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Research paper

Modeling and real time simulation of micrograms using RT-lab platform: application in south algerian

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Abstract

Microgrids are, as their name implies, real-time networks operating between producers, distributors and consumers. Aim of this work is to model and simulate operation of microgrids, including micro power plants, photovoltaic panels, wind farms, diesel power and storage energy, and finally we will apply the model in real time simulation thanks to MEGASIM of the RT-LAB platform Application of this work will be in southern Algeria area, where climate is hot, sunny and arid, and daytime temperatures are very high. It means that both of wind and photovoltaic energies are widely suitable in this location. Results obtained by this tool will allow us to have a very accurate vision of Micro grid operation, in term of power flow or fault responses.

Keywords: *Micro Grid; Modelling; Real Time Simulation*

1. Introduction

The electrical power system generally consists of power generators, transformers, transmission lines and substations linking to distribution companies and large customers. It represents a complete ecosystem that supports socio-economic development through the provision of a secure and reliable supply of electricity at a minimum cost to all sectors. In a number of countries, regulatory reforms have been made to support this transformation by allowing end-users to invest in renewable energy (wind and solar energy sources). As a result, microgrid power supply networks emerge to generate, distribute, and regulate the flow of power on a local dimension. Microgrids are ideal for university campuses, military bases, isolated site, office blocks and industrial sites. Improved power quality, reduced transmission losses, robustness and resilience are the main salient features of micro-grid systems.[1]
Electricity market in Algeria is very important; Sonelgaz (National Society of electricity and Gas), is the major provider of electricity and gas utility. Power plants generation in the country is open cycle gas turbines, combined cycle gas Turbines, conventional steam turbines and more recently renewable energy sources.[2]
Recently the covering capacity for electricity installations network is 98% in which more than 80% is being in the north [3].
Most of electrical installations in the south are powered by diesel or gas. Because of the faults of these production groups, it is necessary to install other sources of production, such as renewable energy, all realizing the micro-grids.
Several scenarios will be considered for the realization of the micro-grid in the southern Algeria, according to region and climate:
PV solar with wind power with diesel power with storage energy.
PV solar with wind power and diesel power.
PV solar diesel power with storage energy.
PV solar with wind power with diesel power.

As we notice in this figure 1, north network is much meshed and strongly interconnected. In other side, south is poorly connected because of its wide surface, and a lot of desert uninhabited areas.
For these reasons, renewable energies, and micro power plants are a suitable solution to provide electrical power to this part of the country.

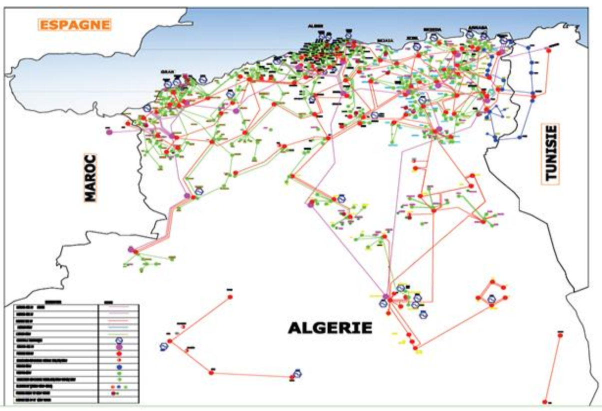


Fig.1. Algerian Electricity Grid [4].

In first part of this article, we will presents global review of renewable energies in south of Algeria. Second part is presenting Real Time simulation tool (architecture and software).In last part; we will present models of Microgrids with different cases scenarios

2. Renewable energy in Algeria

National priority for Algeria is to diversify sources of energies by inserting renewable power plants. Algeria has a big potential in

solar energy, and have ambition to become a leadership in MENA area, and a serious partner in the world. Alternative energies, like solar and wind are a serious and efficient alternative to ensure energy security supply, reliability, increasing efficiency in energy conversion, transmission and distribution. In particular, Sahara Algerian (southern Algeria) desert have a phenomenal potential.
In Sahara, since years seventies, national program strongly supported utilization of renewable energies, mainly solar first, but now wind generation is also enhanced. (Fig 2)
Economically, a conventional power supply by extension of the networks is not adapted to the distant centers. This is true for the areas of the Sahara with its surface about 2millions km^2, and only an autonomous means of feeding is to be envisaged. For this reason, microgrid is the suitable solution.
The sunshine of these regions has made it possible to resort to electrification by solar energy and wind energy [3].

Fig.2. Algerian Renewable Energy.

