



Government of National Unity
Ministry of Planning

NATIONAL STRATEGY FOR RENEWABLE ENERGY & ENERGY EFFICIENCY - LIBYA (NSREEE) 2023 – 2035

March 2023



جهاز الطاقات المتجددة
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State of Libya
Government of National Unity
Ministry of Planning

**National Strategy for Renewable
Energies and Energy Efficiency
(NSREEE)
2023 – 2035**

March 2023



A Word from the Prime Minister:

The world economy is growing everywhere, and this growth is accompanied by growing energy consumption, and at the same time harmful emissions to the climate are increasing. To confront this and to control dealing with traditional limited energy sources, most countries in the world have begun to think about renewable energy and energy efficiency strategies. Libya is no exception, and due to the importance of its location, geography, and after decades of relying on traditional energy based on oil support, it is heading today to a new phase, the first step of which is the search for alternative sources in the fields of energy, as God Almighty has endowed it with diverse and enormous natural resources in the field of clean energies, the most important of which is solar energy, which is the most abundant of all energy sources, as the country receives a daily rate of solar radiation of (7.1 kilowatt-hours per square meter) in the coastal areas and a rate of up to (8.1 kilowatt-hours per square meter) in the southern regions, which allows solar energy technologies to solve the electricity sector crises. Solar energy technologies convert sunlight into electrical energy. Therefore, if these natural resources were optimally exploited, Libya would be among the leading countries in producing electrical energy. Especially in the field of renewable energies, because of their importance in diversifying and supporting the energy supply.



Therefore, in order to ensure the availability of energy to the Libyan citizen in all parts of the country, the Government of National Unity, through the Ministry of Planning, in partnership with a specialized team from the United States Agency for International Development (USAID - LPFM), the General Electricity Company, and the Renewable Energy Authority, sets this National Strategy for Renewable Energy and Energy Efficiency (NSREEE) for the years (2023). - 2035) to be the road map in the field of national renewable energy policy, and all concerned parties must take the necessary measures to put it into effect. We pray to God to guide us all to the wellbeing of the country and the people.

Eng. MOHAMED ABDULHAMID ALDIBIBA

Prime Minister of the National Unity Government

A Word from the Acting Minister of Planning:

For decades, the national economy has relied heavily on oil and natural gas revenues to cover investment and management costs. Despite taking steps aimed at diversifying sources of income, this goal has not been achieved as desired, and oil and natural gas are still the main nutrients of the national economy.

Given the importance of renewable energies in diversifying and supporting the energy supply, and that Libya is rich in sources of this type of energy, and that the world is turning today to clean energy sources, the Ministry of Planning has, over the past years, formed a group of committees as follows:

1. The committee formed pursuant to the Decree of the Minister of Planning Plenipotentiary No. (48 of 2017) to prepare the national strategy for renewable energy and energy efficiency.
2. The committee formed pursuant to Minister of Planning Resolution No. (58 of 2021) to prepare a national vision for energy efficiency.

The Renewable Energy Authority also prepared the National Electrical Energy Efficiency Action Plan for (2021-2023) in cooperation with the Energy Department of the League of Arab States and the Regional Center for Renewable Energy and Energy Efficiency (RCREEE).

Due to the different objectives of each of these studies and the divergence of the time period for preparing each of them, the need arose to compile, review, and update their contents to come up with a single vision and study. For this reason, a specialized team from the United States Agency for International Development (USAID - LPFM) was assigned to communicate with the General Electricity Company and the Renewable Energy Authority for the purpose of deriving a summary representing the results of all the aforementioned studies and updating their data to produce a unified document covering the National Strategy for Renewable Energy and Energy Efficiency (2023-2035).

In reference to the discussions that took place regarding this document at the second regular meeting of the Council of Ministers of the Government of National Unity for the year 2023 AD, and to the valuable comments received from some ministries about the document, which were included in the updated version.

The Ministry of Planning is therefore pleased to present this document to the responsible authorities in the country and to all those interested in the future of energy in Libya as a road map in the field of national energy policy, hoping that this work will be an important contribution to achieving sustainable development.



I take this opportunity to extend my thanks and appreciation to Dr. Al-Taher Al-Juhaimi, the former Minister of Planning, the heads and members of the previous committees and the assigned team for the serious effort they made in preparing this document.

We pray to God to grant us all success for the good of the country and the people.

Muhammad Youssef Al-Zaidani

Acting Minister of Planning

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Summary:

Switching to renewable energies and reducing dependence on fossil fuels will make Libya a source of clean energy, which contributes to achieving sustainable development and achieving well-being for the Libyan citizen, the most important of which is diversifying sources of income, creating job opportunities, and rationalizing energy consumption in all sectors, which includes the fuel used in the production of electricity and achieving regional development that helps citizens settle in their places of residence.

There are many opportunities in Libya to produce electricity from renewable energies, for which a set of general policies have been developed, which are summarized in the rehabilitation and development of existing electric power production stations to maintain their continuity of operation by increasing the contribution of renewable energies to the energy mix from (17%) by the end of 2025 to (19%) by the end of 2030 and to (20%) by the end of 2035.

The strategy emphasized taking the necessary measures to reduce costs in construction and operation, which will contribute to reducing the negative impact on the environment resulting from burning fossil fuels to generate electricity. This requires encouraging, stimulating and supporting industries related to renewable energies.

The strategy also stressed the need to develop current legislation related to the field of energy, pay attention to the regulatory aspects of institutions based on energy affairs, and work to create an attractive environment for local and foreign investors to participate in financing and managing new energy projects necessary to meet the increasing demand for energy.

The strategy also included noting the importance of transferring and localizing technology and knowledge, building local capabilities, and ensuring the adoption of the best practices and standards and communicating with regional and global energy institutions to benefit from the experiences of others in this field.



1 Introduction:

For more than five decades, the Libyan economy has relied almost entirely on oil and gas revenues to finance most of its development and administrative expenses, to the point that it has become described as a rentier or unilateral economy. The oil sector also provides the fuel needed to produce electrical energy, which is considered the basic commodity for consumers and producers of various types of economic activity.

Despite the serious attempts that have been made to create new sources of income in foreign currencies that would support income from fossil fuels in the short and medium term and be an alternative to it in the long term, this goal has not been achieved so far, as oil is still the main source for financing development expenditures.

During the past three decades, that is, since the beginning of the eighties, Libya has tended to engage in renewable energy programs and projects, with the aim of diversifying the sources of electric energy production on the one hand, and taking advantage of the natural potential and advantages that the Libyan state enjoys in the field of renewable energy (sun, wind, etc.), on the other hand. A number of institutions and agencies concerned with the use of renewable energies have been established for this purpose.

The strategic goal of moving towards renewable energies was to cover part of the growing demand for energy, and to prepare for the post-oil phase, as it is a non-renewable and depletable resource, as well as to raise the efficiency of using electrical energy, where institutions concerned with renewable energies have implemented, over the past decades, a number of projects in some regions, but most of them did not bear fruit as planned due to different circumstances.

During the recent period, and as a result of the unfavorable conditions that Libya has gone through and is still going through, the production of electricity from the traditional source has faltered, and it has become necessary to raise energy efficiency and move towards using renewable energies in heating domestic water, lighting buildings, lighting streets, and integrating renewable energy technologies and connecting them to the public electricity network to contribute to the energy mix by developing a strategy based on scientific, technical, economic and social dimensions, taking into account legislative and institutional aspects, and emphasizing the strengthening of environmental protection measures and ensuring the state's energy security.

Reality of the Electricity and Renewable Energy Sector in Libya

The electricity sector is considered one of the most important sectors that have received attention within development plans and budgets to provide electricity service to all citizens, in their various locations, and the state has borne a huge share of the financial burden through its continued subsidy to this sector.

2 Renewable Energy Authority (REAOL):

'REAOL' aims to implement projects based on the use of renewable energy technologies in its various forms and manifestations, and to encourage and support industries related to them, through the public and private bodies licensed in this field (research and executive institutions), and in order to achieve its objectives it has proceeded as the following:

1. Contributing to providing electrical energy from renewable energy sources.
2. Contributing to diversifying the national economy by reducing dependence on oil as a main source of income.
3. Transferring knowledge and experience, localizing technology, and building national capabilities.
4. Contributing to social development and creating job opportunities.
5. 'REAOL' strategy for developing renewable energies aimed to increase its contribution to the national electrical energy supply system from (3%) in 2015 to (10%) in 2025.

During the period 2013- 2015, the agency aimed to establish the following renewable energy projects:

A. Wind energy projects with a capacity of (240 MW), including:

1. Derna wind project, the first phase (60 MW), at a cost of (180 million dinars), and the project was stopped. Its implementation is a result of force majeure, including security conditions and events that the country has been exposed to, as well as the objection of landowners.
2. The Derna wind project, the second phase (60 MW), at a cost of (180 million dinars), was awarded and the project was referred to the competent authorities to complete the contracting procedures.
3. Al-Maqroun Wind Project (120 MW) at a cost of (330 million dinars), where the award was made and the project was referred to the competent authorities to complete the contracting procedures.
4. Studies and consulting services at a cost of (10 million dinars).



B. Solar energy projects, including:

1. A solar cell station (15 MW) during the year 2010 in the Hoon region. It was awarded at a cost of (62 million dinars), but the contracting procedures were not completed.
2. A solar cell station in the Sabha region (40 MW) during the year 2014, at an estimated cost of (120 million dinars), and the project was halted when the procedures for preparing specifications and inviting the tender were completed.
3. Preparing specifications and launching a tender for a solar cell station in the Ghat region (15 MW) during the year 2014 at an estimated cost of (50 million dinars).
4. A solar cell station project on rooftops at a cost of (10 million dinars) during the year 2014, where the specifications document was prepared for the first phase with an installed capacity of (600 KW). The first phase of the project was presented and was awarded to a national company, but no contract was concluded.

Thus, the total financial estimates for the aforementioned projects during the period (2009- 2015) amount to approximately (714.5 million dinars).

Among the works accomplished by 'REaOL':

1. Supply and installation of (26) stations for measuring data and information about wind and solar energy in several regions.
2. Supplying equipment for implementing the Derna wind farm project to generate electrical energy with a capacity of (60 MW).
3. Installing a number of photovoltaic systems to supply remote areas with electrical energy and extract water from pastoral wells.
4. Installing (10) photovoltaic systems on rooftops connected to the general electricity grid with a capacity of (3 KW) for each system.
5. Supplying spare parts and batteries for the maintenance of electrification systems in remote areas.

2.1 Analysis of the internal and external environment for renewable energies:

Strengths	Weaknesses
A. Internal environment	
1. Libya's location within the Sun Belt and its proximity to the availability of liquefied gas and competition in global markets	1. Provides natural gas at reasonable prices
2. There is huge potential for renewable energy sources, especially solar energy	2. The policy of state support for electricity tariffs weakens the ability of renewable energies to compete
3. Provides a cohesive and large electrical network	3. Inability to fully cover electrical peak loads
4. Providing human cadres who can be qualified to implement and operate various renewable energy technologies	4. The absence of stimulating policies and mechanisms to rationalize consumption and the negative impact of the current subsidy policy
5. It provides vast areas of land to generate electrical energy from renewable energies	5. The absence of policies and programs that would raise the efficiency of energy production and use
6. The presence of adequate infrastructure of roads, ports and airports	6. Lack of effective partnerships with the private sector
7. There are plans to localize renewable energies and many technical, engineering and research studies	7. Complete monopoly prevents competitive policies in the energy field
8. The presence of existing institutions working in the field of renewable energies	
B. External environment	
1. Low prices for some technologies and the speed and ease of their implementation	1. Strong competition from neighboring countries and countries of the region in the field of renewable energies
2. The increasing demand for energy helps Libya create a market for exporting solar energy and increase investment in international partnerships	2. Continuing with the policies currently followed represents a threat to national energy security
3. Libya is considered an economic and trade partner with the EU and the world.	3. Volatility in the global energy market

Table (1): Analysis of the internal and external environment for renewable energy



2.2 General Electricity Company of Libya:

Libya is considered one of the first countries to be interested in providing electricity to all parties of economic activity on the one hand, and to citizens in their various locations and residences on the other hand. For this purpose, it has established the 'General Electricity Company' with three branches. Then the corporation turned into an Operation and Maintenance Corporation and then finally to its current status as a vertically integrated general electricity company, which exclusively undertakes all activities of production, transmission and distribution of electricity in the state of Libya.

'GECOL' received the attention of the government, which provided it with the necessary capabilities that would enable it to carry out its duties to the fullest extent. According to available data, the state spent more than (27.8 billion dinars) on electricity activity during the period 2000-2021. These investments also enabled it to achieve There are many objectives of this activity, the most important of which are:

1. Developing electrical power generation capabilities to meet the increasing growth in loads.
2. Increasing the energy produced from 24,000 gigawatt hours in 2006 to 40,731 gigawatt hours in 2021.
3. Developing a 400 kV ultra-high voltage network by establishing a number of 400/220 kV substations and new 400 kV power transmission lines.
4. Developing and strengthening the 220 kV high-voltage transmission network, and increasing the number of substations in various regions.

