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A Review on the Water and Energy Sectors in Algeria: Current, Forecasts, Scenario and Sustainability Issues

Amine Boudghene Stambouli, Ait Mimoune Hamiche and Samir Flazi
Electrical and Electronics Engineering Faculty
University of Sciences and Technology of Oran, USTO-MB, Algeria
BP 1505, EL M'Naouer, Oran (31000), Algeria.
Tel: 00 213 7 71487180. E-mail: stambouli@ssb-foundation.com, aboudghenes@gmail.com

Abstract. The water sector in Algeria has to date paid scant attention to the issue of climate change and is often unaware of its impact on future water resources. Studies will be needed to assess the impact and cost of climate change and draw up adaptation solutions.
Forecasts are not optimistic. Models for climate change indicate that rainfall could decrease by more than 20% by 2050, which would result in even greater worsening water shortages in different basins of Algeria. The construction of 70 dams planned will provide only small additional volumes.
The particular challenge for Algeria in the coming decades will be to adapt to a decrease in renewable water resources. The country will have to carefully manage these resources. Mobilization of non-conventional water resources (desalination and wastewater reuse) will be a strategic component of future water policy.
The development of unconventional resources and the management of water demand will increase more the energy consumption of the water sector. This consumption would reach nearly 12% of the country's consumption and must be integrated dice now in the country's energy forecasts.
More coordinated planning and action will consequently be required between the water and energy sectors if further aggravation of the water deficit is to be avoided.
Moreover, the revolution in renewable energy (wind and solar power) in terms of technological development and costs may help reduce the consumption of fossil fuels and ensure reserves for future generations by fostering decentralized renewable energy projects for alimentation of pumping stations.
Algeria has thus set itself by 2030 a share of renewable energy in the national energy balance of between 30 and 40%. The share of renewable power will represent about 17% of installed capacity (5539 MW) compared to 4.74% in 2011 (540 MW).

Key words

Water, Resources, Demand, Renewable, Sustainability

1. Introduction

Water is something of a rare commodity in Algeria. Renewable natural water resources are estimated at approximately 15 billion m^3 per year that is approximately 404 m^3 per capita per year, near the threshold of 500 m^3 per capita per year, which is widely recognized as the scarcity threshold that indicates developing scarcity and underlying crises.

As part of its development program and in order to meet the needs expressed by users, Algeria has been working for some time on managing exploitation of its water resources. Since independence its policy in the face of water shortages and uneven distribution has been to ensure that water supply corresponds to the requirements of towns, cities and agriculture by constructing dams, developing large irrigation areas and setting up systems to supply drinking water to inhabitants. This has led to the creation of reliable infrastructure and competent agencies.
Nevertheless, the Algerian water sector is facing several limitations and problems which could, if not properly handled, limit the dynamic of economic growth that Algeria is looking for by launching a huge range of large-scale projects.
These limitations and problems relate primarily to decreased water resources due to the impact of climate change which has become a reality in Algeria and whose effects on our environment are already visible.
The future development of water resources depends on solutions characterized by high energy consumption, for example sea water desalination, the reuse of wastewater and the introduction of drip irrigation. Development of the water sector will therefore be closely tied to the development of the energy sector.
This sector must conduct a large-scale program of studies to understand the current and future impact of climate change, identify and quantify associated costs and its interactions with water and energy and specify adequate solutions for adaptation.
This report provides for Algeria an inventory on water resources, water demands and energy, presents strategic development of the sectors of water and energy, analyses the interactions between water and energy.

2. Water in Algeria

Across the country, water resources in Algeria are as follows (as depicted in figure 1 and table1):

- 10 billion m^3 in the northern regions: 7.4 (surface water), 2.6 (underground resources);
- 5.37 billion m^3 in the Saharan regions: 0.37 (surface water), 5 (underground resources from Albian Water-basin)

Fig.1. Five main hydraulics basins of Algeria

Table 1 - Water resources

Basin	Surface water (billion m^3)	Ground water (billion m^3)	Total (billion m^3)
Oranie	0.65	0.6	1.25
Cheliff	1.71	0.83	2.54
Algérois	1.69	0.74	2.43
Constan tinois	3.00	0.43	3.43
Sahara	0.37	5 Albian	5.37
Total	7.42	7.6	15.02

