

The Successful Transition to Environmental Sustainability in Libya

Dr. Mohamad Nasar bin Nasar

Faculty of Science - University of Zintan
mohamed.nasar.bnnasar@gmail.com

Abstract

This study outlines how Libya could become sustainable if it so chooses, the world is moving rapidly towards a transition to environmental sustainability after the dangers of using fossil fuels and excessive use of natural resources without taking into account the environmental aspects have become publicly clear through of the phenomenon of Global warming and climate change. The aim of this study is to identify opportunities for decision-makers in Libya to intensify environmental management and move towards sustainability methods by preserving the three main natural resources in Libya (water, oil, and gas). The paramount needs are to make the water supply sustainable and to make a transition to renewable energy as fast as possible, both water and oil stocks are depleting and will become scarce unless conserved, sales receipts from Libya's declining oil and gas resources could be allocated to accelerate the transition to solar electricity, which should fast become the most profitable and sustainable export to Europe. Conservation of hydrocarbons is essential to boost oil and gas exports to finance solar electricity, the main opportunity is to conserve Libya's three main natural resources, water, oil and gas. Conservation of these resources will firmly catalyze Libya's transition to a sustainable economy while improving the quality of life. This study focuses on water and energy conservation and investment in renewable energy through:1) Benefit from the revenues of oil and gas, which are considered as revenues temporary and exhaustible to create sustainable development based on renewable energy in most economic activities. 2) Transform Libya from a producer and exporter of fossil fuels to a country producer and exporter of clean energy, such as energy generated from wind

and sun. Libya enjoys a privileged location near the continent of Europe can be an important source of electricity generated from solar energy to Europe. 3) Reduce fossil fuel consumption which increases the life of its reserves, and this leads to a reduction in the proportion of greenhouse gas emissions, the main cause of global warming.4) Maintain the groundwater and the rationalization of consumption.5) Create new job opportunities for young people Libyan, because the transformation project for the sustainable economy requires a lot of development projects that need to be trained workforce and efficient.6)Libya is a unique nation in many ways: especially its location that contains the highest solar insolation on the planet, so the daily average of horizontal solar radiation is 7.1 kWh/m²/day, with an average sun duration of more than 3,500 hours per year. 7) Accelerating the development of solar and wind energy will enable Libya to export hydrocarbons for a longer period.

Keywords: environmental sustainability, Renewable energy, natural resources, (water, oil and gas).

التحول الناجح إلى الاستدامة البيئية في ليبيا

د. محمد نصر امحمد بن نصر

كلية العلوم / جامعة الزنتان

mohamed.nasar.bnnasar@gmail.com

الملخص

توضح هذه الدراسة إمكانية كيف يمكن أن تصبح ليبيا مستدامة إذا توفرت الإرادة لذلك، العالم يسير بسرعة نحو التحول إلى الاستدامة البيئية، بعد أن أصبحت مخاطر استخدام الوقود الأحفوري والإفراط في استخدام الموارد الطبيعية دون مراعاة الجوانب البيئية ظاهرة للعلن من خلال إحتراق الأرض أو بما يعرف بظاهرة الاحتباس الحراري والتغير المناخي، ويعد التغير المناخي السمة الأبرز خلال السنوات الأخيرة. ليبيا ليست خارج هذا العالم والتحول نحو الاستدامة بات ضرورة ملحة ، والهدف من هذه الدراسة هو تحديد الفرص لصناع القرار في ليبيا للاهتمام بالإدارة البيئية والانطلاق نحو طرق الاستدامة من خلال

