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Study of management strategy of energy resources in Algeria

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HIGHLIGHTS

- Introduce the energy potential of Algeria.
- Analysis of political and energy policy in Algeria.
- Compare this strategy with other countries.
- Show the role of renewable energies in the development of the energy strategy of Algeria, particularly in the production of electrical energy.
- Suggested some recommendations to improve the energy strategy of Algeria in the future.

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ABSTRACT

Algeria is one of the largest energy-producing and exporting countries in the world. This has been achieved through the implementation of strategies and policies to promote the economic, social and environmental utilization of energy resources. However, the efforts and policies deployed have not yet placed the country in its proper place with regard to the diversification of energy sources. Such efforts have yet to fully exploit its capacities and reserves of renewable and non-renewable energy resources to diversify its economy, reduce its dependence on the hydrocarbons sector and achieve its economic security.

This study aims to establish projections on the strategy of management of energy resources in Algeria. The study will be carried out in different phases: The first phase will be oriented towards the renewable and non-renewable potential available in Algeria.

Then, understanding and analyzing the different aspects of the country's energy strategy (production, export), which will be presented in this article, shows that the Algerian economy is mainly based on the export of exhaustible and polluting fossil fuels. While the integration of renewable resources into its energy strategy remains very low compared to the available potential.

Finally, an analysis of the current and future energy situation of Algeria to guarantee the energy security of countries.

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1. Introduction

In terms of energy potential, Algeria has the tenth world gas reserves and third in shale gas. It also has the third oil reserves in Africa, according to the US Agency for Energy (Anon, 2014d).

The country has great potential in solar energy. With an average annual sunshine 2000 h and assessed a territory composed of 86% of the Sahara desert, its solar power is estimated at about 1700 KWh/m²/year in the north and 2650 KWh/m²/year in the south, which corresponds to a capacity 8 times higher than the natural gas reserves of the country, and the largest solar fields in the world (Sulmont and Meley, 2013b; Anon, 2007).

The potential of other renewable energy sources is more modest, especially hydroelectricity and wind power when wind speeds

vary between 2 and 6 m/s only. The potential of biomass, which includes the recycling of waste from human activities, urban and agricultural waste, is estimated at 1.33 Mtoe/year. Geothermal energy has a more favorable outlook with 200 hot springs listed (Sulmont and Meley, 2013b; Anon, 2007).

The levels of the natural gas needs of the domestic market would be about 45 billion m³ in 2020 and 55 billion m³ in 2030. To these are added the needs volumes dedicated to the export whose revenues contribute to funding of the national economy (Benhamed, 2014).

Similarly, electricity generation should be between 75 to 80 TWh in 2020 and between 130 to 150 TWh in 2030 (Benhamed, 2014).

All these considerations justify the strong integration of renewable energies into the long-term energy supply strategy, while giving an important role to energy savings and energy efficiency.

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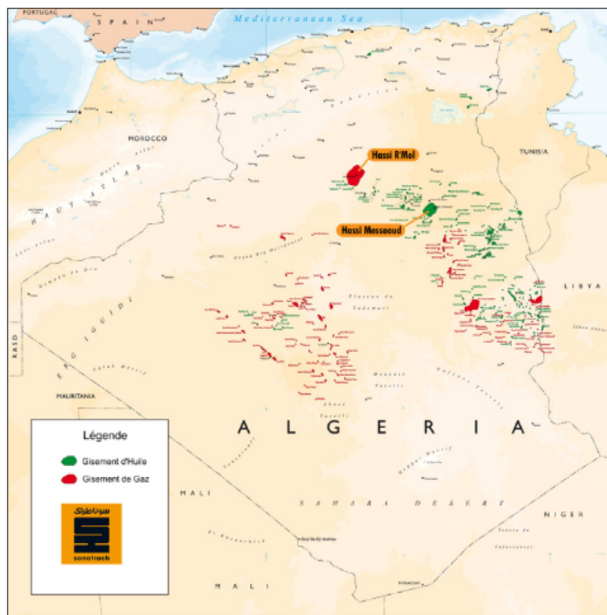


Fig. 1. Map of hydrocarbon fields in Algeria (<http://www.energy.gov.dz/francais/index.php?page=geologie-des-provinces-petroliere-en-algerie-2>).

