REVUE DES SCIENCES COMMERCIALES Vol. 20, N°02: Décembre 2021, pp26- 44
ISSN : 1112-3818 /EISSN : 2602-5396

THE CONTRIBUTION OF INTERNATIONAL PARTNERSHIP TO THE DEVELOPMENT OF INFRASTRUCTURE RELATED TO THE PRODUTION OF ELECTRICITY FROME RENEWABLE ENERGIES IN ALGERIA

ERROUKRMA Fatima Zohra Ikram*
Laboratoire PERMANAN– EHEC, Algeria
i.erroukrma@hec.dz
Dr. RAHAL Farah
Ecole des Hautes Etudes Commerciales – EHEC , Algeria
farah.rahal@gmail.com

Received : 01/01/2021	*Accepted : 22/11/2021*	*Published : 30/12/2021*

Abstract:

Today more than ever, and under the effect of globalization, energy is at the center of all development. In this context, clean energies constitute one of the levers for the economic and sustainable development of nations. However, the sector in Algeria suffers from major obstacles concerning the financial investment costs and the lack of expertise. This work aims to study the Algerian-European partnership relationship with the aim of promoting renewable energies in the country. In fact, we have carried out a critical analysis of the project for the first hybrid solar/gas plant in Algeria, and the largest on the world level, carried out within the framework of an Algerian-Spanish strategic partnership. It emerges from this study that Algeria needs technical support more than financial support in order to be able to develop this sector.

Keywords: International partnership, Investment, Renewable energies, Electricity, Hassi R'mel hybrid plant (Algeria).

JEL Classification Codes : C93, F21, F43, O13

Résumé :

Aujourd'hui plus que jamais, et sous l'effet de la mondialisation, l'énergie est au centre de tout développement. Dans ce contexte, les énergies propres constituent un des leviers du développement économique et durable des nations. Or, le secteur en Algérie souffre de grands obstacles concernant les

* Author Corresponding

coûts financiers d'investissement et le manque d'expertise. Ce travail vise à étudier la relation partenariale algéro-européenne dans le but de la promotion des énergies renouvelables dans le pays. En effet, nous avons mené une analyse critique du projet de la première centrale hybride solaire/gaz en Algérie, et la plus grande sur le plan mondial, réalisée dans un cadre de partenariat stratégique algéro-espagnol. Il ressort de cette étude que l'Algérie a besoin d'un accompagnement technique plus qu'un appui financier afin de pouvoir développer ce secteur.

Mots clés : partenariat international, financement, énergies renouvelables, électricité, Centrale hybride Hassi R'mel, Algérie.

1- Introduction

Algeria's objective in terms of sustainable development is the achievement of its national program for renewable energies, energy efficiency and security. The use of this non-polluting source of energy requires remarkable energy deposits in terms of size, in other words huge infrastructures for the production, transport, and distribution of renewable-based electricity. Considering the natural potential of solar energy scattered over the coastal region; of the highlands and the Sahara, Algeria attaches significant importance to solar energy. However, photovoltaic technology is characterized by the enormous fixed investment costs it generates: a solar power plant costs millions of dollars. However, Algeria needs foreign support to expand its solar energy industry network.

Through this work, we will try to answer the following problem: **How does the international partnership contribute favorably to the strengthening of the infrastructures of the solar energy industry and to the realization of energy challenges in Algeria?**

In order to answer this question, we consider the case of the Hassi R'mel hybrid power plant, a solar electricity production plant carried out in a partnership framework between Algeria and Spain, processed through descriptive analysis with a critical approach using numbers and statistics. While analyzing on the one hand the funding allocated through this partnership, but also seeing the evolution of production **renewable-based electricity** from this station in relation to **total electrical energy including the share of exports, and the economy of gas planned** from its implementation in 2011 until 2018.

It is clear that even if the international partnership plays a crucial role in the evolution of the number of infrastructures in the field of renewable energy in Algeria, unfortunately the big stakes and different interests are, in most cases, badly allocated, consequently, the cooperation is far from being mutually advantageous and the international part is mostly "winning" to the detriment of the national part.

2- The international partnership in an Algerian-European context

The history of this relationship goes back a few decades, but has known some differences concerning social and cultural issues. For the economic and commercial side, the main goal behind the association agreement between Algeria and the European Union was to create a Mediterranean free trade area, and above all to boost the development of the southern shore, including Algeria through economic reforms. It is this association as well as the Mediterranean agreements which gave birth to the Algerian-European partnership. The latter was signed on April 22, 2002 in Valencia, in 2004 some European countries proceeded to its ratification. And with the aim of achieving the free trade area and the elimination of all customs taxes by 2017. (Keltouma, 2010, p. 153)

Among the main axes undertaken in the content of this partnership agreement and represented in article form, we find:

Political dialogue that aims to create a region of peace, security and prosperity. Free movement of goods which indicates that for the next 12 years, there will be an abolition of quotas for international commercial transactions (imports and exports) as well as exceptional measures will be taken on customs duties. And this concerns industrial products, and agricultural and fishing products.

Trade in services: the agreement provides for the engagement of the two parties to the contract, by the principle of treatment no less favorable than that granted to third parties with regard to the service of foreign companies present on the territory of Algeria or the EU.

Liberalization of capital and competition: this dialogue insists on facilitating the movement of foreign capital in Algeria for FDI as well as the respect for the principles of competition and the elimination of any type of monopoly.

Economic cooperation: For some, this cooperation is more favorable to Algeria than the EU, since it affects the liberalization of commercial

transactions, the diversification of Algerian exports to the EU, the creation of wealth through the conclusion of new partnership projects in several sectors, etc.

Cultural and social cooperation: this section mainly dealt with issues relating to immigrant workers (equal treatment, equal payment, social security, vocational training, etc.).

Financial cooperation: this component is based on the obligation to rehabilitate economic infrastructure, promote private investment and entrepreneurship, activities that promote job creation for young people, modernize banking services and postal. With financial resources distributed in the form of donations or loans; in order to ensure a socio-economic balance between the two shores of the Mediterranean.

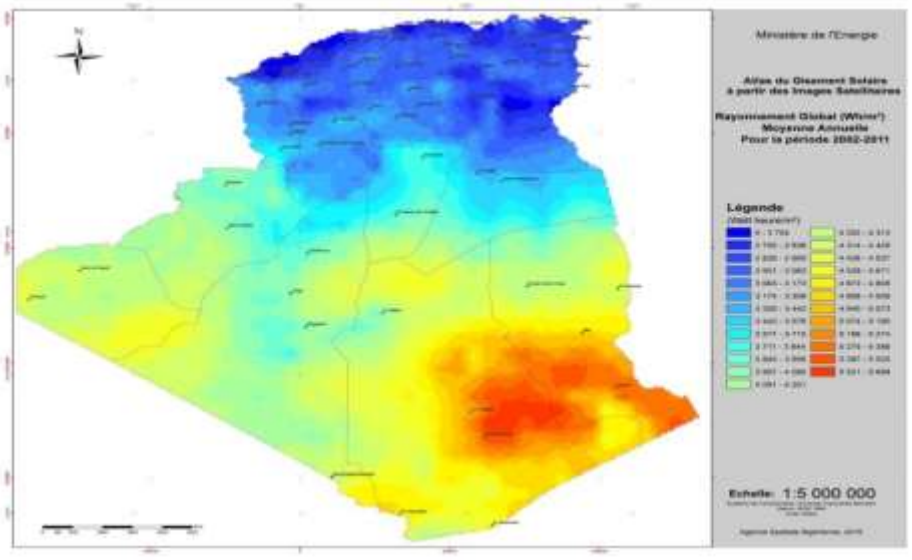
Cooperation in the field of justice and home affairs: the aim was to cooperate in order to fight and prevent certain phenomena such as money laundering, corruption, terrorism, etc.

3- Renewable energies in Algeria

3-1 . Solar Potential and Algerian efforts in renewable energies

In the Mediterranean, Algeria is the country which has the largest source of sunshine. According to the study by the German space agency, it has a potential of 169,440 TWh / year, or 5,000 thousand times the Algerian national electricity consumption. (Kahina, 2014, p. 01)

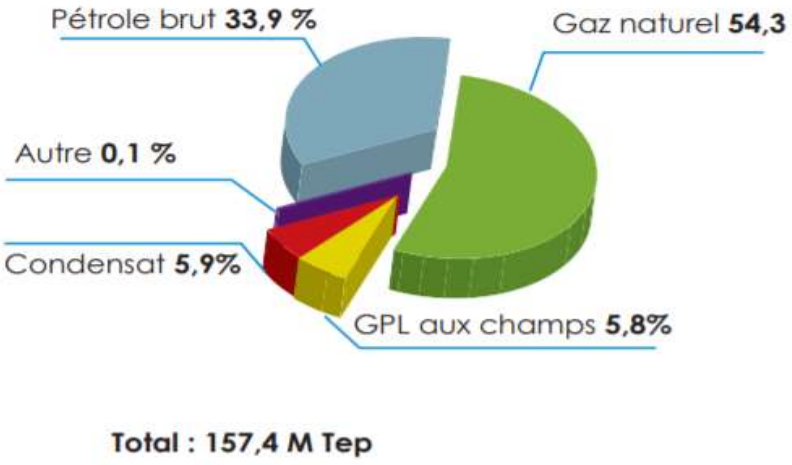
Figure 01: Map of annual solar irradiation in Algeria (2002-2011)



Source: Ministry of Energy www.energy.gov.dz

However, with all of its renewable-based electricity production capacities that the country has, Algeria relies exclusively on fossil fuels to meet its electricity needs, as shown in the figure below.