2.2.1 Challenges Facing Electricity Sector Activity:

The follow-up reports and evaluation of the development program for the previous period prepared by the Ministry of Planning dealt with a number of challenges facing the electricity sector, the most significant of which can be mentioned in the following points:

The change in the exchange rate resulted in an increase in the costs of required supplies such as equipment, spare parts, and others.

Increase in fuel expenses due to the increase in the price of heavy and light fuel (power station fuel).

The percentage of debt collection for the use of electric energy is low, reaching about (38%) for the sectors that are financed from the general budget (public sector) and receive (40%) of the energy sales, causing a liquidity crisis due to the deficit in GECOL's budget.

An increase in the company's debts to others, which amounted to about (9.4 billion dinars) at the end of the year 2021, most of which were in favor of 'Brega Company' in exchange for fuel, oils, and other petroleum products.

2.2.2 Efficiency of the General Electricity Company's performance during the period (2017 - 2021):

The demand for electricity witnessed increasing growth during the period (2017 - 2021), as Table (1) shows. To cover the demand for electricity, the installed electrical capacity increased from about (8,713 MW) in 2012 to about (9,989 MW) by the end of 2021, where the electricity sector was able to complete the installation and started operation of a number of generating units in different locations in the electrical network, allowing the electrical energy produced in the various power plants to reach about (40,731,187 MWh) at the end of 2021, compared to (37,116,922 MWh) at the end of 2017.

Installed Capacity (MW)	Max Load (MW)	Total Loads (MWh)	Max Achieved Generation (MW)	Total Energy Produced (MWh)	Year
9,989	7,383	41,187,794	5,615	37,116,922	2017
9,989	7,185	39,931,661	5,914	36,974,037	2018
9,989	7,639	43,459,992	6,078	38,510,760	2019
9,989	7,350	42,985,097	6,145	35,302,928	2020
9,989	8,150	46,107,476	6,110	40,731,187	2021

Table (2): Quantitative indicators achieved during the period (2017 - 2021)

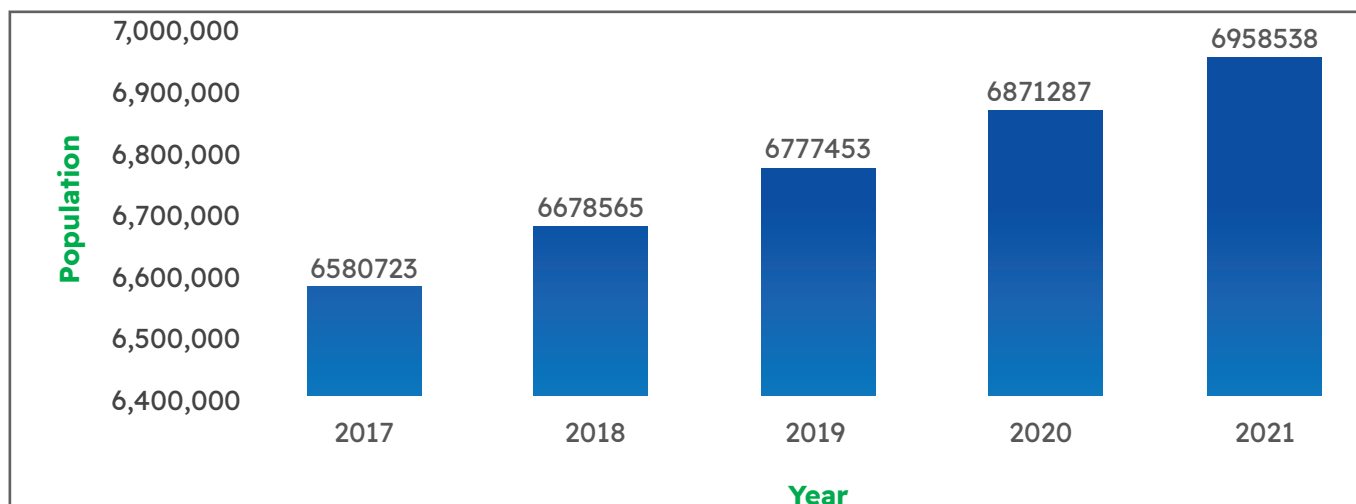


Figure (1): Annual population growth indicators during (2017 - 2021)
Source: (World Bank - 2017)

Year	Population Count	Total Energy Produced (MWh)	Per-Capita Produced Energy (kWh/person/year)
2017	6,580,723	37,116,922	5,640
2018	6,678,565	36,974,037	5,540
2019	6,777,453	38,510,760	5,680
2020	6,871,287	35,302,928	5,140
2021	6,958,538	40,731,187	5,850

Table (3): Energy Produced Per-capita during (2017-2021)



2.3 Other Parties Related to the Electricity Sector

2.3.1 Solar Energy Research and Studies Center

In the context of the search for new sources of energy, the state established a number of institutions concerned with the issue of renewable energies, the first of which was the Center for Solar Energy Research and Studies. This center was established in mid-1978, and the decree to establish it defined its main objectives in the following points:

1. Conducting scientific research and studies in the field of solar and renewable energy.
2. Develop and propose plans to achieve expanded use of solar energy.
3. Spreading awareness in the field of solar and alternative energy.

The decree specified a number of specializations for the center, the most important of which are:

1. Providing climate data and consumption patterns of electrical energy in Libya for the uses of renewable energysystems.
2. Preparing the necessary studies and research in the field of renewable energies.
3. Conducting economic and technical feasibility studies for applied projects in the field of solar energy, wind energy, and other renewable energy sources, and also providing technical consultations and approving the quality of the systems and their components in its specialized laboratories available at the center.
4. Propose specifications and standards for solar energy utilization equipment.
5. Study the social and environmental phenomena that accompany the expansion of the use of solar energy systems, wind energy, and other renewable energy sources, and develop the necessary methods to address them.
6. Contributing to technology transfer and localization programs and working to develop it to suit its uses locally.
7. Establishing pilot and experimental projects and expanded use projects in the field of solar energy, wind energy, and other renewable energy sources, and evaluating the technical and economic performance of these projects.
8. Approval and quality control of renewable energy systems and their supplied components entering Libya.
9. Providing technical and economic consulting services related to renewable energy systems.
10. Providing the necessary training programs and plans to improve and raise the level of cadres working in the renewable energy sector.

The most prominent work accomplished by the center:

Since its establishment until the present time, the Center has generally carried out the work entrusted to it by virtue of its specializations in the field of research and studies, the most prominent of which are:

1. Implementing a project to develop the center's research capabilities "laboratories" as one of the foundations of research work in the fields of solar energy and wind energy, and working to develop them to be a reference laboratory for evaluating the quality of solar cell panels and solar heaters according to international specifications.
2. Implementing some experimental projects in some remote areas, including supplying homes and huts, and pumping water using solar cell systems independent of the network for the purpose of evaluating performance under local climatic conditions.
3. Implementing a field application project for solar water heating and preparing relevant studies and research.
4. Preparing the studies required by some public agencies in Libya regarding the exploitation of solar energy for the purposes of some hospitals, mosques, airports, and municipalities (some Tripoli mosques, Tajoura Hospital for the treatment of heart diseases, Al-Ghuraifa Municipality, Ghat Airport, Shakshuk Municipality, and others) from public agencies and regions in Libya.
5. Installing, maintaining and monitoring some climate data collection stations in some areas in Libya.

2.3.2 Natural Sciences and Technology Research Authority

The Authority carried out an experiment to launch a national project for biofuel extracted from the seeds of the Jatropha plant in the year 2009. The experiment concluded that it is possible to propose and draw up all the necessary policies and procedures and coordinate with relevant authorities such as agriculture, industry, planning, universities and others to make this project a fertile field for further development, training and postgraduate projects at home and abroad.

2.3.3 Sorman Agricultural Development Project

Implementing the 'Libya Green Energy Project' to produce biofuels and industrial oils from biofuel-producing plants, including the Jatropha plant, the jojoba plant, and the American castor plant, in the year 2008. A plan was developed to implement practical programs in preparation for the implementation of several projects, and the Jatropha Curcas plant was planted in several locations in the year 2009.



3 Summary of the Status of the Electricity and Renewable Energy Sectors

By studying and evaluating the performance of programs and projects in the electric energy and renewable energy sectors over a period of more than five decades, it was possible to reach the following results:

1. The General Electricity Company (GECOL) was and still is the main, if not the only, source of production, transmission and distribution of electricity to various parties of economic activity and to all citizens in their various locations.
2. The electricity sector faced many challenges and bottlenecks that affected and are still affecting its performance, and led to a rise in commercial and technical losses.
3. Most of the renewable energy programs and projects that the state began to engage in over four decades have not entered into implementation and application on the ground. Most of them reached certain stages of completion and were halted for various reasons, some of which were previously mentioned.

To ensure the success of plans and programs for developing renewable energies and energy efficiency, the following is proposed:

1. Issuing the necessary legislations to activate all types of energy activities and programs.
2. Opening the way for the national and foreign private sector to contribute to the production and marketing of renewable energies.
3. Develop a medium-term national plan that addresses the goals, policies, and investments of renewable energy projects.
4. Directing state institutions to use solar energy to generate electricity and heat water on the roofs of buildings, etc.
5. Develop a national plan for energy efficiency (for efficient use and/or generation of energy).
6. Urging Libyan institutions to participate in investing in the field of renewable energies.
7. The importance and necessity of having a specialized body concerned with energy efficiency programs.
8. Benefiting from the experiences of neighboring countries and other countries in the field of renewable energies.
9. Achieving electrical interconnection with European Union countries in order to achieve integration in electricity production sources between countries in the region and solve the current technical obstacles to electrical interconnection with neighboring countries.

3.1 Expected Demand for Electricity During (2023 – 2035)

Based on the results of studies related to load development, the quantities of electrical energy required to be produced during the period (2022 - 2035) were determined as in the following figures:

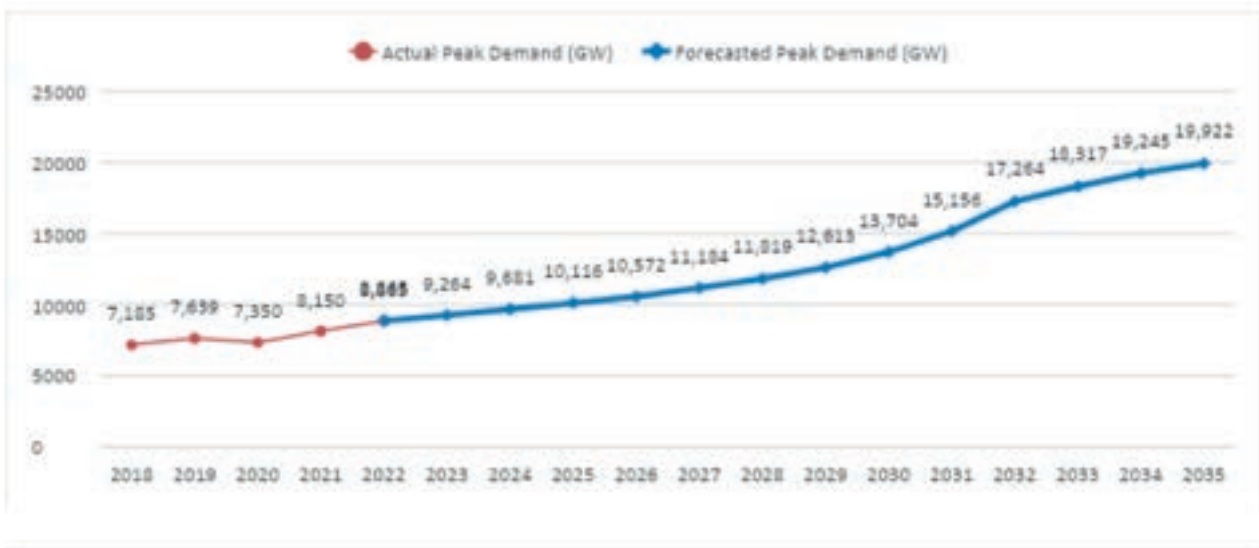


Figure (2): Projections of Peak Load Growth (2023-2035) - (GW)

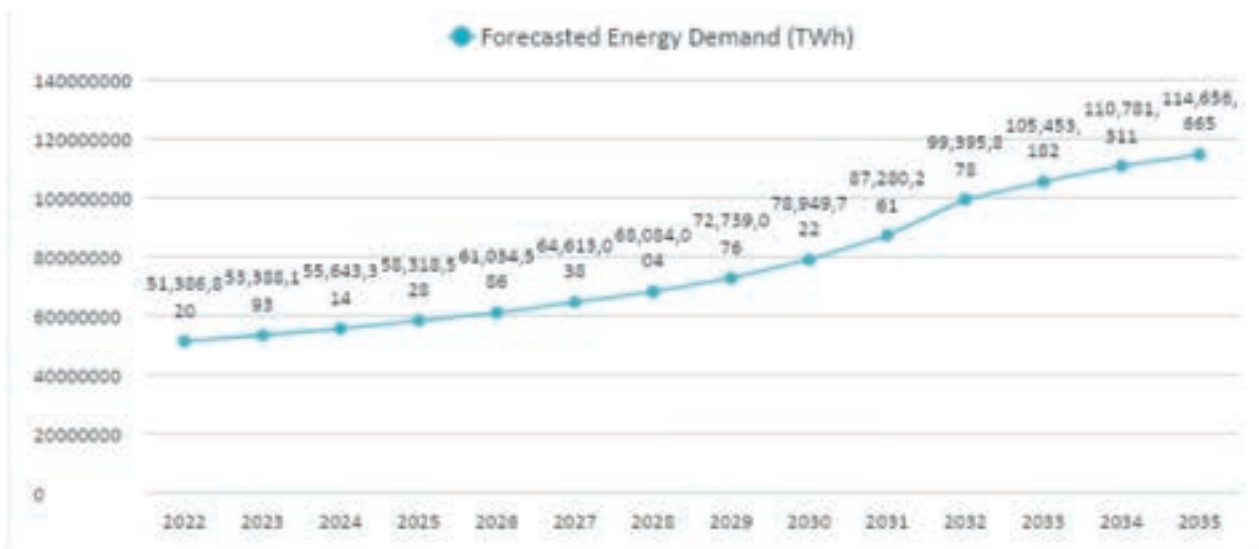


Figure (3): Energy Demand Forecasts (2023 - 2035) (TeraWatt-hours)



4 Reorganization of the Electricity Sector

The increasing demand for electrical energy in various countries of the world has led to the emergence of the need to provide new capital investments that exceed the capabilities of governments of these countries, and the growing concern about environmental degradation resulting from the burning of fossil fuels has created mounting pressures on countries to raise the funds necessary to address this problem. As a result of this, most of these countries were forced to move towards reorganizing, restructuring and developing their energy institutions and accelerating their transformation from the traditional vertically integrated model to the open energy market model to keep pace with developments, in addition to the emergence of the urgent need for self-generation initiatives, especially in the field of renewable energies, as well as the need to pump local and foreign private sector investments to create new sources of financing and increase available generation capacities.

