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THE POSSIBILITY OF CLEAN DEVELOPMENT MECHANISM IN A NUCLEAR POWER EXPASION IN BRAZIL

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ABSTRACT

The nuclear power expansion is a very controversial topic in Brazil, which needs to be carefully addressed, especially because the national energy supply system is becoming more carbon-intensive. Although most of the electricity generated in Brazil is by hydropower plants, the country's electricity matrix expansion is moving towards a larger participation of fossil fuel thermo power generation which is contrarily the global objects of climate change mitigation. Climate change is a reality and the choice facing this problem is between action and delay. There will be needed a huge international mobilization, associated with a great amount of financial, political and engineering resources interested for preventing the aggravation of the greenhouse effect. This article analyses, in the possibility of including nuclear power in the Clean Development Mechanism (CDM) criteria, the revenue that could be generated from the trading of Certified Emission Reduction (CER) in different scenarios of nuclear power expansion in Brazil.

1. INTRODUCTION

According to the Stern Review [10], the power sector around the world is responsible for 24% of the greenhouse gases (GHG) emission, approximately 10 GtCO2e, the major single sector contribution in all sectors, and will have to be least 60%, and perhaps as much as 75%, decarbonised by 2050 to stabilize at or below 550ppm CO_2e.

The annual total GHG emissions arising from the global energy supply sector continue to increase. Combustion of fossil fuels continues to dominate a global energy market that is striving to meet the ever-increasing demand for heat, electricity and transport fuels [5]. No single technology can do the whole job, a variety of strategies will be needed to be used to stay on a path that avoids a CO_2 doubling.

Nuclear energy can play a import role in the transition for global low-carbon economy today. Nuclear energy does not give rise to stack emissions, which accompany the generation of power from fossil fuels. It produces virtually no GHG emission and, according to [11] estimates, each year nuclear power plants around the world avoid emissions up to 2.5 billion tonnes of carbon dioxide (CO_2). According to the estimates of the [3], emissions from the entire nuclear fuel cycle – from uranium mining to waste disposal – are in the range 10 to 50g of CO_2/kWh, which is of the same order as emissions from wind energy. This should be compared with emissions from fossil fuels, which range from 450g to 1,200g CO_2/kWh. The major barriers are: long-term fuel resource constraints without recycling; safety; waste management; security; proliferation; economics, and adverse public opinion.

The Clean Development Mechanism (CDM) allows industrialized countries required to reduce greenhouse gas emissions under the Kyoto Protocol (known as Annex I countries) to invest in projects that reduce emissions in developing countries, as partial fulfillment of their obligations. Nuclear power plants are disallowed as CDM projects. "Parties included in Annex I are to refrain from using certified emission reductions generated from nuclear facilities to meet their commitments," ruled the seventh Conference of the Parties (COP7) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2001 [6].

Many nations and environmentalists oppose expanding the CDM to include nuclear power. No decisions on overhauling the CDM has be taken, a series of negotiations meant to end with a new long-term U.N. climate treaty by the end of 2009 in Copenhagen, to succeed the first commitment period of the Kyoto Protocol.

2. THEORITICAL BACKGROUND

2.1. The Future of Nuclear Energy in Brazil

It has become clear in 2008 that Brazil has the technology, mineral resources and willingness of the federal government to invest heavily again in nuclear energy. The schedule for Angra III has been resumed and there are plans for the least two new power plants, according to the plans of the Mining & Energy Ministry [7].

According to expert, Brazil has enough fuel to build dozens of nuclear plants over the next decades. However, it is still not clear if the country really wants to significant expand the share of nuclear power generation within the energy matrix. There are solid arguments to defend it. Nuclear generation is a reliable source of energy because depends solely on availability of uranium, with Brazil has. It worth mentioning that over the pat few years the lack of rain, natural gas and other raw material – that Brazil does not produce or control – were some factors that resulted in the instability of the power supply. On the other hand, the long-term environmental liability continues to be a problem without a satisfactory solution [1].

Brazil has the six largest uranium reserve in the world with 309 millions tons, considering that only one third of the country's topsoil has been prospected (up to 100 meters in depth). The uranium treatment and enrichment process includes seven main stages. Brazil masters the execution of all stages from a technology standpoint, but two of them are still performed on a pilot or experiment scale, with requires contracting companies. These stages are conversion and enrichment [1].

Angra III will be the third nuclear power plant in Brazil. According to the energy expansion plan announced by the Mining & Energy Ministry, power plant is schedule to start operating in 2014 producing 1,400 MW, capable of generation more than 10 million megawatt-hour

(MWh) per year. The Mining & Energy Ministry has already included in the plans an additional 4,000 MW by 2030 thought another two nuclear power plants to be build with a total investment of R$ 40 to 50 billion [1].

For this article this two scenarios of nuclear power expansion in Brazil were used for the CER calculation: (I) 1,400 MW by 2014 and (II) 4,000 MW by 2030.

