not easy to compile since there is no common or any consistent methodology that is formally agreed on to carry out this task. Of equal importance, the selection criterion one chooses is very much reliant on defined characteristics of the analysis' goals [15]. These indicators will therefore contribute to an overview of the energy system about progress in its sustainability, illustrating both weaknesses and improvements to be undertaken to guide in the energy policy-making decisions and processes.

With the current study, out of three dimensions of sustainable development, indicators under the social dimension are all going to be analyzed. The ones under the economic dimension are going to be analyzed as well except for supply efficiency which is ECO3 there are no conversion machines and processes taking place in Lesotho. Production, ECO4 is due to the absence of reserves like coal, so there is no electricity being produced out of coal. Fuel mix, ECO12 is not assessed as well since in Lesotho there is no non-carbon energy like geothermal and nuclear energy, etc. except for renewable energies and biomass that will be analyzed under ECO13.

This concludes therefore that out of 16 energy indicators in the economic dimension, only 11 of them are going to be assessed. Environmental dimension indicators on the other hand are not going to be assessed due to data unavailability.

Table 3: Description of the selected energy indicators

Abbreviation	Name	Description
Social Dimension		
SOC1	Accessibility	Share of households (or population) without electricity or heavily dependent on non-commercial energy
SOC2	Affordability	Share of household income spent on fuel and electricity
SOC3	Disparities	Household energy use for each income group and corresponding fuel mix
SOC4	Safety	Accident fatalities per energy produced by fuel chain

Economic Dimension		
ECO1	Overall use	Final and residential energy consumption per capita
ECO2	Productivity	Total primary energy supply or energy use per unit of GDP
EOC3	Energy Supply & distribution Efficiency	
ECO6	End use	Energy intensity of the industry
ECO7	End-use	Energy intensity in agriculture
ECO8	End-use	Service/ commercial energy intensities
ECO9	End-use	Energy intensity in household
ECO10	End-use	Energy intensity in transport
ECO11	Diversification (fuel mix)	Fuel shares in energy and electricity
ECO13	Diversification (fuel mix)	Renewable energy share in final energy consumption
ECO14	Prices	End-use energy prices by fuel and by sector
ECO15	Imports	Net energy import dependency

3.3 Data Collection and Description

Primary data was collected from key respondents from relevant organizations and stakeholders like Lesotho Electricity Company (LEC), Department of Energy (DoE), Lesotho Electricity and Water Authority (LEWA), World Research on Tracking SDG7 progress, and Lesotho Bureau of Statistics (BoS) which was done through face to face interviews and some secondary information from the publications by each respondent. Data sources include the household energy survey data for 2017, the share of renewable energy in the final energy consumption, access to electricity and modern energy for cooking, etc. In the absence of survey data for a given year, the readily available information from national energy trends was used with the assumption that access scale-up is likely to be similar.

3.3.1 SOC1: The universal access to affordable and modern energy services.

i. Household electrification (access to electricity)

Under this target, only the electricity access was analysed. And data was sourced from LEWA reports and Energy statistics of Kingdom of Lestho summary. The data indicates the percentage of households with access to electricity from 2014 to 2019.

ii. Access to clean fuels and technologies for cooking

Due to data unavailability, from the local energy entities, the clean energy data was sourced from the World Bank. The data represents the percentage population having access to clean energy for cooking from 2014, 2015, and 2016. In years 2017, 2018, and 2019 where data was not available, the gaps were filled with the uniform growth rate which was observed from one year to the other(i.e aggregate annual growth).

3.3.2 SOC2: Share of household income spent on fuel and electricity (affordability)

The share of household income spent on energy fuel and electricity is analyzed only for 2017 due to data unavailability. For this reason, the data will be compared against the world bank's electricity poor limit. The analysis will therefore indicate whether the affordability of energy and electricity usage is atleast within the acceptable limit for the households to be viewed as energy poor or not.

3.3.3 SOC3: Disparities (Household energy use for each income group and corresponding fuel mix)

The data on household energy use for different income groups is taken from BOS on the 2017 household energy consumption survey where a total of 2684 households were assessed. The assessment was based on the possible fuel mix used by different income groups. This indicator is going to be measured by first counting the total number of income groups that use a certain fuel and its percentage over the overall households surveyed. To also classify income groups into the corresponding fuel mix used. This will make an easy assessment of whether the usage of a certain fuel type is influenced by the amount of money each household earns.

3.3.4 SOC4: Safety (Accident fatalities per energy produced by fuel chain)

The raw data in this indicator were collected from LEC and entails the injuries and fatalities that have occurred at LEC during distribution and transmission of electricity from power stations to different destinations like households and the likes. The data collected indicates the number of injuries, fatalities, and electrocution in each year from April 2015 to April 2020 for both members of the public and staff included. To measure sustainability under this target, data is going to be analyzed in a series form from 2015 to 2019.

3.4 Economic Dimension

3.4.1 ECO1: Energy use per capita (Energy consumption per capita)

From the 2016 census report, 2017 population was projected. And this was used together with the 2017 GDP from national accounts to estimate energy use per capita for 2017. This energy use is measured as the final and residential energy consumption per capita. The indicator determines the overall energy intensity of the country. The aim was to analyze this indicator for several years from at least 2015 to 2019, however, due to data unavailability, only 2017 data is available and can be estimated from 2017 Lesotho energy balance and national accounts.

With the world's population that's reported to be increasing, it is projected that a 99% population increase will be attributed to the developing countries [29] and this suggests major energy usage and intensities. With this being said, it is high time that energy intensity reduction measures are taken into considerations.

3.4.2 ECO2: Energy use per unit of GDP (energy intensity of GDP)

Total energy generation, which can be referred to as the (total primary energy supply, final energy consumption) is the selected indicator for the reduction of energy intensity for the Lesotho economy. The indicator further demonstrates a correlation between energy use and economic development. However, due to data unavailability, this indicator is going to be assessed for 2017 only and this data was estimated from energy balance and national accounts.

3.4.3 ECO3: Energy efficiency

The efficiency of energy use data was sourced from the World Bank due to data unavailability from local entities. The data collected shows the annual growth rates from 2014 to 2016 while data for 2017, 2018, and 2019 is not available. For this reason, these gaps were filled by the average annual growth rate of 1.8%. This data will be used to analyze whether the overall energy efficiency is improving and hence reach the set target by 2030.

3.4.4 ECO6, 7, 8, 9, 10: Energy intensity of the economic sectors

Energy intensity is defined as the measure of energy efficiency or inefficiency of the economy of converting energy into GDP. This is an indication of how much total energy a country uses to produce a single unit of GDP for different energy sectors that include household, agriculture, service, industrial, and transport. Due to the lack of energy data in Lesotho, there are no records of data for energy balance for many years except for 2017, which is the only year that is used in this analysis for 2017 energy balance. The GDP data for 2017 was sourced from the Bureau of statistics. This data will be used as a support for the energy efficiency target and it indicates the energy consumed and the corresponding GDP value that was produced.

3.4.5 ECO11: Fuel shares in energy and electricity (fuel mix)

The data for this indicator indicates fuel shares in energy and electricity that are measured in the *toe* and was sourced from the 2017 Lesotho energy balance. From the fuel share values, the fuel percentage shares are calculated for every fuel like electricity, solid wastes, animal dung, charcoal, wood, hydro power, diesel, and paraffin to mention just a few.

3.4.6 ECO13: Share of RE in the final energy consumption

This explains the final renewable energy consumption from all renewable sources like hydropower, wind power, solid biofuels, and solar photovoltaic. The available data on the share of renewable energy in total final energy consumption for 2015 is used to estimate the annual growth rates for other years.

3.4.7 ECO14: Fuel prices

Although data is required for all fuels in the Lesotho energy mix, only data for different forms of petrol, diesel, and IP was found. The data used under this indicator was sourced from the Lesotho Petroleum fund on the prices spend on each fuel from 2015 to 2019. Unfortunately this indicator was not analysed for household fuels like coal, LPG, and electricity due to data unavailability.

3.4.8 ECO15: Net energy import dependency (imports)

The data on the energy import dependency indicator was sourced from the Lesotho energy balance. Due to data unavailability for other study years, it was impossible to track the progress to 2030 hence only 2017 data was used. The import dependency is going to be calculated from the overall imports, Primary energy production, imports, and energy exports.

3.5 Scenario Development

The recommendations indicated are based and built on the analyses made on the two scenarios outlined below; business as usual and sustainable development scenario.

3.5.1 Business as usual (BAU) or Existing Policy scenario

The Existing Policy scenario indicated in this study provides the current sense of where today's policy intentions and aspirations are likely to take the Lesotho energy sector regarding sustainability. This scenario takes into consideration not only the policy measures that the country has already put in operation, but also considers the possible effects of such policies going forward. It further takes into account the recent and current progress, population growth, economic growth, prices of different fuels in use, and the rate at which households are connected to electricity.

3.5.2 Sustainable Development (SD) scenario

The Sustainable Development scenario is a future determined scenario towards delivering the set goals and targets on energy-related sustainable development goal (SDG7): This will therefore lead to achieving many of other known goals of sustainable development. In this scenario, the study identifies the least-cost technologies and fuels to reach universal access to both electricity and clean cooking facilities and the energy and electricity access rates. The scenario further indicates the strategies and pace at which Lesotho needs to implement to electrify these numbers of households. The results will then be weighed concerning the developed scenarios to see how far or close Lesotho is in achieving the SDG7 in 2030. This will further come up with the strategies and the rate at which Lesotho needs to increase the pace. Informing the policies that will assist in the achievement of SDG7 in 2030 will also be one of the outcomes of this paper.

CHAPTER 4 - RESULTS AND DISCUSSIONS

4.1 SDG 7 – Affordable and Clean Energy

Three main targets correspond to SDG7 and these targets are to be met by 2030, and this is the reason why this study tracks their progress. These targets are SDG Target 7.1 which aims at ensuring universal access to affordable and modern energy services. This indicator is two-fold; 7.1.1 focuses on the proportion of the population that has access to electricity and 7.1.2 on the proportion of the population that primarily depends on clean fuels and technologies for cooking. Target 7.2 is to significantly increase the share of renewable energy in the global energy mix. Target 7.3 is to double the global rate of improvement in energy efficiency in the consumption of energy (energy intensity measured in terms of primary energy and GDP).

The findings drawn from the study concerning these targets, on how far behind Lesotho is in terms of achieving SDG7, are going to be elaborated in more details under the two scenarios: Business as usual (BAU) scenario and Sustainable Development (SD) scenario.

4.1.1 Electricity Access

Table 4 indicates the household electrification rates from 2014 to 2019. It can be deduced from the table that the average annual increase in household electrification is 2.4%. Thus, under the BAU scenario which assumes the status quo until 2030, the household electrification level in Lesotho only grows by 26.4% (= 2.4%/year x 11 years), leading to an access rate of just 68.4%, versus the SDG7 target of 100% as illustrated in Figure 4. Hence, under the BAU scenario, the country will miss the target by about 31.6%. The expected electricity access rate of 68.4% is larger than the access rate of 54% anticipated by Mpholo et al [30].

