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Investments and cleaner energy production: A portfolio analysis in the Italian electricity market

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ABSTRACT

The recent climate change, global warming, environmental disasters and the economic crisis are only the first signs of the failure of an economic system that, for too long, shows an uncontrolled utilization of the planet wealth. The Italian electricity market, which is strongly dependent on hydrocarbons, only in recent years has seen a first attempt to change towards renewable resources for electricity production aimed at self-consumption and for feeding into the grid. This paper presents an economic analysis whose purpose is to evaluate the profitability of investments in renewable technologies for the production of electricity. Each renewable source has its own profitability dependent on a number of factors and subject to market fluctuations, cost and frequent changes in the incentive policies. Applying Portfolio Theory is possible to select the right mix of renewable energy sources and simulate its evolution. Moreover the presented analysis can be useful for energy planners to select future green scenarios finalized to the reduction of emissions and energy imports through the increasing use of renewable energy.

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1. Introduction

Unbridled exploitation of planetary resources as infinite source and disregard of the environmental impact of human works have been the driving forces of world economies and the basis of the recent environmental disasters, the increase in pollutant emissions and failed policies related to the lack of resources and supplies. In this scenario Green and Sustainable Economy represents not only a simple ecological branch of the economy but a real economic model. Only in the last thirty years it is possible to observe the first steps towards an energy policy based on sustainable development; the European Union has laid the foundation for a post-Kyoto protocol (expiring in 2012) with the formalization of the package “climate-energy 20-20-20” (in force since June 2009 and valid from January 2013) which has three main objectives to be achieved by 2020: 20% reduction of emissions compared to 1990 levels; reaching the renewable share of 20% compared to the gross final consumption and improving energy end-use efficiency of 20%. To each member State is also assigned a binding target (with deadline 2020) that in the case of Italy is:

- a reduction of greenhouse gases by 14% compared to 2005;
- a renewable energy share of 17% of gross final consumption (in 2005 it was 5.2%).

In line with the encouraging results, the European Council approved in October 2014 new targets for 2030, which provide for a reduction in emissions of greenhouse gases by 40% and an increase of 27% of renewable and energy efficiency. The guidelines of this strategy, both at European and national level, ranging from the need to address the alarming climatic tasks to the end-user awareness, focusing on renewable sources such as keys to energy efficiency and technological development towards a “growth green” (Popp et al., 2011). The implementation of incentive policies is favouring the spread of so-called renewable energy that can be considered almost inexhaustible resources and ensure a practically zero environmental impact when compared to traditional sources such as fossil fuel. The electricity from renewable energy sources (Photovoltaic, Biomass, Wind, Hydroelectric and Geothermal) is in Italy 38.6% of the total production in the year 2013 (GSE, 2014). The paper aims to present a financial and strategic analysis focused on the renewable energy sector, in particular related to the Italian electricity market, in order to get concrete suggestions to the needs of investors and useful results in the field of the economic sustainability of the investments (Cucchiella and D'Adamo, 2015). For a transition from carbon-based economy to a sustainable one, it's

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essential to reduce energy demand, to use energy as efficiently as possible, and to invest massively in renewable energy systems. Renewable energy investment is crucial for achieving sustainable development and climate goals. Sustainable investors aim for strong financial performance, but also believe that these investments should be used to contribute to advancement in social and environmental practices. In particular the paper aims to evaluate the profitability of investments in renewable technologies for the production of electricity in Italy, to define and analyze optimal technological composition starting from the cost scenarios effectively observed in the market of Renewable Energy Sources (RES) and evaluate the sensibility of national policies (incentives) on the composition, return and risk of the portfolios.

The paper is organized as follows. After this brief introduction in Section 2 an overview on Renewable Energy Sources in Italy is presented. In Section 3 we introduce the problem of optimal portfolio selection (Portfolio Theory) and present the methodology here adopted. In Section 4, starting from the returns and risks of individual activities involved, it is simulated a large number of case studies which correspond to different cost scenarios and sizes (range 10 kW–10 MW) of different RES combinations; such model is able to obtain a set of efficient portfolios maximizing the Sharpe ratio (the excess of return for unit of risk deviation in an investment asset) evaluating the economic sustainability of investments in renewable technologies for the production of electricity; moreover, there are analyzed the current renewable Italian electricity balance (mix) and two simulations related to the effects of incentive policy. Finally the results are discussed in the conclusions.