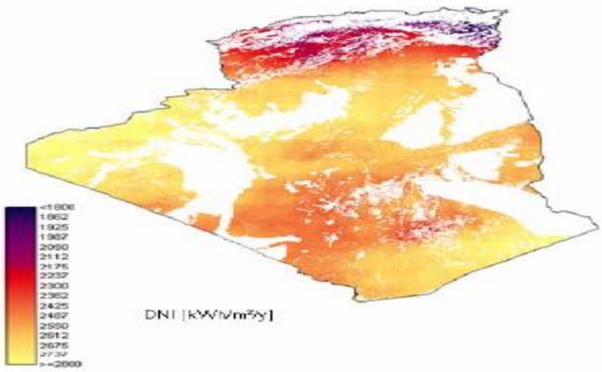


Fig.3 Solar Potential in Algeria.

Photovoltaic energy offers an ideal solution thanks to its phenomenal potential. Photovoltaic technology is enough well proven that it is clean, durable, efficient and highly scalable. This technology is easy to integrate in any area, in both developed and developing countries. This is why; the program of renewable energies in Algeria is based on photovoltaic first, followed by wind energy.(fig 3)

3. Modeling of a micro grid in southern Algerian

In this chapter, we are interested to the micro-grid of the southern Algeria.
Wind farm of Kebertene, (Adrar: West-south of Algeria): For a nominal Power rate about 10,2MW, this project start in June 2014.It is implanted on an area of 33hectars, and produces about 3.25GWh for an average wind speed value of 8m/s.
Zaouiet Kounta power plant: (80 km south of Adrar). With a production capacity of 148 megawatts.A production that contributes to supply the wilaya via two power lines, one to the South to In-Salah (Tamanrasset) and the other north to Timimoune (Adrar).
Third power source is solar power plant of Kabertène (3MW).
Main electrical grid supplies most important areas such as Adrar and Timimoun, in addition of interconnexion with 220kv power network of Ain Salah.

3.1. Micro grid operation

As we cited bellow, southern Algerian area is mainly supplied by gas turbines and diesel generator. But, there is around this locality a lot of isolate populations which are powered by both wind and/or solar energy.
Renewable energy sources connected to the micro-grid are connected to the main network by relays. As soon as one of the sources is insufficient to feed the load, the corresponding switch opens, and the other closes.fig [4]

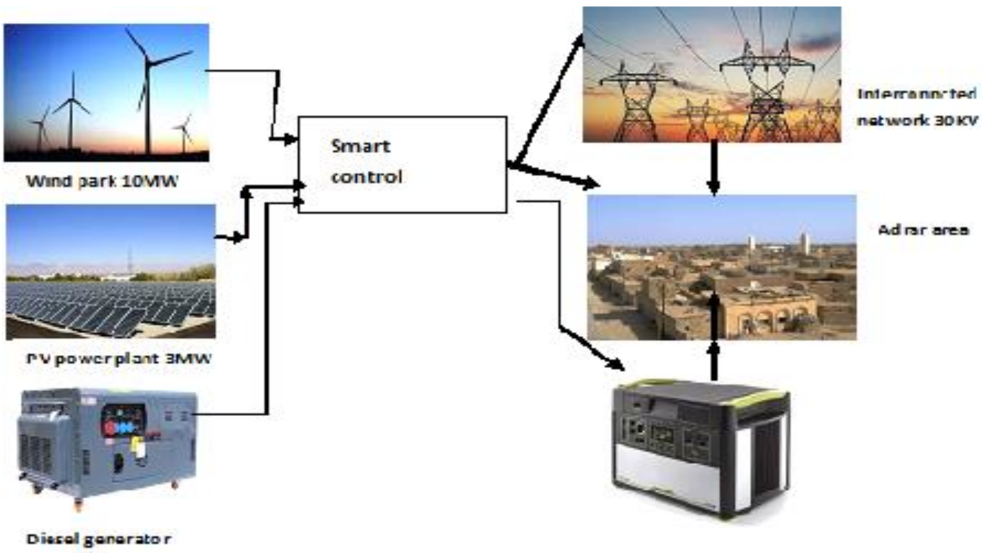


Fig 4. Adrar Micro Grid.

Case 1: If wind speed is sufficient to produce the energy, wind turbines are connected to the load.

Case 2: The speed of the wind and the sun produce sufficient energy at the same time: wind turbine is connected with the load, and the photovoltaic panels charge the storage battery.