الحفاظ على الموارد الطبيعية الثلاثة الرئيسية في ليبيا (المياه والنفط والغاز)، إن الحفاظ على هذه الموارد سيحفز بقوة انتقال ليبيا إلى اقتصاد مستدام مع تحسين نوعية الحياة، تركز هذه الدراسة على الحفاظ على المياه والطاقة والاستثمار في الطاقة المتجددة من خلال: (1) الاستفادة من عائدات النفط والغاز والتي تعتبر عائدات مؤقتة وقابلة للنفاد لخلق تنمية مستدامة تعتمد على الطاقة المتجددة في معظم الأنشطة الاقتصادية. (2) تحويل ليبيا من دولة منتجة ومصدرة للوقود الأحفوري إلى دولة منتجة ومصدرة للطاقة النظيفة، كالتجارة المولدة من الرياح والشمس. تتمتع ليبيا بموقع متميز بالقرب من قارة أوروبا يمكنها أن تكون مصدرًا مهمًا للكهرباء المولدة من الطاقة الشمسية إلى أوروبا. (3) تقليل استهلاك الوقود الأحفوري مما يزيد من عمر احتياطياته ويؤدي ذلك إلى انخفاض نسبة انبعاثات غاز ثاني أكسيد الكربون والمساهمة في خفض نسب التلوث. (4) المحافظة على المياه الجوفية وترشيد الاستهلاك. (5) خلق فرص عمل جديدة للشباب الليبي، لأن مشروع التحول للاقتصاد المستدام يتطلب الكثير من المشاريع التنموية التي تحتاج إلى قوى عاملة مدربة وفعالة. (6) تعدد الطاقة الشمسية في ليبيا من بين أكثر مصادر الطاقة المتجددة كثافة في العالم بسبب موقع البلاد الجغرافي الذي يحتوي على أعلى نسبة اشعاع شمسي على الكوكب، حيث يبلغ المتوسط اليومي للإشعاع الشمسي الأفقي 7.1 كيلو واط / متر مربع / يوم، بمتوسط مدة سطوع شمسي تزيد عن 3500 ساعة في السنة. (7) إن تسريع تطوير الطاقة الشمسية وطاقة الرياح سيكون ليبيا من تصدير الهيدروكربونات لفترة أطول.

الكلمات المفتاحية: الاستدامة البيئية، الطاقة المتجددة، الموارد الطبيعية (المياه، النفط والغاز).

1. Introduction

Climate change is one of the most pressing issues of our time. Many countries proactively address this global challenge to prevent future generations from facing irreversible changes. With rising temperatures, droughts, and desertification, Libya has been particularly vulnerable to the impacts of climate change, additionally, climate change can be increasingly seen as a factor of

instability and conflict, especially in relation to water scarcity in the region. Climate change has significant implications for the country's natural resources, including a decrease in drinkable water and soil for agriculture and public health and economic opportunities for Libya's mostly young population. Clearly, the country's authorities, private sector and civil society must develop and implement a comprehensive climate action plan. The plan should outline specific actions and policies to mitigate and adapt to the impacts of climate change and prioritize actions most relevant to Libya's unique context, such as increasing the use of renewable energy, improving water security, and promoting sustainable green growth. Supporting state institutions in accelerating energy transition through renewable energy is an economic opportunity to benefit society, the economy, and the environment. Renewable energy has become a cost-competitive alternative to fossil fuels that creates new job opportunities, improves health outcomes, and reduces inequalities. This energy transition is critical to addressing the challenges posed by climate change and holds significant potential to transform the country's economy for the better. The supports the development of sustainable water management practices, including improving water infrastructure and implementing water conservation measures, is to ensure people in Libya have year-round access to safe, reliable, and uninterrupted water supply. Promoting sustainable development and greener growth fueled by clean, renewable energy is essential to ensure children born today benefit from the human right to clean water and have opportunities to live a long prosperous life. These initiatives will contribute to environmental sustainability, enhancing resilience to the effects of climate change while providing greener jobs and ensuring that we build a more sustainable and prosperous economy, this can also become a factor of political stability and an area where all Libyan can agree.