Since its inception, the electricity sector in Libya has gone through a number of stages in which the structures affiliated with and supervising the sector have changed in terms of creating a Ministry of Electricity and Renewable Energies and canceling it from time to time, with the continued work of its affiliated bodies, led by the General Electricity Company, the Holding Company, and the Executive Renewable Energies Authority. It was noted during the work and interaction of these bodies with each other, that there was a lack of appropriate legislation that regulates the work relations between them in a properly coordinated and integrated manner, and through which the tasks of each of them can be determined without any overlap in responsibility, tasks, and ownership, which constituted a major obstacle to the possibility of accomplishing joint work between them.

'GECOL' currently represents the main body in the electricity sector, and it performs its duties through the decree to establish 'GECOL' No. (17) of 1984 AD, which stipulates that the company will exclusively undertake all operations of production, transmission and distribution of electrical energy throughout the Libyan territory, which prohibited the private sector, investors, or any other party is from entering into a partnership with 'GECOL' to cover part of the investment expenditures required to keep pace with the demand for energy and the subsequent expansions in production capabilities or transmission and distribution networks. Therefore, it has become necessary to have the needed legislation to govern the sector (Electricity Law), in a way that can resolve the existing problems, bottlenecks and achieve the correct structure for the sector that enables it to be technically and economically sustainable and keep pace with modern developments.

Many studies have been conducted in this regard, including the study funded by the World Bank at the end of 2017, which included several main axes, the most important of which are the following:

1. Evaluating the performance of the electricity sector and reforming its structure.
2. Institutional development and improving the performance of 'GECOL'.
3. Pushing towards developing sources and uses of renewable energies.
4. Develop policies and procedures that support technology localization and capacity building.

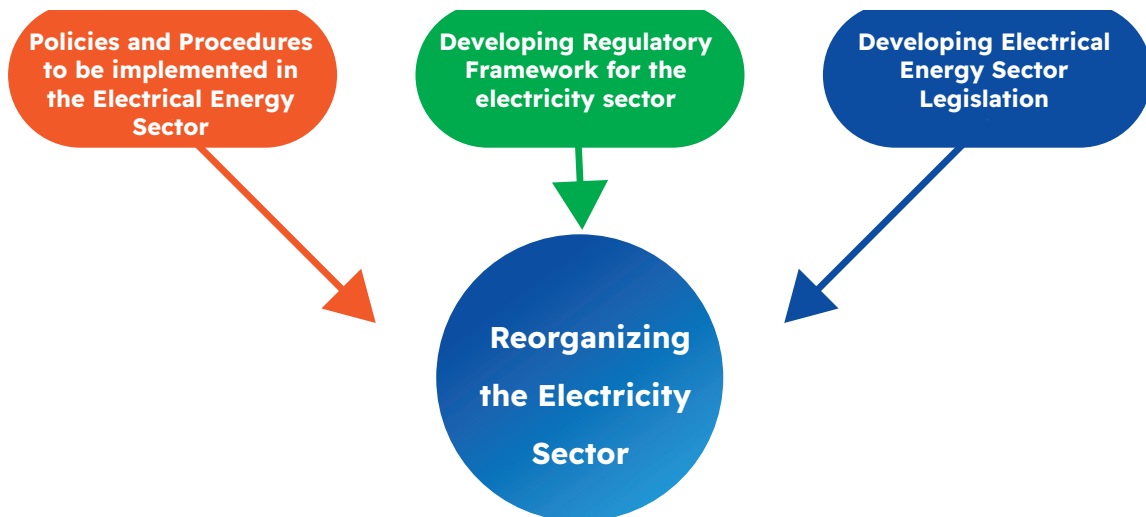


Figure (4): Requirements for Reorganizing the Electricity Sector

This study concluded that it is necessary to address the legislative vacuum that the sector suffers from by working to develop the legislative environment for the sector by issuing a new specialized law that regulates various aspects of electric energy activity from the technical, financial, administrative and legal aspects. It was also clearly shown that regulating the relationship between public and private sectors on one hand, and consumers on the other hand, requires the presence of a sector regulator (the Electricity Regulatory Authority), whose primary role is to supervise the organization of the sector's activity and protects the rights and interests of all parties participating in the sector in a fair and balanced manner. The latest studies carried out by specialized experts from (USAID) have led to the development of a road map through which 'GECOL' will engage in a comprehensive reform program through which the sector will be reorganized and restructured by transforming the company from its current traditional structure as a vertically integrated institution that monopolizes all electricity sector activities (production, transmission and distribution), to the open electricity market model that is full of diversity, competition, and the participation of multiple local and external parties in investing in the sector's activities, taking into account the interests of all parties and aiming to support and enhance the capabilities of the national economy and provide the best services to the citizens at the lowest cost.



Figure (5): Restructuring the Electricity Sector

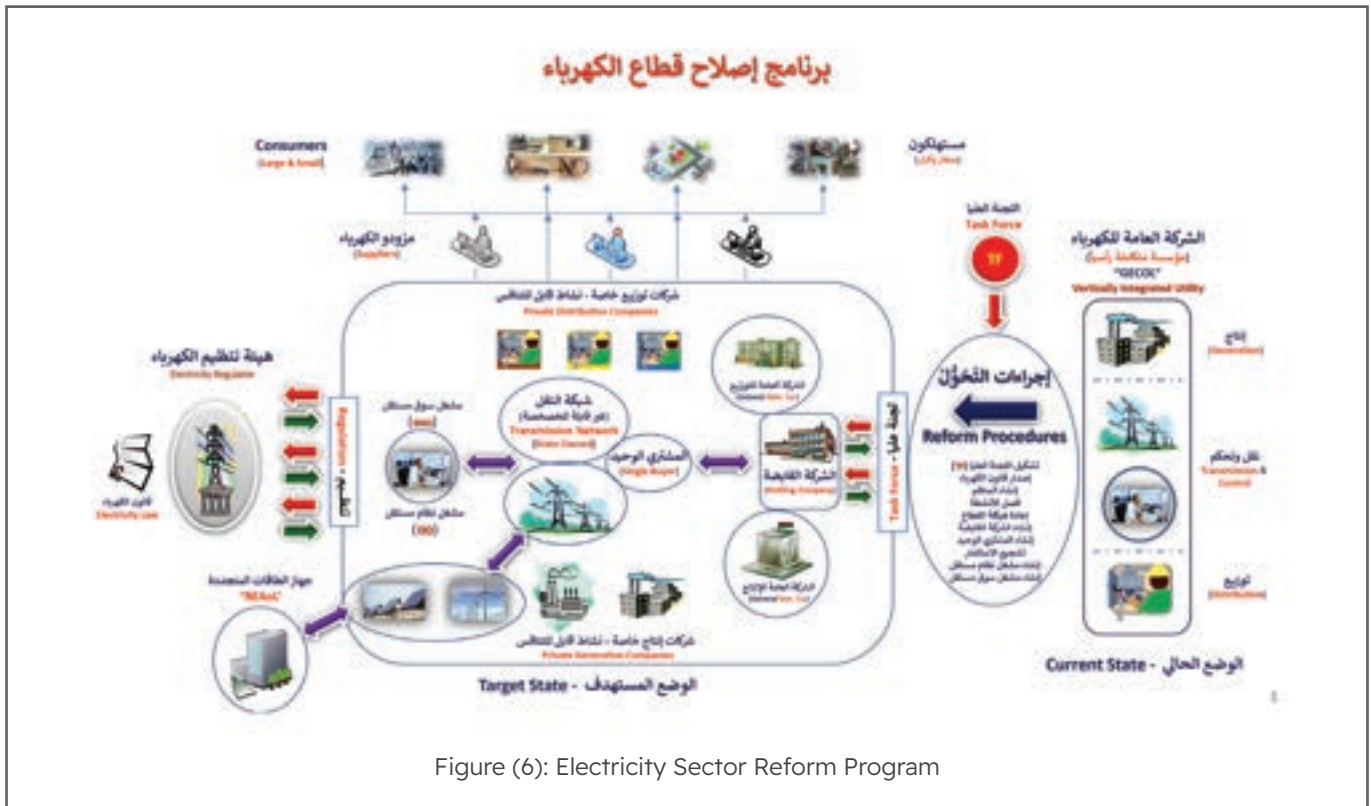


Figure (6): Electricity Sector Reform Program

The basic objectives of reorganizing the electricity sector are summarized in the following points:

1. Transforming the sector from its current state to a sector that operates on economic principles with high efficiency.
2. Ensuring the continuity of electrical energy supply for all economic and life activities.
3. Increasing the sector’s contribution to the gross domestic product and diversifying sources of income.
4. Opening the way for the local and foreign private sector and reducing the burden of government subsidy to the sector.

4.1 Developing Electrical Energy Legislation

One of the most important challenges facing the electricity sector is developing the legal and institutional framework in line with local and international developments. This requires reviewing and developing existing legislations to ensure breaking the monopoly and transitioning to a competitive market, and supporting and stimulating highly efficient and clean sources and uses such as renewable energies that contribute to preserving the environment, in addition to enabling a number of procedures and policies, the most important of which are:

First: Issuing a new law that regulates the activities of production, transmission and distribution of electrical energy on the basis of the open market system, which allows the participation of the private sector in growth and development projects, as well as allowing the establishment of independent electrical power production projects (IPP). It also takes into account the diversity of electrical energy sources and allows the introduction of renewable energy technologies, reducing carbon emissions resulting from power generation.

Second: Issuing the necessary legislation to establish a supervisory body (regulator) that regulates activity in the sector by implementing the tasks and competencies entrusted to it and using the mechanisms included in the legislation that govern its work (the Electricity Law) and the governance model that regulates its relations with the rest of the parties participating in the sector and according to global best practices and taking into account applicable legislation. The role of the regulator is also considered essential in leading the important stages of transformation within the sector reform program to contribute to solving the electricity crisis in an effective and sustainable manner.

4.2 Developing the Regulatory Framework for the Electricity Sector

Through an objective assessment of the reality and performance indicators of the electricity sector as a starting point towards preparing to start implementing the stages of the sector reform program, it has become evident that a number of fundamental changes in the structure and competencies of the sector has to be introduced in response to new developments, as well as to enable the sector to resolve technical, financial and administrative issues and challenges, which confront the sector and limits its ability to achieve sustainable goals. The most important of these fundamental changes are the following:

1. Developing the institutional framework to restructure the electricity sector with regard to production, distribution, marketing and export activities, starting with financial and accounting separation procedures (Accounts Unbundling).



2. Issuing the necessary legislation and creating and empowering regulatory and supervisory divisions to oblige all sectors and entities producing, transporting, distributing and consuming energy of all kinds to adhere to and pay attention to programs to raise efficiency and rationalize consumption.
3. Adopting the general vision of the competencies of existing and targeted institutions necessary for the work of the sector to ensure transparency, safe information transfer, good governance, and consumer protection, by establishing the following:

4.2.1 The Electricity Sector Regulatory Authority (The Regulator)

The Regulator is an independent body that enjoys financial and administrative independence and is responsible for regulating, following up, monitoring and developing the electricity sector to ensure the provision of adequate electrical supplies in line with the best practices adopted internationally to monitor the performance of service providers and ensuring consumers' access to electrical energy supplies at reasonable prices and with high efficiency. The regulator of electricity activity is summarized in the following:

1. Developing the regulatory and structural strategy for the electricity and renewable energy sectors and setting regulatory and supervisory rules and regulations for suppliers and consumers of electric energy in a way that ensures transparency of performance and prevents monopoly.