Table 4: Household electrification rates from 2014 to 2019 [31], [32], [33]

Household Electrification rate (%)	2014	2015	2016	2017	2018	2019
National	30	32	35	37	40	42

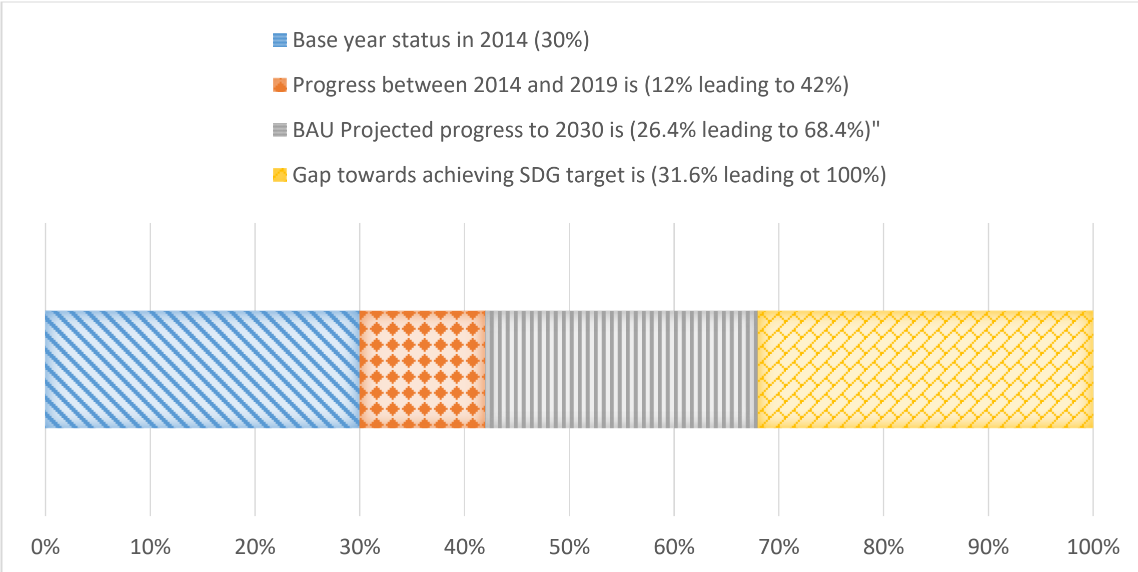

Figure 4: Summary of percentage population with access to electricity

As it can be seen from Figure 4, the capacity to achieve the electricity access target is not enough. With the current efforts or pace, the 100% electricity access target will not be reached by 2030. This is true as around 31.6% of the households would still be deprived of electricity access. To cover this gap, the SD scenario suggests increasing the electricity access growth rate from the current average annual growth rate of 2.4% to 5.3% per annum (= (100% - 42%)/11 years) starting from 2020 until 2030. With this rate, Lesotho will achieve a 100% electricity access target set globally by 2030 as illustrated in Figure 5, provided aggressive policies and strategies are put in place to facilitate the requisite annual average electrification access rate of 5.3%.

To succeed in this objective Lesotho will have to follow tried and tested strategies and policies that were adopted by countries that have already succeeded in electricity access like Brazil [34]. Brazil increased electricity access through the acknowledgment that gave a right for all citizens to access electricity as a public service. If Lesotho can only realize the importance of electricity access for all citizens, universal access would be achieved quickly. Lesotho needs to further ensure electricity access especially for low-income and rural areas through the implementation of new legislations that are fully supported by targets and deadlines to ensure full electricity coverage. For the achievement of universal electricity access, as indicated by the SD scenario, this study recommends that more renewable energy technologies in stand-alone and mini-grids formats are implemented in off-grid areas and supported through the existing Universal Access Fund (UAF) which will accelerate electricity access. Lesotho should take advantage of the abundance of renewable energy sources available in the country.

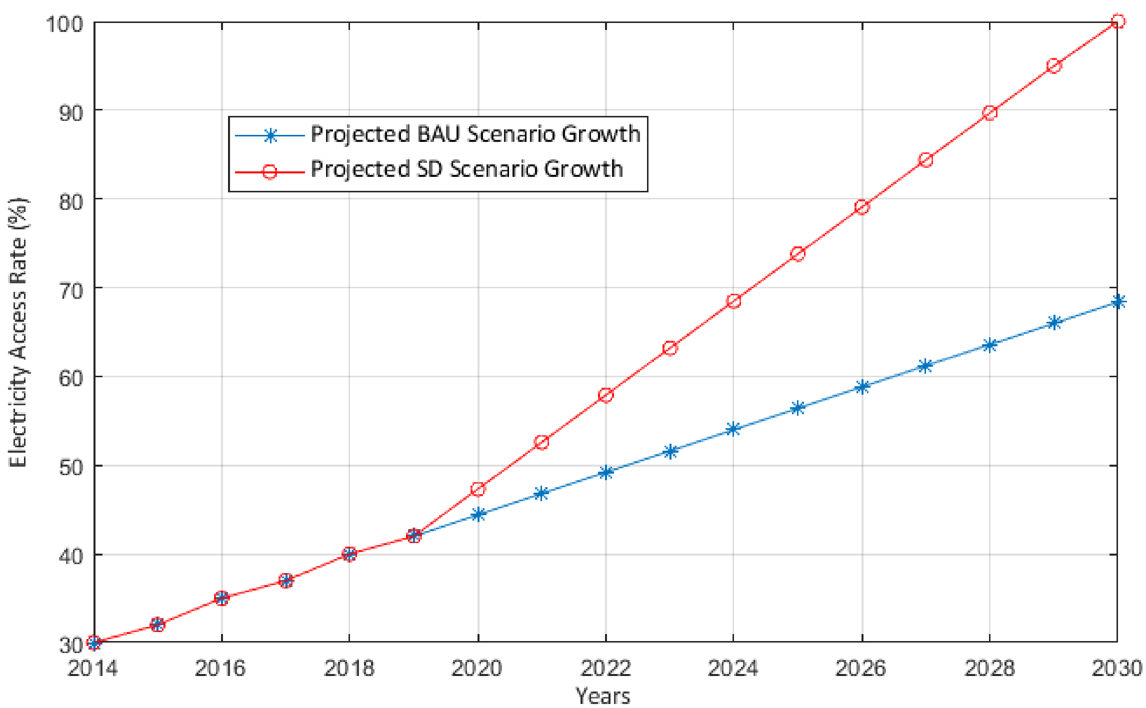

Figure 5: Percentage population with access to electricity from 2014 to 2030

According to Mpholo et al [35], Lesotho Government in collaboration with the Lesotho Electricity Company worked so hard to ensure that the rural population has electricity access. Despite all the effort, there is still low electrification access in Lesotho to date, accounting for around 60% population that does not have electricity access to date [36]. Globally, out of 1 billion population without electricity access in 2016, 600 million lived in Sub-Saharan Africa in which 15 countries had electrification levels that were below 25% [37]. This indicates a need for Lesotho as a Sub-Saharan country to increase electricity access given the increasing electricity demand that has been anticipated in 2013 [38] and keeps on increasing to date.

4.1.2 Clean Cooking Access

Table 5 represents the growth rates to clean energy for cooking from 2014 to 2019. It is apparent from this table that the average annual increase in clean energy for cooking is 1% from one year to the next. This indicates that under the BAU scenario, access to clean energy for cooking in Lesotho will only grow by 11% (= 1%/year x 11 years) from 2020 to 2030. This will result in an access rate of just 50%, in comparison to the SDG target of 100% that needs to be achieved by 2030. Under this scenario, therefore, the country will still run short of about 50% access.

Table 5: Clean cooking access rates from 2014 to 2019 [39]

	2014	2015	2016	2017	2018	2019
Access to clean cooking (%)	34	35	36	37	38	39

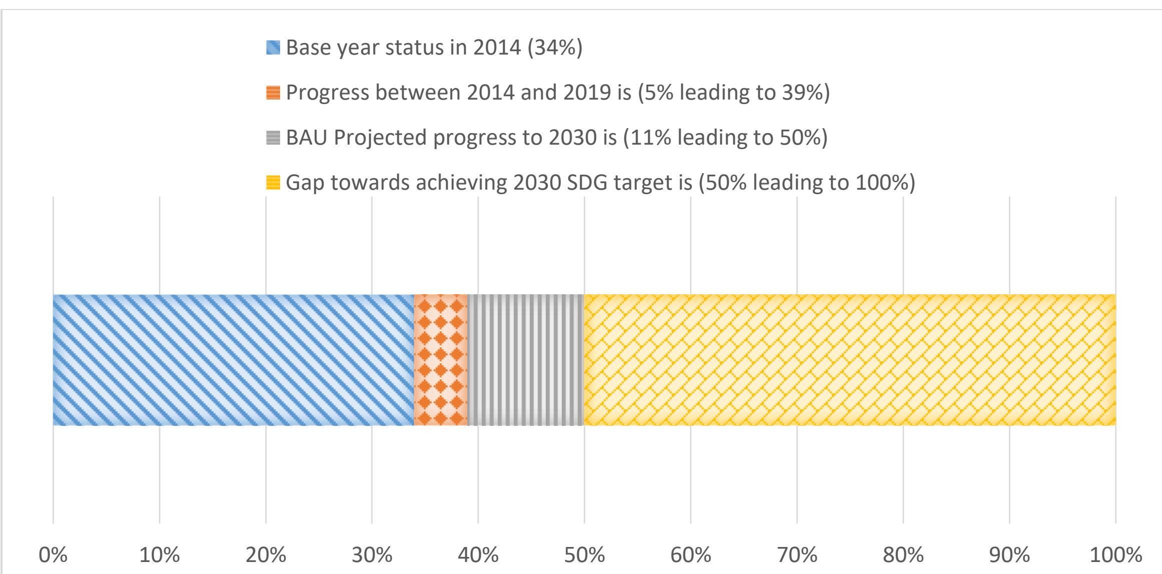

Figure 6: Summary of percentage population with access to clean cooking

As it can be seen from Figure 6, with the current efforts, the achievement of universal access to clean energy for cooking target is very slim. This means the 100% clean energy for the cooking target will not be achieved by 2030. This is evident from this figure since, under the BAU scenario, exactly 50% of the households would still be deprived of access to clean energy for cooking by 2030. To cover this gap, the SD scenario indicates that there is a need to increase access growth rate from the current average annual growth rate of 1% to 6% annually (= (100% - 40%)/10 years) starting from 2021 until 2030. With this growth rate, as shown in

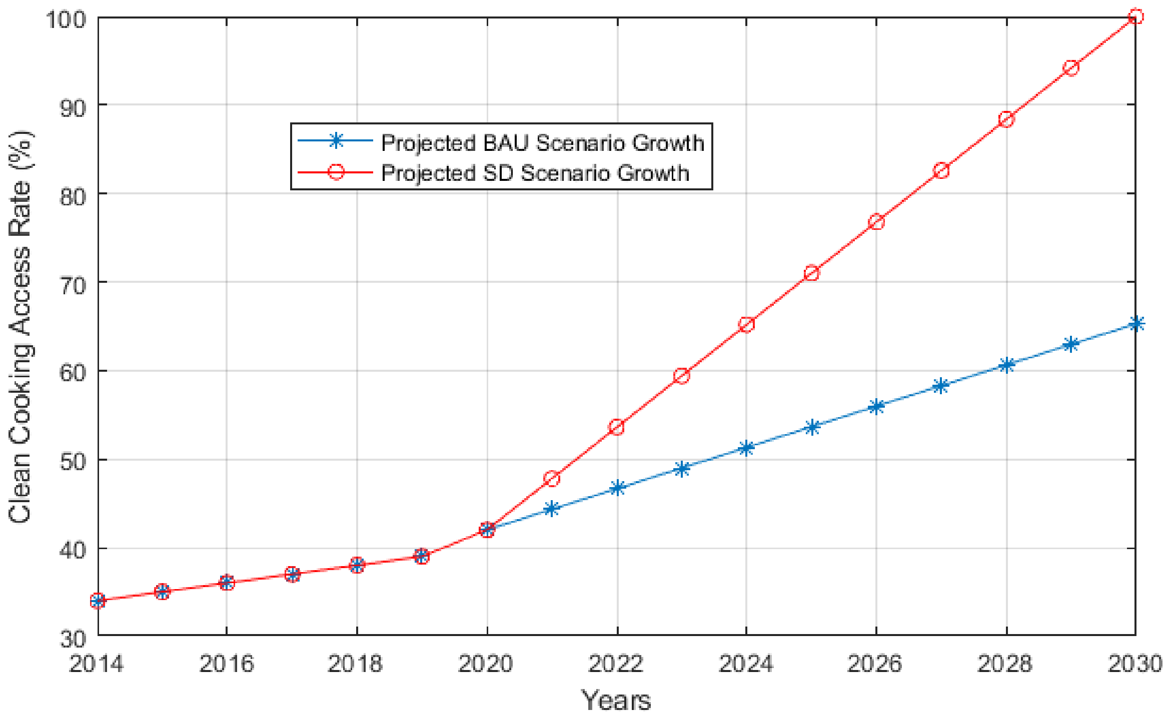

Figure 7, Lesotho will achieve a 100% clean energy for the cooking target set globally by 2030 provided the aggressive policies and strategies are put in action to incentivize or stimulate the required annual average clean energy access rate of 6%.