Sustainability is an effective framework that could convert economic development into a process that directly reduces poverty while conserving the life support systems on which the poor and all others depend. Decision-makers must strive to create action plans to make each sector of the economy environmentally sustainable, As

Libya scored poorly in all measures of governance, according to the International Monetary Fund (IMF) [1]. Libya can become one of the first nations in the world to become environmentally sustainable if it so chooses, sustainability will make us all winners and is feasible for us to achieve as a society, the opposite is too grim to imagine: the scarcity of fresh water and of energy stifling our nation. Transitions to sustainable water and sustainable energy are two of the top current worldwide challenges, from which Libya is luckily in a position to profit. However, taking advantage of such an opportunity will not be a matter of luck, but rather of making the right choices from among a number of options, this does not mean that transitions will be easy—but they are feasible and indeed essential if we are to prosper in the future.

2. Research Aims and Tasks

The goal of this monograph is to identify opportunities for Libya's decision-makers to ramp up environmental management in Libya and set out on the path towards sustainability. The main opportunity is to conserve Libya's three main natural resources, water, oil and gas. Conservation of these resources will firmly catalyze Libya's transition to a sustainable economy while improving the quality of life. This monograph focuses on conservation of water, energy, and Investment in renewable energy. The research aims and tasks can be summarized in a few steps as below:

1. Benefit from the revenues of oil and gas, which are considered as revenues temporary and exhaustible to create sustainable development based on renewable energy in most economic activities.
2. Transform Libya from a producer and exporter of fossil fuels to a country producer and exporter of clean energy, such as energy generated from wind and sun. Libya enjoys a privileged location near the continent of Europe can be an important source of electricity generated from solar energy to Europe.
3. Reduce fossil fuel consumption, which increases the life of its reserves, and this leads to a reduction in the proportion of greenhouse gas emissions, the main cause of global warming.

4. Maintain the groundwater and the rationalization of consumption.
5. Can economists, planners and development planners benefit from the results of this study in the reconstruction programs.
6. Create new job opportunities for young people Libyan, because the transformation project for the sustainable economy requires a lot of development projects that need to be trained workforce and efficient.

3. Scientific Methodology

Scientific methodology includes several steps as followed:

3.1. Identify the Problem

Identifying the problem is the most important step ever. We can summarize the research problem in the following points:

1. Oil and gas reserves, which is the main source of income in Libya, which expect to deplete in half a century.
2. Declining groundwater reserves.
3. The air pollution problem caused by burning fossil fuels in the oil fields and refineries, power plants and other factories.
4. The time factor: Time is very important in the process of investing in renewable energy because the country is enjoying a good income from oil revenues, which has seen a boom in their recovery in recent years.

3.2. Hypothesis

It is a proposed solution to treat causes of problems under the study. The main hypothesis of this research as the followed:

1. Investment in the development of renewable sources of energy has many positives in the short term and long term, will enhance the strength of the economy, and creates new projects as a project to export electricity generated from solar energy to Europe.
2. Sustainable development will ensure the future of coming generations and prolong the life of fossil fuel and Groundwater reserves.

4. Results and Discussion

4.1. Definition of Environmental Sustainability

Environmental sustainability is the maintenance of the factors and practices that contribute to the quality of environment on a long-term basis can be termed as environmental sustainability. In addition, environmental sustainability is the rates of renewable resource harvest, pollution creation, and non-renewable resource depletion that can be continued indefinitely. If they cannot be continued indefinitely then they are not sustainable [2].

4.1.1. The Three Rules of Environmental Sustainability

There are only three rules of environmental sustainability [3]:

1. **On the source side:** Keep harvest rates of renewables within regeneration rates.
2. **On the sink side:** Hold waste emissions within the assimilative capacity of the environment without impairing it.
3. **Nonrenewable resources:** Nonrenewable cannot be made sustainable. But quasi sustainability can be approached for nonrenewable by holding their depletion rates equal to the rate at which renewable substitutes are created.

