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Energy optimization of an electrical supply network by the integration of renewable source Case study: ADE - Adrar

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Abstract - *This research lies within the scope of environmental research for seeking solutions for the optimizations of energy in the electrical supply network ADE- Adrar (Algérienne des Eaux d'Adrar/Algeria). Indeed, the principal aiming of this research is the integration of renewable resources (energy independence and sustainable development) that it pushes us to consider from now on the energy problem not only according to the economic point of view, but also according to an ecological point of view (reduction of CO_2 emission). This with us encouraged to develop our systems of energy on the basis of distributed generation on a large scale including/understanding renewable energy and the high-output energetic solutions.*

Résumé – *Cette recherche s'inscrit dans le cadre de la recherche environnementale pour la recherche de solutions pour l'optimisation de l'énergie dans le réseau d'alimentation électrique ADE-Adrar (Algérienne des Eaux d'Adrar/Algérie). En effet, l'objectif principal de cette recherche est l'intégration des ressources renouvelables (indépendance énergétique et développement durable) qui nous pousse à considérer désormais le problème de l'énergie non seulement selon le point de vue économique, mais aussi selon un point écologique (réduction des émissions de CO_2). Ceci avec nous encourage à développer nos systèmes d'énergie sur la base d'une génération distribuée à grande échelle comprenant l'énergie renouvelable et les solutions énergétiques à haut rendement.*

Keywords: Renewable energy - Sustainable Development - Solar Pumping - CO_2 Emission - PPD - MPR - PV System.

1. INTRODUCTION

Energy production is a challenge of great importance in the years to come. Indeed, the energy needs of industrialized societies are increasing. In addition, developing countries will need more energy to carry out their development. Nowadays, a large part of the global energy production is supplied from fossil sources. The consumption of these sources gives rise to emissions of greenhouse gases and therefore an increase in pollution. The additional danger is that excessive consumption of natural resources stock reduced reserves this type of energy so dangerous for future generations.

Environmental research is a kind of complementarily of sustainable development. Where it involves several conditions:

1. Conservation of the general equilibrium
2. Respect for the environment
3. Preventing the depletion of natural resources

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4. The rationalization of production and consumption of energy.

Just when sustainable development is development that meets the needs of our current situation, the snapshot, towards an absence of risky compromise on the ability of future generations to meet their own needs, in other words ensure that today's growth does not jeopardize the growth possibilities of future generations. Sustainability plays a tripartite paradox.

Not to mention an accompaniment at the consideration and adoption of social policy that should lead to a more stable equilibrium, with positive impact on humanity.

Hence our study is based on finding solutions to optimize energy consumption and fossil generation through the integration of renewable resources such as wind, PV system, farm...

2. RENEWABLE ENERGY

What is ‘Renewable Energy’?

Renewable Energy **(RE)** has been defined, somewhat strictly, as ‘energy flows that occur naturally and repeatedly in the environment and can be harnessed for human benefit’. A looser and, arguably, more widely used description might be ‘energy produced from a renewable and/or sustainable fuel source’. The Characteristics of what qualify, for each individual country, as ‘renewable’, ‘sustainable’, or ‘alternative’ Fuels (that is, alternative to traditional fossil fuels) under such definitions tend to vary, with certain exceptions being made for sources such as municipal and some industrial wastes.

The most widely recognized forms of **RE** are, undoubtedly, wind power and hydro power which, despite the major advances achieved in technology and output rating over the past decade, have a history that goes back centuries. There are, however, various others **RE** technologies both in use and under development which can, as will be explored later, represent solutions that can be both environmentally and economically viable. [1]

3. SUSTAINABLE DEVELOPMENT IN ECOLOGICAL ECONOMICS

The notions of ‘sustainable development’ and ‘sustainability’ are interpreted in various ways. This has become most clear perhaps in the field of ecological economics, where different disciplines have offered particular perspectives on these notions. **E**cological **E**conomics (**EE**) was founded at the end of the 1980s.

It integrates elements of economics and ecology, as well as of thermodynamics, ethics, and a number of other natural and social sciences to provide for an integrated and biophysical perspective on environment–economy interactions. **EE** expresses the view that the economy is a subsystem of a larger local and global ecosystem that limits physical growth of the economy. At the same time, it is critical of the dominant paradigm of (environmental and resource) economics, characterized by rational agents and equilibrium thinking.

Instead, **EE** is characterized by the use of physical (material, energy, chemical, biological) indicators and comprehensive, multidisciplinary systems analysis. Both features are consistent with the fact that sustainable development, generally seen as an important dimension of performance of the overall systems level, occupies a central position in the study of **EE.**

All intellectual founders and antecedents of **EE** have written extensively about sustainable development, even if not using this particular terminology. [2]

3.1 What is Sustainable Development?

Sustainable development has been defined in many ways, but the most frequently quoted definition is from **Our Common Future**, also known as the Brundtland Report, "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- The concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- The idea of **limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

All definitions of sustainable development require that we see the world as a system a system that connects space; and a system that connects time.

When you think of the world as a system over space, you grow to understand that air pollution from North America affects air quality in Asia, and that pesticides sprayed in Argentina could harm fish stocks off the coast of Australia.

And when you think of the world as a system over time, you start to realize that the decisions our grandparents made about how to farm the land continue to affect agricultural practice today; and the economic policies we endorse today will have an impact on urban poverty when our children are adults. We also understand that quality of life is a system, too. It's good to be physically healthy, but what if you are poor and don't have access to education? It's good to have a secure income, but what if the air in your part of the world is unclean? And it's good to have freedom of religious expression, but what if you can't feed your family?

The concept of sustainable development is rooted is this sort of systems thinking. It helps us understand ourselves and our world. The problems we face are complex and serious and we can't address them in the same way we created them. But we *can* address them.

It's that basic optimism that motivates **IISD's** staff, associates and board to innovate for a healthy and meaningful future for this planet and its inhabitants.

3.2 Some definitions

The concept has included notions of weak sustainability, strong sustainability and deep ecology. Sustainable development does not focus solely on environmental issues.

In 1987, the United Nations released the Brundtland Report, which defines sustainable development as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs.'

The United Nations 2005 World Summit Outcome Document refers to the "interdependent and mutually reinforcing pillars" of sustainable development as economic development, social development, and environmental protection.