Figure 02: Structure of primary energy production year 2019



Source: Energy balance 2019, available at https://www.energy.gov.dz/Media/galerie/bilan_energetique_national_2019_5f7b107553bcd.pdf

3-2. Algerian national program dedicated to renewable energies

In the case of Algeria, the solution for better development of renewable energies was to integrate them into its energy policy, by adopting a legal framework encouraging their promotion. The program was adopted in 2011, targeting 22,000 MW of renewable electricity production, including 13,500 MW in photovoltaic energy by 2030, 5,010 MW in wind energy, 2,000 MW in CSP, 1,000 MW in biomass, 400 MW in cogeneration and 15 MW in geothermal energy. In addition, 12 GW will be intended for local consumption and 10 GW for export (with nearly 27% in the national balance sheet of electricity production). While establishing incentive measures such as: opening up to participation by any natural or legal person in calls for tenders for projects linked to the exploitation of renewable energies, the conclusion of electricity purchase contracts with guaranteed tariffs, tax breaks, the granting of subsidies to cover the additional costs incurred on the national electricity system, guaranteed marketing of the electricity produced by private investors for a period of 25 years. (Algerian Ministry of Energy, s.d.)

The development of renewable energy and energy efficiency is framed by a set of laws:

- Executive Decree n°11-423 of December 8, 2011 fixing the operating methods of the special allocation account n°302 - 131 entitled: "National fund for renewable energies and cogeneration".
- Interministerial decree of October 28, 2012 determining the nomenclature of income and expenditure chargeable to the FNER.
- Interministerial decree of October 28, 2012 specifying the methods of FNER monitoring and evaluation.
- Executive Decree No. 13-218 setting the conditions for granting bonuses for the costs of diversifying electricity production.
- Supplementing Executive Decree No. 13-424 of 18 December 2013 relating to the energy audit of establishments that are large energy consumers.
- Interministerial decree June 19, 2014 amending and supplementing the approval of audit offices and experts.
- Ministerial decrees of February 2, 2014 fixing the guaranteed purchase prices for the production of electricity from installations

using the photovoltaic sector and the conditions of their application.

In addition, Law n°11-11 of July 18, 2011 relating to the complementary finance law for 2011 raised the level of the oil royalty which mainly supplies the National Fund for renewable energies and extended its scope to cogeneration.

Figure 03: Consistency of the renewable energy development program

Unité : MW	1ère phase 2015-2020	2ème phase 2021-2030	TOTAL
Photovoltaïque	3 000	10 575	13 575
Eolien	1 010	4 000	5 010
CSP	-	2 000	2 000
Cogénération	150	250	400
Biomasse	360	640	1 000
Géothermie	05	10	15
TOTAL	4 525	17 475	22 000

Source *:* https://era.dz/salon/fr/content/programme-national-des-%C3%A9nergies-nouvelles-et-renouvelables

3-3. Framework of the Algerian-European partnership in renewable energies

According to the European Commissioner for Energy Miguel Arias Canete during the first Algeria-EU business forum on energy, the Algerian renewable energy program will be carried out in partnership between the State and foreign partners (European companies) regarding its financing, but also the sharing of their experiences with Algeria in order to help it produce renewable energy at a cheaper price.

The conclusion of this energy forum gave birth to the Algeria-EU Strategic Partnership Memorandum, signed in July 2013, mainly covering energy branches, including renewable energies, energy efficiency projects, infrastructure development and technology transfer.

Figure 04: Share of renewable energies in the electricity mix according to the national renewable energy program

Source: Ministry of Energy, "Renewable energies in Algeria, Berlin on February 16, 2016". Page 11.

4- Methods and materials

The hybrid Solar-Gas plant in Hassi'Rmel SPPI *(Solar Power Plant One)* was inaugurated in July 2011, this plant is the result of an Algerian-Spanish partnership. It is a power station located on an area of 130 ha, with an electrical capacity of 150 MW, composed of: a) a solar field made up of 224 parabolic-cylindrical collectors imported from Germany which play the role of a generator solar steam with a temperature that rises to 393°C in order to transfer this heat to water and thus produce water vapor (30 MW), and b) of a combined cycle with a capacity of 130Mw, which works with natural gas. On the basis of the annual average value, the geographical site of the power station exhibits 9.5 hours of sunshine daily, thus offering an average DNI estimated at 7138 Wh / m^2 / day. (AMAR, s.d., p. 48)

It should be noted that the strong point of this hybrid power plant is the addition of the steam produced by the solar field to that recovered from the gas turbines to power the steam turbine. The electrical power produced by the plant increases accordingly (Najla, 2011, p. 02).