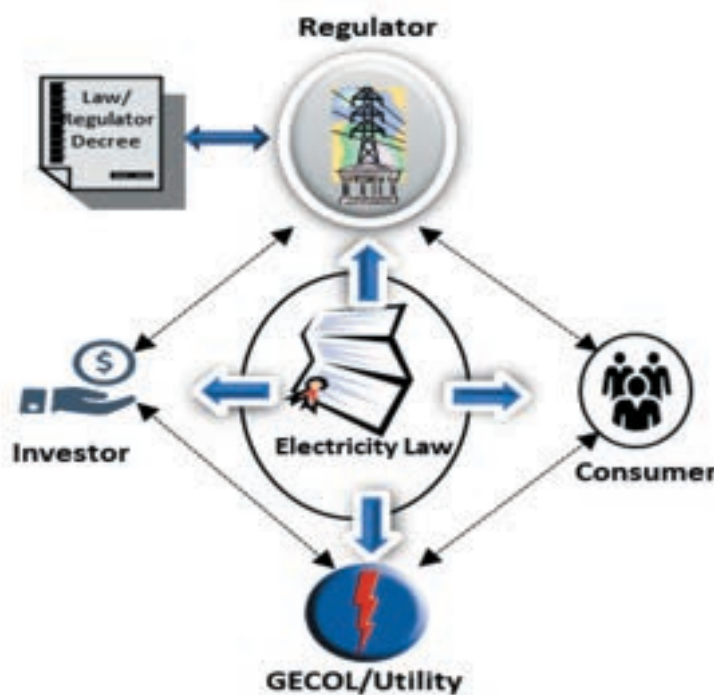


Figure (7): The Regulator and Sector Participants.

2. Follow up on the activities of production, transmission and distribution of electrical energy to ensure the provision of safe, stable and high quality services.
3. Developing the electricity sector in accordance with international standards and establishing controls that ensure competition in electric energy production and distribution activities to achieve the best prices and highest levels of service to guarantee consumer satisfaction.
4. Encouraging investment in the electricity sector and ensuring that all parties participating in the sector comply with environmental conservation standards and public safety conditions applied in accordance with legislations in force.
5. Develop policies that provide incentives and support for the localization of renewable energy technologies, especially solar and wind energy, which contributes to meeting the demand for electricity and ensuring energy supply.
6. Publish information and reports that help the electricity sector and consumers be aware of their rights and obligations.
7. Investigate participants' complaints, protect their interests, and resolve disputes that may arise between parties participating in sector activities.
8. Granting licenses to establish, manage, operate and maintain electrical power generation, transmission, distribution and sale projects in accordance with the eligibility and compliance conditions stipulated in the legislations in force.
9. Preserving the rights of all parties involved in electricity activity in the sector.
10. Regulating the market and evaluating and approving prices in a fair and balanced manner.
11. Regulating procedures for the production, sale and purchase of electrical energy produced from renewable energies.
12. Addressing issues of connecting renewable energy systems to the public grid.

4.2.2 Energy Efficiency Authority

1. Ensuring efficiency and performance in the field of production, transmission and distribution of electrical energy and attracting specialized technical, financial and economic professional competence.
2. Issuing national policies and laws that oblige all users to conserve energy.
3. Develop a system to collect data and statistics related to energy production and consumption patterns.
4. Imposing and implementing mandatory energy efficiency policies, expanding and developing them to include all energy users.
5. Building institutional capacities, spreading the culture of energy efficiency and including it in educational curricula.
6. Benchmarking with neighboring countries, especially those developed in the field of energy efficiency, to benefit from successful experiences.



4.2.3 Investment Guarantee Fund

This fund is an independent institution aimed at supporting and encouraging investors to implement their investments in various sectors. This is done by providing guarantees for their capital and investment returns and adequately compensating them for the political risks to which these investments may be exposed. It has an important role in providing a climate of reassurance to investors and financiers, which enables them to fully focus on completing their projects without fear of any external circumstances that may cause the loss of invested funds and their realized returns. This institution is affiliated with the Council of Ministers and is specialized in the following:

1. Encouraging the flow of direct investments by providing insurance coverage against non-commercial risks to investors and financiers.
2. Guarantee new and existing foreign investments against non-commercial risks such as confiscation, nationalization, wars, unrest, inability to transfer, breach of contract, business interruption, terrorism and sabotage.
3. Providing guarantee coverage for investors' receivables against the risks of non-fulfilment of the debt.

4.3 Policies and Procedures to be Implemented in the Electrical Energy Sector

First: Supporting and strengthening the existing partnership between the electricity and renewable energy sectors imposed by the nature of the work of the two sectors and their complementary role in reaching the optimal energy mix that ensures meeting the growing demand for energy, preserving the environment, and supporting the national economy with the highest possible efficiency.

Second: Developing policies and strategies and activating the plans and programs necessary to transfer and localize technology and knowledge in the fields of electric energy and renewable energies, and working to raise the level of energy awareness among all segments of society about the importance of rationalizing energy consumption and energy conservation.

Third: Focusing on capacity building and developing the skills of local cadres through preparing and implementing qualification and efficiency programs, establishing specialized training institutions, and creating a stimulating environment to encourage workers in the fields of electricity and renewable energy to develop their capabilities, obtain internationally accredited professional certificates, and communicate with international organizations and sources of experience and knowledge for the purpose of learning about new developments and benefiting from the experiences of others.

5 National Strategy for Renewable Energy and Energy Efficiency (2023- 2035)

5.1 Introduction

Preparing a national strategy in the field of renewable energies and energy efficiency that is based on a clear vision and has a serious message to give an important role to renewable energies, all of which is accompanied by noble national values that make the nation's progress in these and other fields an honor for every citizen who deserves to make appropriate efforts for it. The strategy requires a program or action plan, appropriate investments, science and technology.

A. Vision

Exploiting natural resources to obtain clean energy is a strategic option in order to bring about sustainable development and achieve well-being for the Libyan citizen.

B. Message

The contribution of renewable energies to the electrical energy mix to cover (17%) of the total energy needed to cover demand by the end of 2025, (19%) of the total energy needed to cover demand by the end of 2030, and (20%) of the total energy needed to cover demand by the end of 2035, with the aim of building a strong and diverse national economy, in which both the public and private sectors play an active role.

C. Values

- Integrity and transparency.
- Innovation and initiative.
- Capacity building.
- Institutional work.
- Working in a team spirit.
- Participation in decision-making.
- Establishing a culture of achievement.



5.2 Strategy Objectives

Preparing a national strategy in the field of renewable energies and energy efficiency must start from a clear vision that takes into account the current situation, national development goals, and regional and international data and variables. This strategy must also be translated into a development plan that has appropriate goals, policies, and investments. Perhaps the most important goals are the following:

1. Supporting the Libyan economy by turning to the renewable energy industry, localizing it and developing it in Libya.
2. Reducing dependence on fossil fuels for energy generation and reducing the level of carbon emissions.
3. Diversify the sources of energy production and ensure their continuity, and gradually eliminate dependence on government support.
4. Setting standards for designing integrated renewable energy systems appropriate to the local environment.
5. Participation and cooperation with scientific bodies interested in renewable energies locally and internationally to keep pace with the best modern technologies.
6. Involving the local and foreign private sector in the field of investment in renewable energy projects.
7. Educating society about the importance of using renewable energies and their applications.
8. Diversifying sources of investment in the infrastructure of the energy system.
9. Documenting, publishing and increasing the reliability of technical information and building joint databases with institutions and organizations working in the sector.
10. Switching to renewable energies in water production from desalination plants of various types, whether those that rely on thermal energy or that use electrical energy directly to desalinate water.
11. Switching to renewable energies in pumping the artificial river water from its sources to the final consumer.
12. Improving the efficiency of energy use and preserving the main resource represented by the oil and gas sector.
13. Gaining experience and building national capabilities in the fields of manufacturing, installation and maintenance.
14. Achieving spatial development that enhances citizens' stability in their places of residence.
15. Providing the largest possible number of job opportunities and reducing the amount of unemployment.

To achieve the goals and policies of the National Renewable Energy Strategy, it is proposed to attract investments to create (4,000 MW) with an estimated value of about (4.977 billion US\$) or (5.834 billion US\$) to purchase the produced energy from investors, during (2023 - 2035).

5.3 Main Pillars of the Strategy

1. Sustainable development.
2. A global economic hotspot in the field of investment in renewable energies.
3. Knowledge and technology.
4. Logistical system and tight legislation.
5. Globally reliable investments.

5.4 General Policies

1. Maintaining the permissible levels of greenhouse gases resulting from burning fossil fuels and ensuring that the environment is not polluted.
2. Rehabilitation and development of existing electric power production stations to maintain their continuity of operation for the longest possible period and to develop the contribution of renewable energies.
3. Improving the economics of production, transmission, and distribution by improving production efficiency, developing electrical networks at various voltage levels, paying attention to control centers, increasing their number, and providing them with modern means and technologies.
4. Improving electricity services for consumers, increasing the reliability of electricity supply, avoiding fluctuations and surges, and developing billing and collection systems and emergency services.
5. Reducing the cost of operation and investment, reducing the burden on people with limited income, and reducing the negative impact on the environment resulting from electricity generation.
6. Establishing solar energy plants to generate electricity and exchanging experiences with developed countries in this field.
7. Encouraging the manufacture and supply of devices and equipment that use renewable energies and spreading their use at the national level.
8. Encouraging and supporting industries related to renewable energies.
9. Incentivizing the private sector to play its role in the field of electricity production from renewable energies.
10. Proposing policies and procedures that enable the production of electrical energy from other sources (waste, etc.).



6 Main Axes of the Strategy

The strategy adopted four basic axes to achieve its goals, as shown in the following figure:

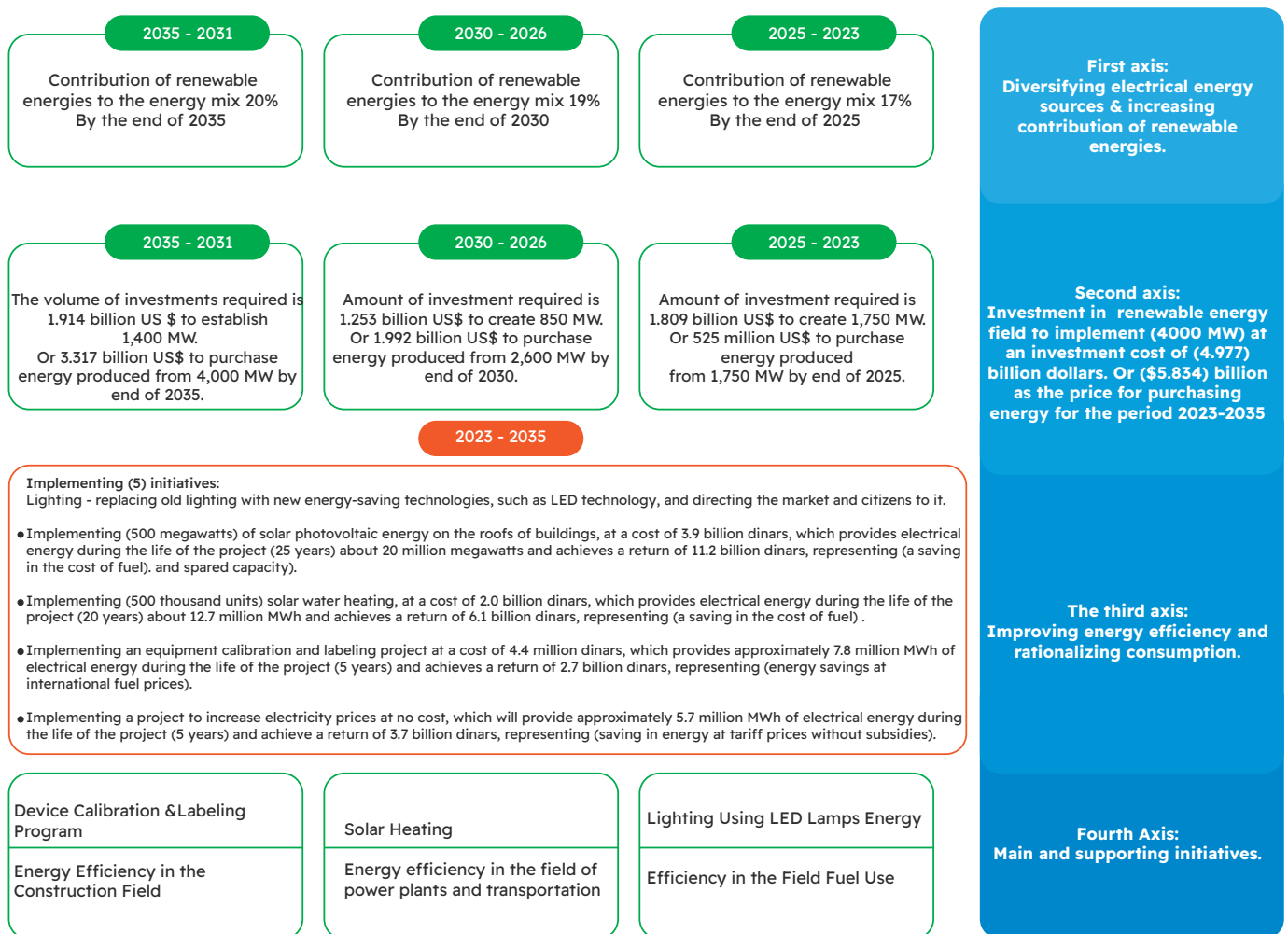


Figure (8): Summary of the Strategy Axes

6.1 First Axis: Diversifying Electrical Energy Sources and Increasing Renewable Energies Contribution

Diversifying electrical energy sources and increasing the contribution of renewable energies to cover (17%) of the total energy needed to cover demand by the end of 2025, to (19%) of the total energy needed to cover demand by the end of 2030, and (20%) of the total energy needed to cover demand by the end of 2035.