2. Energy potential of Algeria

2.1. The conventional hydrocarbon reserves

Algeria is the largest producer of natural gas in Africa, the second largest natural gas supplier to Europe and is among the top three oil producers in Africa (Anon, 2014d).

The conventional hydrocarbon reserves discovered in Algeria to date are contained in just over 200 oil and gas deposits, of which 73 are located in the Illizi basin, 57 in the basins of Central Sahara, 34 in basins Ghadames-Rhourde Nouss, and 31 in the Oued Maya basin (Fig. 1) (Sulmont and Meley, 2013b; Attar and Hammat, 2012).

The latest estimate of OPEC, published in 2015, Algeria is estimated at 12.2 billion barrels of proven reserves of conventional crude oil, an estimate that was unchanged for many years. It is the third largest amount of proven reserves of conventional crude oil in Africa and the 15th in the world (Anon, 2014d, 2015d).

Proven reserves of natural gas from Algeria were estimated at about 4.5 trillion cubic meters, the tenth largest natural gas reserves in the world and the second largest in Africa after Nigeria (about 30% proven gas reserves of the entire African continent) According to BP, as early as June 2014 (Anon, 2014d, e).

These statistics, which represent only the volumes contained in the deposits discovered or in the course of production, could increase due to the development of future discoveries and the technological innovations which will make it possible to transfer resources to additional reserves.

2.2. Shale gas in Algeria

The Algeria has seven (7) basins containing shale gas (Fig. 2). These basins Mouydir, Ahnet, Berkine–Ghadames, Timimoun, Reggane and Tindouf. Which are estimated 19,800 billion m³. This corresponds to four times the level of its current gas reserves (Kuuskraa, 2013; Anon, 2013a).

With this estimate, Algeria is ranked 3rd in the world by the US Department of Energy, overtaken by China with recoverable

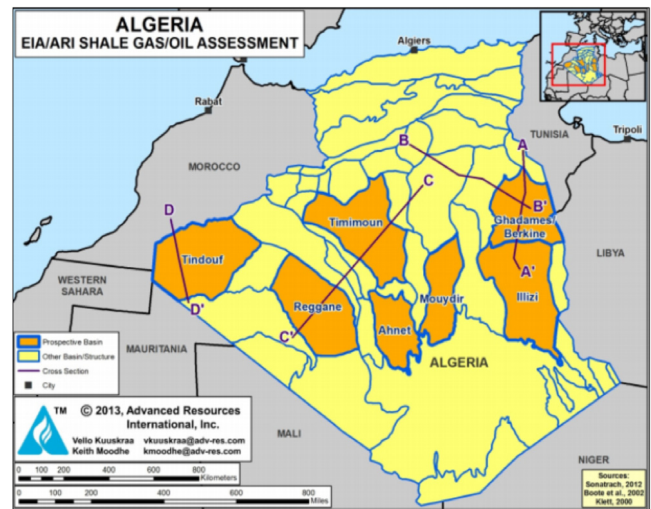


Fig. 2. Seven identified shale gas basins in Algeria (Kuuskraa, 2013).

Table 1

Data on solar radiation in Algeria (Anon, 2007).

Region	Coastal	Highlands	Sahara
Area (%)	4	10	86
Average sun hours per year	2650	3000	3500
Energy received KWh/m ² /year	1700	1900	2650

reserves of shale gas 31.220 billion m³, and Argentina with 22.500 billion m³ (Kuuskraa, 2013; Anon, 2013a).

These numbers are the only ones available and are surrounded by many uncertainties, particularly with regard to the experience of other countries that have seen their declared reserves diminish as a trickle once all started explorations.