4.2. Conservation of Water

The over abstraction of groundwater is a major concern in Libya, Groundwater abstraction has increased fourfold over the past 20 to 30 years [4], Practically all 95% of Libya's fresh water is groundwater [5], mostly 75% from the Great Man-Made River (GMR), the average precipitation is less than 100 mm per year (mm/year), surface water accounts for 2.3%, while recycled sewage effluent provides 0.9%, water from desalination is about 1.4% [6]. Agriculture consumes 3,800 million cubic meters of water annually, or 85% of Libya's freshwater supplies [7]. Urban areas consume about 400 million cubic meters, or 11.5%. Industries including the oil sector consume about 150 million cubic meters, or 3.5% [8], the current abstraction rate of renewable water resources is about 130 % of the replenishment rate [4]. The available renewable water resources are insufficient to meet the present rate of expansion on a sustainable basis. The deficit between renewal and utilization has been presently satisfied through overdraft and mining of

groundwater aquifers and increasing dependence on poor quality water supplies, the result is seawater intrusions, soil salinization and more salt accumulation and pollution in production environments, near Tripoli, seawater has penetrated the water table as far as 20 km inland, and much of the irrigated farming area is saline [4]. When the other rising water demands of urbanization and industrialization that compete with irrigated agriculture are considered, the present situation is by all measures highly unsustainable and calls for serious interventions and reconsideration of the presently established growth and development models, especially those related to irrigated agriculture that represents more than 85% of the total national water consumption, the figure 1 shows balance of water in Libya.

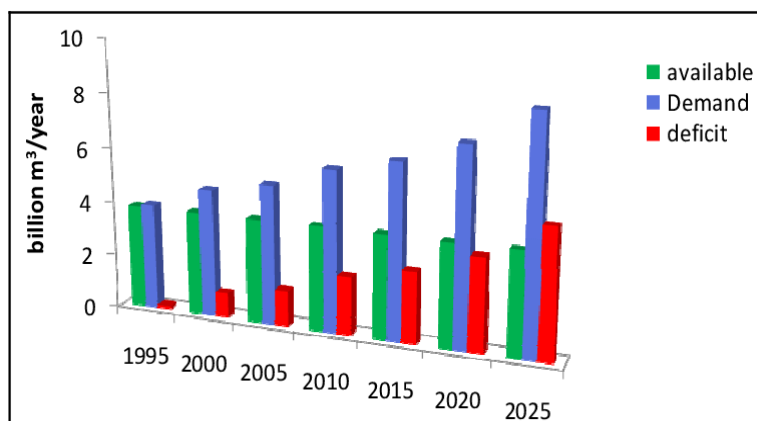


Figure 1: The balance of water in Libya [6].

4.2.1. An Alternative Solution to The Water Shortage Problem in Libya

In Libya, demand for fresh water is increasing, but the fossil groundwater supply is limited. This water supply situation has become more problematic with rapidly increasing population and low rainfall, the agriculture sector especially was exceeding its traditional supplies. Soon after the discovery of fresh groundwater in the deserts of southern Libya, the Libyan Government made huge

efforts to address its water deficit problems, mainly through the implementation of the Great Man-Made River Project (GMR) to sustain its economy, it began to design and install the hydraulic infrastructure needed to withdraw and transport fossil water to demand sites along its Mediterranean coast where most of the population lives and where the water is used. Fossil groundwater resources are over-exploited to meet irrigation demands as a result of a self-sufficiency policy in food. Rapid development of agriculture, expansion of irrigated areas and over-irrigation practices lead to more depletion of water resources, the supply-driven approach to water management has been unable to deliver water sustainability on the national level. Despite the strenuous efforts made by the government, the country still faces serious water deficits due to continuously increasing water demands beyond the limits of its available water resources, appropriate actions have to be implemented to reduce agricultural water consumption to avoid serious environmental and economic crises. Reorganization of water consumption patterns to maintain the country's standard of living and to ensure the economic security for future generations is drastically needed.

The country's water management requires: a) water policy reforms with emphasis on supply and demand management measures and improvement of legal and institutional provisions. b) agricultural water policies should be reviewed to minimize local water deficits and to avoid water quality deterioration in the coastal areas. c) Developing non-conventional sources of water supply needs to be considered. d) Water institutions lead by professional staff should help draft legislation and take decisive measurements to allocate water among consumptive sectors as well as to ensure the protection of the environment.