Libya seeks to diversify energy sources and produce electricity from renewable energies and include them in the national energy components to form part of the energy mix in the future to contribute to achieving sustainable development and a number of goals with economic and social returns. The strategy aims to achieve the contribution of renewable energies by employing the following technologies:

1. PV solar cell technologies.
2. CSP (Concentrated Solar Power) techniques.
3. Wind energy technologies.
4. Solar thermal water heating technology.

This axis will be implemented in three basic stages, by implementing projects with different capacities at achievable proportions. The following figure shows the energy mix targeted to be reached by year 2035.

	2025 -2023	2026-2030	2035-2031
First Axis: Diversifying electrical energy sources and increasing the contribution of renewable energy	Contribution of renewable energy in the energy mix (17%) by end of 2025, with a total capacity of (1,750) MW.	Contribution of renewable energy in the energy mix (19%) by end of 2030, with cumulative capacity of (2,600) MW.	Contribution of renewable energy in the energy mix (20%) by end of 2035, with cumulative capacity of (4,000) MW.

Table (4): Summary of Targeted Energy Mix

1. First phase (2023 - 2025): Achieving contribution rate of renewable energies at (17%) of electrical energy needs by end of 2025, with a total capacity of (1,750 MW).
2. Second phase (2026 - 2030): Achieving contribution rate of renewable energies at (19%) of electrical energy needs by end of 2030 through adding projects to bring the cumulative capacity to (2,600 MW).
3. Third phase (2031 - 2035): Achieving contribution rate of renewable energies at (20%) of electrical energy needs by end of 2035 through adding projects to bring the cumulative capacity to (4,000 MW).



6.2 Second Axis: Investment in the Field of Renewable Energies

Investment is considered the main driver of the economic and social development process and plays an important role in achieving overall economic and sectoral growth. Investment, both national and foreign, can contribute to establishing renewable energy projects according to the available capabilities.

6.2.1 Funding Mechanisms and Sources

Due to the limited state revenues and its dependence on oil and gas, in addition to the fluctuation and fluctuation of global oil prices, which led to the inability of the general budget to cope with the high investments required for the energy sector, the strategy adopted opening the door to investment to the local and international private sector and various financing institutions, and one of the most important possible investment financing mechanisms. the following:

1. Partnership between public and private sectors.
2. National private sector with its various components.
3. Investment institutions, funds and banks.
4. Foreign direct investment and market opening.
5. Allocating support teams from savings in fuel consumed in thermal power plants (to purchase energy from the investor).

6.2.2 Required renewable energy technologies and implementation mechanisms

The following table shows the appropriate options and technology, in addition to initial estimates of the size of investments required for construction and the financial values required to purchase energy at each stage to exploit the renewable energy sources proposed in each stage until 2035.

Technology Type	Power Required for each Technology (MW)			
	First Stage	Second Stage	Third Stage	Fourth Stage
	2023-2025	2026 - 2030	2031-2035	2023-2035
Solar Cell Technology	1,700	600	1,000	3,300
Wind Energy	50	200	350	600
Solar Concentrators	0	50	50	100
Total Capacity (MW)	1,750	850	1,400	4,000
Cumulative financial values required in case of energy purchase (Million US\$)	525	1,992	3,317	5,834
Total estimated investments required to build capacity (Million US\$)	1,809	1,253	1,914	4,977

Table (5): Renewable energy technologies proposed during (2023 - 2035)

Year	Solar Cells	Wind Energy	Solar Concentrator	Total Capacity (MW)	Total Cumulative Power (MW)	Estimated Value Required Each Year to Purchase Energy (Million US\$)	Estimated Cumulative Value Required Each Year to Purchase Energy (Million US\$)	Total Investment Required Each Year for Construction (Million US\$)
2023	500	0	0	500	500	79	79	507
2024	500	0	0	500	1000	158	237	507
2025	700	50	0	750	1750	289	526	795
2026	100	50	0	150	1900	326	851	186
2027	100	50	0	150	2050	363	1214	186
2028	100	50	0	150	2200	399	1614	186
2029	10	0	0	100	2300	415	2029	101
2030	200	50	50	300	2600	489	2518	593
2031	200	50	0	250	2850	541	3059	288
2032	200	50	0	250	3100	594	3653	288
2033	200	50	0	250	3350	646	4299	288
2034	200	100	0	300	3650	720	5019	373
2035	200	100	50	350	4000	815	5834	678
Total	3300	600	100	4000		5834		4977

Table (6): Annual Breakdown of Capacity for Each Technology, Total Estimated Investments for Construction, and Financial Values for Energy Purchase

Note: Initial estimates were calculated based on data included in the World Bank study (source [12])

2031 - 2035	2026 - 2030	2023 - 2025
Volume of investments required is (1,914) million US\$ to create (1,400) MW, or (4,977) million US\$ to purchase (4,000) MW of energy.	Volume of investments required is (1,253) million US\$ to create (850) MW, or (3,317) million US\$ to purchase (2,600) MW of energy.	Volume of investments required is (1,809) million US\$ to create (1,750) MW, or (525) million US\$ to purchase (1,750) MW of energy.
The amount of investments required is (4,977) million US\$ to establish (4000) MW.		

Table (7): Investments Required During (2023 - 2035)

6.2.3 Proposed Policies and Procedures to Accomplish the Second Axis

First: Activating national investments by stimulating the private sector to mobilize its financial capabilities to establish renewable energy projects and providing the necessary facilities such as exemption from taxes and customs duties for a certain period, and the legislation this requires that regulates the role and contribution of the private sector and guarantees its rights, taking into account the following:

1. Providing the necessary data and studies to establish renewable energy projects.
2. Preparing economic and technical feasibility studies.
3. Providing soft, low-interest loans.
4. Adherence to the specifications and conditions necessary to establish renewable energy projects.



5. The Libyan state's commitment to purchase electrical energy produced from renewable energy projects in accordance with energy purchase and sale agreements concluded with investors.
6. Allow the national private sector to export produced energy according to appropriate conditions and guarantees.
7. Facilitating the procedures for obtaining the necessary licenses to establish renewable energy projects.
8. Allowing the national private sector to participate and cooperate with the regional and international private sector in establishing renewable energy projects.
9. The Libyan state provides the necessary infrastructure to establish renewable energy projects.

The following figure shows the policies and procedures that encourage investment in renewable energies

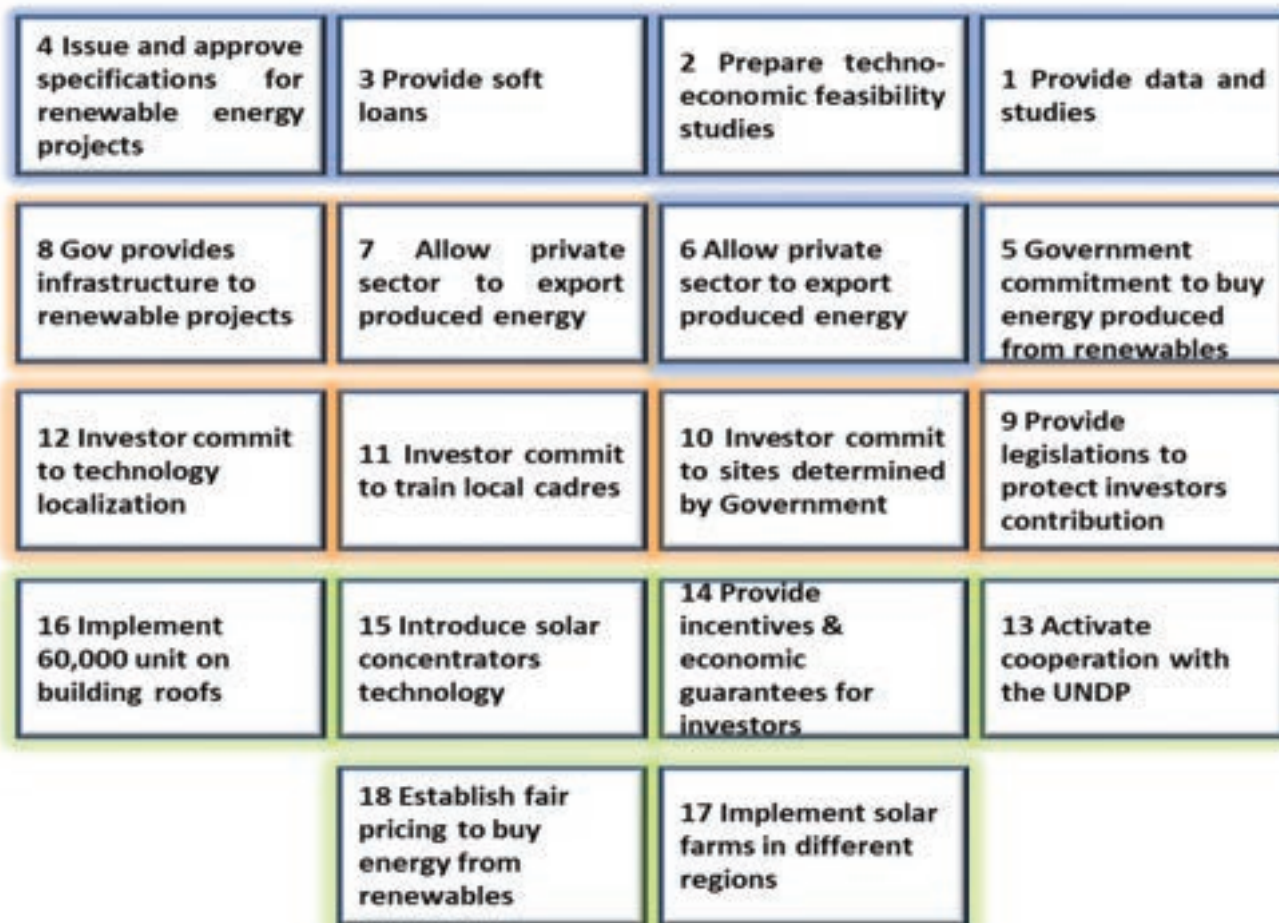


Figure (9): Proposed Policies and Procedures

Second: Participation of foreign investment in the production of electricity from non-traditional sources to benefit from Libya's distinguished geographical location through the following:

1. Issuing legislations that guarantee the contribution of foreign direct investment in renewable energy projects
2. Identifying sites for establishing renewable energy projects and guaranteeing investors rights.
3. Foreign investors commitment to employing and qualifying national cadres, localizing technology and transferring knowledge.
4. Obligating foreign investors to adhere to the applicable Grid Code system.
5. Allowing the foreign private sector, in coordination with the concerned authorities, to export electrical energy produced from renewable energies.
6. Obligating foreign investors to conduct studies of connection to the network according to the applicable grid code.

Third: Strengthening and developing the electrical transmission network to enable it to accommodate electrical production and export capabilities.

Fourth: Appropriate encouragement for the investor when buying and selling energy produced from renewable sources to motivate him to participate in the production of electrical energy.

6.3 Third Axis: Improving Energy Efficiency and Rationalizing Consumption

Energy efficiency is considered the best option for improving energy security, energy supply, reducing air pollution, increasing job opportunities, and industrial competitiveness. Energy efficiency also expresses the lowest use of energy to provide the same service. It is the fastest and least expensive way to overcome the challenges facing the energy sector to reach a sustainable energy system, i.e. obtaining energy needs without endangering the energy needs of future generations. It focuses on preparing long-term plans and policies to secure access to current and future energy needs. Energy efficiency trends have proven to be of high economic feasibility and an excellent strategy for building and developing current energy systems without the need to increase energy consumption. Studies conducted in countries that have followed strict policies regarding directing the use of energy efficiency have shown that these measures, are found to be economically feasible, despite being initially expensive.

Energy efficiency faces many challenges, but the development of appropriate programs and policies may reduce these obstacles and accelerate the implementation of national energy efficiency programs in many countries. Energy efficiency programs include energy conversion sectors and sectors used for final energy, such as the transportation sector, industry, residential, commercial, and service sectors.