The exploitation of shale gas in Algeria was made possible by the 2013 hydrocarbons law (Anon, 2014a).

In July 2014, Sonatrach, the national hydrocarbons company, says it plans to begin operation of the Algeria shale gas deposits from 2020, with a production capacity of 30 billion m³ per year in the first phase, equivalent to the current national consumption. For now, Sonatrach is launching a pilot drilling campaign by hydraulic fracturing to more accurately assess the recoverable reserves (Anon, 2014a).

2.3. Renewable potential

In all Mediterranean basins, there is a gigantic reservoir of solar energy in the north of Africa and particularly the southern region of Algeria. The potential of this type of energy in southern Algeria is the largest (Fig. 3).

The sunshine duration of almost all the national territory exceeds 2000 h annually and reaches 3900 h (high plains and Sahara). The energy received daily on a horizontal surface of 1 m² is about 5 Kwh over most of the country, or nearly 1700 kWh/m²/year in the north and 2263 kWh/m²/year in the south (Sulmont and Meley, 2013b; Anon, 2007).

Table 1 shows the rate of sunshine for each region of Algeria.

The potential of other renewable energy sources is more modest, especially hydroelectricity and wind power when wind speeds vary between 2 and 6 m/s only. The potential of biomass, which includes the recycling of waste from human activities, urban and agricultural waste, is estimated at 1.33 Mtoe/year. Geothermal energy has a more favorable outlook with 200 hot springs listed (Sulmont and Meley, 2013b; Anon, 2007). (See Fig. 4.)

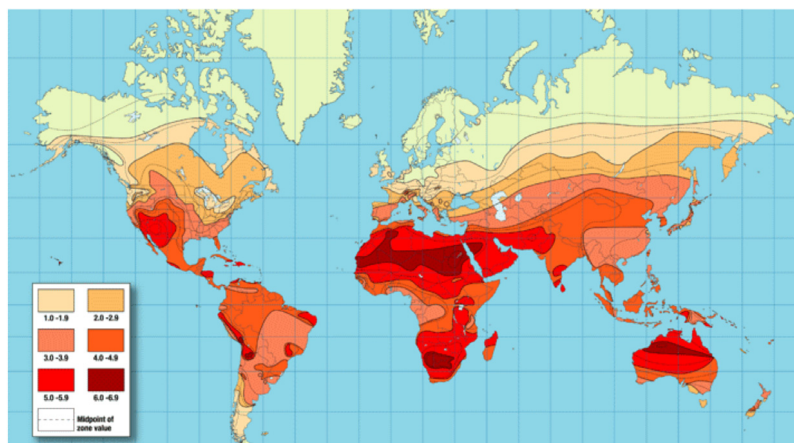


Fig. 3. Solar insolation Map of the World (Adel, 2012).

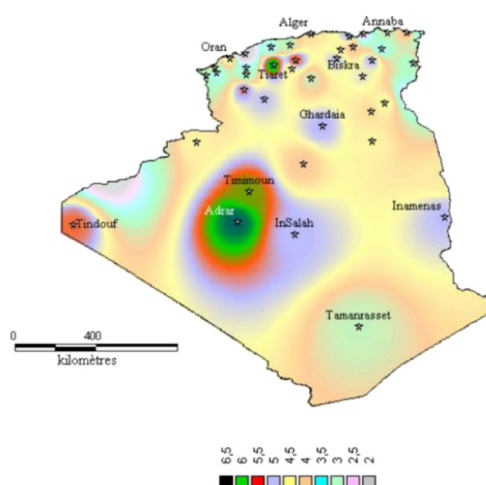


Fig. 4. Atlas of the average wind speed of Algeria estimated at 10 m from the ground (Sulmont and Meley, 2013b).

3. Energy production in Algeria

3.1. Primary energy production

In Algeria, Hydrocarbons occupy a very important place in the country's economic development.