Case 3: If wind speed is insufficient, and sun radiation produce sufficient energy so the photovoltaic is connected the load.
Case 4: absence of wind and photovoltaic generation, the load is connected to the grid.
Main objectives of micro grids conception are to investigate full-scale development, field demonstration, and highlighting performance evaluation of:

- Frequency and voltage control different methods and technologies, under various micro grids operation
- Modes.
- Switching between grid-connected and islanded modes.
- High DER penetration and its impact on the host grid and interaction phenomena between DERs.

We must have in mind that strategies of control, and dynamic behavior of a micro grid in autonomous mode of operation, might be different from that of a conventional power system.

3.2. Modelling and simulation of micro-grid

3.2.1. Adrar main grid

We began first by verify grid operation without microsources in order to calculate power flow.

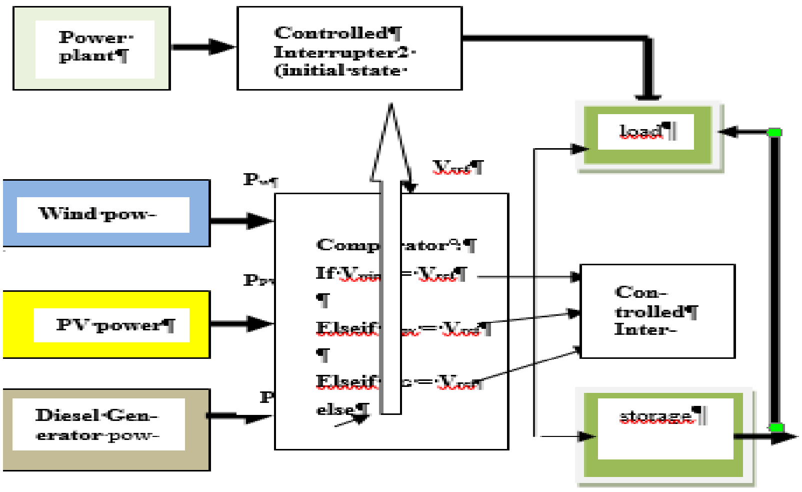
Result of this later is resumed in table1 below:

Table 1: Power Flow of Adrar Main Grid

Generation report		
Subnetwork 1		
	P(MW)	Q(Mvar)
B11.5	6,12330567	167,444605
1	2,08064306	38,8766705
Total	8,20394873	206,321276

3.2.2. Simulation of adrar micro grid

Tanks to different metrological data (wind curve and solar sunshine in Adrar area), we have simulate operation of KEBERTENE wind farm and ZAOUIET KOUNTA photovoltaic power plant with a satisfactory accuracy.
Control of sources supply:
We propose for supply sources control a power electronic interrupter (Mosfet or IGBT), controlled by a signal from an algebraic loop. If voltage value coming from decentralised sources is equal to voltage reference, a positive signal is send to interrupter to be ON.
If not, main power system will power loads.



Control Operation of this system is able to verify three following steps:
Climatic conditions :

- Wind speed is sufficient to produce the energy, so the wind turbines are connected to the load.
- Wind speed and PV plant produce sufficient energy at the same time:

Wind turbine is connected with the load, and the photovoltaic panels charge the storage battery.
Wind speed is insufficient, and the sun radiation produce sufficient energy so the photovoltaic is connected to storage battery, and diesel generator to the load.
All sources are deficient, so the network is connected to the load.

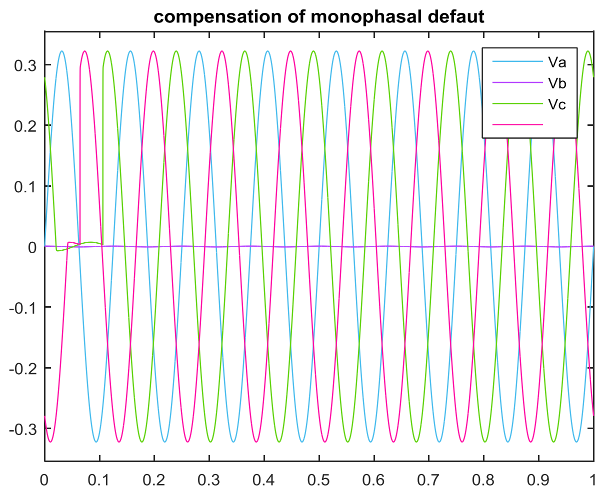


Fig.6 Simulation of a Monophase Fault on Grid.