4.3. Conservation of Energy: Oil, Gas, and Renewables

4.3.1. Conservation of Oil and Gas

The hydrocarbon sector oil and natural gas as the mainstay of the Libyan economy, contributes more than 72 % of the GDP in nominal terms, 94 % of export earnings, and 93 % of government revenues [4]. Libya has low production costs (down to US\$1 a barrel

in places), high-quality oil, proximity to European markets, a well-developed infrastructure, and vast unexplored reserves, proven reserves the largest in Africa will last for at least 20 years, or 60 years at current production rates, cumulative oil production to date is equivalent to 60 % of present estimates of recoverable reserves, Libya is well endowed with oil and gas and has major potential to increase the production and export of both, oil production is constrained primarily by lack of upstream investment [4].The revenues from increased production and export of oil and gas could finance job creation, thus reducing the 25 % unemployment rate, and diversifying away from dependence on oil. At the end of 2021, Libya had proved natural gas reserves of 53 trillion cubic feet (Tcf), the fifth-largest in Africa behind Nigeria, Algeria, Mozambique, and Egypt [15], as gas reserves have been less explored than oil reserves, the conservation of energy is important to facilitate the transition to a sustainable economy, flaring gas leads to wasting a valuable non-renewable resource, which reached a gas flaring volume in 2021 of 2.47 billion cubic meters [9], which harms human health and exacerbates global climate change and desertification. If Libya's hydrocarbon exports accelerate Europe's switch from coal towards gas, it will be a major benefit in meeting the UN Kyoto treaty targets.

In any event, Libya has several years to diversify away from oil and become sustainable. Note that one estimate of groundwater depletion is about 40–50 years, the worst-case scenario is the risk of both oil and groundwater becoming problematic simultaneously. Depletion of oil and groundwater are tightly linked: As groundwater becomes deeper, more energy will be needed for pumping, if groundwater becomes deeper and requires more pumping energy at about the same time that oil is becoming scarce, the problem is stark. As Libya is so well placed to generate solar electricity, the most sustainable choice is to accelerate the transition to renewables before international treaties force coal, and later oil, to be left unused in the ground.

4.3.2. Renewable Energy

Libya is located in the middle of North Africa with 88% of its area considered to be desert areas, the south is located in the Sahara Desert where there is a high potential of solar energy which can be used to generate electricity by both solar energy conversions, photovoltaic, and thermal [10], In addition to the possibility of exploiting wind energy in the northern highlands.

4.3.2.1. Solar radiation

The solar radiation in Libya considered being very high the direct radiation on the horizontal plan is shown in figure 2, the total energy received on horizontal plan reach up to 7.1 KWh/m² per day, with an average sun duration of more than 3,500 hours per year [14], while figure 3 shows a map of Libya indicating the radiation Level. Libya can achieve a lot of gains through its exploitation of solar energy, the most important of them are the following:

1. If Libya uses less than 5 % of the Libyan Desert, annually it could power the whole of Europe.
2. Libya could replace all energy used for GMR water pumping and desalination with solar-thermal energy, which has the added benefit of producing no greenhouse gases.
3. Libya could also become the biggest seller of sustainable electrical power to Europe. " Europe is increasingly uneasy about its reliance on Russia's energy supplies after disruptions caused by the Russian-Ukrainian war " Europe is actively seeking to diversify away from reliance on Russia and away from fossil fuels, Libya fits both criteria admirably.
4. Libya could lead in making Europe carbon- neutral by massive exports of solar electricity. This plan would be highly profitable for Libya and, at the same time, help the world move towards climate stability, harnessing Libya's desert would be particularly effective because the sunlight in this area is especially intense: solar photovoltaic (PV) panels in Libya could generate up to three times the electricity compared with similar panels in northern Europe.