Indigenous peoples have argued, through various international forums such as the United Nations Permanent Forum on Indigenous Issues and the Convention on Biological Diversity, that there are four pillars of sustainable development, the fourth being cultural.

The Universal Declaration on Cultural, diversity further elaborates the concept by stating that "...cultural diversity is as necessary for humankids as biodiversity is for nature"; it becomes "one of the roots of development understood not simply in terms of economic growth, but also as a means to achieve a more satisfactory intellectual, emotional, moral and spiritual existence". In this vision, cultural diversity is the fourth policy area of sustainable development.

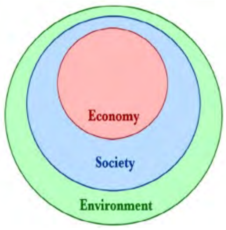

Fig. 1: A representation of sustainability showing how both economy and society are constrained by Environmental limits

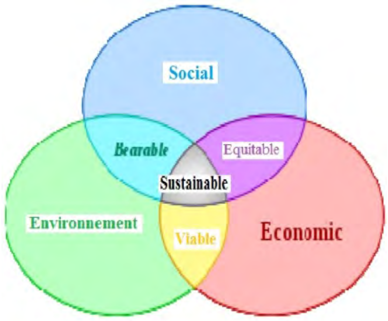

Fig. 2: Scheme of sustainable development: at the confluence of three constituent parts

Sustainable **D**evelopment (**SD**) and, more broadly, **C**orporate Social Responsibility (**CSR**) cannot be ignored in current research on management science and management theory. In the field of strategic management, concerns regarding **SD** are even more acute due to its integration into the general design of overall company policy. Indeed, the development of such a strategy is incomplete if social and environmental responsibility is not taken into account as a crucial element of a company's decision-making process. Therefore, owing to the impact of strategy on the economic performance of the firm, the process of designing and enforcing **SD/CSR** strategies has become a major focus of empirical investigation and theoretical reflection. [3]

3.3 Climate Change

Climate change has been considered a fact for over a decade, following the proof of rising CO_2 levels, rising Earth's temperatures, melting of glaciers, etc.

The consequences can be observed in many regions in daily life, by events such as more frequent or stronger flooding of rivers, increased storms and snowfall, cloudbursts, as well as drought, and desertification. The reason for climate change, natural or anthropogenic, has been under discussion for a long time.

There is no doubt that mankind contributes to climate change through activities connected with emissions of climatically relevant gases. For example, use of fossil fuels with high emissions of carbon dioxide and other climate gases, especially in transportation and traffic, industrial production and application of substances (which are climate gases of extreme high warming potentials), agricultural activities (such as animal husbandry and rice cultivation) leading to emissions of methane or nitrous oxide, and methane emissions from landfills caused by ineffective waste management, etc.

To control the situation, reduction measures of climate gases and other relevant actions, are urgently necessary on all levels. This is understood by the public and by policy makers. Climate related activities thus are high ranking on the political agenda.

They are implemented into the political programmers' on UN level, internationally and single countries, but also on communal levels by climate initiatives of cities or **NGOs**. Examples are the so-called Kyoto Protocol reducing climate gas emissions in industrialized countries, bans of halogenated hydrocarbons, shifting of energy sources from fossil to renewable and international CO_2-emission trading. It is but obvious, that the efforts must be strengthened, to reduce the risks of a dangerous interference with the climate system. [4]

4. CASE STUDY

4.1 Study of (Algérienne des Eaux, ADE- Adrar) network

Introduction

Our study is based on a large consumer of energy in our city (Adrar) which is the (Algérienne des Eaux, ADE-Adrar); the latter has fourteen subscription contracts with the Company of Distribution of Electricity and Gas (**Sonelgaz**).

Firstly a techno-economic study (energy balance) with simulation and interpretation of results and cite solutions (to adapt and others suggest) for the environmental optimization and reduction rates CO_2 emission.

After the detailed study we will rely on the average energy consumption of all the years of study and make a characterization of our solar system to see how many solar panels we need for this facility.

5. STUDY OF DATA GEO-ENERGETIC IN THE TOWN OF ADRAR

Adrar is the administrative capital of Adrar Province, the second largest province in Algeria. The commune is based around an oasis in the Touat region of the Sahara Desert. According to a 2008 census it has a population of 64 781, up from 43 903 in 1998 and 399 714 in 2008; with an annual growth rate of 4.0 %. Adrar is mainly an agricultural town, characterized by its traditional irrigation system, the Foggara.

5.1 Geography

Adrar lies at an elevation of 258 meters (846 ft) above sea level. A large oasis lies to the southwest of the town; this oasis lies in the Touat region, a string of oases running from Bouda in the north to Reggane in the south. A vast area of sand dunes, the Erg Chech, lies to the west, while a large rocky plateau, the Tademaït, lies to the east.

5.2 Climate

Adrar has a hot desert climate (Köppen climate classification BWh), with extremely hot summers and mild winters. There is very little rain throughout the year.

Table 1: Climate data for Adrar

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C	31.5	39.1	40.0	43.8	47.5	49.0	49.6	49.8	49.6	43.5	36.6	33.5	49.8
(°F)	(88.7)	(102.4)	(104)	(110.8)	(117.5)	(120.2)	(121.3)	(121.6)	(121.3)	(110.3)	(97.9)	(92.3)	(121.6)
Average high °C	20.6	24.5	28.0	32.1	36.7	42.5	45.0	44.3	40.0	33.1	26.1	20.9	32.82
(°F)	(69.1)	(76.1)	(82.4)	(89.8)	(98.1)	(108.5)	(113)	(111.7)	(104)	(91.6)	(79)	(69.6)	(91.08)
Daily mean °C	12.4	16.0	19.4	23.6	28.1	33.6	36.0	35.4	31.6	25.0	18.2	12.9	24.35
(°F)	(54.3)	(60.8)	(66.9)	(74.5)	(82.6)	(92.5)	(96.8)	(95.7)	(88.9)	(77)	(64.8)	(55.2)	(75.83)
Average low °C	4.1	7.5	10.7	15.1	19.4	24.7	26.9	26.6	23.2	16.8	10.2	4.9	15.84
(°F)	(39.4)	(45.5)	(51.3)	(59.2)	(66.9)	(76.5)	(80.4)	(79.9)	(73.8)	(62.2)	(50.4)	(40.8)	(60.52)
Record low °C	−4.5	−1.0	−2.2	4.0	9.5	12.5	19.6	19.0	11.0	7.0	0.0	−4.0	−4.5
(°F)	(23.9)	(30.2)	(28)	(39.2)	(49.1)	(54.5)	(67.3)	(66.2)	(51.8)	(44.6)	(32)	(24.8)	(23.9)
Precipitation	2.3	1.3	2.6	4.1	0.3	0.1	0.0	0.2	0.2	1.5	0.6	1.4	14.6
mm (inches)	(0.091)	(0.051)	(0.102)	(0.161)	(0.012)	(0.004)	(0)	(0.008)	(0.008)	(0.059)	(0.024)	(0.055)	(0.575)
% humidity	38.0	30.8	24.1	22.5	19.9	15.4	13.3	15.9	21.5	30.3	35.7	40.6	25.67