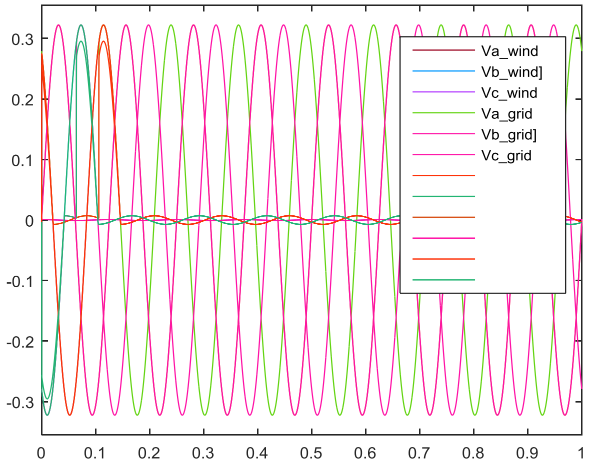


Fig.7 Simulation of Deficiency in Microsources.

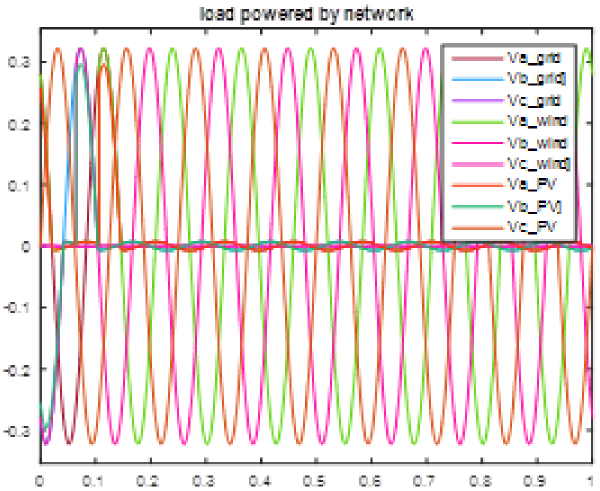


Fig.8 Simulation of Isolated Microgrid.

We have simulated operating scenarios of Adrar microgrid, and results confirm expected specifications imposed for optimal yield. Control and management system will bring different advantages to all voltage levels of the distribution network. For this reason, different hierarchical control strategies need to be achieved at different network levels.

4. Real time simulation

In response to the increasing demands of electrical systems for performance, reliability and cost, the command, control and protection equipments has become increasingly sophisticated.
It is essential to validate this equipment before they are installed on the real power system. To accelerate the development and validation cycle of these equipments, to reduce costs and risks, the current trend is to test these equipments with a real-time digital simulator. The objective of the real - time simulator is to test the different electrical equipments in the most natural possible conditions: as if they were connected to the real physical systems associated with them. Therefore, the real-time simulator must reproduce as closely as possible the dynamic behavior of the electrical system under control. The real-time simulation of the electrical system to be controlled passes first through:

1) A modeling phase that consists in the putting of equation of the system.
2) Then a phase of conception of an algorithmic specification (choice of sampling period, discretization and quantification)
3) Finally, a phase of real - time implantation.

4.1. Hardware architecture

The hardware architecture installed within our laboratory SCAMRE, it is composed of two connected simulators, the Wanda 4u and the OP 5600 (Fig. 5). The target has two CPU processers including 2 cores enabled and 16 I/O, for Wanda and two CPU processers including 2 cores enabled and 16 I/O, for OP5600 (Fig. 6). Main task of the target is the execution of different models. Development, editing, verification, and compilation of models are realized on the host computer. Its second assignment is that it works as a console or command station in charge of control and observation during simulation. Ethernet is used to communicate between hosts and targets.The host computer is a general PC [5].