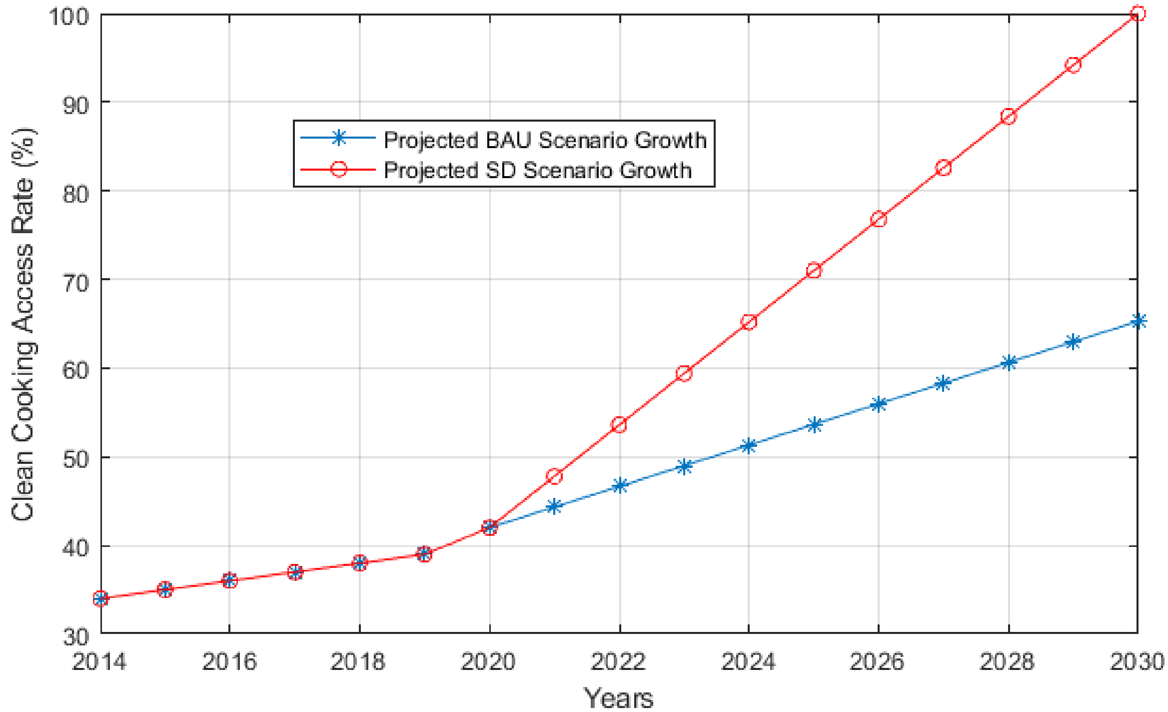

Figure 7: Percentage population with access to clean cooking

Looking at the results, most households in Lesotho use traditional biomass as a source of energy especially for cooking despite the adverse effects of traditional biomass used as an energy source. This happens especially in the traditional cooking systems where it involves the emission of smoke leading to indoor pollution and heavily affect the environment. The depletion of forests also continues to increase as the usage of fuel wood increases. To reduce the usage of polluting biomass and other polluting fuels, some policies need to be adopted immediately like shifting to cleaner and efficient fuels. Therefore, the government needs to consider supporting the adoption of LPG through subsidies as a way to make it accessible and affordable to low-income families. LPG may not be a clean energy source or considered environmentally clean but it does not emit smoke like traditional wood or old modeled stoves and it is more efficient. In Indonesia, the same conversion program was used shifting from kerosene to LPG from 2007 to 2010 and the expectation was to give out 42 million LPG packages to low-income families and the provided packages were to replace about 10 million kilolitres of kerosene per year [40].

The initial cooking system or package of LPG (gas cylinder, cookstoves, and accessories) may be too costly for low-income families hence the government need to provide a free initial LPG package. The subsidy should only be meant for low-income families to avoid inefficient and excessive use of energy which can end up affecting the economy very badly. The government can also opt to subsidize biomass energy-efficient stoves. This cookstove package could come along with some accessories that include a solar panel that helps the users to have clean and recommended solar electricity to light up their homes, a cell phone charger, and an LED bulb. Such stoves normally use almost all fuel available; wood, corns, animal dung, etc.

Also, from the results, the uptake of clean cooking seems to be a battle in Lesotho. This is even true in the global context as Batchelor [41] also indicated that in his paper under business as usual, over half (57%) of the population in the developing world would still be lacking clean cooking access by 2020. The huge the population without access to clean cooking indicates high damaging health implications of open fires [42] and old-fashioned stoves due to their inefficient ways of converting energy into heat for cooking purposes. The study highly recommends Lesotho shifts to more efficient ways of clean cooking. A failure to do that will contribute largely to carbon emissions. Batchelor [43] also adds that a failure to revise ways of cooking in Africa will result in a quarter of global carbon emissions that is associated with residential solid fuel burning.

4.1.3 Renewable Energy Share

There are different forms of renewable energy sources being considered under this indicator such as hydropower, solar energy, and biomass (animal dung, fuelwood, and solid wastes). So, being familiar with Lesotho's agricultural situation, biomass cannot be 100% renewable considering the way it is harvested. Taking trees, for instance, they are not renewable because after they are cut off no other trees are being planted to replace the ones cut off. Also in the worst-case scenario where animals are stolen, it would mean that there will be no more animal dung being produced. So considering all agricultural sources in Lesotho to be renewable is not ideal taking into consideration the issues raised. This has therefore led to an educated guess being taken to come up with the renewable energy share in 2015 while still considering the raw data in Appendix A. It is therefore estimated that 40% of traditional biomass can only be renewable and adding this to hydropower and solar energy has resulted in the value gotten in 2015 as shown in Table 1 which demonstrates the share of renewable energy from 2015 to 2019.

It can be deduced from the table that from the 2015 data, the annual increase in renewable energy share is assumed to be 0.9% which is applied from 2016 to 2019. Thus, under the BAU scenario which assumes the current growth rate, renewable energy share only grows by 9.9% (= 0.9%/year x 11 years) until 2030, leading to the renewable energy share of 45.5%, versus the SDG target of doubling the share of renewable energy in 2015, which doubles to 64% as demonstrated in Figure 8. This, therefore, implies that under the BAU scenario, the country will miss the target by about 18.5%.

Table 6: Share of RE in the final energy consumption

	2015	2016	2017	2018	2019
Renewable Energy share (%)	32	32.9	33.8	34.7	35.6

Source: Author, as indicated in Appendix A

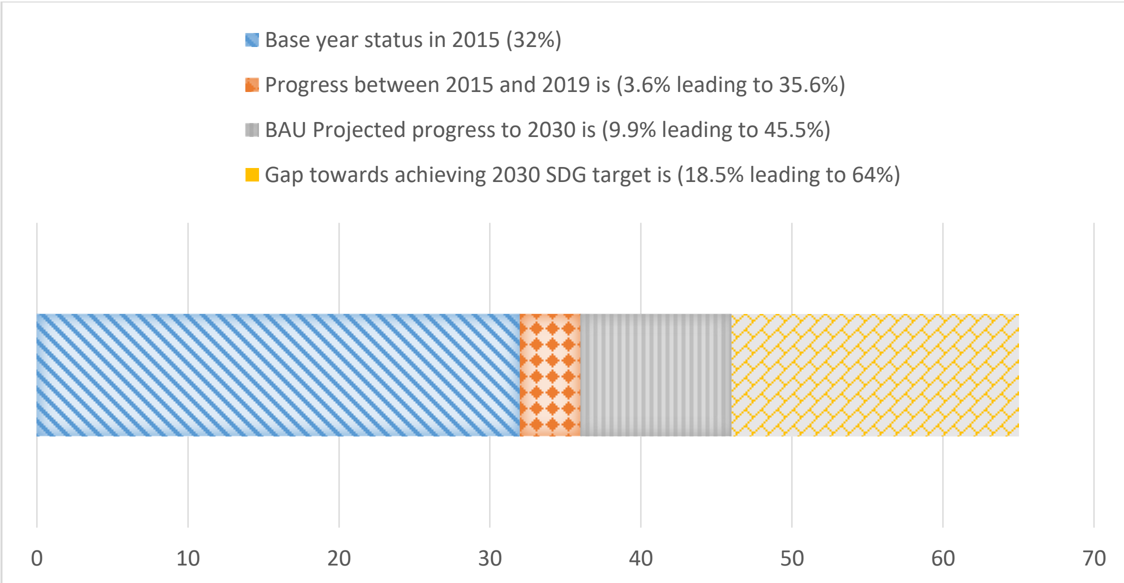

Figure 8: Renewable energy share in the total final energy consumption summary (%)

Figure 8 implies that the capacity to double renewable energy share by 2030 is not enough. With the current efforts put in place, the 64% renewable energy share target will not be possible by 2030. This is true since at around 18.5% renewable energy share is still lacking to double the share. To cover this gap, the SD scenario indicates that the renewable energy share growth rate should be increased from the current annual growth rate of 0.9% to 2.6% annually (= (64% - 35.6%)/11 years) starting from 2020 until 2030. With this rate, Lesotho will double the 2015 renewable energy share target by 2030 as indicated in Figure 9. To increase renewable energy share in the overall energy consumption, aggressive policies and strategies should be put in place.

The unexploited renewable energy resources in Lesotho will make it possible for this indicator to substantially increase by 2030. All the renewable energy resources; solar, wind, and hydropower have the untapped potential that needs to be utilized to facilitate the trend discussed. It is therefore the recommendation of this study that Lesotho needs to adopt more renewable energy technologies. This will not only assist with the cleaner form of energy but will also assist in achieving the energy efficiency target and increase the overall energy mix among others.

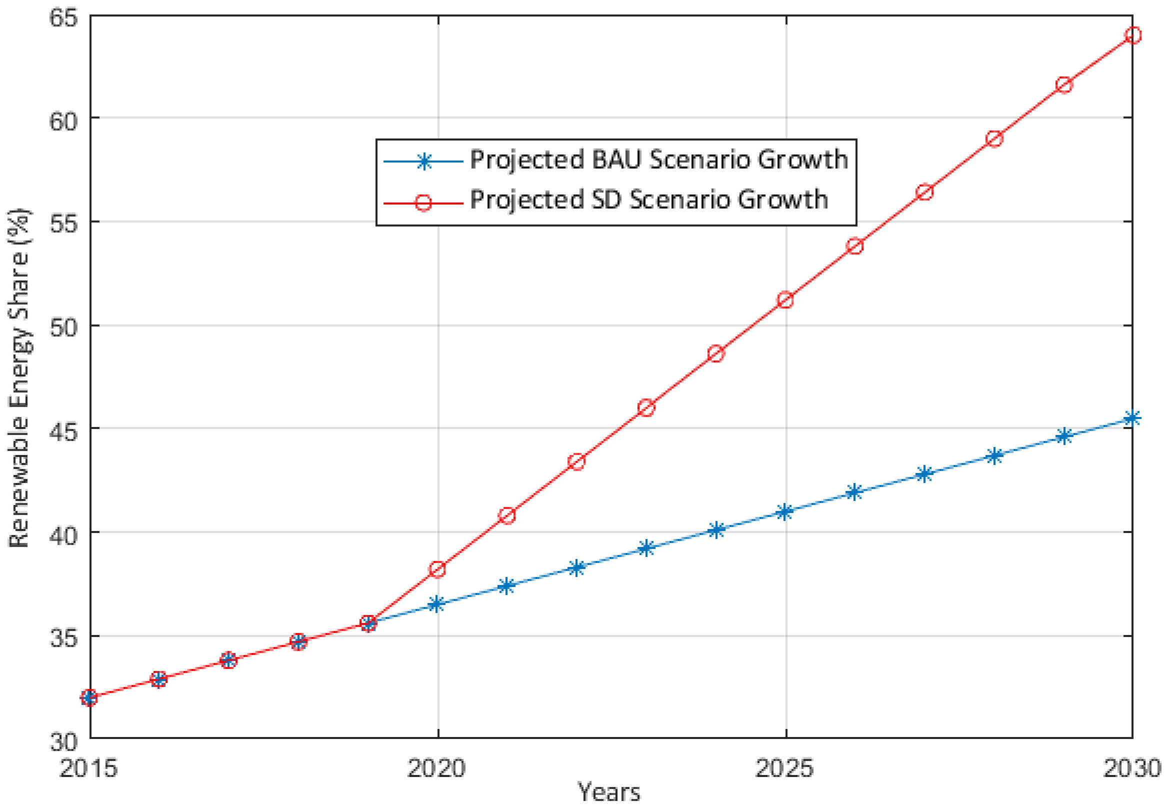

Figure 9: Renewable energy share in the total final energy consumption (%) under BAU

The adoption of the recommended policies will assist the country to reap several benefits from renewable energies. These benefits are inclusive of the reduction of unsustainable use of biomass, reduction of environmental degradation [44] and Lesotho will also be less dependent on the imported electricity from ESKOM that is generated from highly polluting coal to mention just a few. With the increasing carbon print, Bayazıt et al [45] indicated the importance of hydropower in reducing carbon emissions. Kong et al [46] additionally designate that small hydropower as renewable energy can accelerate the economic growth of rural areas.