From documents of Ministry of Water Resources (MWR), updated in February 2012

- 10 billion m^3 in the northern regions: 7.4 (surface water), 2.6 (underground resources);
- 5.37 billion m^3 in the Saharan regions: 0.37(surface water), 5 (underground resources from Albian Water-table)

Structures in sedimentary basins of the Sahara are in favor of large and deep reservoirs which feed back to the rainy periods of the quaternary. The water-table of the continental Terminal (100-400 m depth), and the water-table Intercalary continental called "Albian" (1000-1500 m depth) contain significant reserves (30 000 to 40 000 billion m3) but because their very low turnover (nonrenewable) the exploitable potential is very limited (5 billion m^3/year).

2.1. Renewable and non-conventional water resource potential

2.1.1. Renewable water resources

Renewable water resources (surface water and groundwater) were estimated at around 16.5 billion m^3 for an average year on the basis of climatic series from before the 1980s. This estimate was revised down to around 12.2 billion m3 taking into account the droughts experienced by Algeria since the 1980’s, with a decrease in resources of around 25%.
Water availability dropped to under 447 m^3 per capita per year in 2012, which is significantly below the “scarcity threshold” of 1,000 m3 per year set by the UNDP. It is set to drop below 500 m³ per capita per year, the “absolute scarcity” threshold.

A. Surface water resources

Surface water inflows reach several millions of cubic meters for the basins with the least water for average years: the Sahara Basins DjorfTorba-Bachar (350 hm³) and Brézina- el bayath (122 hm³), and billions of cubic meters for those with the most water: Beni Haroun -Mila (1000 hm³) et Kissir-Jijel (680 hm³) [1].
This runoff is largely due to rapid and powerful floods. They are generally recorded during an average estimated period of 20 to 30 days for the basins in southern Algeria and two to three months for the basins in northern Algeria.

Surface water resources are evaluated at approximately 8.376 billion m3 for an average year (see table below). These water resources are characterized by high variability - the resources for nine years out of ten or four years out of five are significantly below this average.
In a drought year, water inflow can drop to under 30% of this mean value. Managing the uneven distribution of water resources in time and space has involved the construction of large dam reservoirs for storing the inflow from wet years to be used in dry years and transferring water from regions with surplus water to regions with water shortages in order to encourage balanced economic and social development across the whole of Algeria.

B. Groundwater resources

Potential groundwater resources are estimated in 2011 at around 2 602 822 992 m^3 per year, of which 794 213 270 m^3 per year comes from irrigation water returned via surface water in particular [2].

2.1.2. Non-conventional water resources

Non-conventional water resources offer a significant water resource potential in Algeria. They involve reusing wastewater, artificial recharge of groundwater and freshwater production through the desalination of sea water or demineralization of brackish water. The Algerian National Water Resources Strategy estimates the volume of water that could be exploited from non-conventional water resources at over 2 billion cubic meters.

A. Wastewater potential [4]

Park of sewage treatment plants
In operation:
Total = 145
Total treatment capacity = 12000000 EQH (equivalent habitant)
Volume = 800 Hm^3/year
In progress:
Total = 106
Total capacity of treatment to the end of 2012 = 7965058 EQH
At the end of the current program in 2014 = 1.2 billion m^3/year

B. Sea water desalination

Desalination has overcome technological difficulties and is now a viable, economically competitive and technologically achievable alternative for drinking water or agriculture and the irrigation of some profitable crops. The reverse osmosis technique now used involves passing sea water at a pressure of 70 bars through a special membrane to produce freshwater. This technique has made a significant contribution to reducing operational costs, such that it has been adopted by a large number of countries as the method of choice.

- Desalination is now technically feasible. It provides a reliable resource that can be assessed in advance, making it possible to plan investments and construction projects better;
- Desalination facilities can be built using a BOOT (Build, Own, Operate and Transfer) system;
- Desalination facilities can be built quickly (12 to 24 months including the design stage).