Fig. 3: Adrar Town - Algeria

The Company of Distribution of Electricity and Gas **(Sonelgaz)** placed a power at the disposal for ADE-Adrar (Algérienne des Eaux) for each contract which is the Power Placed at the Disposal (**PPD**) whose the latter one ever needs reached this power it is always necessary remains in the margin of the Maximum Power Reached (**MPR**) which is lower than the Power Placed at the Disposal (**PPD > MPR**) according to the following figure.

6. POWER PLACED AT THE DISPOSAL (PPD) AND MAXIMUM POWER REACHED (MPR)

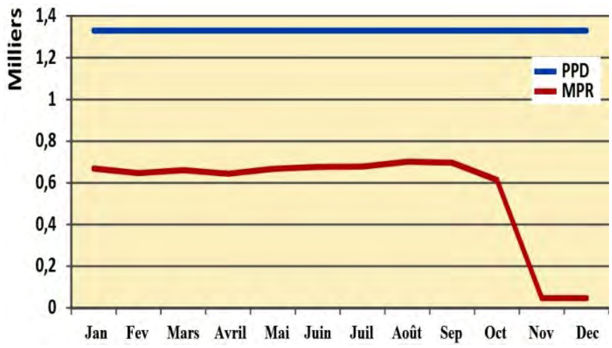

Fig. 4: Power placed at the disposal
and maximum power reached for the year 07

If the maximum power reached (**MPR**) exceeds the power placed at the disposal (**PPD**) (ADE - Adrar, Algérienne des Eaux) will be penalized.

7. ELECTRICAL SUPPLY NETWORK (ADE)

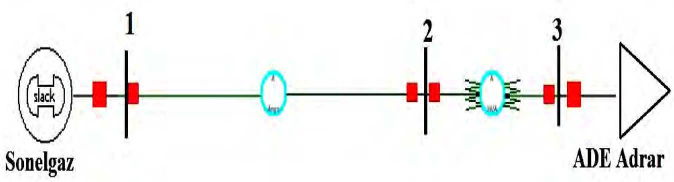

Fig. 5: Electrical supply network (ADE)

7.1 Consumption of energy in the electrical supply network (ADE/Adrar)

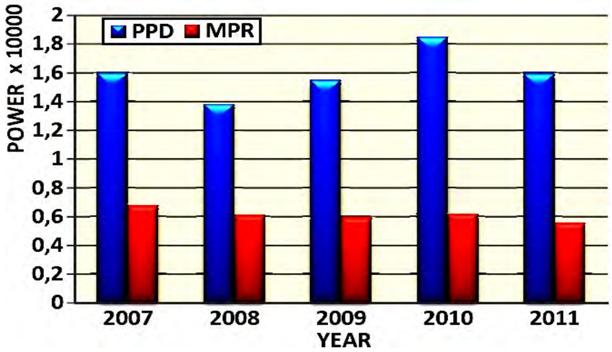

Fig. 6: Power placed at the Disposal
and the Maximum Power Reached for the year (07-08-09-10-11)

It is noted that the power placed at the disposal (**PPD**) in the five years is higher reached (**MPR**) almost is doubles; what implies (**ADE-Adrar**) has badly treats these energy needs, for there are losses in cost (loads moreover), and the energy problem according to the ecological point of view (CO_2 emission) is very significant (we will see the equivalent of CO_2 in the following section).

7.2 Consumption of energy (off-peak hours and energy reactivates) per quarter for the five years (07-08-09-10-11)

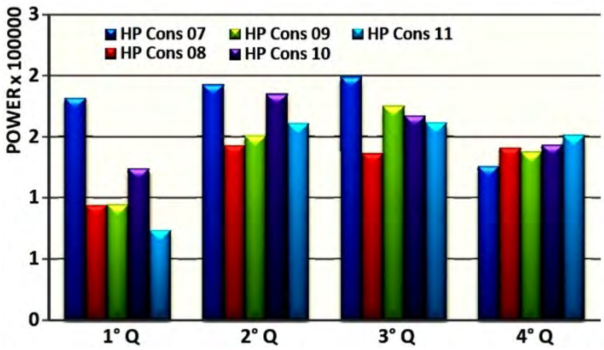

Fig. 7: Consumption of energy in the peaks hours per
quarter for the years (07-08-09-10-11)

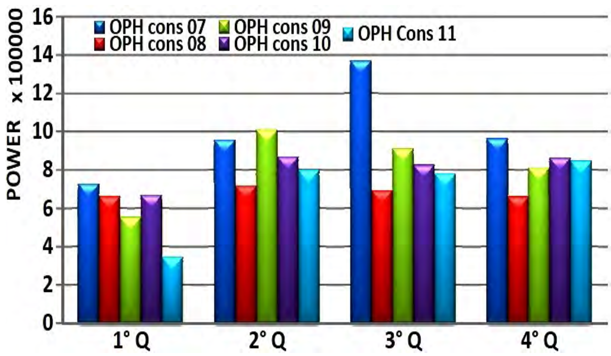

Fig. 8: Consumption of energy in the off-peaks hours per
quarter for the years (07-08-09-10-11)