Energy Efficiency in Domestic and Commercial Sectors:

The domestic sector in Libya consumes about (51%) of the total consumption of electrical energy, according to the statistics of 'GECOL', for the year 2021. The commercial sector consumes (12%), and public sector facilities consume (9%) of the total consumption of electrical energy for the same year. There is a large waste of electrical energy consumption in these sectors, as there is no awareness of rationalizing energy consumption at the individual or family level in the domestic sector, the commercial sector, or the governmental sector, as many electrical equipment are left working without stopping (computers, audio-visual broadcasting devices, heating, cooling, lighting, etc.), whether in the domestic, governmental, commercial or public sectors. It is worth noting that there are no data and statistics available on the amount of wasted energy, and work must be done to improve energy efficiency through some procedural steps such as moving towards highly efficient green buildings, improving the quality of windows, optimal orientation of buildings, and requiring them to use household electrical equipment and appliances with high specifications and efficiency.

Given that domestic water heating consumes about (30%) of the total electrical energy consumed in Libya, the strategy therefore emphasizes interest in using solar energy to heat domestic water. This requires developing a clear policy and action plan for manufacturing solar heaters in Libya by setting incentives for the private sector and external partnerships to localize this simple industry so that it can be provided to the local consumer at prices and methods commensurate with the citizen's income.

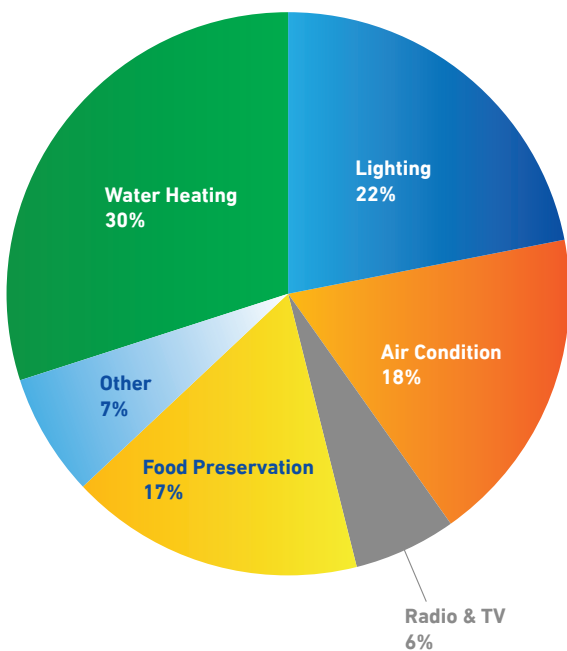


Figure (10): Energy Consumption in Domestic Sector

Energy Efficiency in Industry:

Considering that Libya is a non-industrial country, the industrial sector is a modest consumer of electrical energy, where its consumption was only (8.9%) of the total energy demand in 2006 (according to national energy data for 2006), and about (9%) of the total consumption of electrical energy according to the general company's statistics for the year 2021.

Libya is considered a producer of waste in large quantities that can be reused or recycled to benefit from it and reduce the environmental impact that results from its accumulation in landfills. It is hoped that measures and policies will be taken that will contribute to the reuse or recycling of this waste.

Energy Efficiency in Transportation:

There are no accurate statistics in Libya on the number of private or public vehicles or other means of transportation, nor is there any information on the efficiency of use of this sector, or indication on the efficiency of these means and the desired efficiency in the future or policies related to purchasing vehicles that are more efficient and less polluting of the environment.

6.3.1 National Energy Efficiency Action Plan

The National Energy Efficiency Action Plan (NEEAP) is an extension of the plan developed by 'REaOL' in cooperation with the Regional Center for Renewable Energy and Energy Efficiency (RECREE), as well as the results of the work teams formed from various Libyan state institutions to prepare strategies and action plans for national energy efficiency under the guidance of the Ministry of Planning, GECOL and REaOL. These plans aim to develop a strategy for renewable energies and introduce a group of energy efficiency initiatives and supportive programs leading in their entirety, to achieve an indicative goal of reducing electricity consumption by (15%) by the year 2028.

This goal is in line with regional and international efforts known as the guiding frameworks for improving the efficiency of electricity for the Arab end user, which was approved by the Arab Ministerial Council for Electricity in 2010.

Due to the multiplicity of studies and the different objectives and results of their outputs, coordination was made with His Excellency the Minister of Planning in charge of integrating the outputs of these studies and unifying them into one document that expresses the strategy for renewable energies and energy efficiency programs in Libya.

Energy efficiency involves using less energy to provide the same or better level of services to energy consumers in an economical manner. Action plans for national energy efficiency in the Arab region are



currently being prepared in order to effectively create a sustainable and long-term market shift towards energy efficiency through saving electricity.

‘NEEAP’ is a document that defines a national strategy and key initiatives to improve energy use and creates a roadmap to achieve national energy efficiency goals. This document represents the first national action plan for energy efficiency for the State of Libya for the period (2023 - 2028).

This plan was prepared as part of the Best Practice Program for Economic Growth in the Middle East/ Libyan Economic Stabilization Program (MEG/LESP) and the Libya Public Finance Management Program (LPFM), which aims to provide the necessary technical assistance to develop key policies and institutional reform measures. Due to its critical importance in achieving social and economic stability, it began responding to a request from the Libyan government to determine the causes of the recurring power outages that caused an ongoing crisis in electricity supply in Libya and to provide recommendations for strategic measures that the government and the ‘GECOL’ must take to reduce the severity of the crisis. The per capita share of electricity consumption in Libya was constantly exceeding international averages, but this trend changed during the period of instability that began in 2011. However, compared to its neighbors in North Africa, Tunisia, Morocco, Egypt and Algeria, the per capita consumption of electricity in Libya has remained higher than the global average.

Electricity consumption in Libya has increased over the past years by an average of (8%) annually, while the average growth of GDP has reached (6%). This trend indicates that the targeted projects and sectors selected for development were intensive in terms of electricity consumption. Moreover, residential consumption has risen rapidly, especially the demand for air conditioning, as the level of national per capita energy consumption is similar to that of Italy (4.8) MW/capita, even though the economy does not have a similar energy need to the industrial sector. These observations clearly indicate that there is an opportunity to achieve electricity savings through the use of energy efficiency measures.

6.3.2 Past and Present Initiatives Related to Energy Efficiency

Work on energy efficiency activities was recently implemented as part of the Best Practices Program for Economic Growth in the Middle East/Libyan Economic Stabilization Program, which aims to improve the cost efficiency and reliability of electricity service provision in Libya. This work includes conducting a top-down assessment of energy budgets and national statistics and Sectoral analysis to identify the status of energy use areas in the country.

In addition to the above, several energy efficiency programs have been identified that will help alleviate the electricity crisis in Libya and move the country towards achieving energy efficiency potential in the

long term. These programs will be considered and included as part of the energy efficiency program recommendations outlined in this report.

The strategy aims to improve electrical energy efficiency to achieve savings at the end consumer level by reducing energy consumption. The efficiency of using electrical energy and rationalizing consumption will be raised through five initiatives in order to reach the general goal, which is to achieve a saving of (15%) of the total electrical energy consumption in various sectors by 2027, taking into account the current and expected energy consumption rate.

Sector	(%) Consumption in 2021	Consumption 2025 (GWh)	Consumption 2030 (GWh)	Consumption 2035 (GWh)
Household	50.9%	23,450,463	31,746,473	46,104,592
Large Agri.	8.4%	3,870,018	5,239,104	7,608,616
Small Agri.	4.4%	2,027,152	2,744,292	3,985,466
Light Industry	4.4%	2,027,152	2,744,292	3,985,466
Heavy Industry	4.1%	1,888,937	2,557,181	3,713,729
Commercial	12.1%	5,574,668	7,546,804	10,960,031
Public Sector	9%	4,146,447	5,613,325	8,152,089
Street Light	6.7%	3,086,800	4,178,809	6,068,777
Total	100%	46,071,637	62,370,280	90,578,765

Table (8): Current and Expected Energy Consumption in Various Sectors During (2021 - 2035)

6.3.3 Specific barriers to energy efficiency programs

1. Low energy prices - Electricity and fuel prices were maintained at a rate lower than the actual cost of power generation through government subsidies for fuel and cost differences. Energy prices do not reflect the true cost of production and supply. The cost pricing structure below not only mitigates the need for large government subsidies, but also encourages inefficient use of electricity and limits investment in energy efficiency because the associated monetary savings are small. Energy pricing policies must send the right signals to the end user. Appropriate pricing encourages the efficient and productive use of the commodity and protects the ability of the state and society to operate the electricity sector in a financially stable manner.
2. Lack of financing for energy efficiency - There is difficulty in obtaining financing specifically for energy efficiency from commercial lending institutions, as banks have not built sufficient capabilities to deal with the evaluation of energy efficiency projects and financing plans for projects.



3. The lack of a comprehensive national plan for energy efficiency previously - energy efficiency was not part of the national energy strategy process.

All state institutions are confident that the observations, analyses, conclusions and recommendations contained in this report can be effectively used to form the final action plan for national energy efficiency, strengthen national institutional capabilities, enhance energy efficiency policy, and implement energy efficiency initiatives that improve the outlook for energy efficiency. The country's electricity sector will significantly enhance the level of reliability of the national electricity supply.

6.3.4 Indicators for the electricity sector

No.	Sector	Percentage (%)
1	Household	50.9%
2	Commercial	12.1%
3	Public Sector	9.0%
4	Agriculture (Large)	4.4%
5	Agriculture (Small)	8.4%
6	Heavy Industrial	4.1%
7	Light Industrial	4.4%
8	Street Lighting	6.7%

Table (9): Share of Electricity Consumption per Sector (Based on 2021 Releases)
(Source – GECOL Customer Service, billing data 2021)

6.3.5 Analysis of indicators at the country level

When evaluating these indicators during the period from 2000 to 2021 and comparing them to countries in the North African region and international rates, the measures of primary energy use per 1,000 US\$ of GDP and the share of electrical energy use per capita are considered prominent aspects. These statistics show the historical nature of the Libyan economy, which is characterized by excessive consumption of electrical energy per capita compared to countries in North Africa, with no clear reference source. From 2002 to 2010, the per capita share of electrical energy consumption in Libya was much higher than international averages, but it began to decline during the period of insecurity between 2011 and 2014 to levels close to its neighbors in the region. However, since 2015, the level of consumption has rebounded well above the international average. From 2000 to 2014, the total energy used in Libya equivalent to a kilogram of oil per capita remained higher than the international average. Moreover, Libya's GDP depends heavily on oil production, which has been subject to pressure from both large differences in production rates due to the security situation and to fluctuations in global oil prices. As a result, Libya's energy use in kilograms of oil equivalent to every \$1,000 of GDP saw significant increases that far exceeded the international average for the years 2011, 2013 and 2014.

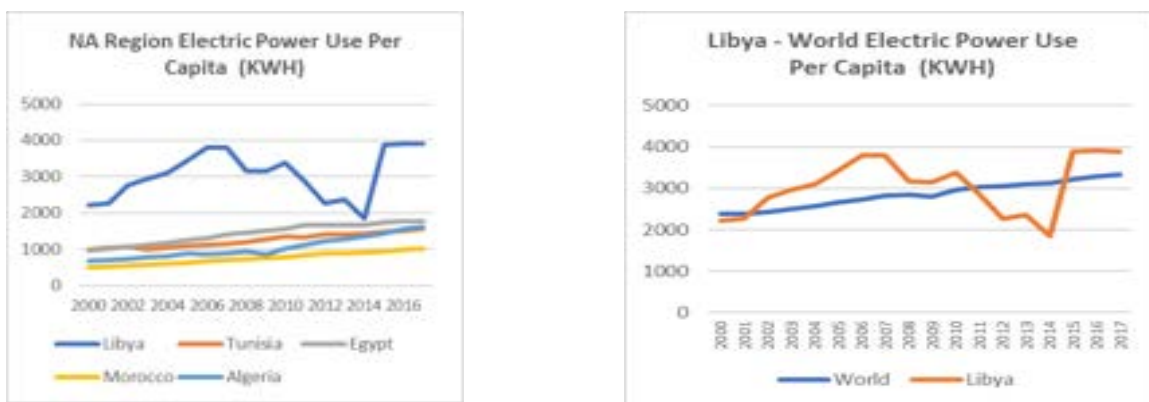


Figure (11): Comparisons of Energy Consumption with Neighboring Countries and the World