Algeria is only just starting to produce freshwater by desalination or demineralization (2005). Overall production capacity is already around 2310000 m^3 per day. Sea water desalination may be the most appropriate solution to the situation faced by many regions in Algeria to plug the gap between water demand and supply.
The national strategy estimates the contribution of sea water desalination at approximately 1000 Mm^3 by 2030 [6].

C. Brackish water

In Algeria, around a quarter of groundwater is, either in whole or in part, brackish water. This water is mostly situated in the country's desert and semi-desert regions.
Exploitation of brackish water resources began in 2000.
The volume of brackish water mobilized is estimated at 510 160 hm^3/year whose 160 hm^3/year are used to satisfy the drinking water supply.
Twelve (12) stations are operating in the provinces of Tlemcen, Oran, Tizi Ouzou, Bejaia, Illizi, Biskra, Ouargla, Medea and Ain Defla. The production of drinking water is 24.2 hm^3/ year [3].
Also, 241 hm3/year of brackish water will demineralized from a mobilized volume of 464 hm3 through 35 stations which are actually under study and work (included in different programs). The overall capacity of stations is 91.5 hm^3/year. Overall throughput mobilized in upstream exceeds 428.9 hm^3/year.
The situation is as follows [3].
In Study: 06 stations (Tamanrasset 4, El Oued 2) With 04 station whose studies were completed (Tamanrasset 2 and El Oued 2);
Study and realization: 01 station (Bechar);
In Works: 12 stations (10 Ouargla, El Oued and Tamanrasset (ADE));
Launching work in Progress: 02 stations of ADE (Tindouf and Illizi)
Installation of Mono-Blocks: 15 stations (El Oued) whose: 01 station completed and commissioning (Réguiba C.).

2.2. Future water demand

Overall, water demand for all use sectors is evaluated at approximately 20 billion m^3 in 2030, distributed as follows:

Table 2 - Changes to future water demand not taking climate change into account in Mm^3 [5]

Use sector	2011	2030
Drinking (urban and rural) and industrial water	2 900	3 500
Not served industry and tourism	0.125	0.2
Irrigation water	8 600	15 400
Hydroelectric power	-	-
Total excluding not served industry and tourism	11 500	18 600
Total including isolated industry and tourism	11 500.125	18 900.2

2.2.1. Water demand for the supply of drinking and industrial water

Forecasts for future domestic water use are based on population growth, rural to urban migration and water demand per capita projections.
Overall, drinking, industrial and tourist demand forecasts for the whole of Algeria by 2030 are evaluated at 3.5 billion m^3.

2.2.2. Irrigation water demand

Agricultural water demand corresponds to the potential irrigation water needs evaluated on the basis of recommended rotations and theoretical water needs of crops.
This water demand has been evaluated in the PDAIREs at approximately 8.5 billion m^3 including approximately 0.4 billion m^3 for the areas served by large-scale hydropower dams (including water demand for areas not equipped for irrigation), 8 billion m^3 for small- and medium-scale hydropower dams and around 0.1 billion m^3 for private irrigation.

2.3. Resources-demand balance

The current balance of water supply and demand is analyzed by river basin. It involves comparing water resources and demand in order to establish a representative picture of the water situation at a given date. The assumptions taken into account can be summarized as follows:

- Water demand taken into account corresponds to the demand expressed by users, mainly in the drinking water and irrigation sectors;
- The water resource value taken into account in this balance corresponds to the volume of water regulated by the dams and water abstractions made directly from rivers and groundwater, despite the fact that the latter significantly exceeds renewable levels.

2.4. Surface water projection

The planning studies performed allow by 2030 for the construction of around seventy dams across all river basins(139 dams in total) in order to secure supply for Algeria's water needs. The volumes of exploited and exploitable surface water are taken from the Algerian National Water Debate report, the National Water Plan study and specific studies performed for dam construction projects.
The planned dams are intended to be built increasingly far away from the place of water use, and their construction is increasingly complex and costly in both technical and economic terms. They will make it possible to exploit additional water in the region of 5 billion cubic meters. These projects primarily involve increasing irrigation to areas already equipped for irrigation, and will not make any significant difference to water balances. Table15 below shows the volume may be raised by the construction of new water dams.
Exploiting this additional water as a resource would require, according to the National Water Resources Strategy, the construction of new water transfer project.