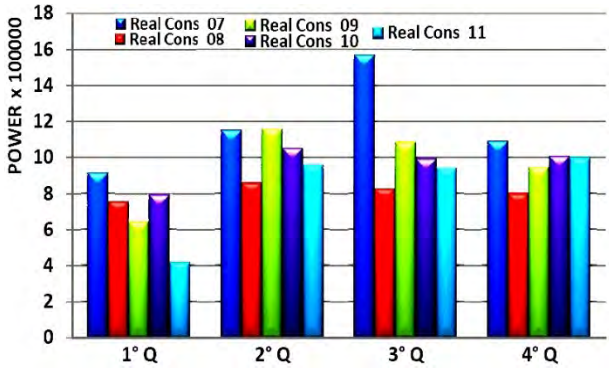

Fig. 9: Real consumption of energy per quarter for the years (07-08-09-10-11)

Generally the consumption of energy in the off-peak hours and the peaks hours for the years 2007-2008-2009-2010 and 2011 is in the maximum in the second and the third quarter (per month: April, May, June, July, August and September) because the two seasons spring and the Summer where we use all the means to satisfy subscribed; because Summer is the most difficult period of the year because of the heath of which the use of all the equipments.

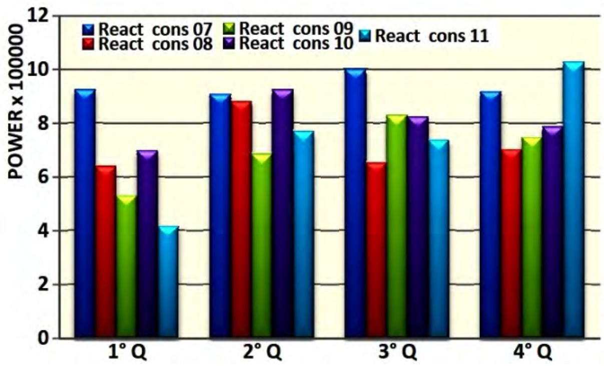

Fig. 10: Reactivates consumption of energy per quarter for the years (07-08-09-10-11)

Even for the consumption of reactivates energy we note that during the second and the third quarter consumption is in the maximum from where the latter and even because is too much is load and even it to create a disturbance on network (Sonelgaz).

In normal state, generally, the goal is to reduce costs and maintain adequate capacity to generate reactive power, to deal with possible incidents. To do so, maintaining adequate margins of generation of reactive power is not a critical issue in times of low load, but it acquires a crucial importance when the network is operating at full load. The latter must ensure continuity of service.

Automatically for consumption with the peak then the payment of the invoices of the consumption of energy will be in the peak what implies that there is a bad management!!!

From where we try to find solutions of environmental optimizations of energy in the electrical supply network (**ADE-Adrar**) (obligation to reduce the emission of CO_2 and not only according to the ecological point of view, but also according to an economic point of view.

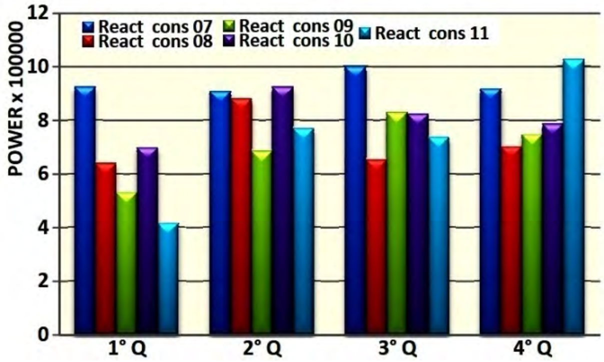

Fig. 11: Total amount with all inclusive of tax per quarter for the years (07-08-09-10-11)

7.3 Calculation of CO_2 emissions of ADE-Adrar (Algérienne des Eaux) [5]

ADE-Adrar (Algérienne des Eaux) is one of the largest consumers of energy in Adrar city, for example the consumption in the year 2010 is **3 847 355 kWh** and in the five years (2007, 2008, 2009, 2010 and 2011) studies the total real consumption is of **18 970 364 kWh**; of another share an overall consumption of **24 535 836** kWh it is rather significant especially for the CO_2 emission.

Indeed, the principal aiming of this research is to find solutions of environmental optimizations of energy in the electrical supply network of (**ADE-Adrar**) (obligation to reduce the CO_2 emission).

Table 2: Calculation of CO_2 emissions of (**ADE-Adrar**, Algérienne des Eaux) for a real consumption

Year	Real consumption (kWh)	CO_2 emission per (t)
2007	4 726 278	368.65
2008	3 242 628	252.92
2009	3 837 856	299.35
2010	3 847 355	300.09
2011	3 316 247	258.67

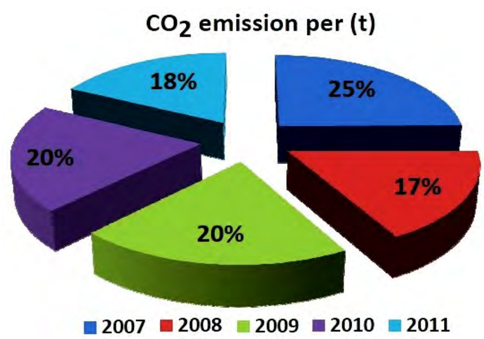

Fig. 12: CO_2 emissions of (**ADE**) per (t) for a real consumption

According to the calculation of CO2 emission and the graphs we note that the emission of (Algérienne des Eaux, **ADE-Adrar**) is rather signifiant (more than 200 T of CO_2 emission) for each year from where it is necessary when to reduce it and to find solutions.

7.4 Economic solution

1. Revision of the power placed at the disposal (PPD):
2. Stops in the peak hours:
3. Solutions to be proposed:

Integration of the renewable resources like wind turbine, photovoltaic, biomass and the solar pumping for wells; (ADE-Adrar has 14 Wells)!!!! And even solar lighting, etc.

For these we can do some things like;

- Change total of the equipment since are all out of date
- Integration of the Micro grids; witch there reasons are:

- Reduction in gaseous emissions (mainly CO_2).
- Energy efficiency or rational use of energy.
- Deregulation or competition policy.
- Diversification of energy sources.
- National and global power requirements.