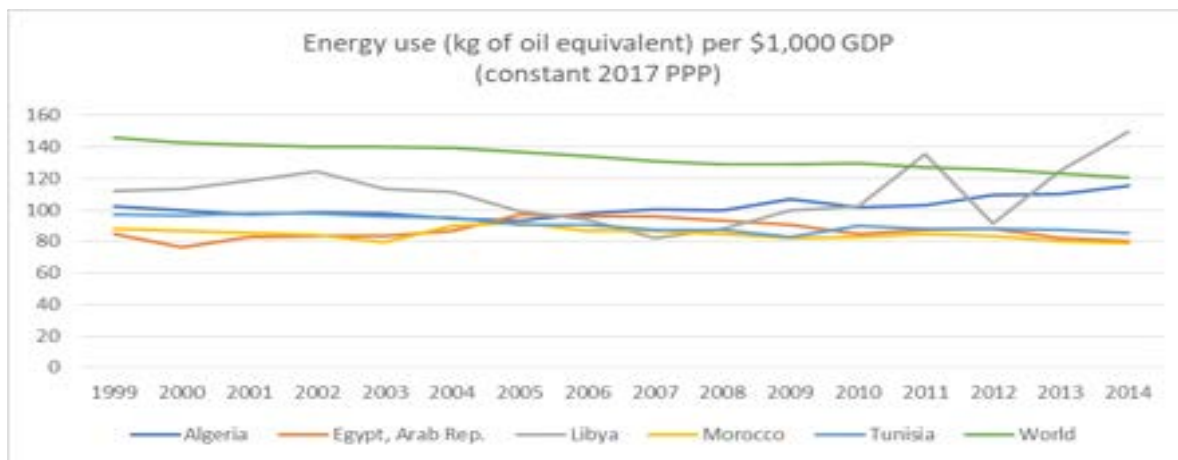


Figure (12): Energy use (oil equivalent) per \$1,000 GDP at constant prices
(Source: World Bank database)



These statistics indicate that there is a tremendous opportunity for energy efficiency programs to reduce the volume of consumption and reduce the amount of energy in the Libyan economy, as shown in the following table:

Year	2021	2022	2023	2024	2025	2026	2027
Total Energy Demand	46,107,476	51,386,820	53,388,193	55,643,314	58,318,528	61,034,586	64,613,038
Technical Losses	25%	25%	25%	25%	21%	21%	21%
Total Energy without DSM	34,580,607	38,540,115	40,041,145	41,732,486	46,071,637	48,217,323	51,044,300
Savings from all Programs	0	0	2,459,528	4,530,290	5,586,592	6,612,186	7,581,887
Total Energy with DSM	34,580,607	38,540,115	37,581,617	37,202,196	40,485,045	41,605,137	43,462,413
Year	2029	2030	2031	2032	2033	2034	2035
Total Energy Demand	72,739,076	78,949,722	87,280,261	99,395,878	105,453,182	110,781,311	114,656,665
Technical Losses	21%	21%	21%	21%	21%	21%	21%
Total Energy without DSM	57,463,870	62,370,280	68,951,406	78,522,744	83,308,014	87,517,236	90,578,765
Savings from all Programs	7,581,887	7,581,887	7,581,887	7,581,887	7,581,887	7,581,887	7,581,887
Total Energy with DSM	49,881,983	54,788,393	61,369,519	70,940,857	75,726,127	79,935,349	82,996,878

Table (10): Energy Demand Forecasts with and without Demand Side Management System (MWh)

6.4 Fourth axis: Main and supporting initiatives

6.4.1 Key Initiatives

The main energy efficiency initiatives presented in this section are further explained in terms of the programs that will be implemented under the National Energy Efficiency Plan over the period (2023-2027). The programs are designed to ensure attention to energy efficiency measures provided to consumers. The main initiatives that will be introduced during the plan period are as follows:

Main Initiative 1: Energy-Efficient Lighting.

Main Initiative 2: Distributed Solar PV Program.

Main Initiative 3: Solar Water Heating Program.

Main Initiative 4: Electricity pricing program in existing state-owned entities.

Main Initiative 5: Appliance calibration and labeling program (air conditioning, motors, refrigeration, ...).

The following is a table that gives an overview of the percentage of savings, estimated costs, and the value of benefits achieved for each program over a period of (5) years and during the life of the project:

Program	2023	2024	2025	2026	2027	(%) of savings from year 2027	(%) of savings from total transmitted energy
Incandescent lamp replacement (MWh)	950,591	1,901,183	1,901,183	1,901,183	1,901,183	25.10%	4%
Distributed Solar PV (MWh)	172,233	344,467	516,700	688,933	861,167	11.35%	%2
Water Heating By Solar Energy (MWh)	142,162	284,325	426,487	568,649	710,812	9.40%	%1
Increasing Electricity Prices (MWh)	816,667	1,244,568	1,608,601	1,941,926	2,219,357	29.25%	%4
Instrument Calibration (MWh) Amount of	377,874	755,747	1,133,621	1,511,495	1,889,369	24.90%	%4
Electricity Savings from All Programs	2,459,527	4,530,290	5,586,592	6,612,186	7,581,888	100%	%15

Table (11): Savings Projections from Energy Efficiency Initiatives

Program	Estimated cost of Program (LYD)	Implementing Period	Percentage of savings in usual business	Benefits of program during (5) years	Benefits of program during life of project (LYD)	Implementing Agency
Lighting using (LED) lamps	547,835,464	2024-2023	4%	6,155,175,405	11,183,973,660	Government and 'REAoL'
Distributed solar photovoltaic energy	3,863,166,667	2027 - 2023	2%	2,998,112,400	11,168,861,733	Government and 'GECOL' and 'REAoL'
Heating using solar energy	2,021,000,000	2027 - 2023	1%	1,011,627,331	6,069,763,988	Government and 'GECOL' and 'REAoL'
Calibration and Labeling of devices (lighting, motors, A/C, refrigeration)	4,456,120	2027 - 2023	4%	2,686,682,320	2,686,682,320	National Center for Metrology and Standards
Increase in electricity prices	--	2027 - 2023	4%	3,711,950,378	3,711,950,378	'GECOL'
Total	6,436,458,251		15%	16,563,547,834	34,821,232,079	

Table (12): Program Costs and Benefits

Note: Benefits related to solar PV and lighting have been calculated using international fuel prices during 2021 plus spared capacity costs. As for the other benefits of the programs, they were calculated using the spared cost of fuel based on international prices during the year 2021.

Detailed Information for Each Program

1. Lighting Program Using LED Lamps

Action has been taken by the Minister of Economy and Industry to ban the import of incandescent lamps into Libya. This measure has been taken to gradually reduce energy consumption in lighting as replacement bulbs are purchased by consumers. The website page of the United for Efficiency (U4E) initiative of the United Nations Environment Office states that "electricity for lighting represents approximately (15%) of global energy consumption and (5%) of global greenhouse gas emissions."

Switching to efficient on- and off-grid lighting globally will save more than \$140 billion and reduce carbon dioxide emissions by (580) million tons annually. "Few actions can reduce the level of carbon emissions as cheaply and easily as phasing out inefficient lighting, making it one of the most effective and economically beneficial ways to combat climate change." In recognition of LED-based lighting technology and its ability to reduce the capacity that 'GECOL' can provide and reduce the level of carbon emissions, the Libyan National Program for Diode Lighting is designed to systematically replace (30,000,000) home lamps inside Libya with LED lamps over an implementation period of two years.

Program Name	Replacement of old Lighting Lamps by 'LED' Lamps
Target	This initiative aims to replace (30,000,000) incandescent lamps with LED lamps by the end of 2024.
Implementing Agency	Renewable Energy Authority - 'GECOL' - Libyan Government
Involved Stakeholders	Libyan Center for National Standards - Renewable Energy Authority
Target Group	Residential buildings
Program Cost	(547,835,464) LYD
Energy Savings (MWh)	(8,555,323) MWh for the cumulative 5-year program, or (3.72%) of the total expected consumption for the year 2027 and (18,061,237) MWh for the 10-year cumulative program.
Total Revenue and Realized Savings (LYD)	(6,155,175,405) LYD for the total 5-year cumulative program, (11,183,973,660) LYD for the total cumulative 10-year program.
Fuel Revenue (LYD)	4,525,918,429 LYD for a total of (5) years cumulative program, 9,554,716,684 LYD for a total of (10) years cumulative program.
Avoided Capacity (LYD)	(460 MW) (1,629,256,976 LYD)
Funding Source	Development Budget
Outreach	A promotional campaign through local media and national workshops in coordination with the engineers & architects syndicates, as well as building developers and suppliers.
Monitoring and Estimating Impact	Track the number of incandescent LED lamps distributed and the number of regular lamps collected and calculate the energy savings based on the energy difference according to the average hours of use specified in the reference studies.

Table (13): Detailed Information on LED Lamps Initiative

2. Solar Photovoltaic Energy Distribution Program

The distributed solar PV program is designed to encourage the installation of solar PV panels on residential and commercial sites. A program of this type can help the country by increasing energy security through the use of distributed renewable energy sources, increasing the number of actors in the electricity market, and protecting the environment by reducing greenhouse gas emissions. These systems can also serve as a source of backup power supply for the consumer. The program can also provide an opportunity to obtain macroeconomic benefits, such as job creation, through the engineering design, installation, and maintenance activities necessary to deploy and operate the systems effectively.

The recommended program design suggests that consumers bear (60%) of the costs of installing individual systems and that the government contributes the remaining (40%) by offering a discount to customers or direct payment to installation contractors. It also proposes creating a special program that would allow the consumer to secure low-cost financing covering his share of the installation from approved banks or financial institutions.



Program Name	Distributed Solar Energy on Rooftops Program
Target	<ul style="list-style-type: none"> • Raising the level of renewable energy use • Spreading the supply of renewable electric energy in the transmission and distribution networks (T & D) to reduce the size of the national deficit related to generation • Reducing carbon emissions
Description of the Procedure	Deployment and distribution of Solar Photovoltaic energy (500 MW) at an annual rate of (100 MW) starting in (2023)
Implementing Agency	'GECOL', Renewable Energy Authority and the Ministry of Economy
Involved Stakeholders	Consumers and Banking Institutions
Target Group	Residential and Commercial Facilities
Program Cost over (5)-Years	3,863,166,667 LD
Program Cost over the Lifetime of the Equipment	6,281,833,333 LD.
Returns Achieved During (5)-Years	2,998,112,400 LD
Revenues Achieved During Lifetime of the Program	11,168,861.73 LD (9.4) Fuel savings + (1.8) Avoided capacity in Billions of Dinars
Funding Source	40% by Libyan Government & 60% by consumers
Followup and Monitoring of Impact	An annual report to be submitted to the Higher National Committee for Energy Efficiency in relation to the units developed and the energy produced by these systems
Outreach	Promotional campaign on TV & Social Media

Table (14): Detailed Information on Distributed/Rooftop Solar Initiative

3. Water Heating Program Using Solar Energy

The Solar Water Heating Program is designed to encourage the installation of solar water heaters in residential facilities. Similar to the distributed solar PV program, this program can increase Libya's energy security while reducing grid-supplied energy requirements and related greenhouse gas emissions. Solar water heating also provides an opportunity to capitalize on the overall economic benefits of job creation associated with the engineering design, installation and maintenance activities necessary to deploy and operate the systems effectively.

The program design proposes that consumers bear (60%) of the costs of installing individual systems and that the government contributes the remaining (40%) by offering a discount to customers or direct payment to installation contractors. Creating a special program that allows customers to secure the minimum financial cost that covers their share related to the installation by approved banks or financial institutions.

Program Name	Distributed Solar Energy on Rooftops Program
Target	<ul style="list-style-type: none"> • Raising the level of renewable energy use • Spreading the supply of renewable electric energy in the transmission and distribution networks (T & D) to reduce the size of the national deficit related to generation • Reducing carbon emissions
Description of the Procedure	Deployment and distribution of Solar Photovoltaic energy (500 MW) at an annual rate of (100 MW) starting in (2023)
Implementing Agency	'GECOL', Renewable Energy Authority and the Ministry of Economy
Involved Stakeholders	Consumers and Banking Institutions
Target Group	Residential and Commercial Facilities
Program Cost over (5)-Years	3,863,166,667 LD
Program Cost over the Lifetime of the Equipment	6,281,833,333 LD.
Returns Achieved During (5)-Years	2,998,112,400 LD
Revenues Achieved During Lifetime of the Program	11,168,861.73 LD (9.4) Fuel savings + (1.8) Avoided capacity in Billions of Dinars
Funding Source	40% by Libyan Government & 60% by consumers
Followup and Monitoring of Impact	An annual report to be submitted to the Higher National Committee for Energy Efficiency in relation to the units developed and the energy produced by these systems
Outreach	Promotional campaign on TV & Social Media

Table (15): Detailed Information on Solar Water Heating Initiative

4. Electricity Pricing Program

'GECOL' is currently seeking to obtain approval for the revised pricing rates for the purpose of enhancing its financial stability, but the proposals that are currently being evaluated by government authorities do not include mention of its energy efficiency benefits. Energy pricing policies must send the right signals to motivate the end user to consume the commodity efficiently.

By using the conclusions of the price elasticity study, which stipulated a decrease in the level of electricity use in the short term by (15%) when prices doubled, the advisory team estimates that implementing the proposed tariffs will lead to a decrease in energy savings by (4%) in the year 2027 compared to usual situation. This is equivalent to a reduction of (2,219) GWh in 2027 and a cumulative energy reduction of (7,831) GWh during the period (2023-2027).

When evaluating international fuel prices during the year 2021, which was avoided, savings estimated at approximately (3.7) billion dinars could be achieved over the five-year evaluation period of the program through the implementation of a new electricity pricing system on commercial basis and ending the government subsidy policy for energy.