2.5. Groundwater projection

The groundwater projection takes into account the impact of the measures in the National Water Resources Strategy on inflow and outflow. This mainly involves:

- Implementing the irrigation water conservation program, which will lead to a significant reduction in water abstraction and irrigation returns;
- Use of surface resources to replace groundwater abstraction. A volume of around 100 Mm^3 abstracted for drinking water from groundwater will be replaced by surface water (100 Mm^3 per year by 2025);
- Artificial recharge of groundwater. The National Water Resources Strategy evaluated this recharge at around 200 Mm^3 per year by 2030, with around 100 Mm^3 from treated wastewater;
- Strengthening of the monitoring and sanctions system for over-users and the restriction of pumping from groundwater (revised pricing framework, removal of subsidies providing incentives to overuse, implementation of measures for the setting up of protected and prohibited areas, etc.)

These measures to improve groundwater recharge and especially reduce water abstraction will make it possible to contain demand, set to vary very little between 2013 and 2030, and especially between 2030 and 2050. In these conditions, groundwater balances will slowly even out, mainly by a decrease in outflow by natural outlets.
The groundwater projection takes into account changes in irrigation return water which will be realized by implementation of the National Water Conservation Program, changes in outflow realized by changes in irrigation return water and the ongoing decrease in groundwater levels, and changes in water abstraction realized by the National Water Conservation Program and the strengthening of the control system.

2.6. Non-conventional water resources projection

Non-conventional resources primarily consist of artificial groundwater recharge, sea water desalination and treated wastewater.
The Algerian National Strategy for Development of Water Resources gives a significant place to the exploitation of non-conventional water resources.
This strategy estimated the proportion of this resource at around 1.624 billion m^3 per year, of which 824 Mm^3 from sea water desalination and around 800 billion m^3 from wastewater.
The forecasts are levels in 2030 to nearly 3 billion m^3. This water potential is intended to be used for watering green spaces and sports fields and developing irrigation around urban areas.
The table below presents the anticipated contribution of desalinated sea water and treated wastewater.

Table 3 - Forecasting of unconventional waters for 2030 per basin in Mm^3 [7]

Basin	2011		2030	
	Waste water	**desalina tion**	**Waste water**	**desalination**
Oranie	153.33	383.432	In study	In study
Cheliff	99.23	111.325	In study	In study
Algérois	293.00	276.743	In study	In study
Constanti nois	166,54	053.400	In study	In study
Sahara	87,90	0	In study	0
Total	800	824.900	2000	1000

3. Electricity in Algeria

3.1. Energy context

The Algerian population is around 38.5 million people and is expected to reach 45 million by 2030; more than 60% live on the coastal area. The population growth and rapid urbanization have an impact on the demand for energy and the environment. The total energy consumption of Algeria in 2012 was about 50.9 million tons of oil equivalents (TOE) and should increase to 91.54 million TOE in 2030 [8]. It is expected to increase by 3.3% per year, due to significant development needs and for universal access to energy.
The trend scenario, which extrapolates current policies, indicates that energy consumption in the country remains mainly based on fossil fuels which will still account for about 80% of demand in 2030. Oil will remain the dominant energy source well it is losing share for the gas in electricity generation. Gas demand will increase and account for 40% of global energy demand. Oil demand will continue to grow by 1.7% on average, reaching 12% of the energy mix by 2030.
In 2030 in the case of trend scenario, will dominate the fossil energy, oil and gas mainly. However, it should be recalled that Algeria does not have endless resources; it holds only 4% of proved global gas reserves. Prospective studies indicate that oil production in Algeria is expected

to increase by only 20% in twenty years, while gas production is expected to double. Algeria, in the current state of knowledge on reserves could become energy importers and much more of Oil [9].

3.2. Hydrocarbon resources

We recall the difference between the concepts of reserves and resources. The ultimate resources represent what the nature has bequeathed to us; they are estimated for Algeria to 10.6 billion m^3 of initial proved reserves for oil (Figure 3). Proved resources are the part that we are able to extract physically, this part is about 60% of ultimate resources (7.6 billion m3).