Algeria is the largest producer of natural gas in Africa, the second largest natural gas supplier to Europe and is among the top three oil producers in Africa. However, crude natural gas and crude oil production have declined steadily in recent years (Fig. 5), mainly due to new production projects and infrastructure has been repeatedly delayed (Anon, 2014d).

The primary energy production in 2013 was down by -3.9% to 148.8 Mtoe. This decline affected all energy products except LPG, which remained stable at 7.3 Mtoe (Anon, 2014b).

Production of primary electricity fell Sharply (-47%) in 2013 to 83 ktoe, reflecting the decline in hydropower generation (Anon, 2014b).

The structure of primary energy production in 2013 is dominated by the gaseous products (NG and LPG) at 57%, as detailed in Fig. 6 (Anon, 2014b).

3.2. Derived energy production

Energy production derived in 2013 increased by 3.5% to 55.2 Mtoe, driven by increased production of petroleum products ($+3.8\%$), thermal electricity ($+4.9\%$), LPG ($+5.4\%$) and liquefied natural gas ($+2.4\%$) (Anon, 2014b).

The structure of the energy derived remains dominated by oil products 44%, as shown in Fig. 7.

4. Export of energy in Algeria

The balance of energy exports for 2013 showed an overall net exporter of balance 101.5 Mtoe. This balance has decreased by -7.2% compared to 2012, due to lower exports (Anon, 2014b).

The primary energy exports reached 73.5 Mtoe in 2013, down -10.2% compared to 2012. This reflects the decrease in exports of natural gas (-12.5%), crude oil (-11.8%) and LPG (-2.9%). In contrast, condensate exports increased by 6.1% (Anon, 2014b).

While energy exports derived experienced in 2013 an increase of 1.7%. This increase is mainly due to the increase in exports of petroleum products which rose to 13.6 Mtoe (Anon, 2014b). Indeed, the increase in volumes processed by the refinery of Skikda rehabilitated and Arzew, allowed an increase in production and hence increased exports (Anon, 2014b). In contrast, exports of electricity fell (-61%), reaching 97 ktoe in 2013 (Anon, 2014b).

Fig. 8 shows the share of each type of energy in the export structure of primary energy.

5. Renewable energy and energy efficiency Algerian program

The Algeria initiates a dynamic green energy by launching an ambitious program of development of renewable energy and energy efficiency. This vision of the Algerian government relies on a strategy focused on the development of inexhaustible resources such as solar and using them to diversify energy sources and prepare for the Algeria of tomorrow.

The program adopted in 2011 for an overall objective consists in the installation of 22,000 MW by 2030, of which 10,000 MW could be dedicated to export (Anon, 2011).

The part of renewable energy program for export will be implemented in partnership if access to the European market is guaranteed.

For the national market the achievement of the stated objective will, in 2030, the renewable electricity to represent 40% of national electricity production (Anon, 2011).

The deployment of renewable electricity production program (12,000 MW), dedicated to the national market, will be conducted in three stages, namely (Anon, 2011):

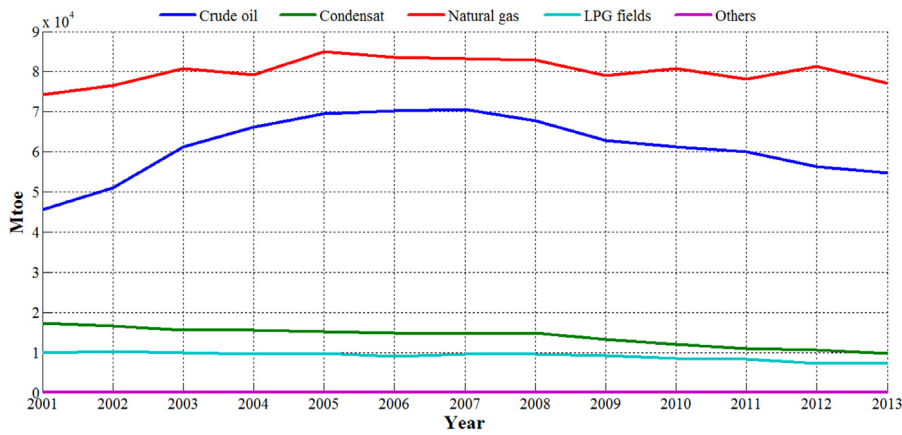


Fig. 5. The production of primary energy in Algeria (Anon, 2001–2013).