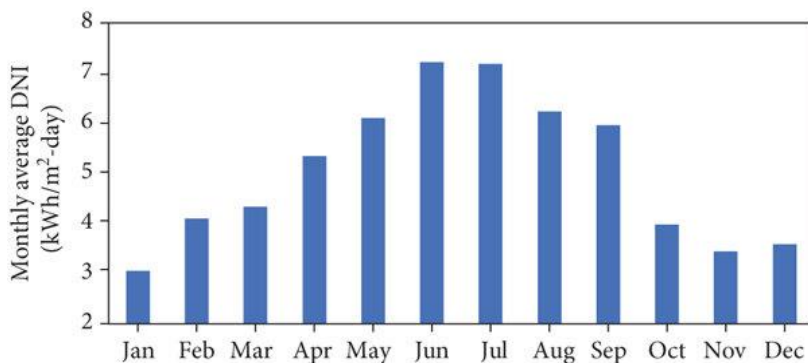


Figure 2: The Monthly average global daily solar radiation on a horizontal surface [11].

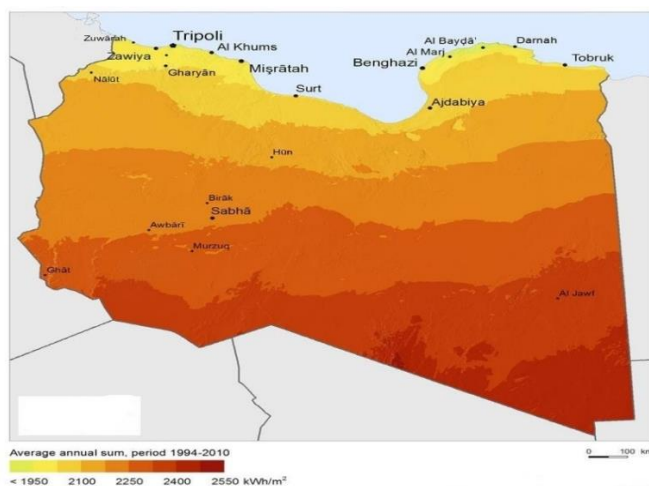


Figure 3: The average radiation on the horizontal plane in Libya.

4.3.2.2. Wind Energy

Wind energy was utilized for water pumping in many oasis beginning 1940, sizes of 50 – 1000W, the use of this energy has not been developed as the wind-mills need some maintenance from time to time. A demonstration project of one unit of size 10 KW was installed 1993. In 2004 measurement of the wind speed for wind potential has been conducted, the measurements showed that there

is a high potential for wind energy in Libya and the average wind speed at a height of 40 meter is between 6- 7.5 m/s [10]. Wind-generated electricity should be important for Libya because the electricity can be transmitted from where the winds are strongest to where the energy is needed, namely in groundwater pumping and desalination. In addition, wind electricity complements solar-thermal electricity by generating more power at night after the sun has set. While solar-thermal electricity is likely to be the most profitable of Libya's exports, diversification would be prudent by means of a modest component of wind electricity in the national energy mix.

5. National Plan for developing The Renewable Energy in Libya

The Plan, released by the Renewable Energy Authority of Libya (REAOL), aims at integrating the locally available renewable energy resources with the national energy system, and increase the share of renewable energy in the national energy mix. The Plan seeks a 10% renewable energy contribution to the electric energy mix by 2025 and 22% by 2030. This will come from wind, and concentrated solar power, [12][15]. Although this goal is ambitious, Libya's vast solar potential has attracted some foreign investors, in addition to its recent investment in Libya's oil and natural gas sectors, Total Energies intends to develop 500 MW of solar power projects in the country, and Libya has also discussed solar power projects with ENI and Shell. The National Plan for Developing Renewable Energy includes the following:

5.1. Plan the work of Renewable Energy Authority of Libya(REAOL)- in the Short -term (2016– 2025)

Table 1 Shows the Plan for the work of the Renewable Energy Authority of Libya.