The fortunate part with the Sub-Saharan African countries including Lesotho is that these countries are blessed with abundant renewable energy sources, which when utilized are more than enough to achieve two targets all at once; the universal electricity access [47] and also increasing the share of renewable in the energy consumption. Lesotho alone receives a daily average solar radiation of 5 and 7 kWh/m2/day with the most radiation from December to January and the least radiation from June to July [48]. This radiation is ranked among the world's highest solar irradiation. The greatest news about PV systems is that they have the potential to decrease the maximum power demand as they can supply power during off-peak hours [49]. Wind power on the other hand is also convenient since it does not even require fuel that can pollute the environment for turbine transportation [50].

4.1.4 Energy Efficiency

Table 7 indicates the energy efficiency improvement from 2014 to 2019 of which data was only available for 2014, 2015, and 2016. The rest of the years were filled with the energy efficiency improvement of 0.3 MJ experienced between 2015 and 2016. Thus, under the BAU scenario which assumes the status quo until 2030, energy efficiency improvement in Lesotho will increase by 3.3 MJ (= 0.3 MJ/year x 11 years), leading to an improvement of 14.3 MJ, versus the SDG target of doubling the 2015 energy efficiency improvement resulting to 19.6 MJ as illustrated in Figure 10Figure 4. Hence, under the BAU scenario, the country will miss the target by about 5.3 MJ.

Table 7: Energy Efficiency improvement [14], [3]

	2014	2015	2016	2017	2018	2019
Energy Efficiency (MJ/USD 2011 PPP)	10.3	9.8	10.1	10.4	10.7	11

As illustrated in Figure 11, the capacity to achieve the energy efficiency improvement target is still lacking as around 5.3 MJ is needed. To cover the gap, the SD scenario suggests increasing the improvement from the current annual improvement of 0.3 MJ to 0.78 MJ per annum (= (19.6 MJ – 11 MJ)/11 years) starting from 2020 until 2030. With this rate, Lesotho will achieve an energy efficiency improvement of 19.6 MJ by 2030 as depicted in Figure 11, provided aggressive policies and strategies are put in action.

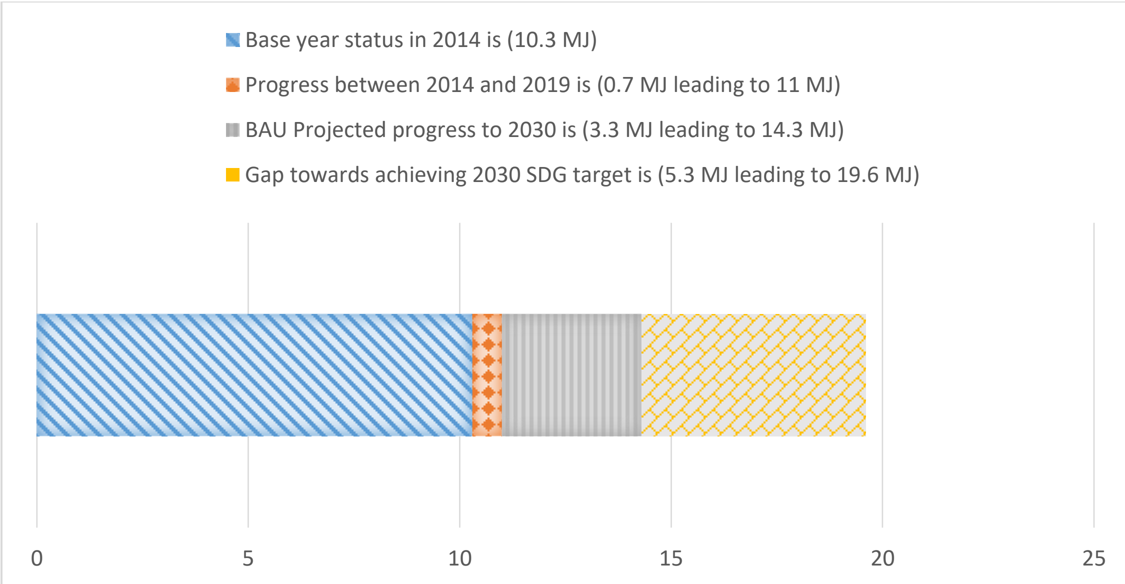

Figure 10: Summary of energy efficiency improvement

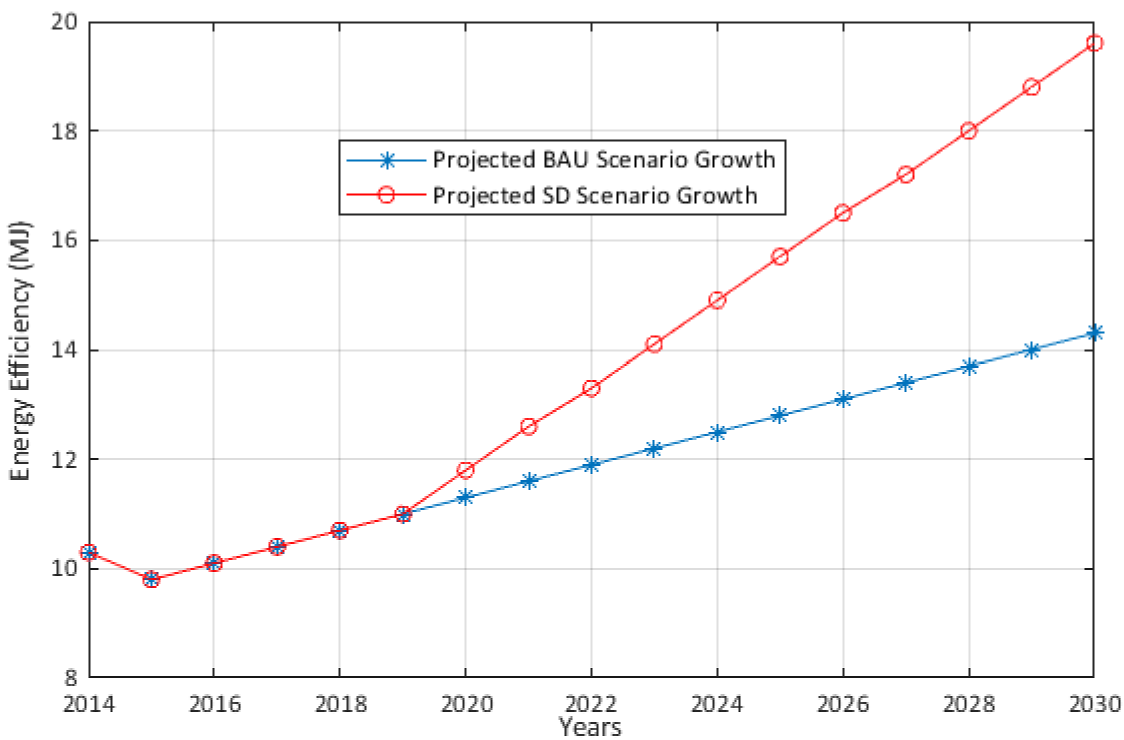

Figure 11: Energy efficiency improvement

As one of the policies to improve energy efficiency, certain building measures should be implemented. This was recommended by Raatikainen et al [51] when highlighting the importance of energy efficiency when building the school as a very essential cost factor. Energy efficiency is viewed as a policy priority by multiple countries [52]. Sector regulators like LEWA are the greatest stakeholders that can promote the success of energy efficiency through reduced line losses, improvement in load patterns, etc.

The initiatives to accelerate the improvement on energy intensity in Lesotho require the country to adopt the informed policy decisions. As indicated below, there are some policy approaches that can be implemented concerning possible and practical measures. Some proven energy efficiency policies are continuously adopted in many countries that include China, India, Japan, Northern America, and Europe [53]. These include building codes for both residential and commercial facilities in which energy performance standards for new construction and renovation are incorporated.

Besides, as it has been adopted with success in countries like China and Europe [53] it would even be more advantageous for Lesotho to also adopt cross-sectoral integrated policy approaches that aim at promoting improvements through financial incentives to energy consumers. The incentives may include but are not limited to subsidies, tax relief, and loans. Grants and subsidies have successfully been adopted to decrease the capital cost on energy-efficient appliances to consumers. The educational information to the community and capacity-building measures to improve community awareness to use high energy efficiency appliances [54] is also an essential measure.

End-use energy prices (efficient energy pricing) by fuel and sector play a major role in economic growth in terms of efficient energy supply and use. These energy prices have a greater ability to encourage efficiency of energy use or improve access levels. For this reason, more efficient electricity generation technologies like wind turbines, hydropower, and solar energy.

4.2 Energy Indicators for Sustainable Energy (EISD)

To further elaborate on the progress of Lesotho concerning achieving SDG7 targets by 2030, below is the assessment of the supporting energy indicators for sustainable development, to weigh how much the EISD is going to help accelerate the progress. However, due to data restrictions, these indicators are not projected throughout the study period, but rather, the available data was compared with the progress from other developing countries to get a feel of how far Lesotho is regarding energy sustainability and also the possible strategies that may need to be adopted.

The list of these indicators that are not projected through sustainable development scenario is ECO15 (Net energy import dependency), ECO11 (Fuel shares in energy and electricity), ECO6, 7, 8, 9, 10 (Energy intensity of the economic sectors for 2017), ECO2 (energy intensity of GDP), ECO1 (Energy use per capita).

4.2.1 Share of household income spent on fuel and electricity (affordability)

This indicator is going to be assessed for the affordability of households on accessing energy on monthly basis for both electricity and non-electricity users as illustrated in Table 8. From the table, it can also be deduced that a lot of spending is accounted on gas for both electricity and non-electricity users followed by paraffin spending.

Table 8: Energy share as monthly total spending [55]

	Electricity	**Firewood**	**Gas**	**Paraffin**	**Other**	**Total**
Non-electricity users %	-	6	8.2	6.3	0.9	21.4
Electricity users %	9	2.3	7.4	7.4	0.9	27

As seen in Figure 12, electricity users spend about 26% of their total household expenditure monthly on energy sources. The expenditures look very high and this puts a lot of strain on households' budgets. This judgment is based on the fact that ideally, the household expenditures that are more than 10% on energy sources are regarded to be energy poor leading to consumers not being able to afford energy sources [55]. Furthermore, World Bank considers electricity expenditures that are above 5% to be energy poor as well [56].