The advantage of this new technology which has already been tested in California and Spain (recently in the MENA region) is that it allows the storage of thermal energy (up to 50MW) in the form of heat for electricity production even in periods when there is no sun, namely during the night.

Moving on to the economic characteristics of the plant, estimated at 315.8 million euros. The project was carried out by: - the Spanish subsidiary of the large energy group Abengoa, known as "Abener" which maintains technological systems with a share of 51%, As part, the technology is provided by Abengoa Solar and the realization of the plant is entrusted to Abener.

- *BTP Teyma* with a rate of 15%. This 66% elected external financing is explained by the high cost of solar technology projects.
- *NEAL (New Energy Algeria)* 20%, a subsidiary resulting from a partnership between Sonatrach and Sonelgaz.
- *A public banking pool (BEA-BNA-CPA)* of 14%, in the form of long-term credit.

Through this information we can see that this project is an **international partnership in the form of a joint-venture contract for the sale and purchase of electricity.**

The main objectives pre-established in this partnership contract and which we are going through this work to try to see if they were achieved or not are:

- Increase the electricity produced by 16.5% electricity per year.
- The evolution of the share of electricity exports to Europe.
- Save 5.13 billion m^3 of gas per year, ie: 11% of annual gas exports.

The methodology used in this article constitutes a qualitative analytical study using some quantified data in order to see if the objectives mentioned above have been achieved after 9 years since its implementation.

5- Discussion

5-1. Electricity produced:

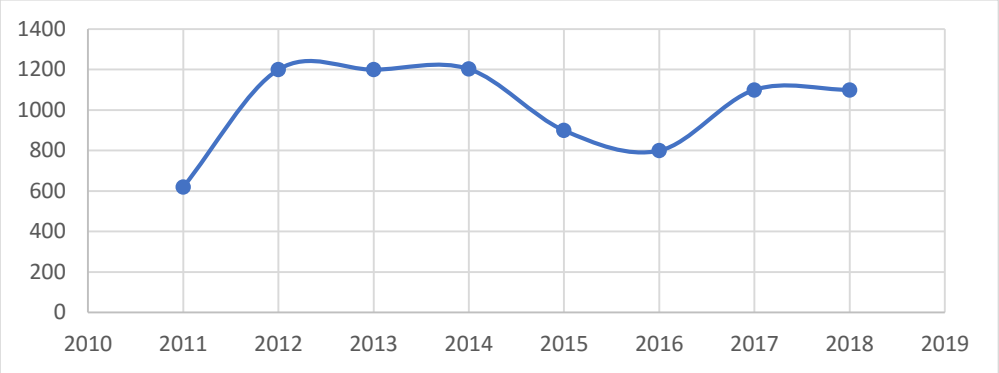
First of all, we start by monitoring the volume of electricity produced by the plant in question for the period from 2011 to 2018 in order to see the pace of productivity of the latter.

Table 1: Electricity production of the Hassi R'mel power station in Gwh

Year	2011	2012	2013	2014	2015	2016	2017	2018
Electricity production of SPP1 (Gwh)	620	1200	1200	1203	900	800	1100	1100

Source: Elaborated by us after the figures collected from Sonatrach's annual reports

Figure 05: Electricity production from the Hassi R'mel power station in Gwh



Source: Developed by ourselves from the data in Table 01 using Excel

We consider the production of electricity by the SPP1 plant during the period (2011-2018) as the first step. The development was remarkable in 2012, that is to say after one year of commissioning the plant, while doubling in value (going from 620 to 1200 Gwh). Until 2018 we noticed a certain variant stability between 900 and 1200 Gwh, with a significant drop between 2014 and 2016.

On the other hand, the 150 Mw planned to be produced was never reached during this time period. Only the first two years that have proven productive efficiency.

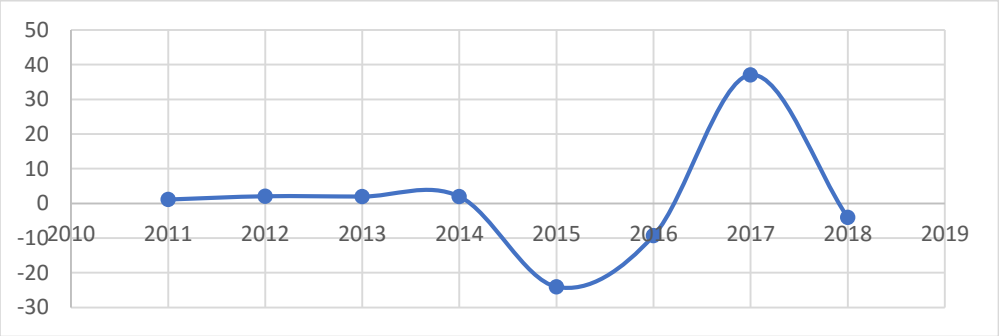
The objective of drawing up the table below is to analyze the variation (see the increase) in the national production of electricity by the Hassi R'mel power station.