2.2. Climate Change and the Kyoto Protocol

Since the 1980's, the United Nations (UN) has been moving progressively closer to environmental issues, given that climate change is a topic of great concern and being increasingly discussed, UN was concluded that the world needed to take measures to reduce greenhouse gas emissions, since at that time studies already indicated that global warming could bring serious consequences to life on Earth.

The United Nations Conference on Environment and Development of 1992, known as Rio-92, constituted the United Nations Framework Convention on Climate Change (UNFCCC) to deal exclusively with this issue. In 1997, the Kyoto Protocol was launched with the purpose of meeting the convention's targets. Two of the main definitions were [8]:

- The establishment of a target of reducing 1990 greenhouse gas emissions by 5.2%, applicable to the countries in Annex I of the Convention in the first period of commitment – 2008 to 2012;

- Creation of flexibility mechanisms to achieve the targets.

Annex I of the United Nations Framework Convention on Climate Change comprises the convention's signatory countries, including the countries belonging to the Organization for Economic Cooperation and Development (OECD) and the former Soviet Union and Eastern Europe industrialized countries. There are no reduction targets for most developing countries, which integrate the so-called Non-Annex I.

The Kyoto Protocol stipulates that part of the emission reduction and/or CO_2 sequestration of the countries in Annex I may be obtained beyond its borders. Flexibility mechanisms, including the Clean Development Mechanism (CDM), Joint Implementation (JI) and Emission Trading (ET), were thus created. The CDM is the only one that allows the participation of developing countries [6].

2.3. Clean Development Mechanism

The CDM market is extensive because it is the only market certified by the United Nations for trading of carbon credits, being largely called the "compliance carbon market". All the methodologies have to be accepted by the UNFCCC. The crediting periods are seven years renewed twice or ten years.

The process takes around two to three years until the Certified Emissions Reduction (CER) are issued but sales can be made at any stage of the project. The sales price is small in the initial stages and grows with the development of the approval processes. Each CER is equivalent to 1 tonCO_2e.

The whole approval process entails a high cost. Only for selling the carbon credits, 2% of the CERs are paid to the UNFCCC. Moreover, there are fees in connection with the registration (up to 15,000 CERs, the fee is US$ 0.10 per CER per year and more than 15,000 the fee is US$ 0.20 per extra CER per year). The sales price is about € 10,00 to €15,00 per CER.

2.4. Perception of the boardroom thinking in utility companies across the globe

According to [2], challenges and barriers to nuclear energy development, related mainly to economic and financial issues as well as socio-political aspects, explain the difficulties encountered by decision-makers potentially interested in this technology. Energy analysts and policymakers generally agree that the necessary conditions for a nuclear renaissance include:

- financing;
- a well-defined role for nuclear energy in national policy;
- a regulatory context which provides a stable,
- level playing field for all energy sources including a legal framework for nuclear energy covering long-term liabilities;
- recognition of the value of carbon-free energy sources;
- acknowledgement of civil society concerns; and
- enhanced project management.

The main driving forces that could trigger a renewed development of nuclear energy include:

- increasing energy and electricity demand;
- measures to reduce greenhouse gas emissions;
- concerns about long-term security of energy supply;
- volatility and escalation of fossil fuel prices; and
- capability of nuclear systems to penetrate non-electricity product markets.

The most obvious reason for a nuclear renaissance is the increasing need for energy, including large requirements for baseload electricity generation capacity. Recent studies have shown that not only eradicating poverty and disease but also improving the economy and the quality of life depend on a massive and reliable supply of electricity [2].

While the economic competitiveness of the nuclear option is well-established in most countries relying on nuclear energy, including in deregulated markets [4], financing new nuclear power plants remains very challenging owing in particular to policy uncertainties. The cost structure of nuclear electricity generation, with some 60 percent of the total levelized generation cost due to capital investment (**Figure 1**), requires at least two decades of operation to guarantee its amortization.