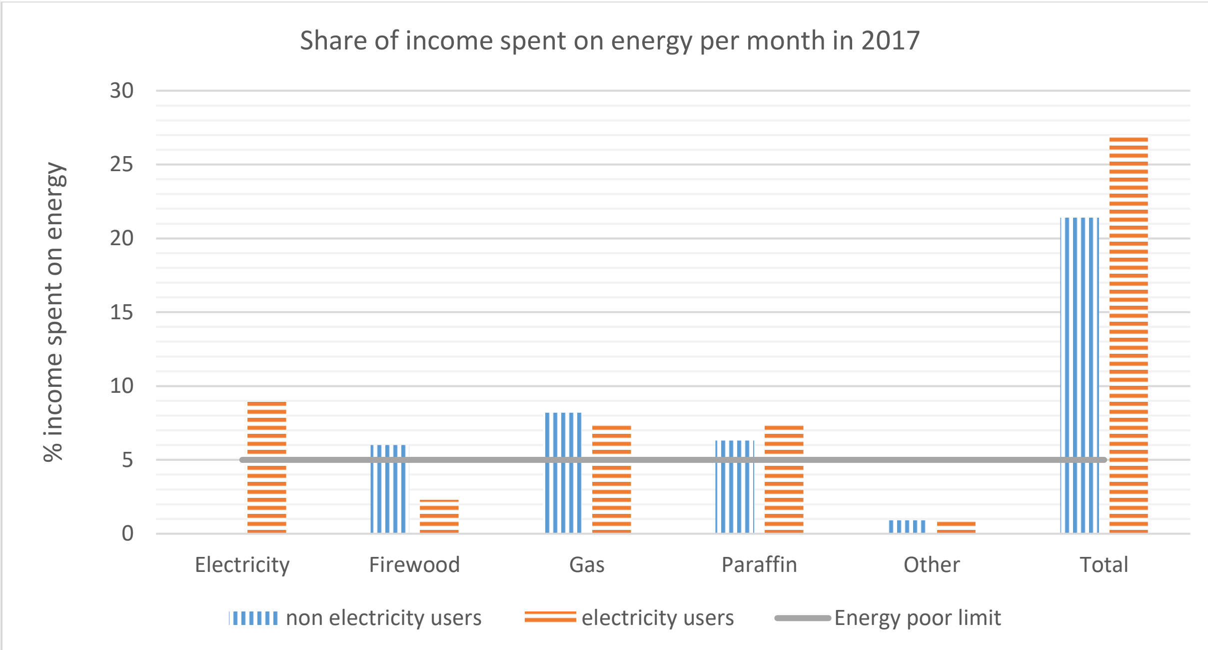

Figure 12: Share of household income spent on energy

The results gotten on this indicator indicate that Lesotho is very much energy poor with electricity expenditure above the set line of affordability. The same analysis goes for the affordability of accessing other energy sources. In comparison to other countries like Brazil with 3.4%, South Africa with 4.7%, and Bangladesh with 8% average share of household income spent on energy in 2002 [34], Lesotho has very high expenditures of around 21.4% which is more than 4 times that of South Africa. This supporting analysis should increase a need for the government just like in Brazil, to discount tariff structure that can accommodate all different income groups. The residential sector tariff should be discounted based on the household consumption level. This says, the households consuming up to 30 kW h/month pay only 35% of the overall tariff, 100 kW h/month pay only 60% of the overall tariff, 100 to 220 KW h pays 90%. If the issue of energy affordability is not fixed, the expectation is that the same poor energy access will be experienced heavily in 2030.

However, it was also emphasized that most of the households that have access to electricity do not utilize such services [35]. And the problem may not be with electricity access per se but the affordability of such services since most people that are grid-connected, largely use electricity only for lighting and media access which are believed to consume less energy. Access to grid connection and electricity does not guarantee electricity usage but the affordability of such services leads to its usage. It is through these observations that the government is highly recommended to adopt policies concerning energy affordability.

4.2.2 Disparities (Household energy use for each income group and corresponding fuel mix)

Table 9 shows the energy usage by different income groups with their corresponding fuel mix from the 2017 household survey. It can also be noted that LGP and wood are the most used fuels with the highest total numbers.

Table 9: Income groups and corresponding fuel mix for 2017 [57]

	Animal dung	Crop waste	Electricity	LPG	Paraffin	Shrubs	Wood	Other
M30000 and above	0	0	3	5	0	0	0	0
M10000-M29999	0	0	39	34	0	0	2	0
M5000-M9999	1	1	38	110	3	1	12	0
M2000-M4999	18	3	80	201	20	8	46	0
M1000-M1999	44	8	62	229	53	22	102	0
M500-M999	110	17	28	115	54	65	258	5
M300-M499	41	3	8	38	33	29	76	4
< M300	67	6	3	15	15	52	109	5
None working	72	12	9	89	15	43	132	0
TOTAL	353	50	270	836	193	220	737	14

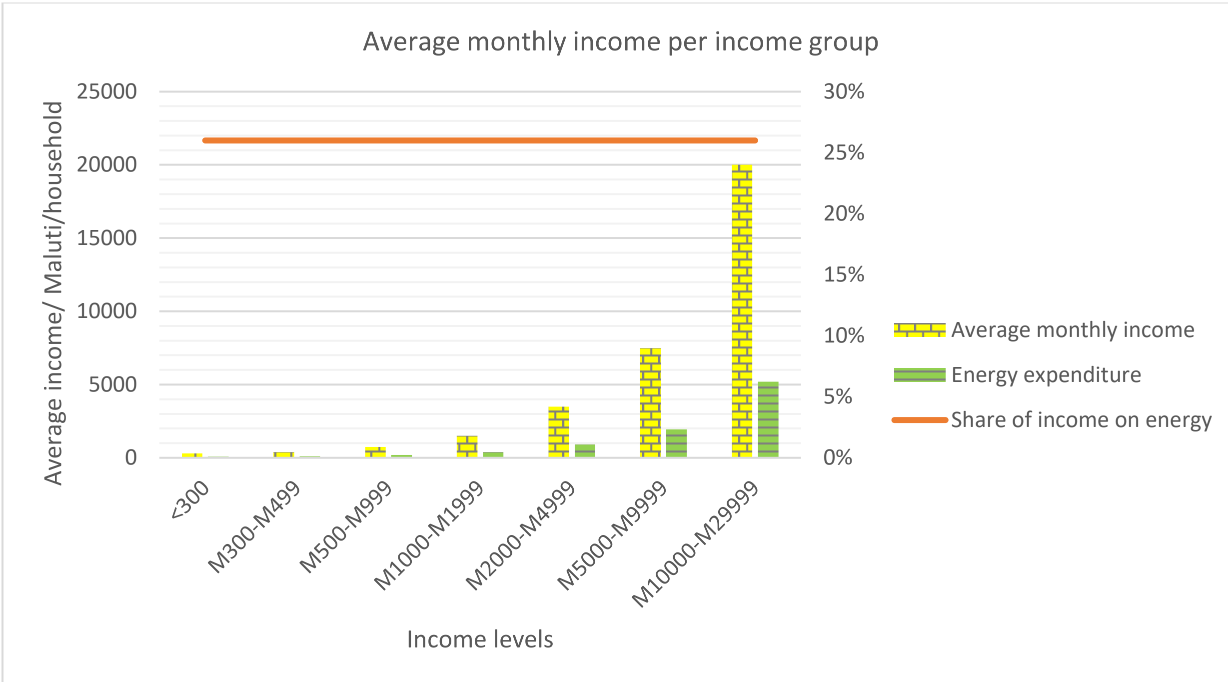

Figure 13: Household energy use for different income groups

Figure 12 indicates that lower-income groups significantly spend less in absolute Maluti, but much more as a share of income on energy than the middle and higher-income groups. As the rural household electricity consumption survey in 2017 indicated, electricity users spend about 26% of their household expenditure per month on energy sources [55]. These high energy costs force low-income groups to opt for less efficient fuels because they can only afford them. The figure further indicates energy usage on nine different income groups of which when combined, LGP is a highly used fuel with 31.2% followed by wood with 27.5%, animal dung at 13.3%, and electricity with 10%. This analysis concludes that a smaller number of households rely on electricity while a larger portion is dependent on LPG and traditional wood. However, the high number of LPG usage is saturated on the high-income groups while low-income groups dominate the usage of less efficient fuels like wood and animal dung. And this seems to be in correlation with Indonesia where low-income groups use less efficient fuels with cooking energy consumption high on biomass with 77%, LPG with 1.5% [40].

It is so unfortunate that this happens when there is a call for the whole world to adopt cleaner ways for cooking, to achieve this, the country needs to adopt strategies and policies for the utilization of clean energy for cooking through modern technologies like efficient biomass stoves that emits lesser smoke. From the analysis, as shown in Figure 14, the corresponding fuel mix per income group is not obvious since almost all of the fuel is present in each income group except for M10000-M29999 and M5000-M9999 category that seems to be using electricity and LPG. This seems to be supporting the issue raised by Anwar [40] that, people with increased income tend to move to more efficient fuels such as electricity and LPG and become even more affordable.

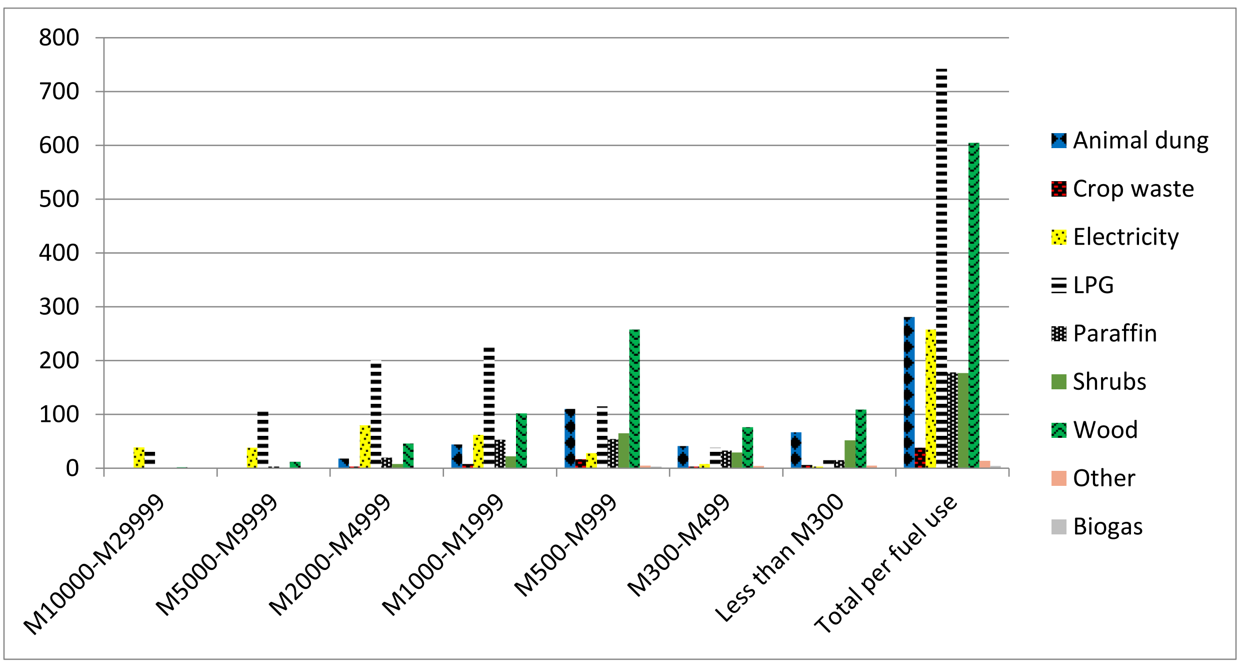

Figure 14: Energy use for income groups with corresponding fuel mix

4.2.3 Safety (Accident fatalities per energy produced by fuel chain)

Table 10 indicates the number of injuries and fatalities that occurred during electricity transmission and distribution from LEC starting from mid-2015 to mid-2019. Looking at the table, the injuries seem to be the greatest as opposed to the fatalities and electrocution in all the years.