Table 2: The change in percentage of national electricity production by the operator SPP1

Year	2011	2012	2013	2014	2015	2016	2017	2018
The change in national electricity production by the operator SPP1 (%)	1.15	2.09	2	2.2	-24	-9.3	37.1	-4

Source: Elaborated by us from the figures given by the reports of the achievements of the Ministry of Energy.

Figure 06: Evolution of national electricity production by operator SPP1 (%)



Source: Elaborated by ourselves from the data in Table 02 using Excel

Between 2011 and 2014, the share of electricity by the SPP1 in relation to the total national production was quite moderate (between 1 and 2.2%). However, the decline in the plant's productivity between 2014 and 2016 caused a very significant drop in the **ratio** with a negative rate of 24% for the year 2015 and -9.3% for the year 2016.

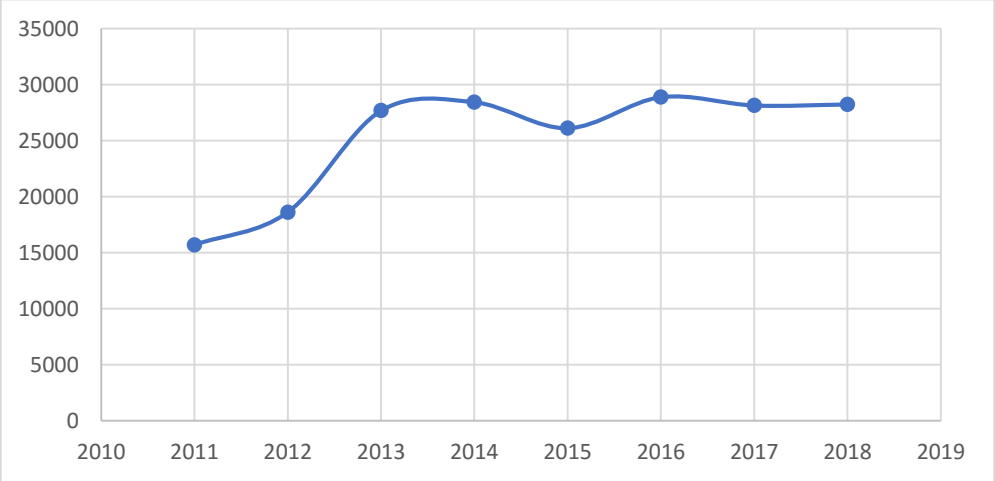
This third table will help us see the volume of electricity produced by all the power stations operating using combined cycles in Algeria, in order to measure the development of this new technology in Algeria.

Table 3: The production of electricity all combined cycle plants in Algeria

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
power generation combined cycle in Algeria (Gwh)	15701	18623	27685	28444	26123	28898	28154	-

Source: Developed by ourselves according to figures collected from the Arab Union of Electricity balance sheets.

Figure 07: Electricity production of combined cycles in Algeria in Gwh



Source: Developed by ourselves from the data in Table 03 using Excel

The production of electricity by the combined cycles had progressed since 2011 (the same year of the commissioning of the plant) and has continued to increase until today with the same way as the production curve of the plant. SPP1 (a decrease between 2014 and 2016).

This means that despite the minimal contribution of the power station in the electricity production of all the cycles combined, the latter vary with the same tendency as it.

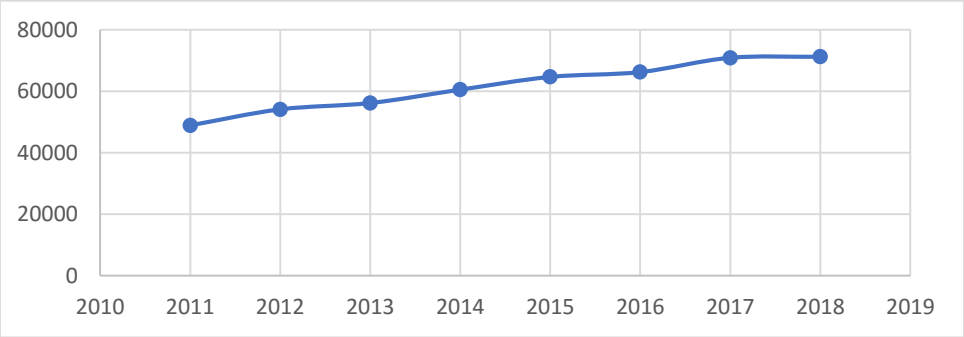
The following table represents the net quantity of production in Gwh by all the power plants in Algeria without taking into account the part lost in transmission and distribution.