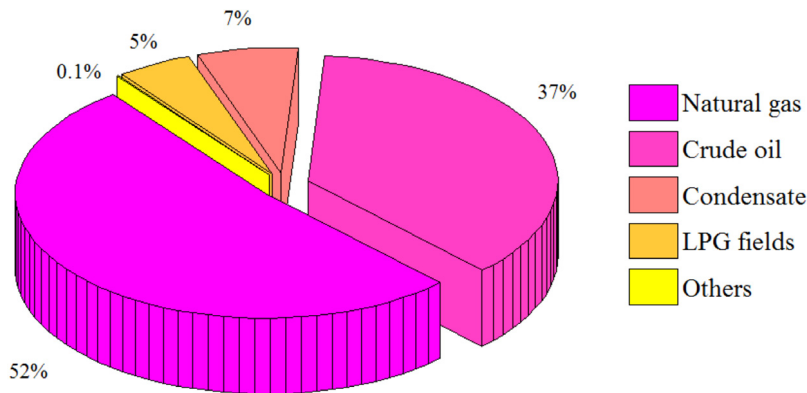


Fig. 6. Structure of primary energy production in 2013 (Anon, 2014b).

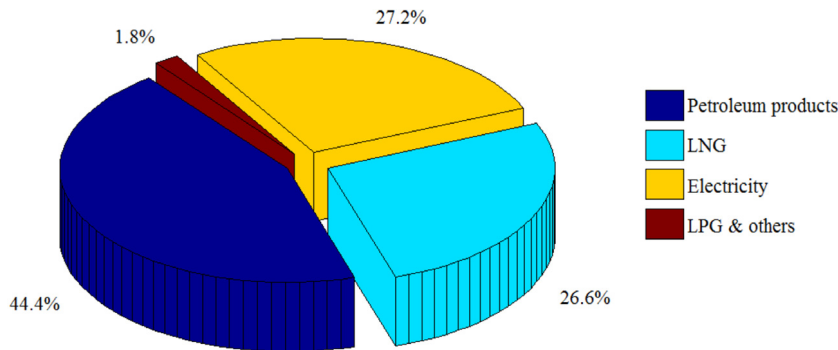


Fig. 7. Structure of the power generation derived in 2013 (Anon, 2014b).

- Step 2011–2013: pilot projects to test different technologies available;
- Step 2014–2015: beginning of the program deployment;
- Step 2016–2020: large-scale deployment.

This program has been a first phase dedicated to pilot projects and testing various technologies available, during which relevant evidence about the technological developments of the relevant sectors have appeared on the energy scene and led to the revision of the program (Anon, 2015a).

The revision of the new program (2015–2030) door and, on the development of photovoltaic and wind energy on a large scale, the introduction of biomass sources (waste recovery), cogeneration and geothermal, and also on the report, in 2021, the development of solar thermal (CSP).

The distribution of this software technological process is as follows (Anon, 2015a, b) (See Fig. 9.):

- Photovoltaic Solar: 13,575 MW;
- Wind power: 5010 MW;
- Solar thermal: 2000 MW;
- Biomass: 1000 MW;
- Cogeneration 400 MW;
- Geothermal energy: 15 MW.

The phases of the renewable energy development program are as follows: (See Fig. 10, Table 2.)

But the realization of the new program will achieve in 2030 a share of renewable nearly 27% only in the national electricity production balance (Anon, 2015a, b).