Recovered reserves correspond to the volumes of hydrocarbons contained in the production oilfields which we are able to extract with the technical and economic conditions of the moment, this part is about 2.6 billion M^3 minus 1.4 billion M^3 already produced.

It remains a last category, oils located in the remaining oilfields (Probable & possible) yet to be discovered, oils that could be extracted through recovery technologies and unconventional oil (heavy oil, extra heavy ...) see (Figure 2 and 3)

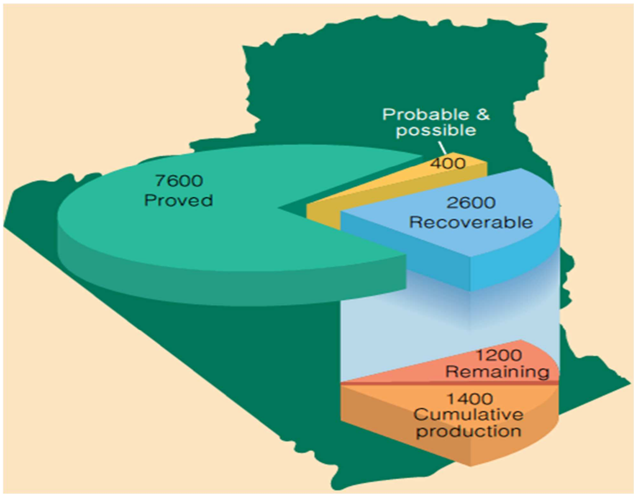

Fig.2. Oil Statistics in Algeria (Billion m^3EP) [9]

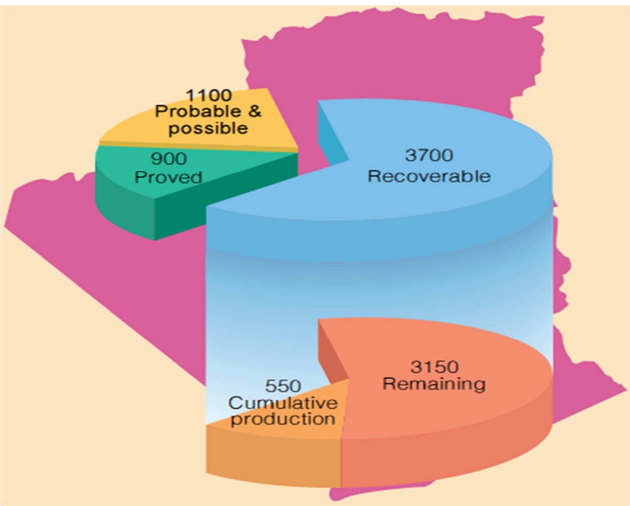

Fig.3. Statistics Gas in Algeria (Billionm3EP) [9]

3.3. Hydrocarbon reserves

Referring to the most famous statistical review of Schlumberger, the evaluation of proved hydrocarbon reserves of Algeria in late 2007 was 5.6 billion TOE including:

- Oil reserves estimated at 1.5 billion tons (12.3 billion barrels)
- Gas reserves estimated at 4.1 billion TOE (4500 billion m^3), which represents 4% of global gas reserves. Thus Algeria ranks fifth in the world for natural gas reserves.

These data represent only the volumes of Oilfield discovered or in production, these data could increase thanks to future discoveries and technological innovations that will pass resources to additional reserves.

The life expectancy of reserves in Algeria is about 35 years from 2008, measured by the ratio (reserves / production). This ratio is statistic ones and does not take into account future production (the prospects for new discoveries), it provides the time to associate allocations of reserves to government policy.

Table 4: Proved reserves of Algeria in billion TOE (end of 2007) [8]

Proved reserves	Reserves	Production	Res /Prod (years)
Crude Oil	1,5	0,086	18
Natural gas	4,1	0,074	55
Totals	5,6	0,162	35

Sources :API

3.4. Electricity

In Algeria, the forecast for electricity demand is established by operator system (OS) Sonelgaz Subsidiary.