Table 1. Plan for the work of the Renewable Energy Authority of Libya [13]

Short -term projects (2016 – 2025)			
Field	Method of financing	Total capacity (MW)	Notes
Projects of wind power	Country budget	340	Site selection will be conducted based on the results of technical and economic feasibility studies along with the follow up reports of the short-term projects.
	investment	400	
Projects of solar PV	Country budget	220	
	investment	500	
Projects of Concentrated solar power (CSP)	Country budget	125	
	investment	250	
Projects of solar water heating	Country budget	250	

5.2. Proposed national strategy for the development of Renewable Energy in Libya (2013 – 2025)

The Strategic Plan is a mixed and least cost expansive RE plan ready to increase Libya's RE production. It includes a 5,000 MW PV/wind energy generation plan aiming to achieve a 20 % penetration rate by 2030, as shown in figures (4 – 5) [13].

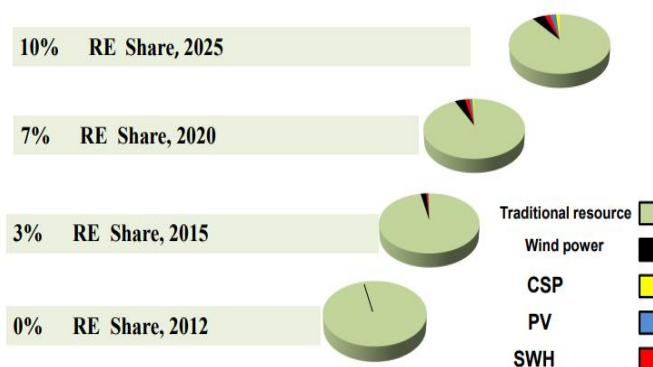


Figure 4: Proposed national strategy for the development of RE in Libya (2013 – 2025).

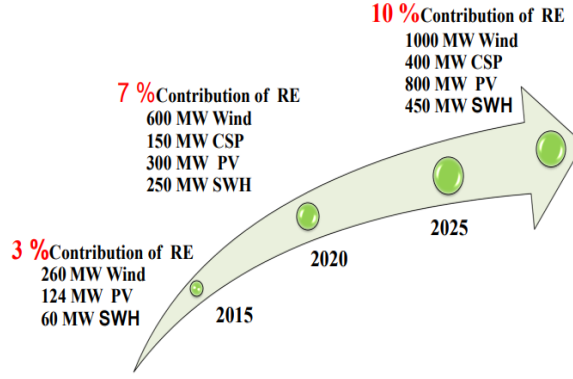


Figure 5: Proposed national strategy for the development of RE in Libya (2013 – 2025) [13].

5.3. Indicators that can be achieved from Plan the work of Renewable Energy Authority of Libya in the Short-term (2016– 2025)

Implementation of this program will be placing Libya at the forefront on the regional scale and will bring the following benefits:

- 1) Saving 2.9 million barrels of oil per year.
- 2) avoid about one million tons of carbon dioxide annually.
- 3) Financial returns from the sale of certificates reduction in carbon emissions valued at about (6 – 8 million US Dollars annually).
- 4) Contribute to cover part of the demand for electric power.
- 5) Gain experience and transfer of knowledge and technology localization.
- 6) Sustainable spatial development and job creation.
- 7) Will pave the way toward having Libya as a clean energy exporter.

6. Conclusion

First, the most significant finding of this analysis is that conservation of fresh fossil water is urgent and that its use should largely be solar-powered, not powered by oil as it is today. Achieving sustainability in fresh water is the major achievement necessary for Libya, importing one metric ton of grain is equivalent to importing 1,000 metric tons of water, so conserving fresh water

is beneficial for Libya, import of liquid fresh water is too expensive. The second step on the path to sustainability is to export solar electricity to Europe. Libya is unusual in that it has the financial and other resources to become sustainable fast if it decides to aim for sustainability, Libya's solar energy on the other hand is among the most intense in the world and inexhaustible, accelerating the development of solar and wind energy will enable Libya to export hydrocarbons for much longer. Sustainability will benefit Libya to the fullest extent before oil depletion and GHG regulations hit. Worldwide, most coal and other fossil fuels cannot be used; they have to remain unmined in order to achieve some semblance of climate stability. The challenge is to ensure that by then Libya will be based on sustainable solar-powered water supply, and the export of sustainable solar-powered electricity.