2. The Italian electricity market

The GSE, Energy Services Operator, periodically publishes data and statistics on the renewable sources used in Italy (GSE, 2014). In 2013 the total gross production of electricity (not purified of energy losses and the energy absorbed by auxiliaries), amounted to a value of 290 TWh, showing weak signs of recovery following the decline suffered in the period between 2008 and 2010 in conjunction with the economic crisis (Fig. 1). The share of RES total production earns about 7.9% compared to 2012 (38.6% of the total gross) continuing its growth in the period 2000–2013 in Italy. Contrary to what is happening to the “new” renewable sources (photovoltaic, wind, bioenergy), the electricity produced by hydroelectric plants is undergoing a strong recovery after the observed reduction in period

2011–2012 in the overall national scene. Fortunately this fluctuating trend is filled by the rapid growth in the last five years of the “new” renewable led by the photovoltaic. The entire renewable energy sector guarantees a more than positive overall trend that has achieved the record production of electricity from RES in 2013 amounted to 112,008 GWh (Fig. 2). So in the last decade, wind, photovoltaic and bioenergy, which are the most promising sources in terms of technological development and investment in Italy, have provided an increasing contribution to electricity production. As for hydropower, in Italy the limit of possible exploitation has almost been reached, because the most favourable and viable sites from the technical and economic point of view have already been used. As a consequence, the future of hydropower in Italy, where the annual growth rate is approximately 0.8%, seems to be limited to the construction of small systems (SHP - small hydropower). As for the regional distribution of electricity production from renewable sources, the regions of northern Italy account for 54% of national production, thanks to the presence of almost all the hydroelectric plants in Italy. This paper considers only the shares of energy produced by hydro, wind, photovoltaic and biomass (bioenergy) for which, excluding the geothermal, the overall balance in the total gross production amounted to 86,630 GWh in 2012 and 106,349 GWh in 2013 of renewable energy as well divided: Hydropower 41,875 GWh (48.33% of total production) in 2012 and 52,773 GWh (49.62%) in 2013, Photovoltaic 18,862 GWh (21.77%) in 2012 and 21,589 GWh (20.30%) in 2013, Wind 13,407 GWh (15.48%) in 2012 and 14,897 GWh (14.01%) in 2013 and Bioenergy 12,487 GWh (14.41%) in 2012 and 17,090 (16.07%) in 2013. At the end of 2013, the mix of renewable power plants installed in Italy was extremely diversified in terms of sources, technologies and sizes. In particular the size of the plants of RES installed in Italy ranges from power below 50 kW up to powers greater than 10 MW (Fig. 3). There were 591,029 photovoltaic installations in Italy (99% of total renewable energy systems) with an installed capacity of 18,053 MW. Compared to the previous year, in 2013 there was an increase of 8.2% in installed capacity and 22.8% in the number of photovoltaic systems. From 2008 to 2011 the number of photovoltaic systems more than doubled from year to year. At the end of 2012, the country had more than 480,000 systems installed, which reached almost 600,000 systems at the end of 2013. At the regional level, 44% of installed capacity is in the north, 38% in the south and 18% in central Italy. As regards the number of systems, at the regional level, 54% of systems are situated in the north, 29% in the

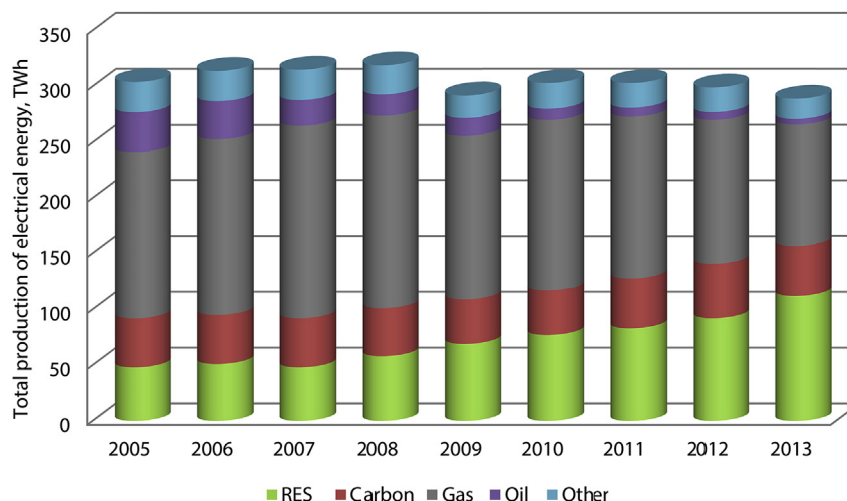


Fig. 1. Total production of electrical energy in Italy from 2005 to 2013.

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