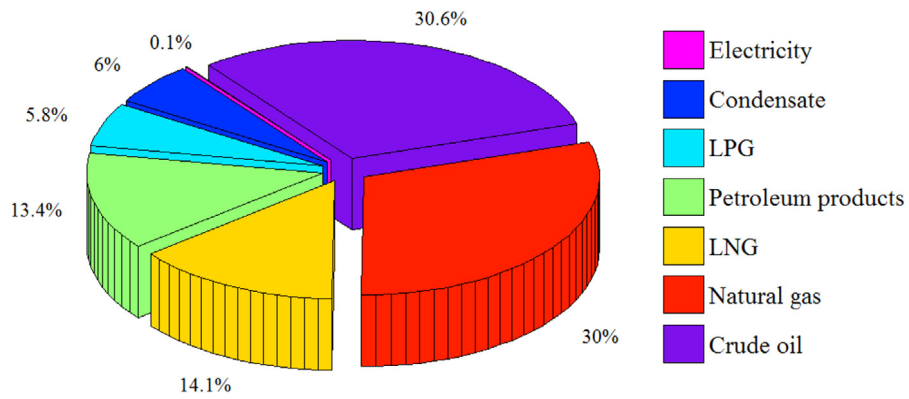


Fig. 8. Structure of energy exports in 2013 (Anon, 2014b).

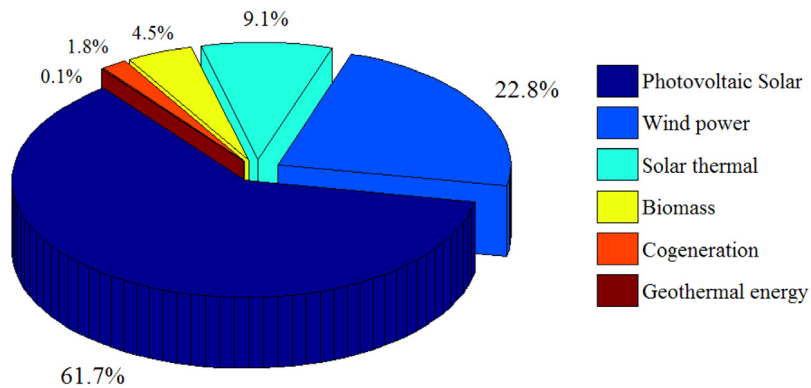


Fig. 9. Distribution of development program of renewable energy technology sector (Anon, 2015a, b).

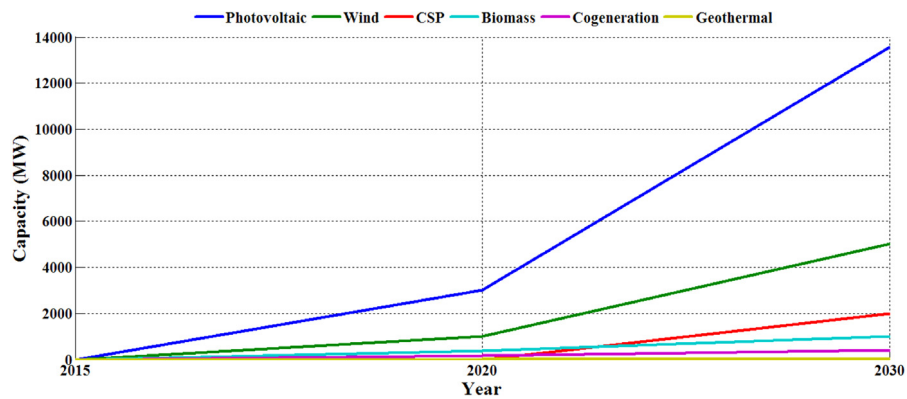


Fig. 10. Algerian renewable energy program (Evolution objectives by sector) (Anon, 2015b).

Table 2
Phases of the Algerian renewable energy program (Anon, 2015b).