6.1. Recommendations

1. Conservation and efficiency as essential in agriculture, by far Libya's biggest consumer of water.
2. The sooner water pumping can be powered by renewable energy (wholly or partly); the sooner Libya will become sustainable.
3. The transition from fossil-fuel GMR water pumps to solar-energy water pumps is possibly the most important step for Libya's approach to sustainability, the costs of conversion will be more than paid for by the export of the increased volumes of oil that will be freed by the use of renewable energy.
4. Export sustainable, greenhouse gas-free electrical power to Europe.
5. The transition to renewables needs efforts, the efforts should focus first on solar energy, then on wind energy.
6. Wind-generated electricity should be a component of Libya's national sustainable energy strategy.
7. The sustainable water strategy should calculate the least-cost water expansion strategy, However, the first and least-cost measure for approaching sustainability is the conservation of water.

8. Efficiency of water use must be the sustainability goal. Policies should be put in place to ensure that irrigation efficiencies are as high as possible.
9. Irrigation water must be allocated only to the crops with the highest returns.
10. Accelerate the transition to renewables before international treaties force coal and later oil to be left unused in the ground.
11. Pursue sustainability as a national priority before groundwater and oil reserves become scarce.

7. References

- [1]. Renewable Energy Authority of Libya (REAOL), National Plan for developing The Renewable Energy in Libya (2013-2025), January (2013).
- [2]. Dr.A.R.Nithya, A study on Environment Sustainability by Satisfying Rural requirements in Agriculture and food processing via Urban solid waste treatment, International Conference on Innovative trends in Business Practices for Sustainable Development, November (2017).
- [3]. Daly, H. E. and Cobb, For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future, Beacon Press, Boston (1994)pp. 492.
- [4]. European Commission DG Trade, Trade Sustainability Impact Assessment (SIA) of the EU-Libya Free Trade Agreement, Final Report, October (2009).
- [5]. Abdulmagid Abdudayem and Albert H.S. Scott, Water infrastructure in Libya and the water situation in agriculture in the Jefara region of Libya, African Journal of Economic and Sustainable Development, Vol.3, No.1,(2014) pp. 33–64.
- [6]. Mukhtar M. Ashour and Salem M. Ghurbal, Economics of seawater desalination in Libya, Science Direct165 (2014) pp. 215–218.
- [7]. Robert Goodland, Libya: The Urgent Transition to Environmental Sustainability, The Environment General Authority, Tripoli, Libya (2013).
- [8]. Guinness World Records Book, (2008).

- [9]. The World Bank, Global Gas Flaring Tracker Report, April (2021).
- [10]. Ibrahim M. Saleh Ibrahim, Prospects of Renewable Energy in Libya, International Symposium on Solar Physics and Solar Eclipses (SPSE), (2006).
- [11]. Aysar M. Yasin, The Impact of Dispatch ability of Parabolic Trough CSPPlants over PV Power Plants in Palestinian Territories, International Journal of Photoenergy, October (2019).
- [12]. Libya Renewable Energy Strategic Plan 2013-2025, JOIN IEA/IRENA Policy and Measures Database, March (2018).
- [13]. Ralph Chami, Ahmed Al-Darwish, Serhan Cevik, Joshua Charap, Susan George, Borja Gracia, Simon Gray and Sailendra Pattanayak, Libya Beyond the Revolution: Challenges and Opportunities, International Monetary Fund, (2012).
- [14]. Observatoire Méditerranéen de l'Energie (OME) Report for GswH-Unep- Undp, Solar Thermal in the Mediterranean Region: Market Assessment Report, September (2012).
- [15]. U.S. Energy Information Administration, Country Analysis Executive Summary: Libya, May (2022).