Users	The Revenue Return Tariff in Dirham/kWh @ New XR 4.48 LYD/US\$					
	2023	2024	2025	2026	2027	2028
Residential	30	78	140	260	370	474
Agricultural (Small)	45	127	238	307	373	433
Agricultural (Large)	55	107	154	228	300	368
Light Industrial	130	253	364	386	407	419
Heavy Industrial	85	166	238	287	333	376
Commercial	150	292	420	424	427	422
Public Facilities	150	292	420	419	415	409
Street Lighting	150	292	420	426	429	428
Average Tariff	73	155	240	314	382	444

Table (16): Proposed Electricity Tariffs According to Customer Category (AED/kWh)

Furthermore, if these tariffs, which are calculated to achieve a cost-of-service revenue recovery level in 2028, are applied, there will be no need for government subsidies for both fuel and operational expenses assuming the company's billing and metering challenges can be addressed to achieve the levels of international best practices related to commercial losses. There is a detailed discussion of the zero-subsidy initiative task force in a separate report for review by policy makers.

Program Name	Electricity Pricing Program
Target	<ul style="list-style-type: none"> Implementation of the energy subsidy reform program to motivate citizens to reduce their consumption of electric energy Reducing the requirements of 'GECOL' for government subsidies
Description of the Procedure	The official announcement and approval of the gradual increase in electricity prices during the period (2023-2028)
Implementing Agency	General Electricity Company and the Ministry of Economy
Stakeholders Involved	National Oil Corporation (NOC)
Target Group	All Sectors
Program Cost	0.0 (LYD)
Program Benefits	3,711,950,378 (LYD)
Energy Savings (MWh)	7,831,119 (MWh) is the cumulative total of the (5)-year program, or (4%) of the total expected consumption for the year (2027)
Funding Source	None
Followup and Monitoring of the Impact	Submitting an annual report to the authority supervising energy efficiency on the impact of increased custom duties on energy consumption
Outreach	TV, social media

Table (17): Detailed Information on Electricity Pricing Initiative

5. Device Calibration and Labeling Program

As part of its scope of work, the Libya Energy Efficiency Task Force implemented a policy formulation program for appliance labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. Work is currently underway within the framework of the Energy Efficiency Task Force and the Libyan National Center for Standards and Specifications to develop a program such as the ENERGY STAR program that the United States and the European Union are implementing. The ENERGY STAR program was launched by the US Environmental Protection Agency in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. The US Environmental Protection Agency and the European Union signed a formal bilateral agreement in 2001 to promote concrete action aimed at raising the level of energy efficiency..



The agreement provides means of continuously updating international standards and enhancing the technical standards of equipment by coordinating the testing procedures used to certify the performance of products bearing the ENERGY STAR logo. More than (2,200) product models from more than (140) manufacturers were recognized as “Most Efficient Energy Star” in 2017. In the United States alone, the program, since its inception in 1992, has saved families and businesses more than (\$450 billion) from energy costs and more than (3.5) trillion kWh of electricity and reducing the level of associated greenhouse gas emissions by (3.1) billion metric tons.

While the establishment of device standards has been the driving force behind the widespread adoption of such technical innovations as efficient incandescent LED lighting, power management systems for office equipment, and reduced standby power use for electronic devices in developed world markets, developing and implementing this program for Libya will take time, but its benefits in terms of energy savings and carbon emissions reductions could be significant.

Specifications will need to be codified and approved, as well as testing procedures and facilities. Market penetration by new products will require time for them to become the largest mass, and mechanisms must be put in place to monitor the device market and enforce compliance and adherence. However, with the recent publication of the U4E regulations for air conditioning, space heating, refrigeration, three-phase



motors and lighting, it is possible to achieve (5.12%) of the targeted savings for 2027 from this initiative if the U4E regulations are allocated and adopted for implementation in Libya during the last half of the year 2022. To this end, it is recommended that the Libyan National Center for Standards and Specifications and focus on five categories of products based on air conditioning, space heating, refrigeration, three-phase motors, and lighting, and develop marketing regulations that can be implemented at the national level. Since most of these products are imported, the pace of market transformation can be accelerated by imposing appropriate controls on imports and programs to utilize old devices. Model regulations (U4E) have been provided to the Energy Efficiency Team to assist the Libyan National Center for Standards and Specifications in preparing marketing regulations and energy efficiency requirements for the targeted appliance groups.

Program Name	Equipment Tagging Program
Target	<ul style="list-style-type: none"> Reducing energy consumption of domestic appliances and industrial engines Subjecting the appliance market to the performance and consumption requirements of new energy efficiency performance parameters
Description of the Procedure	<ul style="list-style-type: none"> The Libyan Standards and Specifications Center approves the standards for the imported and locally produced equipment Legislation requiring suppliers to affix energy efficiency labels. Providing the appropriate tools for monitoring the market to ensure that manufacturers adhere to national standards.
Implementing Agency	The Libyan Standards and Specifications Center
Stakeholders Involved	The Libyan Customs Authority, the Ministry of Economy, the Industrial Research Center, the National Center for Libyan Standards and Specifications, the National Center for Accreditation, the General Electricity Company and the Renewable Energy Authority
Target Group	Suppliers, importers and end users of air conditioning, refrigeration, three-phase motors and lighting.
Program Cost	(4.5) million dinars, of which (1.4) million dinars is the cost of a new laboratory for testing equipment + the cost of annual fees that must be paid by Libya in return for the membership required to reach the specifications
Revenues Achieved from the Program	2,686,682,320 LYD
Energy Savings (MWh)	(5,668,706) MWh is the total cumulative (5)-year program, or (4%) of the total expected consumption for the year (2027)
Funding Source	General Development Budget.

Table (18): Detailed Information on Instrument Calibration and Labeling Initiative

6.4.2 Supporting Initiatives

In the context of further research into methods and procedures for improving the efficiency of electric energy production from generation and desalination plants with various existing and future steam and gas technologies, and also through developing technical specifications for building and construction works, it has become necessary to add a number of important strategic initiatives related to the implementation of new projects and the development and modernization of the generation and consumption for the existing electrical energy sources as follows:

In the Field of Fuel::

1. Work to implement marine natural gas transmission lines proposed by the joint technical committees between the electricity and oil sectors to supply production and desalination plants with the required quantities of gas located near the sea shores.
2. Work to develop standards and design specifications for all types of fuels manufactured inside Libya and adhere to them when imported from abroad, in line with international specifications for environmental protection and the specifications of manufacturers of electric power production units.
3. Working to establish the infrastructure required to use liquefied natural gas (LNG) in large power plants with the possibility of direct pumping into operating natural gas transmission and distribution networks.
4. Accelerating the implementation of the project to supply the Ubari gas station with natural gas from the Al-Atshan field instead of operating it with crude oil to reduce the costs of operation, maintenance and serious overhauls while protecting the environment and nearby equipment.

In the Field of Power Plants and Transportation Networks

1. Implementation of combined cycle projects in the existing gas power plants and expansion in the construction of steam power plants.
2. Updating and developing measurement and control systems for combustion systems and emissions monitors at existing power plants.
3. Adopting reverse osmosis (RO) technology in future desalination projects, as it is closer to protecting the environment than others.
4. Work on the implementation of major overhauls and periodic inspections at the specified times to avoid the big difference in capabilities between the rated and available ones, especially during peak periods.



5. Work to improve the energy efficiency of the power plants of the oil and gas sector.
6. Electrical interconnection of electricity networks between the electricity and oil sectors.

In the Field of Building and Construction

1. Installing solar energy systems in the buildings of the departments of the electricity and oil sectors and in ancient historical sites (cities).
2. Inclusion of additional articles in the regulations of administrative and public tender contracts regarding adherence to the principles of energy efficiency and protection of the environment and the surroundings.
3. Developing the technical specifications for building and constructing public and private buildings and their equipment and devices to be of high quality.
4. Supporting and encouraging civil society organizations to contribute to educating the various segments of society of the need to rationalize consumption, spread energy awareness, and focus on youth in particular.

6.5 Proposed Policies and Procedures to Accomplish the Third and Fourth axes

1. The specialization of energy efficiency be an original specialty of the Renewable Energy Authority, which will undertake the planning and supervision of energy efficiency programs.
2. Developing and following up executive action plans for energy efficiency, improving procedures, and proposing governing laws and regulations.
3. Setting standard specifications for devices, equipment, lighting systems, means of transportation, etc., in order to rationalize and improve energy efficiency.
4. Setting specifications for imported and locally produced household electrical appliances, and adopting guidelines and incentives that encourage saving energy in homes.
5. Using high-efficiency devices and equipment to carry energy efficiency labels or labels, especially air-conditioning and refrigeration devices, water pumps and other energy-consuming devices.
6. Issuing decrees to ban the import of non-energy-saving light bulbs, electrical equipment and appliances, and electric heaters.
7. Reducing customs duties on economical lamps and energy-saving devices and equipment.
8. Rationalizing the consumption of electrical energy for public lighting in streets and parks, and shifting towards LED technology and using renewable energy technologies.
9. Exempting solar energy equipment from customs to encourage citizens to purchase it.

10. Establishing a system for collecting data and statistics related to energy production and consumption patterns.
11. Approving the specifications of environmentally friendly buildings.
12. Supporting the manufacture of solar heaters and encouraging its use.
13. Imposing and implementing mandatory energy efficiency policies and expanding and developing them to include all energy users.
14. Introducing the electricity tariff system according to the timing to ensure a reduction in the use of electricity during the peak period.
15. Building institutional capacity and raising awareness of the deployment of solar water heating systems in homes and public facilities.
16. Capacity building and spreading the culture of energy efficiency and including it in educational curricula.
17. Benchmarking with neighboring countries, especially the developed ones, in the field of energy efficiency to benefit from successful experiences.
18. Transforming state buildings into environmentally friendly buildings, and using high-efficiency thermal insulation and window technologies.
19. Spreading the culture of orientation towards the use of electric cars in the Libyan market by reducing customs duties and motivating the sectors of the state to replace their traditional cars with electric ones.

7 Conclusions and Recommendations

7.1 Conclusions:

1. Over a period of more than five decades, the Libyan economy relied on revenues from crude oil and natural gas to finance most of its administrative and investment expenses.
2. Development plans and budgets prepared during the period 1963-2018 adopted the goal of diversifying sources of income from foreign currencies, but this goal was not achieved.
3. In an attempt to diversify energy sources, the state established a number of institutions to produce electricity and other renewable energies. Despite the efforts made by these institutions, these efforts did not bear fruit for many reasons.
4. The potential of renewable energies in Libya (especially sun and wind) is a renewable resource that can contribute about 20% of the energy supply during the period 2023-2035.



5. Efficiency and rationalization of solar energy consumption for domestic water heating and public lighting saves about 15% of electrical energy consumption in the same period 2023-2035.
6. Cultivation of biofuel-producing plants produces sustainable, environmentally friendly biodiesel as an alternative to fossil diesel that can be used to support the national economy.

7.2 Recommendations

To activate the production of electrical energy from renewable energies, and rationalize energy use in general, the proposal for the National Strategy for Renewable Energy and Energy Efficiency 2023-2035 was prepared and updated, which studied the topic through four main headings:

1. The reality of the electric energy and renewable energy sectors.
2. National goals.
3. Public policies.
4. Investments necessary to finance renewable energy projects.

To put the National Strategy for Renewable Energy and Energy Efficiency into practice, we propose the following recommendations:

1. Implementation of the strategy through medium-term development plans.
2. Pushing the national private sector to implement renewable energy projects and take the necessary legal, administrative and financial measures.
3. Encouraging the entry of foreign investors to contribute to the production of electricity through renewable energy, and taking the necessary measures to achieve this.
4. The State is limited to providing infrastructure and some incentives for renewable energy projects.
5. Participation of the banking sector in financing renewable energy projects in accordance with controls, standards and foundations that guarantee their rights.
6. Obligating the banking sector to grant soft loans to citizens to finance the cost of solar energy systems for the purposes of lighting and water heating.
7. The Libyan side understands how to deal seriously with the United Nations Development Program, the European Union, and the competent international agencies and organizations to provide thousands of support for renewable energy projects, in order to make the most of them.
8. Communicating with regional and international countries for their expertise and benefiting from their experiences in the field of renewable energy .
9. Developing and approving specifications and technical standards for equipment, electrical appliances, and renewable solar energy equipment.
10. Supporting the transfer and localization of technology and know-how in the field of renewable energy

, especially in the sectors of the Libyan state, and relying on national cadres to absorb this technology and refine their skills.

11. Providing the necessary direct support for educational, technical and research institutions specialized in the field of renewable energies to build national cadres with high skills and encourage young people to turn to solar energy and acquire its skills to transform the labor market and contribute to national economy.
12. The need to involve the technical, practical and research education sector in the various stages of implementing the strategy.
13. Working to educate the community, technically and economically, in parallel with the implementation of the strategy axes to achieve sustainability and ensure positive change.
14. Enhancing cooperation with the Energy Department of the League of Arab States as well as the Arab Regional Center for Energy Efficiency «RCREEE» and specialized regional and international agencies and organizations.
15. Supporting and encouraging civil society institutions to rationalize consumption, spread energy awareness among the various circles of society, and focus on youth groups in particular.
16. Creating an investment fund for renewable energy and energy efficiency projects.



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