Energy type	1st phase 2015–2020 [MW]	2nd phase 2021–2030 [MW]	Total [MW]
Photovoltaic	3000	10,575	13,575
Wind	1010	4000	5010
CSP	–	2000	2000
Cogeneration	150	250	400
Biomass	360	640	1000
Geothermal	05	10	15
Total	4525	17,475	22,000

The energy efficiency program is primarily in the realization of the following (Anon, 2011):

- Improving the thermal insulation of buildings (Its consumption accounts for over 42% of final energy consumption);
- The development of solar water heaters;
- The promotion of cogeneration;
- Conversion to combined cycle power plants where possible;
- The implementation of solar cooling projects.

6. Policy and energy strategy for Algeria

The levels of the natural gas needs of the domestic market would be about 45 billion m³ in 2020 and 55 billion m³ in 2030. To these are added the needs volumes dedicated to the export whose revenues contribute to funding of the national economy (Benhamed, 2014).

Similarly, electricity generation should be between 75 to 80 TWh in 2020 and between 130 to 150 TWh in 2030 (Benhamed, 2014). The massive integration of renewable in the energy mix in this sense is a major challenge to preserve fossil resources, diversify electricity production sector and to contribute to sustainable development.

The volume of natural gas saved by 22,000 MW in renewable, will reach about 300 billion m³, a volume equivalent to eight times the national consumption of 2014 (Benhamed, 2014).

Many countries have also turned to the use of renewable energy to save the consumption of its fossil resources such as Morocco, Tunisia and same Saudi Arabia, despite its huge reserves of oil and natural gas.

Fig. 11 shows the capacities that planned to install in each country by 2020 and 2030, and the share of capacity in the energy mix of the country.

The analysis of the share to be installed in each country shows that Algeria is the least developed and invested in this sector. While the country is the richest in renewable energy, in particular solar potential (it receives nearly 3000 h of sunshine a year and irradiation between 4 and 7 kWh/m²/day).

Algeria has adopted in 2011 a strategy with the objective of produce by 2030, 40% of electricity from renewable resources. Generally this share must be elevated after the revision of the new program in 2015, but actually it was reduced to 27%.

When one is interested in the question of renewable energies in Algeria, we see that the country has both financial and human resources technology that enables it to develop this sector. But fast you realize that it lacks the essential: political will.

The least we can say is that the country has several constraints, to be able —INS with his ability to live without oil and gas.

He must take the train of progress. Algeria has a window of a few years to be able to implement a voluntarism policy based on energy sobriety. Like the developed countries, a bold strategy must be put in place. A 50% renewable energy mix.

It is therefore important to put in place an energy transition that will allow it to reduce its dependence on fuels by reserving oil only for noble uses, to save energy, to launch without delay the energy plan Renewable energy sources, for example, a 1000 MW solar power plant would save 1.5 billion m³ of natural gas. It is also necessary to go towards a gradual truth of the prices of energy and water through pedagogy to train the eco-citizen of tomorrow in school but also in the university with the new professions of sustainable development.

A good example has been given by Norway. Despite its reserves of hydrocarbons, this country is the good student in terms of energy transition: 60% of the energy consumed comes from the renewable. With 1200 green power plants, it has become Europe's

leading energy company and the world's sixth-largest energy company.

Thanks to its geographical location and its strategic position in the energy sector, all the conditions are met for Algeria to play a crucial role in the future in the supply of green electricity, in accordance with the Trans-Mediterranean Plan.

7. Analysis and perspective

Exports of Algeria remain dominated by fossil fuels (about 95% of the total export volume, according to preliminary figures from the National Centre for Informatics and Customs statistics) (Anon, 2014c).

The country exports almost 50% of primary energy and 50% of energy derived. While electricity has only 0.1% of total energy exports (Fig. 8). On the other hand, electricity production is almost totally provided from natural gas and absorbs about 40% of the consumption of this primary energy (Anon, 2014b).

Renewable energy (hydro, wind, solar...) occupy a virtually zero in the energy balance.

The production of hydrocarbons is entered, since 2006, a long phase of decline, the result of the combination of the decline in production and the depletion of reservoirs and low reserve replacement rates.