Table 4: Net electricity production

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
General annual net electricity production (Gwh)	48872	54086	56148	60501	64663	66234	70898	71 227

Source: Developed by ourselves based on figures collected from the Arab Union of Electricity balance sheets.

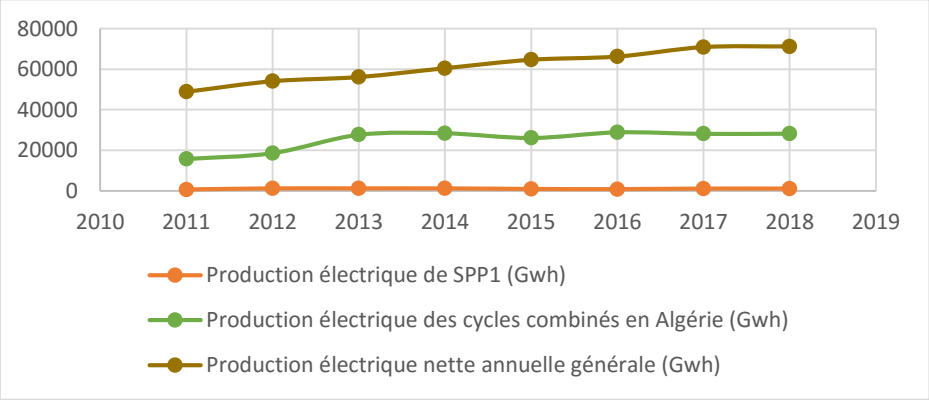
Figure 08: Net electricity production in Gwh



Source: Developed by ourselves from the data in Table 04 using Excel

During all this time, the net electricity produced in Algeria experienced a fairly stable increase without any decrease, but in a less than proportional way.

Figure 09: Electricity production of the three variables studied



Source: Prepared by ourselves from the data in table 01-02 and 04

This figure represents the projection of the three preceding curves, in order to see if there is a relativity between them. From a global view, we can see that the total production of electrical energy did not vary by the same trend as that of the combined cycles and the SPP1. Especially in the period between 2014 and 2016 where we noticed a drop in the last two.

5-2. The evolution of the share of electricity exports to Europe:

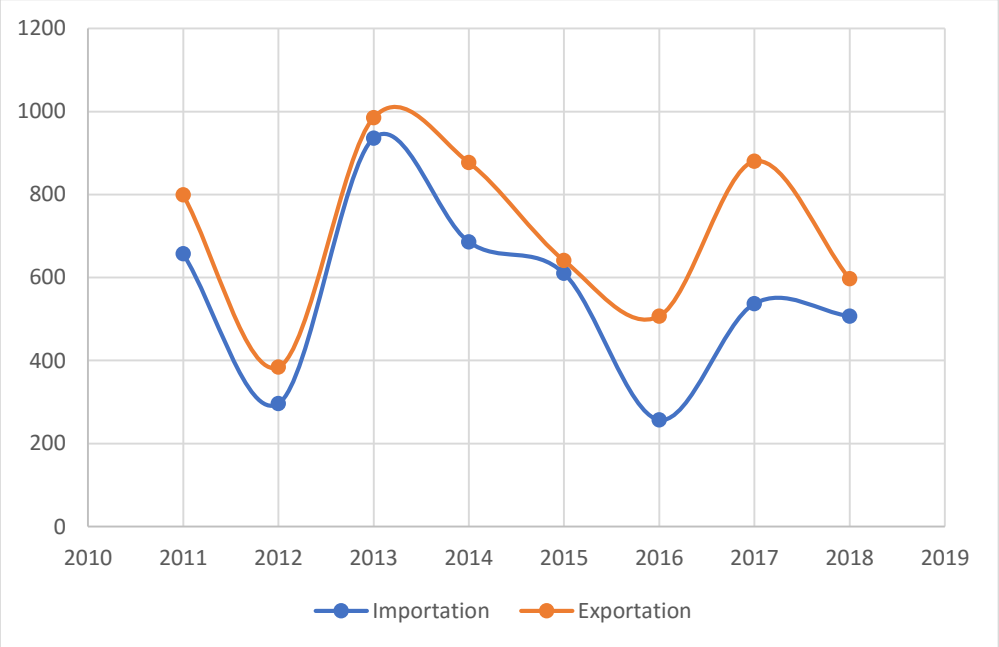
For this part, we will analyze the variation of electricity exports to the whole world by comparing it to imports in Gwh (the data indicating the share of Europe of these exports were inaccessible).

