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Optimization of energy mix - Nuclear power and Renewable Energy for low emissions energy source a benefit for generations to come

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Abstract

The paper addresses the general issues concerning nuclear power generation in today's energy market. Nuclear power with its characteristic generating cycle parameters is common for base load applications but modern operating nuclear power stations are able to vary their load according to the demand. Emissions are one of the most important aspects in power generation and the nuclear power is one of the few low emissions power source. Although nuclear power has at this moment low efficiencies it is a competitive and reliable power source for generations to come. Recent research achievements showed that nuclear energy could be also considered renewable.

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Keywords: low carbon emissions; reliable; competitive power source; energy market; operation procedure

1. Introduction

Two of the most polluting industries, when it comes to greenhouse gas emissions, are considered to be the transport and power. Power generating industry is a complex mixture between high, medium and low emitter technologies, each one having its advantages and disadvantages. Among other technologies, nuclear power is considered to be one of the less CO2 emitters in the world. In the European Union (EU), limitations imposed by various regulations when it comes to greenhouse gas emissions had important impact over technologies allowed and

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available to be used, transposed directly into an important economic impact. Security of supply is also an important factor that needs to be taken into consideration.

Energy mix is an important factor for ensuring security of supply but today's energy market imposes very high flexibility for power generating units. On the one hand, considering economical aspects, electricity must be provided according to ongoing contracts. On the other hand, from the technological point of view, situation has a high degree of complexity. The newly and highly encouraged technologies like wind, solar, geothermal although are very low CO2 emitters they are very volatile when it comes to actual energy production. This volatility must be compensated with the help of other energy producing technologies present in the energy mix in a specific area. The most difficult situation can be encountered when most of the powers producing technologies are the ones usually used in base loads with low capabilities for ensuring rapid variations. One key aspect when encountering such situation is a good interconnectivity between systems present in different areas or in different countries.

Nomenclature

EU	European Union
EC	European Commission
NDC	Nationally determined contributions

2. European Context

In December 2011, European Commission (EC) issued an Energy Roadmap [1] that needed to be adopted by 2050 by EU member states. The Energy Roadmap is focused on the idea of ensuring the "well-being of citizens, industrial competitiveness and a functional society" ensuring in the same time a diverse energy production system, capable of fulfilling these needs. Security of energy supply is a key factor promoted in this roadmap. The roadmap is based on the "Green Paper on the security of energy supply"-November 2009 [2] and later on "Green Paper - A European Strategy for Sustainable, Competitive and Secure Energy"-2006 [3]. Within these documents six strategic pathways were identified that need to be tackled in order to obtain a sustainable development (promotion of energy sources with reduced carbon footprint), competitiveness and security in the power supply (reducing imports, energy mix diversification, etc.). The stipulated pathways were:

1) build-up of an European electricity and natural gas market;
2) security of supply based on a durable, more efficient and more flexible energy mix;
3) an internal energy market able to guarantee the security of supply;
4) an integrated approach when it comes to issues related to climate change;
5) innovation boost;
6) a coherent external policy with respect to energy issues.

As deadline for actions foreseen in these documents, the year 2020 was stipulated. The year itself was wisely chosen for the so called 20-20-20 climate and energy package. According to [4], it is a set of binding legislation to ensure the EU meets its climate and energy targets for the year 2020: 20% cut in greenhouse gas emissions (from 1990 levels); 20% of EU energy from renewable and 20% improvement in energy efficiency.

In December 2015 a historic agreement was agreed in Paris. During the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21) 195 countries set path to keep temperature rise below 2 degrees Celsius this century. After four year negotiations and clear difference between developed and developing countries, the treaty was finally signed. According to [5] following main decisions were agreed:

- Reaffirm the goal of limiting global temperature increase well below 2 degrees Celsius, while urging efforts to limit the increase to 1.5 degrees;