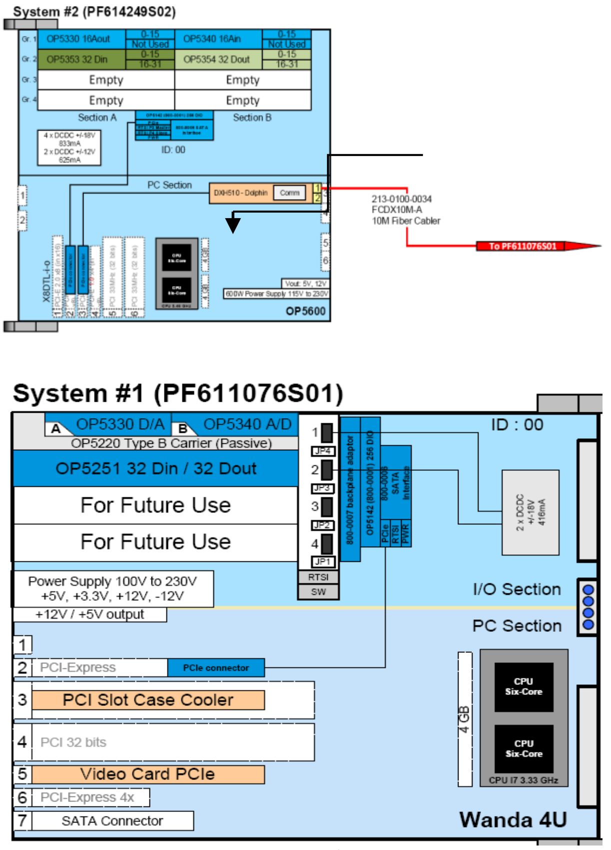


Fig.9. System Hardware Overview for OP 5600 and Wanda 4u.

4.2 Software architecture

Software architecture on the host is shown in Figure 10. All studied models must be developed under the Matlab/Simulink environment. RT-LAB is a real-time GUI platform, and it is dedicated to achieve the real-time simulation of the Simulink models. RT-LAB builds parallel tasks from the original Simulink models and run them on each core of the multi-core CPU computer [5]
is (is a fixed time-step size solvers) which is designed specifically for power system, can improve the simulation speed greatly. Multi-processor operating mode allows it to achieve real-time simulations on RT-LAB platform. Purpose is to separate a complex system to some simple subsystems and do parallel operations in multiprocessor. RT-LAB is able to connect physical devices to the simulation system to make the simulation closer to the reality and get more realistic results.

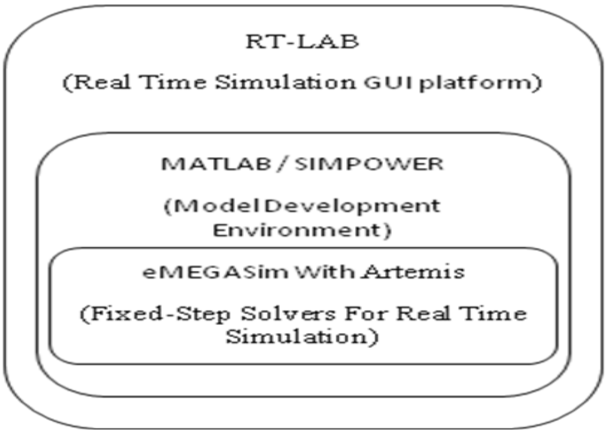


Fig.10. Software Architecture.

For better visibility of the project, it is mandatory to realise a model of micro grid and to simulate it in real time with the Opal-RT software. For this reason, the entire model has to be rearranged mainly into three subsystems, which are master, slave and console subsystems. (Fig 8)

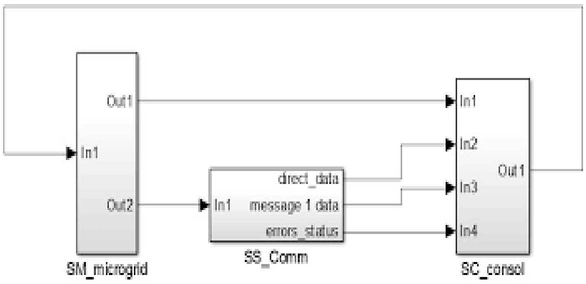


Fig.11. Example Micro-Grid Model with the Real-Time Software

The micro grid system is modelled in an environment that integrates Simulink/SimPowerSystems with the eMEGAsim simulation of the RT LAB platform [6],[7]. This platform improves the simulation of increasingly large systems with real-time performance across multiple CPUs [6].
Next step, we will present different models of micro grids, defining best adaptive one to real time simulation.
The results with the graphs of the real-time simulation micro grid models in southern Algeria and their interpretations will be later presented in a second part of the article.

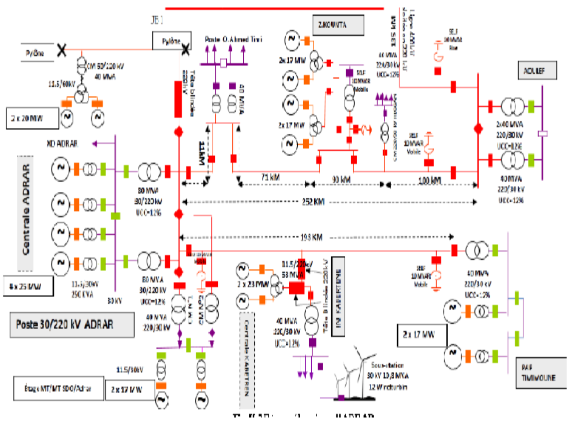


Fig 12: Adrar Micro Grid.