Table 5: The share of M's and X's of electricity

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Import	657	296	936	686	610	257	537	507
Export	799	384	985	877	641	507	880	597

Source: Elaborated by ourselves according to the figures collected from the annual balance sheets of Sonatrach

Figure 10: The share Algerian M and X of electricity



Source: Developed by ourselves from the data in Table 05 using Excel

The two curves show a great similarity of variation, it should be noted that despite this same variation the Gwh imported are less than those of exports. The year 2013 and 2017 were the two unique years in which Algeria increased by 156.5% and 73.57% respectively (something which is beneficial for the country). But this after having experienced a drop of 51.93% in 2012 and 20.9% in 2016.

5-3. Saving 5.13% billion m^3 of gas per year, i.e. 11% of annual gas exports

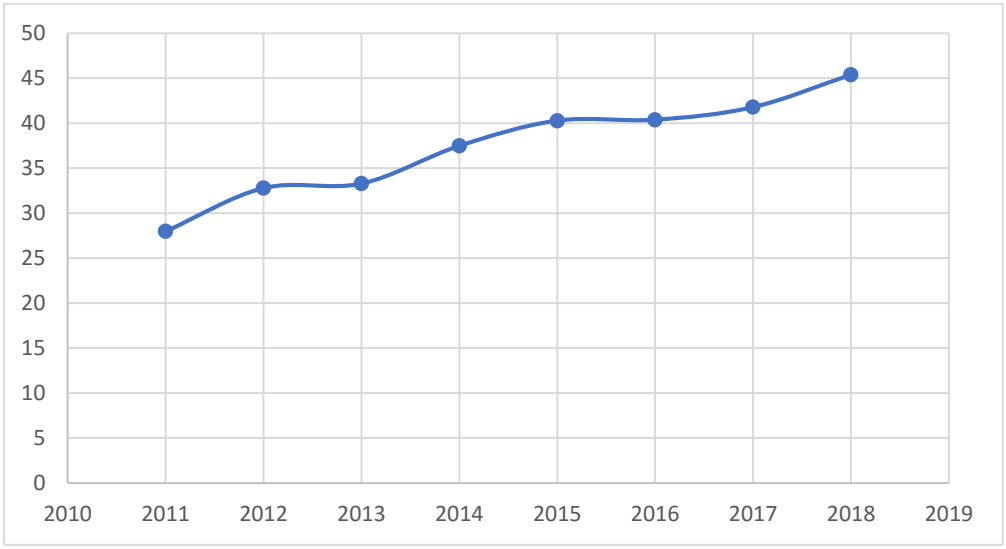
In order to see if the goal of saving billions of cubic meters of gas and exporting it every year by Algeria, the development of the following table was essential to illustrate the figures since the implementation of la centrale (2011).

Table 6: volution of consumption and export of natural gas

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Consumption of gas in billion M3	28	32.8	33.3	37.5	40.3	40.4	41.8	45.4
Exports (%)	-5.7	4.5	-12.56	-16	-0.2	42.2	-2.2	1

Source: Elaborated by ourselves based on figures collected from the annual performance reports of the Ministry of Energy.

Figure 11: Consumption of natural gas in M3



Source: Developed by ourselves from the data in Table 06 with Excel

Gas consumption has continued to increase from 2011 to the present day, we note that in no case has Algeria been able to save one m3, on the contrary in 2012 the marked increase at a rate of 10.5%. Also, in 2014-2015 the evolution was considerable (9.8% and 7.4% respectively).
The same is for exports, we do not see any annual increase by reaching the 11% forecast, except for the year 2016 we reached 42.2%.

6- Results

After having analyzed the productive capacity of the plant in question, we are probably witnessing a handicap related to its operation during the day and only when the sun is shining. So even though the sunshine is strong during specific hours of the day, the solar energy storage systems collected is strongly weak. Suddenly not only solar panels offer us not even 20% of total productivity (because of problems of duration and intensity of light, and technical failures), but also the part operating with gas consumes 4 times more quantity of gas during the day (faults related to luminosity) and 4 times more at night (since there is no storage).

We can link the failure of the plant after its first five years to: a) the cessation of financial subsidies issued by the Algerian state which were intended for its maintenance, b) the exemption from taxes that should be paid to the plant. national investment promotion agency. The result is: a very expensive maintenance of these new technologies which have not seen the light of day in Algeria and which make the energy produced very expensive, or outright a drop (or stop) in productivity as was the case with Hassi R'mel power station.

For combined cycles in general, the progression of their production can be defined as modest, we have noticed a very slow evolution during the last years despite the very large number of new projects inaugurated everywhere by the State. Likewise, their share in total production has never exceeded 13.5%.

Turning to the total net electricity production curve, we do not see any downward trend during the period (2014-2016) when the combined cycle and SPP1 production experienced a drop. From there we can deduce that these new technologies operating on the basis of clean energies do not play such an important role in the variation of the national production of electricity.