Based on the country's energy policy, the OS matches supply to demand in two steps:

- An initial step to study electricity demand.
- A second step to define an equipment program in order to satisfy that demand at the lowest possible cost.

3.4.1. Study of the demand

A. Retrospective analysis of demand

Over the last twenty years (1992-2012), overall electricity consumption has more than tripled, far exceeding economic and population growth.

The elasticity of electricity demand to GDP, estimated over this period, is almost two units. Over a period of two decades, the growth rate of electricity consumption has continuously exceeded GDP and population growth rates, and the difference has become more pronounced since 1998.

For the same period, electricity consumption per capita increased from 721.53 kWh per capita in 2001 to around 1406 kWh per capita in 2012, equivalent to an average

annual increase of 6.25%. The graph below traces these developments.
Moreover, between 2002 and 2012, electricity demand increased from 20.53 GWh to 54.09 GWh, reflecting an average annual growth rate of approximately 9.5%.

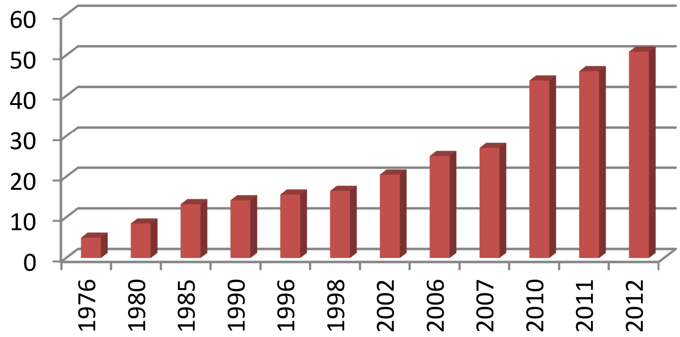

Fig.4. Evolution of the power consumption (Twh)

It should be noted that this growth has been uneven, however, as illustrated in the graph below: moderate growth between 2000 and 2005, followed by a period of burgeoning demand for electricity from 2006 to 2012, with an annual average of 10% reflecting the economic and social dynamism experienced by Algeria, in particular in terms of increased access to basic infrastructure.

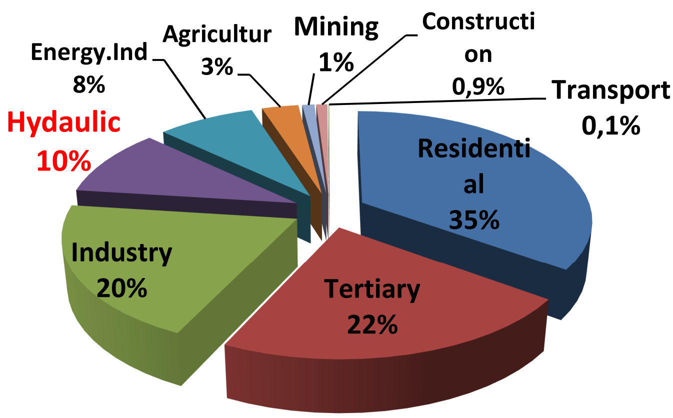

Fig.5. Distribution of electricity consumption by activity sector "2011"

The peak maximum power demand increased from 3 913 MW in 2001 to 8 850 MW in 2011 and 10 464 MW by 2013. This represents an average annual growth rate of 8% over the first 10 years (2001-2008) and 12% for the second period (2009-2013). In 12 years, the peak maximum power demand has thus experienced an average annual growth rate of 9.35%.

B. Projected electricity demand

By 2017

The "emergence scenario" was adopted as a baseline for developing the equipment plan. This scenario predicts a 7% increase between 2012 and 2017, leading to a net energy demand of 75.79 TWh by 2017. In this scenario, growth is driven mainly by the development of services and tourism in the service sector, and by construction in the secondary sector. Growth in the residential sector is also extremely strong as a result of demographics, urbanization and especially, the development of new specific uses.
The "economic efficiency prioritization scenario" involves an 8% growth rate of net energy demand between 2012 and 2017, resulting in a net energy demand of 79.4 TWh by 2017.
The "exhaustion scenario" predicts a 6% energy increase between 2012 and 2017, limiting consumption to 72.32 TWh in 2017.