Microgrid below (fig 8) is modelled with Simulink, and simulation must be achieved in discrete method for running it in real time simulator.

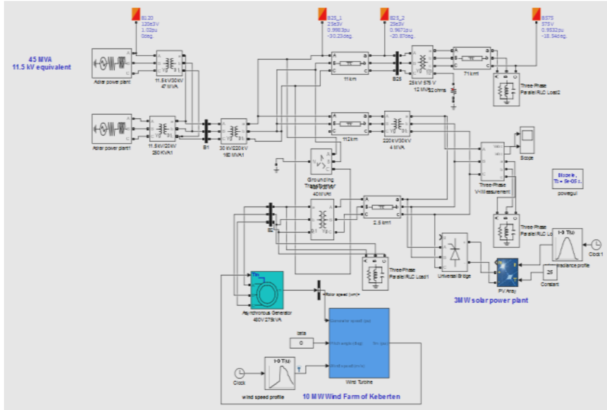


Fig. 13: Simulink Model of Adrar Micro Grid.

5. Conclusion

Application of micro sources can in evident manner, regulate consumption for distribution and transmission facilities. Particular geography of southern Algerian is very suitable to organize diversity of power sources in micro grids in order to optimize their operation, to make easier their command. Autonomous micro grids applications for remote locations are mainly achieved for electrification of electrically nonintegrated areas: like islands, and isolated areas as southern Algerian. Few years ago, some communities in Sahara have been electrically supplied almost exclusively by diesel generators. In addition to reducing fuel costs, the main objective of autonomous micro grid applications is to investigate and develop field experience with planning and operating autonomous distribution grids [12].
This article is a first conception of a micro grid in southern Algerian which includes diesel, wind and solar energy. This will be providing a continuity of service.
RT-LAB, simulation of this model, will give us real data, and enhance local reliability, by reducing gas emissions, improving power quality by supporting voltage and reducing voltage dips, and giving potentially lower costs of energy supply.
There will be a focus on local supply of electricity to nearby loads. Results of research and field tests are used to identify technology requirements, and to promote electric utility acceptance of the Microgrid concept.[13]
In perspective, after results on power flow and different operating scenarios with provisional changes in load, we will propose cartography of feasible Microgrids in Algerian Sahara, and a control strategy for both of them in insulate case and in interconnected one.

Acknowledgements

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References

[1] Pei Zhang, Fangxing Li, Navin Bhatt, “Next generation monitoring , analysis, and control for the future smart control center,” IEEE Transactions on Smart Grid, vol. 1, no. 2, September 2010, pp. 186-192
[2] Himri Y, Stambouli ABoudghene, Draoui B. Prospect of wind farm development in Algeria. Desalination (Elsevier) 2009; 239: 130–8.
[3] A.Boudghene S, Z. Khiat,S.Flazi, Y. Kitamura “A review on the renewable energy development in Algeria: Current perspective, energy scenario and sustainability issues”, Renewable and Sustainable Energy Reviews 16 (2012) 4445–4460(Elsevier) .
[4] Y. Huang,S. Mao, and R. M. Nelms, ``Adaptive electricity scheduling in microgrids," in Proc. IEEE Global Commun. Conf., Apr. 2013, pp. 119.

[5] M.Khiat; L.Ghomri “" Real time of HVDC and VSC- HVDC models: Application to Algerian- Spanich power system interconnection", ICREPQ'16, Madrid, Spain, 2016.
[6] User is Guide, “SimPowerSystems R2013a”, Hydro-Québec and The MathWorks, 2013.
[7] User’s Guide, “Real-Time Workshop 7”, by The MathWorks, Inc., 2010.
[8] H. C. Su, G. W. Chang, H. M. Huang K. K. Jen, G. C. Chun, and G. Z. Wu, “Analysis of
[9] Wind Generation System by Real-Time Simulation ”National Chung Cheng University Chia-Yi,Taiwan 2012.
[10] http://portail.cder.dz/spip.php?article3811.
[11] G. Eason,B. Noble, and I.N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551, April 1955.
[12] N. Hatziargyriou, H. Asano, R. Iravani, and C. Marnay, “Microgrids,” IEEE Power Energy Mag., vol. 5, no. 4, pp. 78–94, 2007.