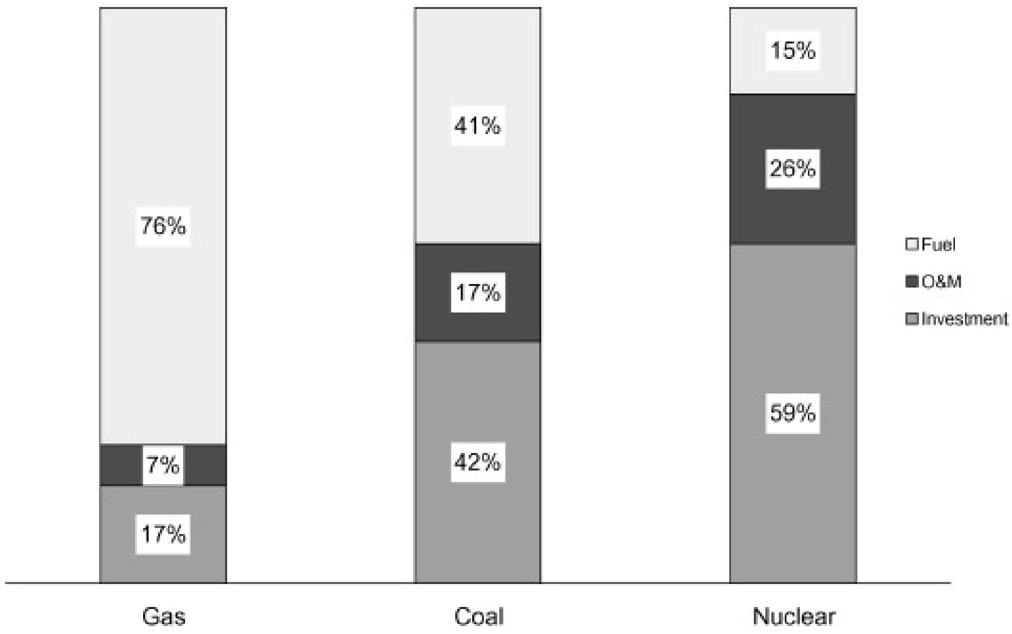

Figure 1. Average Generation Cost Structure for Nuclear, Gas, and Coal Power Plants [2]

A nuclear energy CDM project could raise the recognition of the value of carbon-free energy sources and at the same time lower the capital investment the biggest cost in a nuclear power plant.

A PricewaterhouseCoopers (PwC) survey based on a research conducted between January-February 2008 with 118 senior executives from 115 utility companies across 37 countries. The research covered the four major regions of Europe, the Americas, Asia Pacific, Middle East and Africa. The majority of utility participants were Senior Vice-Presidents and Presidents, CEOs or other senior managers. No more than two interviews were taken from any individual company, although multiple respondents were taken from some countries. The survey sample is comprised of power and gas utilities (suppliers, transmission companies, traders or generators) that have developed a broad range of interests in a number of complementary utility sectors or other regions [9].

According to this PwC survey, the medium term (10 years) and in the longer term (by 2050), the expansion of nuclear power that is cited by most of the utility company executives interviewed. Just over half (53%) put nuclear power at the top or in second place in their ranking of what will have the biggest GHG mitigation impact in the next 10 years, rising to nearly three-fifths (58%) when respondents look ahead to 2050 [9]. Thus, despite the long lead-in time for the construction of new nuclear plant and continuing opposition to nuclear power by many governments, a majority of utility company executives see nuclear playing more of a lead role than renewable generation even in a relatively short 10-year time frame.

3. METHODOLOGY

For the calculation of the CO_2 emission reduction were used the approved consolidated baseline and monitoring methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" and the methodological "Tool to calculate the emission factor for an electricity system" approved by the CDM Executive Board and published in Annex 12 of the EB 35 Report.

The CDM Designated National Authority (DNA) in Brazil, defined a single system for the connected electric system, the National Interconnected System (SIN), for the purpose of using the methodological tool. They are calculated from generation records of plants dispatched in a centralized manner by the National Electric System Operator (ONS) [6].

The emission reductions are calculated as follows:

$$\mathbf{ER_y = BE_y - PE_y} \qquad (1)$$

Where:
ER_y = Emission reductions in year y (t CO_2e/year)
BE_y = Baseline emissions in year y (t CO_2e/year)
PE_y = Project emissions in year y (t CO_2e/year)

The project emission is considerate 0, given in the operation of nuclear power plants there is no GHG emissions.

Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

$$\mathbf{BE_y = EG_{PJ,y} \,.\, EF_{grid,\,CM,\,y}} \qquad (1)$$

Where:
BE_y = Baseline emissions in year y (tCO_2/year)
$EG_{PJ,y}$ = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/year)
$EF_{grid,CM,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

4. RESULTS

The **Table 1** presents the assumption and the results of the CER estimative in both proposed scenario of nuclear energy expansion in Brazil.

Table 1. Assumptions and CER estimative in both scenarios of nuclear expansion

	Scenario I 2014 (Angra III)	Scenario II 2030
Electric power installed (MW)	1,400	4,000
System efficiency	85%	85%
Dispatched electricity (MWh/year)	10,424,400	29,784,000
Emission factor for grid connected power generation in Brazil – 2008 (tCO_2/MWh)	0.3112	
Emission reduction (tCO_2/year)	3,243,725	9,267,787
CER revenue (R$)*	90,824,310.50	259,498,029.90

* €1.00 = R$ 2.80

The total estimate revenue for the CER in both scenarios is R$ 350,322,340.30 per year.

3. CONCLUSIONS

There still a great uncertainty whether nuclear energy will be eligible as a project activity in the CDM criteria. The potential revenue from the sales of CERs were calculated and the values proved significant for both scenarios of nuclear expansion in Brazil. The value represents approximately 0.7% per year of the total investment planned by the government. Therefore, the CERs could be an important financial incentive, but also simultaneously an improving factor for the public awareness about the carbon-free energy source which nuclear energy represents.

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