Table 10: Accidents fatalities occurred at LEC from 2015 to 2019

	2015	2016	2017	2018	2019
Injuries	2	23	7	30	21
Fatalities	1	0	0	0	1
Electrocution	0	2	1	3	7

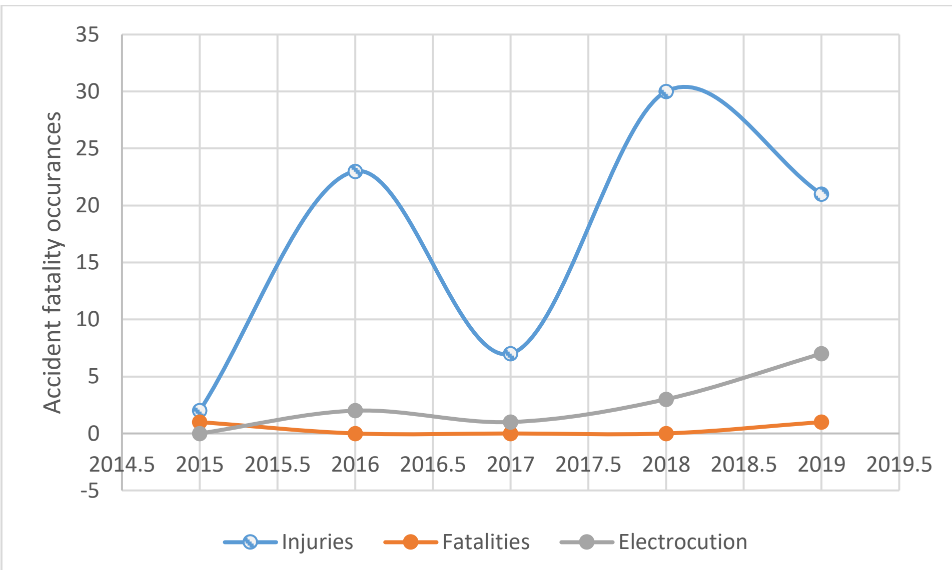

Figure 15: Accidents fatalities occurred at LEC from 2015 to 2019

Figure 15 represents a graphical form of the analysis and it indicates that there are only 2 fatalities from 2015 to 2019. There is however a greater number of injuries from 2016 to 2018 although there was a decrease in 2017 as there are only 7 injuries experienced. This explains that there could be a possibility that there are no safety guidelines and proper equipment to be used in electricity transmission and distribution.

4.2.4 ECO1 - Energy consumption per capita

Energy consumption per capita indicates the potential of the country's economic development. For this analysis, data was sourced from the 2017 energy balance and from 2017 population that was projected from 2016 population using a growth rate of 0.47% as presented by Population Projection summary Report of 2010 [58], [59].

Figure 16 indicates both energy and electricity consumption per capita in Lesotho for 2009 and 2017. The figure reveals that energy consumption per capita in 2017 was 6010 kWh. Comparing this value to other developing countries like Egypt with around 45 million Btu per capita [60] which when converted to kilowatt-hour is 15581.99 KWh, Lesotho has lower energy consumption. This is also true for the Baltic States in 2002 for all the three provinces Lithuania, Latvia, and Estonia at approximately 29075, 22097, and 44194 KWh/capita respectively [6]. The electricity consumption per capita in Lesotho as indicated in the figure, is below the World Bank benchmark of about 340 KWh for low-income countries [8]. This indicates that when it comes to electricity, Lesotho needs very high energy to facilitate its economic development.

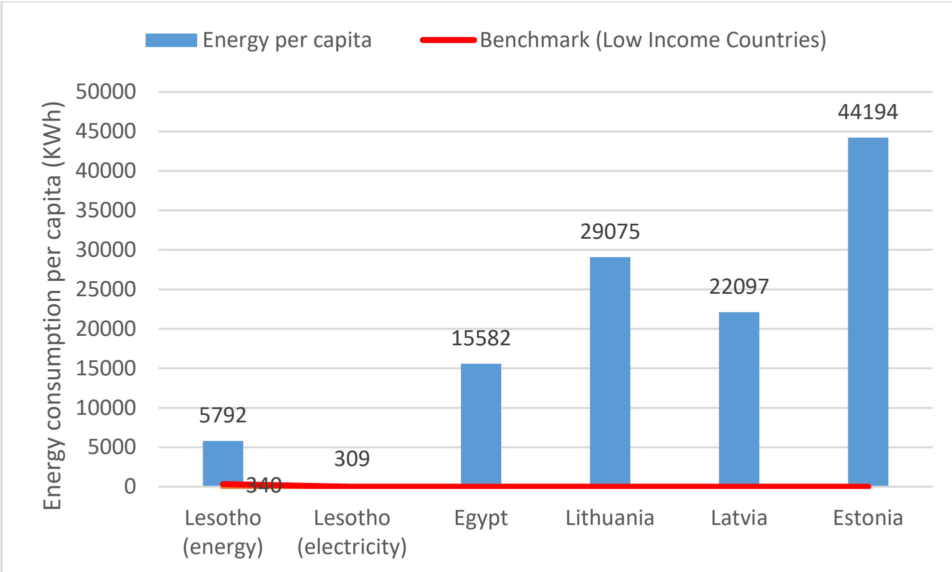

Figure 16: Energy Per capita for Lesotho vs World Bank benchmark

4.2.5 ECO2 - Energy use per unit of GDP (energy intensity of GDP)

On the assessment of the overall energy intensity of GDP for 2017 estimated from total primary energy (TPES) and Gross Domestic Product (GDP), it gave a positive value of 32.5 toe/million maloti. This value is very high and demonstrates the inefficiency of the economy in generating its GDP, which means there is no improvement in GDP intensity. In comparison with Baltic States in Estonia country that had an energy intensity of GDP of about 0.55 kgtoe/EUR in 2010 [61], Lesotho seems to have a very high energy intensity of GDP, which concludes that Estonia is more efficient than Lesotho.

4.2.6 ECO 6, 7, 8, 9 and 10 - Energy intensity of the economic sectors for 2017

Represented in Table 11 is the data on consumed energy by the sectors measured in toe per Maluti taken from 2017 and the value added by the sectors. The data for energy intensity for economic sectors was sourced from the 2017 Lesotho energy balance as presented in Appendix B, while GDP data was sourced from 2017 national accounts.

Table 11: Energy intensity of economic sectors for 2017 [62]

	ECO6 Industrial	ECO7 Agriculture	ECO8 Service	ECO9 Household	ECO10 Transport
Energy consumed (toe/maluti)	37680.4	124.3	61495.5	366741.8	194768
GDP	5212000	1366000	6387000	1367000	599000

The results in Figure 17 reveal that all economic sectors have a significant effect on the overall energy intensity but with varying weights, with the most intense sector being transport and household respectively. Other studies, however show that buildings are the most energy-consuming sector [44], this seems not to be fully supported by these results that indicate the transport sector as the most energy-consuming sector in the case of Lesotho. The least intense sector is the service sector even though it adds the greatest share of value-added of 42.8%. In comparison to Pakistan as a developing country, the agricultural sector contributes 20.9% which is the largest share of GDP [63]. Equally so, in Rwanda and Togo, the largest motivation for economic growth is the Agricultural sector that contributes about 40% and 1/3 of GDP respectively [64]. In Lesotho, both transport and household sectors use a considerable amount of energy while producing a lower economic value.

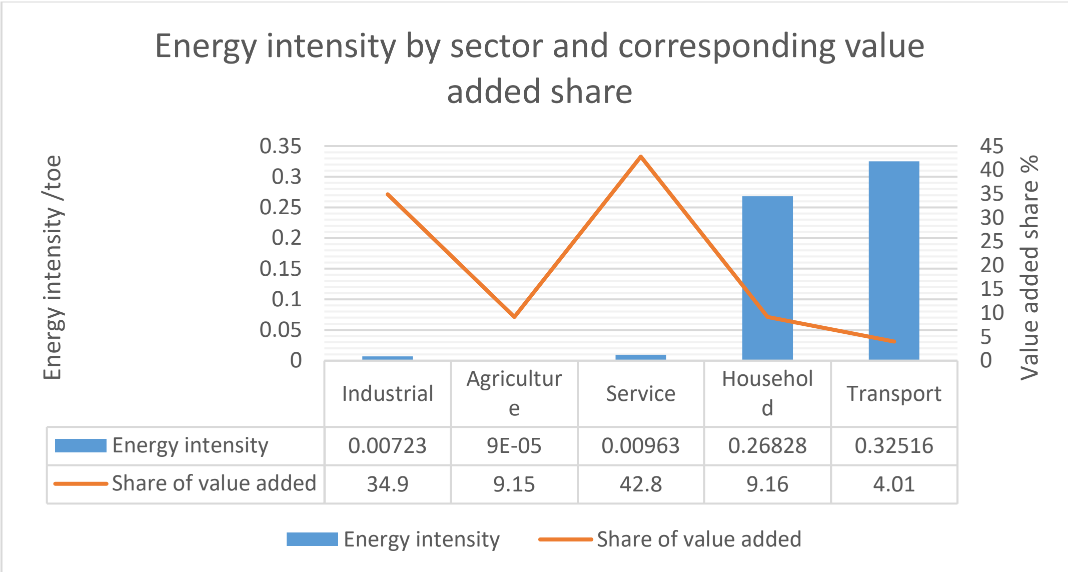

Figure 17: Energy intensity of economic sectors in 2017

On the other hand, Daniel [65] defined energy intensity as an energy efficiency measure of a particular country. With this definition, the results show that all sectors are not energy efficient, with transport and household sectors having the higher values of energy intensity. It is also evident that the activities of industrial and service sectors seem to have lower energy intensity than the previous two sectors and this is an indication of an improvement in energy consumption efficiency within the latter sectors.

The high values of energy intensity in transport industry may be caused by higher number of inefficient vehicles that have been imported in Lesotho for several years now thereby slowing the rate of improvement in the transport economy. To improve the energy intensity of this sector, only diesel vehicles must be imported since they are more energy-efficient than petrol cars. World Bank indicates that for a significant improvement, there is a need to adopt fuel economy policies. The success of this policy was recognized when 60% improvement was seen in countries that adopted such policies that include an increase in the strength of fuel economy standards and tightening of rules in the fuel economy on-road compliance [53].

4.2.7 ECO11: Fuel shares in energy and electricity (diversification)

Table 12 shows the fuels and their corresponding percentage share to the overall energy diversity in Lesotho from the 2017 energy balance data shown in Appendix B. From the table, fuelwood represents the larger value followed by LPG.

Table 12: Fuel shares in energy and electricity

Fuel shares	**Values (toe)**
Electricity	33344.8
solid wastes	30223.9
Animal dung	89821.9
Charcoal	630.9
Fuelwood	429137.1
Solar heat	86
Electricity solar	200.7
Hydro	43104
Diesel oil	85422.8
Paraffin	30662.5
Jet fuel	94.2
Motor gasoline	126329.3
LPG	158057.1
Coal products	10336.2
unknown	4759.8
Total	**1042211**

The fuel shares percentages in every fuel and electricity were calculated and the analysis indicates that there is a drop in the share of traditional fuel from the 2015 value of 47.65%. In 2017 the value decreased from 41.18%.

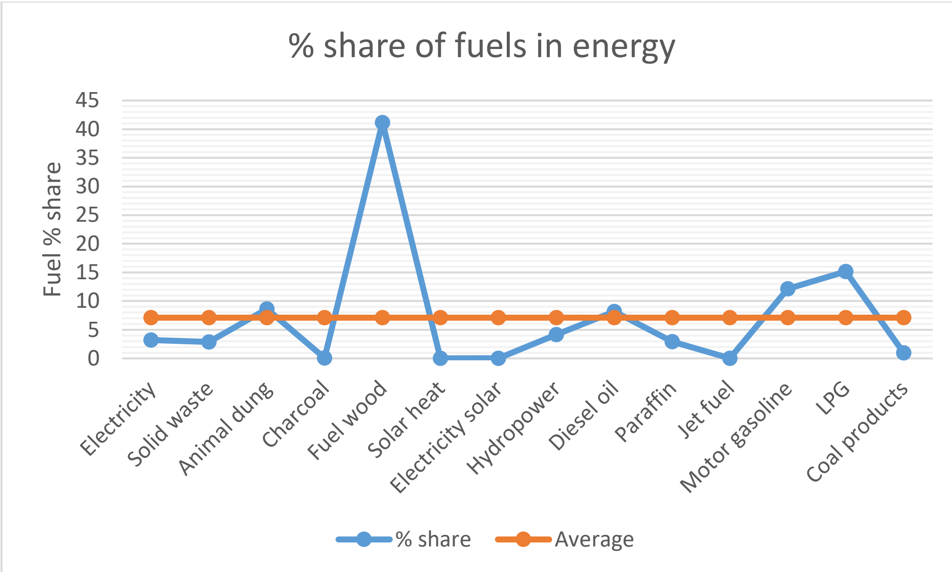

Figure 18: Share of fuel in energy and electricity for 2017

Figure 18 shows the energy mix diversification of different fuels relied upon in Lesotho. Even though most of the fuels in the energy mix are mostly imports, energy diversity seems to be very high which incorporates 15 different fuels. The fuel mix seems to be highly dominated by non-renewable sources despite the emphasis on the need to diversify on renewable energy sources [66]. Out of these 15 fuels represented, fuelwood contributed a larger share of 41.2% followed by LGP and motor gasoline with 15.2% and 12.12% in that order. The least percentage share is attributed to solar heat and jet fuel. At least the usage of polluting charcoal is below average.

4.2.8 ECO14: Fuel prices on different fuels (Maluti/liters)

The data for this indicator is taken from Lesotho petroleum fund fuel pricing reports from 2015 to 2019. As shown in Table 13, only three derivatives of crude oil are shown with their corresponding annual prices.

Table 13: Fuel prices from 2015 to 2019 (Maluti/liter) [67]

	Petrol (LP & ULP)	**Petrol 95**	**Diesel 500**	**Diesel 50**	**IP**
2015	9.75	-	9.86	10.11	6.96
2016	9.43	9.9	9.26	9.51	6.45
2017	9.99	9.18	10.01	10.26	6.89
2018	12.2	7.43	12.7	12.95	8.57
2019	12.13	12.43	13.1	13.38	9.01

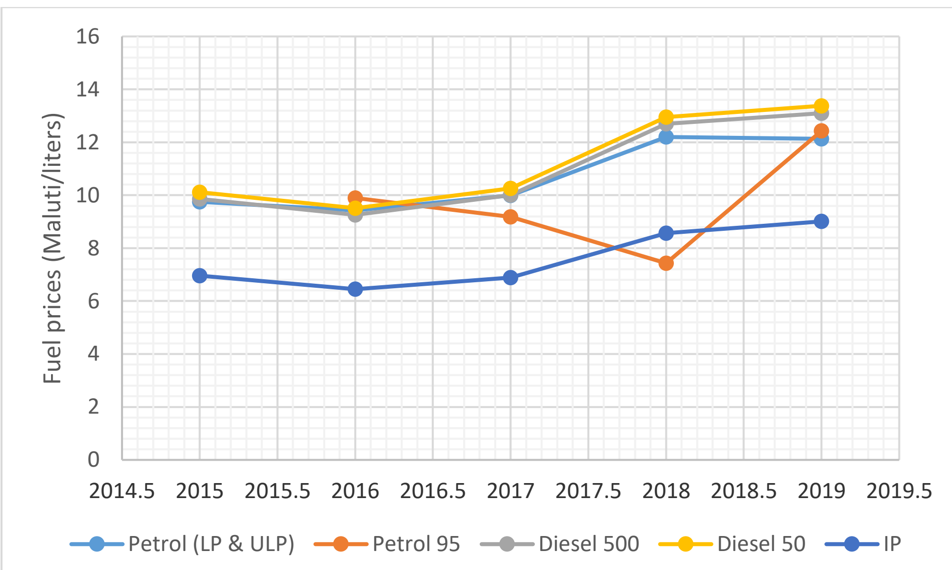

Figure 19: Fuel prices on different fuels (Maluti/liter

Looking at the graphical fuel prices in Figure 19 , there is a certain pattern that's being followed by the fuel prices on price change from one year to the other except for petrol 95. There was also a price increase from 2017 to 2018, for both diesel 50 and 500 at a price difference of 2.96, while in the same year there was a price decrease in petrol 95 by 1.75. Looking at the figure, it is apparent that fuel prices could continue to increase in the years to come.

4.2.9 ECO15: Net energy import dependency

From the overall energy of the country, the percentage of import dependency on each imported fuel was calculated using the data in Table 14. This data was taken from the 2017 energy balance from which the percentage of energy import dependency for Lesotho was estimated. Data source is shown in Appendix B.

Table 14: Net energy import dependency in 2017

Energy imports	**Import dependency (toe)**
Electricity	33,276.0
charcoal	630.9
Diesel oil	85422.5
kerosene	30,662.5
Jet fuel	94.2
Motor gasoline	126,329.3
LGP	158,057.1
other coal	10,336.20
Total	**444809,1**

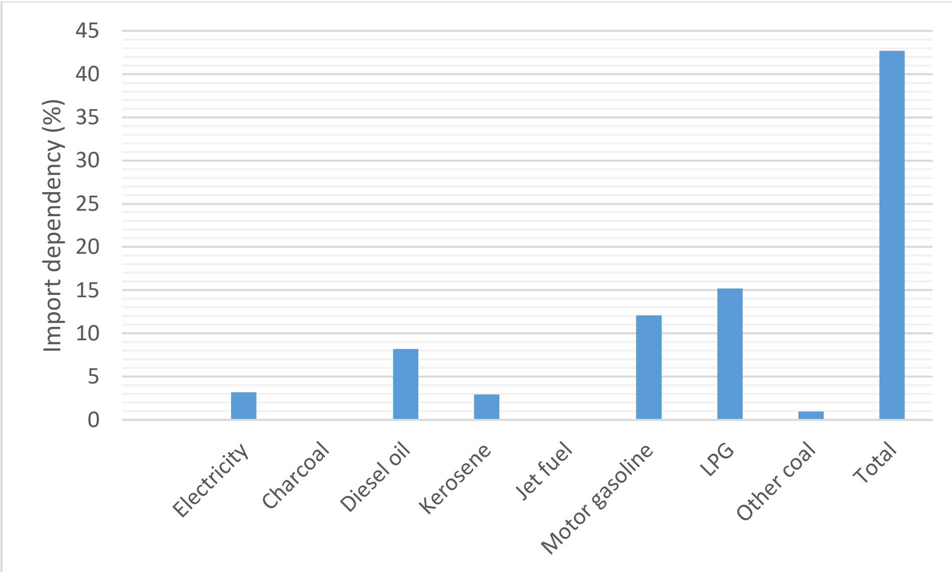

Figure 20: Net energy dependency

Net energy import dependency is used in this analysis to access the security of the energy supply. Energy security is viewed as a socio-economic influencer that contributes largely to sustainable development in any country [68]. This indicator alone is affected by several indirect force indicators like energy supply mix in the shares of energy fuels and electricity generation (ECO11), renewable energy share (ECO13), and energy efficiency (ECO3) [52].

Looking at Figure 20, Lesotho is one of the countries that is affected by energy security due to its high dependency on energy imports just like Pakistan and Turkey. And such countries need to consider taking energy security very seriously. These countries are in great danger because of the energy prices that are increasing or if the energy supply decreases, the growth of these countries will be adversely affected [60]. The results indicate that in 2017 Lesotho imported 42% of its energy from neighboring countries (South Africa and Mozambique). Lesotho as a developing country is not the only country that's dependent on imports. Sri Lanka country also due to its lack of fossil fuels, imports both petroleum, and coal to meet its energy needs [69].

Unlike Lesotho, Mozambique is reported as an emerging energy producer that is believed to have the potential to export around 80-90% of its energy generation from coal and natural gas. While hydropower is exported to near countries like South Africa and Lesotho while also coal is exported to India. The expectation is that Brazil will also import coal from Mozambique, while the domestic energy needs are met through wood and solar [70].

Lesotho's imports may look so small when compared to those of Turkey 70% (importing oil products and natural gas). Very unfortunately Lesotho imports most and different forms of energy like electricity, oil derivatives, coal, wood, and LPG which has contributed a bigger share of 15% to the overall energy import dependency. It is high time that Lesotho increases its energy production using renewable energy sources. This will also be in line with the global agenda of increasing renewable energy share in the overall energy consumption.

4.3 Informing Energy Policies

For more clarification, Figure 21 is a graphical representation of the policies already recommended, to also show the interrelation among energy indicators (EISD) and energy policies. And this interrelation will make it easy to inform relevant policies to accelerate SDG7 targets. For more emphasis, there are key indicators that Lesotho should put focus on energy affordability (which may be due to incurred costs that include generation costs, equipment, distribution, transmission, etc), energy efficiency, and increasing share of renewable energy. Just like Pakistan was encouraged [60], Lesotho needs proper energy strategic planning where they install both solar and wind energy projects in the villages, engage achievable energy efficiency programs, and increase the number of hydropower plants. There should also be an entity (Lesotho Energy Council) that is built with stakeholders that include people from public sectors, private sectors, professionals from sustainable energy academics. With this team, many of the energy-related problems starting from data unavailability up to achieving SDG7 targets would be solved successfully.

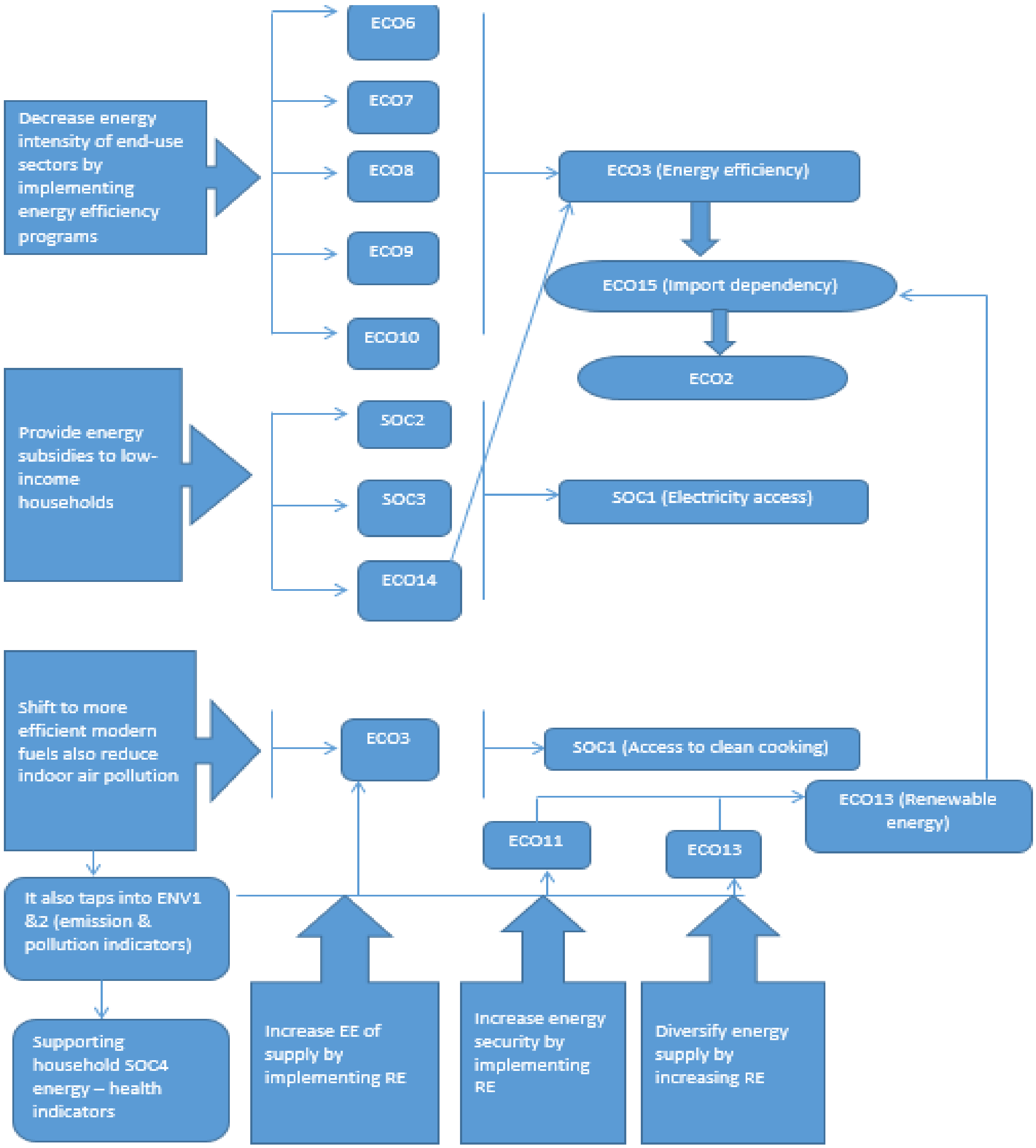

Figure 21: Relationship between EISD and policies to be informed for Lesotho energy sector

To achieve SDG7 by 2030, Lesotho should recognize that affordability affects electricity access or usage hence it needs to be improved through energy subsidies and shifting to more efficient fuels like implementing renewable energy technologies which will not only improve energy efficiency but will also decrease energy import dependency. Lesotho is an energy-dependent country and needs to put more effort into increasing energy security, energy efficiency, and renewable energy. Just having a mere look at the difference between the total energy exports and imports, from 2017 energy balance (Appendix B), the ratio is very high, as a result, the current account deficit (CAD) or GDP ratio is very high. This concludes that Lesotho is spending a lot of money on energy imports than it receives on exports. To a larger extent, this affects the economy very badly (ECO2). However, this issue can be solved by increasing energy efficiency which in turn will decrease Lesotho's dependence on foreign energy supplies and hence energy imports.

Net energy import dependency is used in this analysis to assess the security of energy supply. This indicator alone as Streimikiene et al [6] mentioned, it is affected by several indirect force indicators like energy supply mix, shares of energy fuels and electricity generation (ECO11), renewable energy share (ECO13) and energy efficiency (ECO3). For Lesotho to decrease its energy imports dependency, it needs to first address the mentioned indirect forces. It should also be noted that energy prices (ECO14) need to be taken seriously as they are a major determinant of energy intensity since energy prices really influence energy consumption. These energy prices have a greater ability to improve energy access levels. For this reason, it is also advised that efficiency aspects in this area be improved by introducing more efficient electricity generation technologies like wind turbines, hydropower and solar energy. Sekantsi et al [71] also emphasized that Lesotho policymakers should consider ensuring electricity availability by promoting energy efficient sources that will ultimately decrease dependence on electricity imports and reduce greenhouse emissions [49].

CHAPTER 5 – CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Conclusion on Findings

The EISD demonstrates a principal tool used in the policy making decisions to be utilized in the assessment and strategic guidelines that monitor progress towards a more sustainable future. These energy indicators go further to identify relevant and specific areas in which focused measures and policies should be directed for successful energy system. To successfully achieve this, two scenarios are used, which serve as a corner stone to measure the progress and hence do projections.

Looking at all four SDG7 targets, the progress is still slow hence with the current progress (BAU scenario), all the set targets will not be achieved by 2030. Electricity access results indicate that only 68.4% population will have electricity access by 2030 under BAU scenario. This verifies the SDG gap of 31.6% to meet 100% access. Under cooking access, only 50% of population will have clean cooking access by 2030 leaving a gap of another 50% to have 100% access. Renewable energy on the other hand indicates that by 2030 renewable energy share will only be 45.5% and still lacking 18.5% to double the share to 64%. Under energy efficiency target, results show that in 2030 the improvement will only be 14.3 MJ and still lacking 5.3 MJ to double the improvement to 19.6 MJ.

5.2 Policy Recommendations

As indicated by BAU scenario, Lesotho is not on track to achieve Sustainable Development Goal (SDG) 7 at the current rate of progress in all four targets by 2030. For this reason, the failure to achieve the anticipated progress by 2030 under BAU scenario has induced the need for the SD scenario as a future scenario that will deliver the set targets. This increases the growth rates of the indicators from one year to the other. To successfully achieve these targets there should be policies and strategies to follow. This being said, the policy makers will have to put into greatest consideration the recommended policies and strategies to accelerate the success of SDG7 by 2030. The fundamental policies recommended include implementation of more renewable energy technologies that will increase electricity access and share of renewable energy in the overall energy mix, shifting into more efficient biomass cook stoves to reduce over-exploitation of trees and hence protect the environment and also taking into consideration the affordability of energy services. For all the energy indicators to be achieved by 2030 there should be specific targets set.

5.3 Study Limitations and Future work

There still exist challenges in contributing to a more comprehensive visualization of Lesotho energy situation. Hence this matter calls for more sustained initiatives to improve data quality, availability, authenticity and access. So as to improve the project in the future, more emphasis should also be put on the improvement on coverage of household surveys with the aim to precisely reflect the quality of services for electricity and clean cooking. Lesotho energy balance reports should also be updated annually.

Equally important, there is a need to strengthen the statistical capacity so as to produce accurate energy balances, particularly in Lesotho as a developing country where there seems to be a difficulty in data capturing like the traditional usage of biomass. Furthermore, there is no present information about the energy efficiency of the major consuming sectors like household, agriculture, industry, mining and manufacturing. This bears a critical challenge to inform policy. To wrap up, on regular basis, Lesotho should have a thorough evaluation of country's energy sector for a strategic sustainable energy development.

There is also one important issue lacking in this current study where even though there is a greater emphasis on the need for the country to see to other means to accelerate the achievement of SDG7 goals, the possible solutions cost to achieve the set goals by 2030 especially in the Sustainable Development scenario is needed. In essence, there is a need to gain more insights concerning financial efforts and initiatives that are required to achieving these goals. The overall analysis should be done on all the targets: electricity access, access to clean cooking, substantial increase in renewable energy, and energy efficiency improvement on the sustainable development goal scenario.

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Appendix A : Lesotho Energy Balance – 2016 (in ktoe)

	Oil products	Coal/products	Hydro	Solar PV	Biomass/waste	Electricity	Total
Production			44.35	0.04	1000.00		**1044.39**
Imports	270.10	50.00			10.00	23.32	**353.42**
Exports (-)						-0.26	**-0.26**
Bunkers (-)							**0**
Total Primary Energy Supply	**270.10**	**50.00**	**44.35**	**0.04**	**1010.00**	**23.06**	**1397.55**
Statistical difference	0.15	0	0		0	6.03	**6.18**
Transformation	**-7.00**		**-44.35**	**-0.04**		**44.35**	**-7.04**
Electricity producers	-7.00		-44.35	-0.04		44.35	**-7.04**
Energy industry own use						-1	**-1**
Losses						-13	**-13**
Total Final Consumption	**263.25**	**50.00**			**1010.00**	**59.44**	**1382.69**
Industry	8.55	47.00			110.00	20.10	**185.65**
Transport	166.60						**166.60**
Households	16.61	2.50			800.00	20.02	**839.13**
Commercial & Public	35.88	0.50			100.00	18.67	**155.05**
Agriculture / Forestry	33.47						**33.47**
Construction	2.14						**2.14**
Others						0.65	**0.65**

Appendix B: Lesotho Energy Balance, 2017

	m products - secondary energy products				RENEWABLES											
23.8845897	Gasoline type jet fuel	Other kerosene/ paraffine	Gas Diesel Oil	Other products	Hydro	Solar Electricity	Solar Heat	Biogas	Fuelwood		Wood wastes and other solid wastes	Animal dung	Charcoal	Electricity	Heat	Total
	toe	toe	toe	toe	ktoe	ktoe	ktoe	ktoe	ktoe		ktoe	ktoe	ktoe	ktoe	ktoe	ktoe
1. GROSS INLAND CONSUMPTION																
Primary energy production	0.0	0.0	0.0	0.0	43,104.0	200.7	86.0	-	429,137.0	4,759.8	30,223.7	89,821.9	0.0	0.0	0.0	597,333.2
Imports	94.2	30,662.5	85,422.8	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	630.9	33,276.0	0.0	444,809.1
Exports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.8	0.0	68.8
Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stocks - beginning of the year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stocks - end of the year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total gross inland consumption	**94.2**	**30,662.5**	**85,422.8**	**0.0**	**43,104.0**	**200.7**	**86.0**	**0.0**	**429,137.1**	**4,759.8**	**30,223.7**	**89,821.9**	**630.9**	**33,344.8**	**0.0**	**1,042,211.0**
2. TRANSFORMATIONS, ENERGY SECTOR CONSUMP																
2.1. Transformation Sector - Inputs	**0.0**	**0.0**	**158.5**	**0.0**	**43,104.0**	**200.7**	**86.0**	**0.0**	**228,993.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**272,542.7**
Main Activity Producer Electricity Plants																
- HPP Muela	0.0	0.0	0.0	0.0	43,078.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43,078.2
- TPP Diesel	0.0	0.0	158.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	158.5
- Small HPPs (3)	0.0	0.0	0.0	0.0	25.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.8
Autoproducer Electricity Plants																
- Solar PV Airport	0.0	0.0	0.0	0.0	0.0	168.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	168.4
- Small generation - Industry	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Small generation - Service	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Small generation - Households	0.0	0.0	-	0.0	0.0	32.2	86.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	118.2
-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Charcoal plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	228,993.5	0.0	0.0	0.0	0.0	0.0	0.0	228,993.5
Non-specified (Transformation)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.2. Transformation Sector - Outputs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63,413.6	43,191.4	23.9	106,628.9
Main Activity Producer Electricity Plants																
- HPP Muela	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43,078.2	0.0	43,078.2
- T																
- S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.8	0.0	24.8
Autopr																
- S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.1	0.0	56.1
- S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0
- S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0
- S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.2	23.9	56.1
-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Charco	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63,413.6	0.0	0.0	63,413.6
Non-specified (Transformation)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.3. Consumption in Energy Sector (Own Use)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1,423.9**	**0.0**	**1,423.9**
Main Activity Producer Electricity Plants																
- HPP Muela	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	861.6	0.0	861.6
- Small HPP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5
Autoproducer Electricity Plants																
- Solar PV Airport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Small generation - Industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Small generation - Service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Small generation - Households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Charcoal plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-specified (Own Use for Energy Prodution	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	561.8	0.0	561.8
Transmission/Distribution losses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9,716.3	0.0	9,716.3
2.4. Available for final consumption	**94.2**	**30,662.5**	**85,264.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**200,143.6**	**4,759.8**	**30,223.7**	**89,821.9**	**64,044.5**	**65,396.1**	**23.9**	**865,157.0**
2.																
3. FIN Final non-energy consumption	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
in Transformation Sector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
in Energy Sector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
in Transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
in Industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
of which in Chemical/Petrochemical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
of which in Chemical/Petrochemical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
in Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
in Other Sectors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final energy consumption	**94.2**	**16,189.9**	**68,338.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**200,143.5**	**23,692.3**	**33,030.8**	**102,802.3**	**373.8**	**64,808.2**	**0.0**	**661,306.4**
Industry Sector	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**776.2**	**0.0**	**0.0**	**0.0**	**0.0**	**26,569.9**	**0.0**	**37,680.4**
Iron and Steel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemical (including Petrochemical)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Ferrous Metals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Metallic Minerals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transport Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Machinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Energy Mining and Quarrying	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,346.4	0.0	2,346.4
Food, Beverages and Tobacco	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0
Paper, Pulp and Printing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wood and Wood Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.8	0.0	113.8
Textiles and Leather	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0
Non-specified (Industry)	0.0	-	-	0.0	0.0	0.0	0.0	-	776.2	-	-	-	-	24,109.7	0.0	35,220.3
Transport Sector	**94.2**	**0.0**	**68,338.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**194,768.0**
International Aviation	33.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.6
Domestic Aviation	60.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.5
Road	0.0	0.0	68,338.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	194,673.9
Rail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
~~Pipeline Transport~~	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-specified (Transport)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Sectors	**0.0**	**16,189.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**199,367.3**	**23,692.3**	**33,030.8**	**102,802.3**	**373.8**	**38,238.3**	**0.0**	**428,857.9**
Residential	0.0	16,189.9	0.0	0.0	0.0	0.0	0.0	-	153,359.5	23,692.3	33,030.8	102,802.3	373.8	21,825.2	0.0	366,741.8
Commercial and Public Services	0.0	-	0.0	0.0	0.0	0.0	0.0	-	46,007.8	-	-	-	-	15,487.7	0.0	61,495.5
Agriculture/Forestry	0.0	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.3	0.0	0.0
Fishing	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Streeg lighting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	180.6	0.0	0.0
LHDA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	620.6	0.0	620.6
Non-specified (Other)	0.0	14,436.8	16,946.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63,670.8	669.8	0.0	238,333.6
Statistical Differences	0.0	14,472.6	16,926.0	0.0	0.0	0.0	0.0	0.0	0.0	-18,932.5	-2,807.1	-12,980.4	63,670.7	587.9	23.9	203,850.6

Households
?solar PV. Number o
households is 3100,
capacity 5-200 W, to
160981W
? generation units 12