By 2020

A "segmentation" study, through the identification and consideration of different factors explaining the changes in electricity demand, conducted by Sofreco consultants as part of a study entitled ("Gradual integration of the Algerian, Moroccan and Tunisian electricity markets in the European Union's internal electricity market") analyses the economic and social contexts that prevailed during the past period and plausible future changes for Algeria, in the light of its potential but also regional and international opportunities and constraints.
The study was set in the context of the scenarios mentioned above. Each of these identifies a plausible situation that could describe possible future electricity consumption trends.
These three scenarios were constructed based on the determining factors considered as explanatory of the electricity consumption of the different sectors.
Thus, the emergence scenario is characterized by 6% annual growth between 2017 and 2020; the economic efficiency prioritization scenario would involve an annual growth rate of net energy demand in the region of 7.2%; the exhaustion scenario would see an average annual increase of 5.2%.

By 2030

It is assumed that by 2030 a form of saturation will have occurred in a number of sectors of economic activity, that consumption in the residential sector will have stabilized and that tangible effects of the energy efficiency policy will be felt throughout the country.
At this point, then, the emergence scenario would be limited to growth of 4.2% per year; the economic efficiency prioritization scenario, 5.5% per year and the exhaustion scenario would not exceed an average annual rate of 3.5%.
The growth in consumption at the various dates quoted above is summarized in the following table:

Table 5 - Projected electricity demand in TWh

Date	**2012**	**2017**	**2020**	**2030**
Exhaustion scenario	54.04	72.32	93.18	110.67
Emergence scenario	54.04	75.79	101.42	124.58
Efficiency scenario	54.04	79.40	112.40	146.90

3.4.4. Meeting demand

A. Meeting demand for 2013-2017

To meet the demand for electricity, Sonelgaz has programmed an additional power of 8050 MW by the realization of projects listed below:

Table 6 - Projects 2013-2017

Region	Combined cycle [MW]	Gas turbine [MW]	Total [MW]
West	1900	800	2700
Center	1600	1100	2700
East	1600	1050	2650
Total	5100	2950	8050

B. Meeting demand beyond 2018 [10]

The additional capacity planned for the period 2013-2023 will amount to 35 505 MW of which 21 305 MW are decided and 14200 MW in project idea (conventional type) [10].
The 21 305 MW already decided consist of:
5 539 MW of renewable energy,
14 370 MW of conventional for the interconnected North grid (ING)
50 MW of gas turbine to In Salah - Adrar - Timimoun
421 MW of gas and diesel turbines for isolated south grid(ISG).
925 MW for strategic mobile reserve.
The total development program for the production of electricity 2013-2023 will amount to more than 4,791,391 million dinars (more than 2,664,878 million dinars for renewable).
14 370 MW of additional capacity are under construction on the 2013-2017 period, of which 1 140 MW of Koudiet Eddraouech site (SKD).
Additively to a conventional park, it is expected the realization by SKTM (Shariket Kahrabaa li Takat Moutadjadida, subsidiary of Sonelgaz group) of a renewable energy park of 5539 MW distributed as follows:
Interconnected Grid of North (IGN): 5084 MW of renewable energy planned for the period of 2013 to 2023 which can be carried out in collaboration with the SSB (Sahara Solar Breeding) project for example.
Isolated Grid of South (IGS): 167 MW of renewable energy planned for the period of 2013-2023.
InSalah - Adrar - Timimoun: 288 MW of renewable energy planned for the period of 2013-2023.
Beyond 2023, the various types of electricity generation will be investigated and the necessary decisions will be taken at the appropriate time, wind farms, solar farms, natural gas power plants or even the hydroelectric sites.

4. Energy needs for water

Electrical energy is used mainly for the operation of pump and injection stations for drinking, industrial and irrigation water, drinking water treatment plants and activated sludge wastewater treatment plants. It is also used for lighting and for pumping in marine outfalls.