The additional 16.5% of electricity expected to be produced per year after the start of SPP1 has never been achieved. We see that the greatest percentage of evolution had been marked in 2012 with a value of 10.66% that is to say that it was at the time when the SPP1 had achieved its largest volume of production of 1200 Gwh. For us, this coincidence is not of great importance since we are also witnessing in 2012 the finalization and the inauguration of 13 new power plant projects on the national territory.

The deduction can easily be made, since the share of electricity produced by the operator in question now remains very low compared to the others, and the latter has not brought any advantage to the total production of electrical energy. Electricity exports, even if they experienced an increase in 2013 as well as in 2017, SPP1 had no role in it.

However, the question that arises is the following: If the primary goal of this project for Algeria was to produce more electricity from clean energy and increase exports, why latter have not experienced any increase after the plant is started up and how does Europe supply electricity from here?

In our opinion, the contract is of the BOO type *(Built-Own-Operate)* which legally means that Algeria has entrusted to Spanish partners the partial financing of the project, the total construction of the plant, but with an operation (buy back electricity at a very low price) in order to recover their investment costs. And it is only after several years that full operation will be delivered to the Algerian authorities with the right to all the electrical energy produced and to its marketing at a more profitable price.

As for gas, since 2012 saving natural gas for export was an impossible business for the country according to the figures collected. In fact, the more the productivity of the Hassi R'mel plant increases, the more the total gas consumption increases. The example of 2012 shows this, where the SPP1 was at its peak of production with 1200 Gwh and a 10.5% increase in natural gas consumption for the same year. The cause always comes back to the imbalance of the two production cycles (gas and solar) and to the storage problems already described.

7- Conclusion

The main objective of this study was the analysis of one of the largest international partnership projects, initiated by the Algerian State within the framework of the promotion of renewable energies. The goal was to see if this project was up to the standards of a strategic partnership in all that is financial and development support, by seeing if there is a convergence or nuances between the theory and our results.

To begin with, a flagrant divergence appeared between the technical and commercial objectives predefined in the contract and our results. Algeria has by no means reached a positive point (except for the negligible contribution of the plant in the production of electricity). And by better examining its economic aspect and its profitability linked to: 1) the gas economy and the increase in exports (+ 11%) of the latter, and 2) its investment cost estimated at $ 132 billion: the 5.13 billion m³ / year of gas expected to be saved and sold at $ 10 / Mb hu for the next 30 years have not been achieved, the cause was well defined during the discussion of our results.

Suddenly, we can generalize the degraded state of technologies related to the development of renewable energies in the country, a powerful solar storage system in the SPP1, would have boosted the volume of energy production, reduced production costs, and saved gas. Unfortunately, a huge lack of state encouragement from R&D and university laboratories activating in the field has meant that the technology is imported and that we do not even succeed in its maintenance later (one of the goals of this project that we couldn't reach).

This strategic partnership with Spanish companies in the form of a joint venture contract with the aim of promoting clean energies in the country, was supposed to lead a mutually beneficial project, being a foreign contribution in the capital that s 66% student (financial support), a technology transfer (ISCC initiated in California (USA), then in Italy and Florida (USA)), and a transfer of skills in favor of Algeria by technical assistance from Spanish experts and advisers. However, only 24 Algerian employees drew a little experience from 7 foreign experts, which could not cover the station's maintenance needs.

Due to a lack of data, and the dissolution of the NEAL subsidiary (responsible for the project) just a few years after the plant was finalized, we were unfortunately held back to look for even more. For Algeria and starting from the development side of renewable energies, the case can

be qualified as “fruitless”: *“The project cannot be understood or justified as a solar project, because it is very strongly unbalanced in favor of gas, which deviates it from the sought solar objective. "(Mr. M. TERKMANI)*

Bibliography

1. Algerian Ministry of Energy, s.d. *programme national de développement des énergies renouvelables.* [En ligne] Available at: Website of thhttps://www.energy.gov.dz/?rubrique=energies-nouvelles-renouvelables-et-maitrise-de-lrenergie
2. AMAR, F., s.d. *Study of the combined cycle solar-gas hybrid plant of Hassi R'mel.* UNIVERSITY BADJI MOKHTAR ANNABA: s.n.
3. Kahina, D., *Contribution to the development of numerical methods using,* 2014. *artificial neuron networks for the characterization of the solar deposit in ALGERIA.* Houari Boumediene University of Science and Technology: s.n.
4. Keltouma, H., *Algeria-European Union association agreements, what prospects for the Algerian economy.* University of Oran: s.n., 2010.
5. Najla, E. G., The hybrid power plant of Hassi R'mel. *Renewable Energy Bulletin N21 available at www.cder.dz,* 2011, p. 17.