7.4.1 Revision of the power placed at the disposal (PPD)

According to the exchange we have 1 € = 143 DA June 2010/ BNA Algeria (Generally 1 € = 100 DA).

Table 3: Revision of the (PPD) in the year 2010

Month of January/ Wells	Revision of the PPD	Gain realized per month (DA/ET)(*)	observation
T2	Revision of the PPD from 80 to 50	967,50	Revision of the contract TILILANE2
T4	Revision of the PPD from 120 to 80	1 290,00	Revision of the contract TILILANE4
T5	Revision of the PPD from 120 to 50	2 257,50	Revision of the contract TILILANE5
T6	Revision of the PPD from 80 to 50	967,50	Revision of the contract TILILANE6
T7	Revision of the PPD from 120 to 80	1 290,00	Revision of the contract TILILANE7
T8	Revision of the PPD from 80 to 50	967,50	Revision of the contract TILILANE8
T9	Revision of the PPD from 120 to 80	1 290,00	Revision of the contract TILILANE9
Aeroport	Revision of the PPD from 120 to 50	2 257,50	Revision of the contract Aeroport
Barbaa	Revision of the PPD from 80 to 50	967,50	Revision of the contract Barbaa
Chateau zone	Revision of the PPD from 80 to 50	967,50	Revision of the contract Chateau zone
Chateau 103 Logts	Revision of the PPD from 80 to 50	967,50	Revision of the contract Chateau 103 Logts

(*) The difference between the price of PPD = 120 kw and the price of PPD = 50 kw.
(*) The difference between the price of PPD = 120 kw and the price of PPD = 80 kw.
(*) The difference between the price of PPD = 80 kw and the price of PPD = 50 kw.

Table 4: Gain realized in the year 2010

Gain realized per month (DA/ET)	Months	Total gain realized (DA/ET)
967,50	12 (*)	11 610,00 * 6
1 290,00	12 (*)	15 480,00 * 2
2 257,50	12 (*)	27 090,00 * 3
	Total gain realized per year 2010 (DA/ET)	170 280,00

(*) the revision of the PPD made in January (we calculate the 12 Months)

ET: Excluding Taxes

In the year 2010, we are made 11 revisions of the PPD so we are realized the total gain of **(170 280,00 DA = 1 190,77 €).**

7.4.2 Stops in the peak hours

Table 5: Stops in the Peak hours in the year 2010

Month	Total consumption (kwh)	Peak consumption (kwh)	Peak rate (%)	Realized gain (DA / ET)(*)	Observation
January	381 814	41 020	32%	298 084.14	Outages during peak hours:
February	304 173	33 365	31%	242 456.78	Outages during peak hours:
March	398 011	49 555	32%	360 106.27	Outages during peak hours:
April	327 496	47 640	33%	346 190.35	Outages during peak hours:
May	447 080	55 210	30%		
June	597 757	81 978	32%		
July	591 170	82 609	33%		
August	606 461	75 088	31%		
September	107 841	9 358	28%		
October	306 055	34 565	31%	251 176.94	Outages during peak hours:
November	339 476	37 449	33%	272 134.39	Outages during peak hours:
December	626 067	71 322	32%	518 282.71	Outages during peak hours:
TOTAL	5 033 401	619 159	32%	2 288 431.59	

(*) : multiplying the peak consumption by its unit price.

We made Outages during the peak hours in the months (January, February, March, April, October, November and December) (only 07 Months in the year 2010); so we realized the total gain of **2 288 431,59 DA = 16 003,02 €.**

So just the revisions of tree PPD we realized the total gain of **(170 280,00 DA = 1 190,77 €)** and outages during the peak hours only 07 Months in the year 2010 we realized the total gain of **2 288 431,59 DA = 16 003,02 €.**

Then it is very interesting with only two solutions have been realized a significant gain, so if we work with other proposed solutions we will realize a gain very important so we are going to study an installation of PV system then we conclude some conclusion in the next.

8. SOLUTIONS TO BE PROPOSED

Table 6: Consumption of energy in ADE-Adrar (Tililane4) Year 2010

Month	OPH.10	HP.10	FH.10	React. Cons.10	Real. Cons.10	Tot. Cons.10	TA / IAT 10
January	16 820	2 549	28 932	52 300	48 301	76 450	109 811.33
February	11 338	3 727	19 986	38 771	35 051	56 296	94 507.10
March	16 398	8 935	27 450	56 660	52 783	83 051	152 824.66
April	11 823	7 981	24 295	46 152	44 099	68 201	132 398.06
May	11 179	8 929	27 829	51 185	47 937	75 153	144 446.14
June	18 548	11 610	36 363	66 992	66 521	100 252	189 692.05
July	18 626	11 666	36 464	67 063	66 756	100 441	190 185.25
August	18 466	11 559	36 317	67 172	66 342	100 343	189 099.05
September	302	161	1 181	7 321	1 644	8 143	20 810.13
October	312	166	520	6 374	998	998	6 555.66
November	6 501	156	2 295	5 781	8 952	10 257	29 541.41
December	18 492	1 913	33 620	5 975	54 025	32 988	97 890.19
Tot. Cons.	**148 805**	**69 352**	**275 252**	**471 746**	**493 409**	**712 573**	**1 357 761.03**
1°Q	44556	15 211	76 368	147 731	136 135	215 797	357 143.09
2° Q	41 550	28 520	88 487	164 329	158 557	243 606	466 536.25
3° Q	37 394	23 386	73 962	141 556	134 742	208 927	400 094.43
4° Q	25 305	2 235	36 435	18 130	63 975	44 243	133 987.26

PPD = 120 Kw **MPR**= (39:75) Kw.