At current production rates, reserves will be consumed in approximately twenty-five years (i.e. by 2040) if there is no new hydrocarbon discoveries and if the deposits are mined in the same conditions prevailing currently no improvement then the recovery rate (25% for oil, 70% for gas).

Algeria must adopt a new policy of energy consumption to ensure a better future for future generations. The solutions lie in renewable energy and sustainable development. But the political will has not been shown clearly in this domain. The evidence lies in the investments made by the state in this sector considered divorced from the capabilities available in the country.

A well-developed energy transition will go towards sustainable development by setting up an energy mix where every power will be developed rationally but with determination. Algerian Solar is one of the largest in the world in intensity and surface and yet he hardly soars. The country has more than 200 sources of geothermal energy that can be harnessed to heat homes but also for industrial use outside the medical aspect, it does nothing. Adrar region is known for the strength of the wind and development that will allow the development of agriculture.

The following recommendations are needed to improve the development program for renewable energy and energy efficiency of the country (Anon, 2015c):

- Involve scientific research in all stages of the RE program;
- The renewable energy program should be followed by scenario studies based on the development of the renewable market in the short, medium and long term, the evolution of the consumption of electricity, and the development of technologies and their costs. Develop intelligent solutions (smart grid, ...) to improve the management of electricity from fluctuating sources, develop forecasting models and predictions to overcome the intermittent problems caused by the weather;
- Adapt systems running on renewable energy to desert conditions, especially regarding high temperatures and sand winds;
- Develop storage technologies;
- Develop hybrid systems, PV, wind, CSP, biogas, gas, diesel;
- Improve the performance of PV modules to reduce space and costs;
- Develop renewable in the building sector to ensure the support of the people;

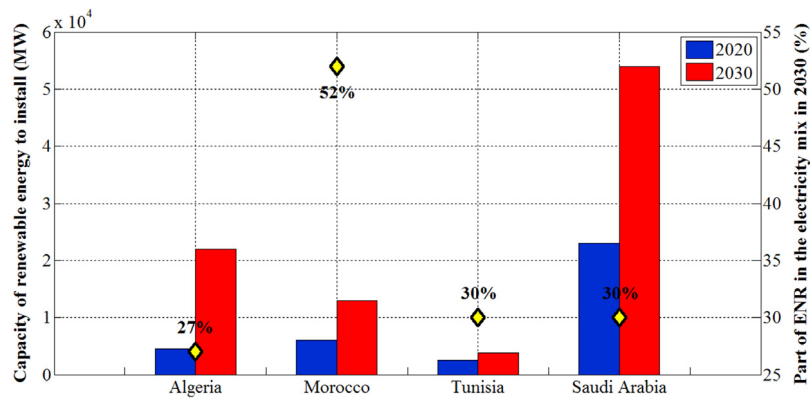


Fig. 11. Capacity and the share of renewable energy to be installed by each country (Anon, 2015b, 2013b; Khazen, 2015; Anon, 2010).

- Establish a communications policy, popularization and awareness; to avoid resistance to keep the existing model;
- Encourage more professional and higher education;
- Involve banks in investment projects in the field of renewable;
- Create new energy market models;
- Encourage autonomous networks in remote areas;
- Encourage low power individual installations.

8. Conclusion

The three foundations of the Algerian strategy have always been the same:

- Ensuring the satisfaction of national energy needs;
- Increase and ensure optimum exploitation of the country's hydrocarbon reserves;
- Continue to contribute to the financing of national economic development.

More generally and more specifically, it is first to ensure national energy security today and tomorrow, since the potential of hydrocarbons in Algeria will ensure its future needs. But beyond 2040, it will face enormous difficulties to meet its internal needs in this area, hence the need to establish mechanisms to ensure a progressive contribution of renewable resources in the energy economy, more particularly of solar origin. Note also the possibility of exploitation of shale gas, including Algeria seems well placed in this field, provided good control of operating techniques that resource and many respect the environment.

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