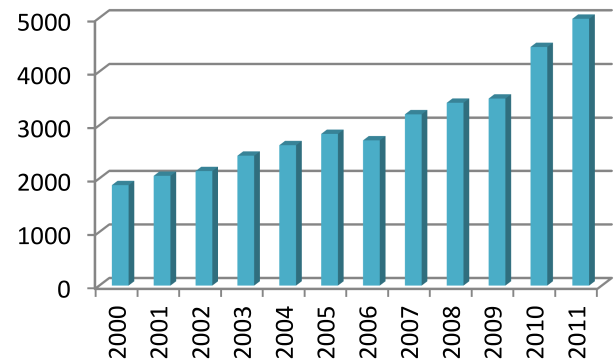

Fig.6. Evolution of consumption in GWh [7]

Overall, the water sector in 2011 consumed around 4 983 GWh. This consumption is set to rise to 16 090 GWh by 2030 (0.7-0.8 kWh/m^3), more than three times the consumption of 2011. This predicted increase is mainly due to:
The use of energy-intensive solutions for example sea water desalination and the water transfer project.

- Use of conventional, high energy-consuming resources in order to meet water demand. This is the case of water pipes for drinking water supply for the cities.
- Development of sanitation and wastewater treatment activities.

4.1. Current need

These needs, collected from water users, seem to be in the region of 4 983 GWh, or 0.44 kWh/m^3.

4.2. Energy needs by 2030

These energy requirements were evaluated on the basis of current needs and the provisions adopted regarding usage of conventional and unconventional water resources, water saving programs, drinking water generation programs, sanitation and wastewater reuse programs, and programs aimed at water conservation and expansion of irrigation.

A. Drinking water

Energy requirements were estimated on the basis of current needs and drinking water supply projects adopted in connection with planning studies. These energy needs are estimated at around 2 606 GWh, or 0.90 kWh/m^3:

- Sea water desalination, these needs are estimated at approximately 1,642 GWh, or 3.7 kWh/m^3.
- Use of energy-consuming drinking water supply systems.

B. Sanitation

Electrical energy is used mainly for the operation of activated sludge wastewater treatment plants (in lagoon-based wastewater treatment plants (WWTPs) it is used for pumping and sometimes for treatment), for network pumping and for lighting. It is also used for pumping in marine outfalls.

The electrical energy estimate is based on the following assumptions:

- The activated sludge purification process was adopted for WWTPs serving more than 100,000 inhabitants. The power consumption for these WWTPs was calculated on the basis of 1 kWh/kg BOD5 eliminated.
- The lagoon-based purification process was adopted for all other towns and cities. The power consumption for these WWTPs is negligible. The national sanitation plan has estimated this consumption at around 10% of the consumption of WWTPs that use activated sludge.

On this basis, the national water plan estimated the energy requirements for sanitation and wastewater treatment at 397 Gh by 2030.

This data does not take into account energy needed for wastewater reuse (additional treatment, pumping water to the place of use, etc.).

C. Irrigation

Overall, the water needs of the agricultural sector are estimated at around 9 193 GWh per year. The assumptions used in estimating these water needs can be summarized as follows:

- Current (2011) energy needs of agricultural areas are estimated at about 1 513 GWh per year.
- The energy requirements of extensions to agricultural areas,

D. Wastewater reuse

Overall, the energy requirements of wastewater reuse projects are estimated at around 800 GWh, or 0.7kWh/m³. The assumption used to estimate this need is:

- Reusing a volume of treated wastewater in the region of 1200 Mm³ per year for watering golf courses and green spaces as well as for irrigation of those crops that are suited to it.

5. Conclusion

In order to cope with population growth and economic development, energy and electricity demand in Algeria will increase substantially between now and 2030.

In the absence of a rigorous energy efficiency policy, the energy sector's water requirements will be also envisaged in terms of electricity generation in hydroelectric plants (dams), as make-up water for cooling in classic thermal power stations, and cleaning for the hybrids stations (solar-stream) particularly for those located in the country's interior (Sahara).

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Annexes

Appendix 1

Table7-- Trend scenario of water and energy sectors

	2011	**2030**
Water demand **(Mm³)**	12 300	20 100
Electricity demand for water**(GWh)**	4 983	16 090
Total electricity demand **(GWh)**	48 860	146 900
Natural gas reserves (years)	52	33
Oil reserves (years)	15	0