8.1 Case study Tililane4

8.1.1 Stops in the peak hours in the year 2010

Table 7: Outages during peak hour's Tililane4

Month	Tot. Cons (kwh)	Peak cons. (kwh)	Realized gain (DA / ET)
January	76 450	2 549	18 523,07
February	56 296	3 727	27 083,36
March	83 051	8 935	64 928,86
April	68 201	7 981	57 996,33
May	75 153	8 929	
June	100 252	11 610	
July	100 441	11 666	
August	100 343	11 559	
September	8 143	161	
October	998	166	1 206,29
November	10 257	156	1 133,62
December	32 988	1 913	13 901,39
TOTAL	712 573,00	69 352,00	184 772,92

So we are realized a gain of: **184 772,92 DA = 1 292,12 €.**

8.1.2 Estimate the power of photovoltaic panels [6]

Using a simplified method to determine the power of solar panels we need. Initially we must divide the amount of our daily energy requirement expressed in Watts per Hour index of sunshine which is our geographical area:

· For Africa: * **1.3**

Then we divide the result by a coefficient corresponding to the season of use of our photovoltaic panels:

- For the winter: 1 ; - For spring and autumn: 3 ; - For the summer: 5

The result gives the total power in Watts peak (Wp) of solar panels we need. We need to cover 50 % of the Real energy consumption (kWh/day) in the region of Tililane (Adrar) during the spring and autumn.

1 054 / 1.3 = 811 kWp

811 / 3 = 270 kWp (because it is based on the season which sunlight is the least).

We always recommend taking a safety margin of 10 % to 20 % from this value to compensate for energy losses due to losses in the cables and connections and use a converter.

In this case, then we would recommend to install a power of 270 kWp + 10 % to 20%, or 297 kWp to 324 so we chose 297 kWp ≈300 kWp.

For this installation, it will be possible to choose the configuration panel as follows:

-Photovoltaic panels of 100 Wp:

$300 * 1000/100 = 3 * 10^3$

-The price of the panel is: 223.95 €

223.95 € * $3*10^3$ = 671 850.00 € = 96 074 550.00 DA

9. TECHNICAL CHARACTERISTICS [6]

Electrical data

- Rated power (1): 100 Watts Peak
- Power tolerance: + / -3%
- Max. (Vmp): 18 Volts

- Max. (Imp): 5.56 Amperes
- Circuit voltage (Voc): 22.4 Volts
- Short circuit current (Isc): 6.53 Amperes

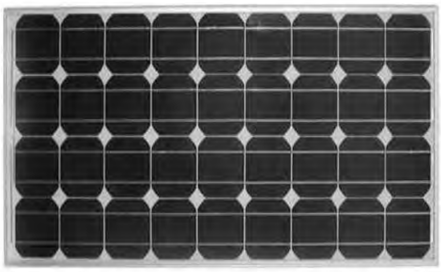

Fig. 13: Monocrystalline solar module 100 Wp VICTRON - High efficiency

Features

- Monocrystalline cells.
- Aluminum frame.
- Operating temperature: -40° C to +80° C
- Maximum surface load: 200kg / m^2
- Resistance to impact (hail): 23 m / s, 7.53 g
- Junction box for PV-RH02.
- Connector Type: PV-JH02.
- Cable length: 900 mm
- Dimensions (in mm): 963 x 805 x 35 (W x L x H).
- Weight: 10.5 kg
- Anchors fixed to the frame.
- 2 years product warranty.
- Performances guarantee 10 years 90 years 80% + 25% of the minimum power.
- (1) Standard Test Conditions (STC), defined as follows: power of the radiation of 1000 W/m^2 at a spectral density of 1.5 AM (ASTM E892). Cell temperature of 25 °C.

10. SOLAR PUMP [6]

These panels are using for solar pump for wells.

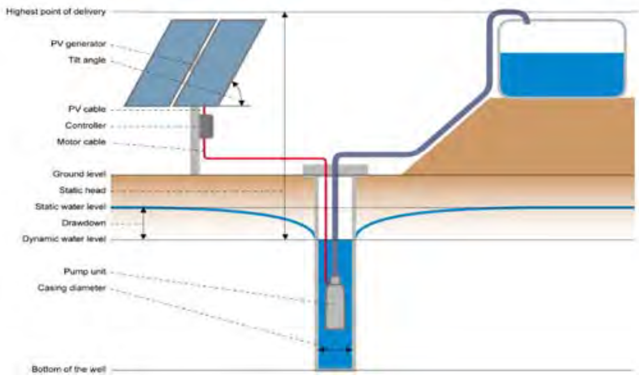

Fig. 14: LORENTZ PS (200-600-1200-1800)
submersible solar pump up to (50-180-240-250) m

11. RESULTS AND DISCUSSION

Table 8: Global warming potential of gas

Gas	CO_2	CH_4	NO_2	HF_6	PFC	SF_6
GWP (100 Y.)	1	21	310	140-11700	6500-9200	23900

Table 9: Calculation CO_2 emissions of (Algérienne des eaux) for a real consumption

Year	real consumption (kWh)	CO_2 emission per (t)
2007	4 726 278	368.65
2008	3 242 628	252.92
2009	3 837 856	299.35
2010	3 847 355	300.09
2011	3 316 247	258.67

11.1 Carbon offsetting (Carbon compensation)

International mobilization, especially around the IPCC scientists, challenged the policies that have created a first contract, the UNFCCC, and a second that depends on the Kyoto Protocol. It sets targets for reducing emissions for the six main greenhouse gas emissions by 2030.

Table 10: Carbon compensation

years	Real Cons. kwh	Gases Emission	Compensation	OBS
2007	4 726 278	368.65	7 373.00 €	That means how times what the land can support per person per year for stop the increase in greenhouse.
2008	3 242 628	252.92	5 058.40 €	
2009	3 837 856	299.35	5 987.00 €	
2010	3 847 355	300.09	6 001.80 €	
2011	3 316 247	258.67	5 173.40 €	
Total	18 970 364	1 479.68	29 593.60 €	

From the **Table 10**, the emission of gases is quite important and it needs to reduce and offset.

The principle of geographic neutrality is at the heart of the mechanisms established by the Kyoto Protocol. This text, written in 1997, defines the obligations of the signatory countries to fight against climate change and the means used, including the implementation of flexible mechanisms.

The purpose is to give a price on carbon and put pressure on major emitters for that term, it is more profitable to reduce its own emissions than to buy carbon credits.

For these we have 20 € (1 860 DA) per Tone of CO_2 Eq.

11.2 Integration of renewable resources

The management of energy adapted, through the optimization of the production with the integration of the renewable resources like a wind farm, panel's photovoltaic, etc... Allows to decrease the total over cost binds to the fuel for the production (in any expenses of investment) and consequently the reduction of CO_2 emission (less production = less emission), in our case, this optimization makes it possible to carry out an economy of **First we choose the year of 2010 for study.**

11.3 Political solution

Algérienne des Eaux pays more than **52 998 390,68 DA** for the five years (07, 08, 09, 10 and 11); whose it can't pays all this amount.

