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HVDC electricity transportation technology: feasibility study (Algeria)

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***Abstract*— HVDC technology is gradually becoming a standard in electrical energy transportation. Even more, in some situations it's the best practical solution. The research work presented hereafter is dedicated to the exploration of the basic notions, the induced gains, the basic components, the basic and extended structures, the applications and the real implemented projects of such technology. An overview on the research works concerned by the challenges of this expandable technology and an economic study of the deployment of real electrical transportation lines and their feasibility in Algeria are presented.**

Keywords—HVDC, Electrical power transportation, LCC, VSC, valve

I. INTRODUCTION

Since the use of electricity as a source of domestic energy, distribution and transport are major concerns for energy companies.

HVDC (high voltage direct current) technology can operate and transport electricity over long distances with minimal loss. HVDC electrical cable networks are deploying faster and faster between countries. Economically, this solution can quickly become a very attractive alternative to HVAC transport over long distances (beyond 500 km) and for large powers (beyond 200 MW). Indeed, this electricity transport system has losses of around 3% per 1000 km [1]. In addition, a 1/2 gain in wiring can be obtained as well as a huge reduction in the cost of cable supports. It also happens that this type of electricity technology is most suitable for PV electricity since the latter is directly produced in continuous form [1][2].

Given that Algeria is a highly sunny country; which allows it to claim a very high production of clean PV energy which will far exceed its consumption and will thus become an exporter of this type of highly coveted energy. However, the sites for mass production of this type of energy are far to the south; which makes HVDC electricity transportation technology a suitable candidate for the case of our country and encourages its adoption.

Research in the HVDC field is very active and is mainly focused on electronic parts called boost converters, the exploitation of PV energy in HVDC form for everyday applications and of course the transport.

II. BASIC NOTIONS AND IMPORTANCE

Since HVDC is not a new technology, it took advantage from several decades of research works, laboratory experimentations and real projects deployment. In the following subsections we will the essential basis of this technology.

A. Basic notions on HVDC

The old competition between AC and DC electricity operating forms has primarily turned in favor of the AC. For long decades, AC electricity dominated the market especially for electricity usage in production, transport, distribution and consumption. However, researches and applications on DC electricity continued actively exploiting the developments in materials science, semiconductor technology and control theory and their applications. Significant developments brought HVDC technology comeback on the scene of the electricity transportation. This comeback was aided by 4 general advantages versatile the AC configuration namely [3];

- Lower investment and lower losses for bulk power transmission
- Possibility to realize interconnections between Asynchronous grids
- Possibility of use to improve transmission in parallel AC circuits
- Better controllability since it permits an instant and precise power flow control
- For an equivalent ROW, DC provides 3 times more power than AC.

Moreover, advanced HVDC configurations permit also more advantages namely;

- More adaptability for underground and submarine cables realization
- Costs are close to overhead lines
- Possibility to connect passive loads
- Useful for enhancement of connected AC networks
- Active and reactive power are controlled independently

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- Short delivery times for comparable projects with AC ones.

B. HVDC projects' deployment :

HVDC electrical power transport had been exploited since the middle of the past century. Hereafter is a graphical HVDC projects' deployment in the different part of the world.

Figure 1: World's projects deployment of HVDC electrical power transmission

Despite the fact that HVAC technology is by far the most widely used in different electrical process such as production stations, electrical line transmission, distribution and industrial and domestic consumption; HVDC technology is in full expansion and is starting to conquer some terrain like electricity production through the widely spread of PV plants and electricity transportation especially on longue distances which has been favored by the trend of the globalization of the electricity transportation [4][5].

For Algeria, HVAC technology is exclusively used. the availability of petroleum fuel resources had pushed the exclusive producer of electricity (SONELGAZ) to create production stations close to the consumer and therefore the transport of electricity is limited to short distances [6].

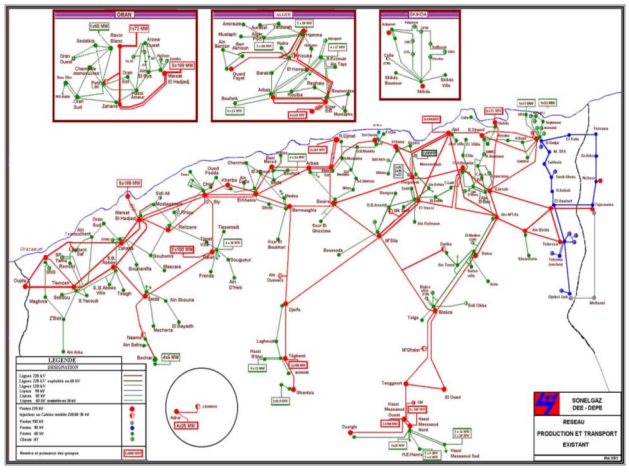

Figure 2: Algerian electricity production and transmission network deployment

The figure 2 gives an overview of the topology of the electricity production stations and transmission lines of the Algerian network deployment. Red and blue circles determine the production stations with different power's production and the red and blue lines determine the transmission lines with different powers and voltages [7][8].

However, new development trends tend to change the course of this industry. The following Algerian specificities could drive such a trend:

- Emergence of so-called renewable and especially photovoltaic electricity production technologies.

- Algeria has enormous photovoltaic potential

- The largest solar deposits are far to the south (the Sahara)

- The large area of the country (more than 2.3 Million Km^2)

- Algerian economic strategy plan could be to become a major exporter of renewable electricity, especially to Europe

Technologists, economists, and even politicians are all aware of energy issues in the coming decades. Renewable energies became not only a trend subject of discussions for different interested actors in Algeria but a real challenge that has to be met. The Algerian electricity and gas company (SONELGAZ), exclusive producer and distributor of electricity in Algeria, had already taken a practical step by creating a subsidiary which deals with the production of renewable electricity. Plans and schedules are ongoing to attain important renewable electrical power production not only for local consumption but also exportation. However, important production stations will be spread far to the south where the most important irradiation rates are recorded. To support this trend, HVDC technology could be deployed according to economical and environmental studies.

III. ENVIRONMENTAL AND ECONLOMICAL ASPECTS

Many solutions are found to protect the environment and meet this growing energy demand such as offshore wind and solar energy in deserts and at the same time these types of energy are clean and they are also adapted to our environment. But these sources of energy are located in areas far removed from cities and the transmission of enormous electrical energy is carried out over long distances. To solve this problem, the use of HVDC technology is one of the solutions that can help to provide power from these areas. Therefore, new trends to attain a more sustainable world will give the HVDC technology an important role in this way of developments. In addition, the new HVDC technology enhancements like VSC and MTC technologies appear to be economically good alternatives for the future extensions of the transmission networks across the planet.

Power transmission efficiency, economical benefits, technical concerns and environmental issues are the main supports of the HVDC technology.

A. Environmental adventages of HVDC

- Visual impact and space requirements: