Renewable Energy Management with a Multi-Agent System

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ABSTRACT

Renewable energy generation (Wind, solar ...) is rising rapidly around the world. Energy storage is being today realistic with some kind of variable renewable electricity sources such as the Pumped Hydraulic Storage (PHS). The incorporation of the PHS requires different policies since there are a variety of electric generation technologies that can be exploited commonly with the PHS. The energy management system, the scheduling of the generation units is a crucial problem for which adequate solutions can optimize the energy supply. This paper focuses on the applicability of the PHS technology in the development of renewable energy generation in Tunisia. This paper proposes also a multi agent system that can be implemented to simulate the exploitation of the PHS, commonly with other energy sources: conventional energy, wind energy, photovoltaic energy etc.

Keywords: Energy Management, Multi Agent Systems, PHS, Renewable Energy

1. INTRODUCTION


The geographical situation of Tunisia allows it to have the aspiration to provide a platform for development of combined projects for renewable energy exploitation in the region and become an export center of this green energy to Mediterranean countries. The development of renewable energy generation in Tunisia has been characterized by significant intensification since 2000.

The Tunisian strategy aims to increase the part of renewable energy (excluding hydraulic) in the total electricity production: from 2% in 2010 to 30% in 2030. This share will be divided between wind, solar photovoltaic (PV), and Concentrated Solar Power (CSP) as follows: 15% wind, 10% PV, and 5% CSP. Renewable energy should cover 30% to 60% of require-
ments by 2050. The challenge is to meet the variation in electricity demand and supply. This has motivated the development of energy storage. Hence, several Pumped Hydraulic Storage (PHS) plants will be built in Tunisia within 2020.

A central goal of this study includes the operating simulation of PHS in Tunisia combining other energy sources which generate electricity from conventional or natural inflow.

This paper is organized as follows: in the second section we present the energy production in Tunisia. In the third section we introduce the Pumping hydraulic storage. In the section four we discuss Pumping hydraulic storage project in Tunisia. In the fifth section we give details about the proposed approach based on multi agent system to simulate the operation of the PHS. The last section is the conclusion with some perspectives.

2. ENERGY PRODUCTION IN TUNISIA

Tunisia is the first southern Mediterranean country to start up in 1985 a voluntary policy of energy conservation, particularly through the creation of the National Agency for Energy Management (ANME) (ANME, 2014). The Agency for Environment and Energy Management (ADEME) (ADEM, 2014) is working for twenty years to support energy efficiency in Tunisia, in different economic sectors, to develop renewable energies, sensitise, and inform the general public. The installed power of the national park production in 2013 is about 4425 MW. Renewable energy sources supply 7% of the total country energy demand.

The production of renewable energy in Tunisia began in 2000. The rate of integrating renewable energies evolved 7% in 2013 compared to 3% in 2011, 2009, and 2003. Main renewable energy sources and their proportion are given in (Table 1).

The Tunisian Solar Plan (TSP)’ main objective is to instigate specific programs to streamline the country’s energy consumption and developing the use of national capacities of renewable energy sources. It also confirms the ambition of Tunisia to become an international platform for production and export of industrial and energy especially in the field of solar energy. It belongs to MENA (Middle East and North Africa) region (MENA, 2014).

The development prospects of renewable energy to the year 2021 are estimated at 725 MW Photovoltaic, of which 73 MW will be produced by STEG (STEG, 2014) and 652 MW produced by the private sector, 630 MW Aeolian, of which 190 MW will be produced by STEG and 440 MW produced by the private sector, and 130 MW Original Concentrated Solar Power (CSP), of which 50 MW will be produced by STEG and 80 MW produced by the private sector (Figure 1).

The Renewable energy should cover 30% of energy needs in Tunisia by 2030 (ANME, 2014). This will imply a complete change in supply and consumption modes. The energy

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<tbody>
<tr>
<td>Wind (in MW)</td>
<td>10.56</td>
<td>20</td>
<td>54</td>
<td>54</td>
<td>244</td>
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<td>Hydraulic (in MW)</td>
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<td>62</td>
<td>62</td>
<td>62</td>
<td>62</td>
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<tr>
<td>PV (in MW)</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Total RE (in MW)</td>
<td>72.56</td>
<td>82</td>
<td>116</td>
<td>116</td>
<td>310</td>
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<tr>
<td>Total production (in MW)</td>
<td>2892</td>
<td>3473</td>
<td>4024</td>
<td>4425</td>
<td></td>
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<tr>
<td>RE rate</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>7%</td>
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Optimization of Micro-Grid Electricity Market Based on Multi Agent Modeling Approach

The Use of the Data Transformation Techniques in Estimating the Shape Parameter of the Weibull Distribution for the Wind Speed