So we can realize a significant gain if we terminate the contracts which are stopped and when we need it for another time we must renew it automatically (find a solution between the two companies).

11.4 Economic solution

a- Revision of the power placed at the disposal (PPD)

We made only 11 revisions of the PPD so we are realized the total gain of **(170 280, 00 DA = 1 190, 77 €).**

b- Stops in the peak hours

We made Outages during the peak hours in the months (January, February, March, April, October, November and December) we realized the total gain of **2 288 431.59 DA = 16 003.02 €.**

12. SOLUTIONS TO BE PROPOSED

According to the proposed solutions; integration of renewable resources such as PV system for example, so we are going to use the (PVGIS) on line simulator.

Photovoltaic Geographical Information System (PVGIS) provides a map-based inventory of solar energy resource and assessment of the electricity generation from photovoltaic systems in Europe, Africa, and South-West Asia.

It is a part of the SOLAREC action that contributes to the implementation of renewable energy in the European Union as a sustainable and long-term energy supply by undertaking new S&T developments in fields where harmonization is required and requested by customers.

13. SIMULATION RESULTS [7-11]

13.1 PVGIS estimates of solar electricity generation

Location: 27°53'57" North, 0°14'13" West, Elevation: 270 m a.s.l.,
Solar radiation database used: PVGIS-helioclim
Nominal power of the PV system: 300.0 kW (crystalline silicon)
Estimated losses due to temperature and low irradiance: 15.1 % (using local ambient temperature)
Estimated loss due to angular reflectance effects: 2.6 %
Other losses (cables, inverter etc.): 14.0 %
Combined PV system losses: 28.8 %

Table 11: Fixed system

	Fixed system: inclination=26 deg., orientation=0 deg. (optimum at given orientation)			
Month	Ed	Em	Hd	Hm
Jan	1210	37400	5.24	162
Feb	1360	38100	6.05	169
March	1470	45600	6.76	209
April	1480	44500	6.99	210
May	1400	43500	6.77	210
Jun	1390	41700	6.86	206
Jul	1390	43000	6.93	215
Aug	1390	43000	6.92	215
Sept	1360	40800	6.66	200
Oct	1250	38700	5.90	183
Nov	1140	34300	5.14	154
Dec	1090	33700	4.73	147
Year	1330	40400	6.25	190
Total for year		484000		2280

Table 12: Vertical axis tracking system optimal

	Vertical axis tracking system optimal inclination=51°			
Month	Ed	Em	Hd	Hm
Jan	1550	48000	6.79	210
Feb	1740	48800	7.79	218
March	1900	58900	8.70	270
April	1970	59000	9.17	275
May	1920	59500	9.11	283
Jun	1980	59300	9.60	288
Jul	1940	60100	9.54	296
Aug	1850	57400	9.12	283
Sept	1760	52700	8.54	256
Oct	1580	49000	7.46	231
Nov	1450	43600	6.57	197
Dec	1390	43100	6.10	189
Year	1750	53300	8.21	250
Total for year		639000		3000

Table 13: Inclined axis tracking system optimal

	Inclined axis tracking system optimal inclination=28°			
Month	Ed	Em	Hd	Hm
Jan	1510	46700	6.55	203
Feb	1740	48800	7.77	218
March	1950	60400	8.95	277
April	2030	60900	9.53	286
May	1960	60700	9.33	289
Jun	1990	59700	9.68	290
Jul	1970	60900	9.70	301
Aug	1910	59100	9.44	293
Sept	1810	54300	8.84	265
Oct	1600	49500	7.83	234
Nov	1430	42800	6.40	192
Dec	1340	41500	5.81	180
Year	1770	53800	8.29	252
Total for year		646000		3030

Table 14: Inclined axis tracking system optimal

	2-axis tracking system			
Month	Ed	Em	Hd	Hm
Jan	1590	49200	6.96	216
Feb	1780	49900	7.97	223
March	1950	60400	8.96	278
April	2050	61500	9.63	289
May	2030	63000	9.75	302
Jun	2110	63300	10.40	311
Jul	2070	64000	10.30	318
Aug	1940	60300	9.65	299
Sept	1810	54300	8.84	265
Oct	1610	50000	7.62	236
Nov	1480	44500	6.71	201
Dec	1430	44200	6.26	194
Year	1820	55400	8.58	261
Total for year		665000		3130

Ed: Average daily electricity production from the given system (kWh)
Em: Average monthly electricity production from the given system (kWh)
Hd: Average daily sum of global irradiation per square meter received by the modules of the given system (kWh/m^2).

Hm: Average sum of global irradiation per square meter received by the modules of the given system (kWh/m²)

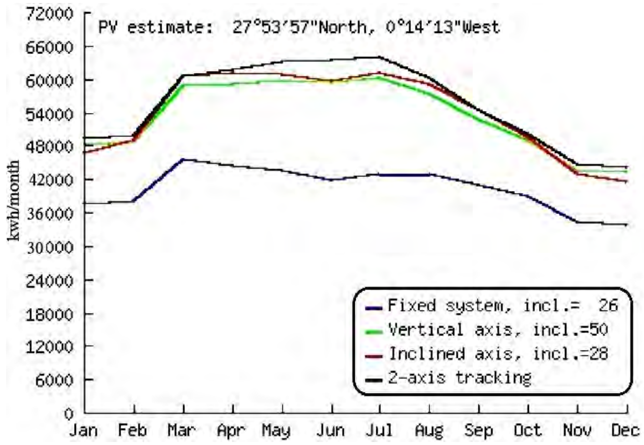

Fig. 15: Monthly energy output from fixed-angle PV system

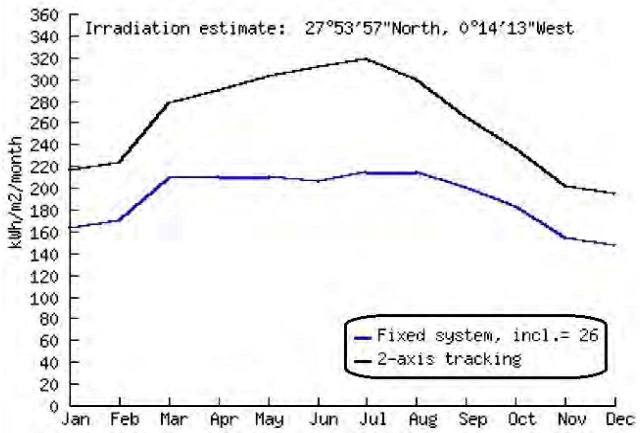

Fig. 16: Monthly in-plane irradiation for fixed angle

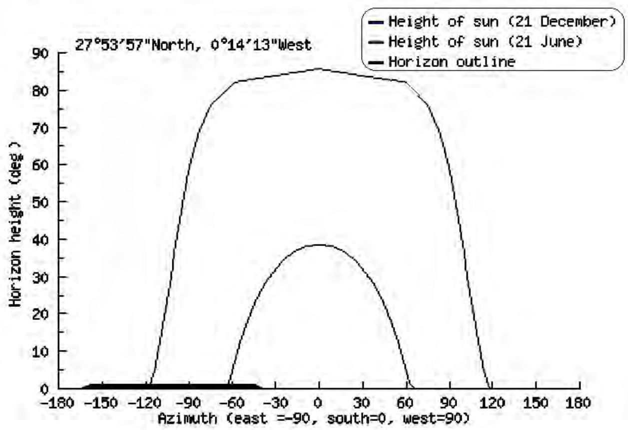

Fig. 17: Outline of horizon with sun path for winter and summer solstice

13.2 Interpretation of results

According to the results of the simulation and the consumption of energy in (Algérienne des Eaux, **ADE-Adrar**).

In the graph (figure 16), the average monthly electricity production from the given system (Em) by month. Graphs have the same shape for the fixed system, vertical axis tracking system optimal, inclined axis tracking system optimal and for the 2-axis tracking system. That means that for a Saharan area as (Tililane / Adrar) the average sum of global irradiation per square meter received by the modules of the given system {graph (figure 16)} is in a maximum between March and July.

Appearing in the **Table 6** and (**Table 11**, **Table 12**, **Table 13**, **Table 14**) we see that (**ADE-Adrar**) consumes much more in the first and the second quarter period of the spring and summer (the graphs have the same shape), which can be produced and consume power only by the PV system in the two quarters (2nd and 3rd / between March and August) and can even occur in the peak hours and avoid outages.

For the graph figure 17 describe the outline of horizon with sun path for winter (21 December) and summer (21 June) solstice which is an astronomical event that happens twice each year when the Sun reaches its highest position in the sky as seen from the North or South Pole. The day of the solstice is either the "longest day of the year" or the "shortest day of the year" for any place on Earth, because the length of time between sunrise and sunset on that day is the yearly maximum or minimum for that place.

14. CONCLUSION

L'Algérienne des Eaux (**ADE-Adrar**) is one of the largest energy consumers in our town Adrar, annual consumption in excess of 3 Million kilowatts, it is quite important especially for the CO2 emission which is more than 200 tons for each years.

Indeed, the main aim of this research is to find solutions for environmental optimization of energy in the electricity grid of (**ADE-Adrar**), the obligation to reduce CO2 emissions. Where there are two out of the policy solution and the other economic.

1- Policy

Is usually a major problem and it affects all Algerian companies because of mismanagement and financial losses over the losses in energy.

2- Economic

a - Revision of the power placed at the disposal

Power Placed at the Disposal (**PPD**), which is larger than necessary; So (**ADE-Adrar**) does not know its energy needs, all of which must be just see all the history of the energy consumption of all equipment to choose the powers available.

In the year 2010 we are made 11 revisions of the PPD so we are realized the total gain of: **(170 280,00 DA = 1 190,77 €).**

b - Stops in the peak hours

Even though the hours are peak hours but are more expensive in the hourly positions then tries to consume energy in the off-peak Hours or the Full Hours (gain).

We made Outages during the peak hours in the months (January, February, March, April, October, November and December) (only 07 Months in the year 2010); so we are realized the total gain of: **2 288 431,59 DA = 16 003,02 €.**

So just the revisions of three (3) PPD we are realized the total gain of: **(170 280,00 DA = 1 190,77 €)** and outages during the peak hours only seven (07) Months in the year 2010 we are realized the total gain of: **(2 288 431,59 DA = 16 003,02 €).**

3 - Reduce the consumption of reactive power by the use of capacitor banks;

4 - Solutions to be proposed

The inclusion of distributed generation, distributed and renewable energy and seems economically attractive.

It is true that the installation of renewable resource is too expensive but if you follow good energy balance of (ADE-Adrar) many of charges and fees are for nothing, and we noticed a lot of losses in the energy and even financial, hence our study and we are realized a very important gain for all solutions was distinguished.

On the other hand and according to the detailed simulation although we had some good results, for integration of renewable resource which is a PV system and we are managed to have a great result for the period of spring and summer (the second and the third quarter).

Our problem is the reduction of greenhouse gas emissions, from the decrease in consumption by trying to achieve equality (less production = less emission) in which based on the quality of energy, control of energy and the energy management and to satisfy demand and maintaining equal balance equation $\sum PD = Pc + Pl$ with a total cost $CT = \sum Ci$ feasible and controllable, for our case study **ADE-Adrar** has many problems and among them the massive consumption of active and reactive power in excess of more than 3 million kWh; 3 million kVar per year, then we must seek solutions to optimize it, on the other hand we can also integrate other renewable resources.

And after all these solutions we wanted to reduce the use of **ADE-Adrar** from the reduction of fossil fuel production and integration of renewable resources that are cleaner to reduce the emission of greenhouse gases (reduce CO_2 emissions), and achieve equality: Less Production = less Emission.

NOMENCLATURE

ADE, Algérienne des eaux	OPH, Off-peak hours
PV, Photovoltaic	HP, Peaks hour's
RE, Renewable energy	React, Energy reactivates
SD, Sustainable development	TA, Total amount
PPD, Power placed at the disposal	IAT, All inclusive of tax

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The source: All data are calculated with the invoices of the Company of Distribution of Electricity and Gas of the West (Sonelgaz, Adrar). We have 14 contracts.