2021 International Nuclear Atlantic Conference – INAC 2021
Virtual meeting, Brazil, November 29 – December 2, 2021

ISBN: 978-65-594-1256-3

Analysis of the SWOT/FOFA Matrix as a strategy for implementing the AP-Th1000 Reactor in Brazil

Francky Roger A. da Silva[1], Giovanni L. de Stefani[2]

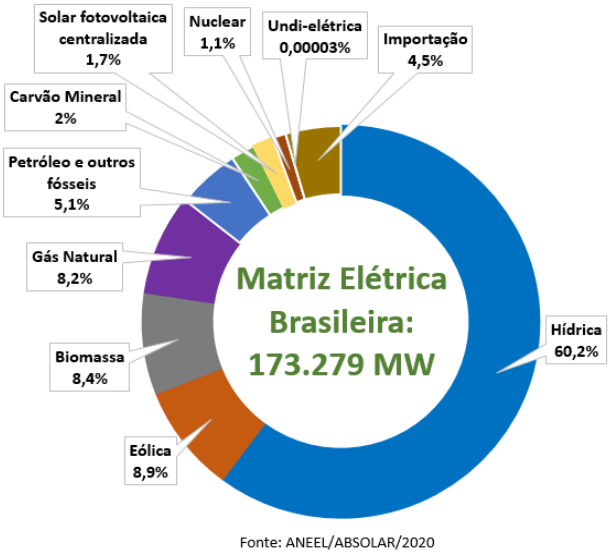
[1] *frsilva@nuclear.ufrj.br*
[2] *laranjogiovanni@poli.ufrj.br,*
[1,2]Correspondence Address: Av: Horacio Macedo, 2030,Bloco G – Sala 206 – CT, Cidade Universitária. CEP: 21941-914 – Rio de Janeiro-RJ

1. Introduction

Currently, in Brazil, in the year 2021, we are facing a water crisis, arising from climate change and global warming, resulting in a reduction in electricity generation. Government authorities decided to increase power generation in thermoelectric plants and with it the increase in the production of greenhouse gases, contributing to global warming and the increase in tariffs in energy consumption and a possible need for rationing and risks of blackouts.

Therefore, there is a need to review current energy generation sources. Among the actions needed to increase power generation, nuclear power plants are an option [1].

Nuclear reactors work independently of the weather and generate energy continuously at any time of day or night. Different from the energy matrix based on water, wind and solar resources... which generate electricity intermittently and are dependent on climatic variations.



(1)

Figure (1): Brazilian Electric Matrix. Fonte: ANEEL/ABSOLAR/2020

As we can see in Figure 1, about 60% of the Brazilian Electric Matrix comes from water resources, which depend on climate variation. We note that nuclear energy is not widespread. Brazil has large reserves of nuclear material (uranium and thorium), in addition to mastering the technology for extracting and processing these ores; Uranium Enrichment; Conversion, Tablet Production; Fuel Element Assembly; and electricity generation via nuclear power plants.

For the generation of electrical energy, most nuclear reactors use enriched uranium as a fuel element. Studies show that uranium reserves do not meet current demand [2]. Among the alternatives for replacing the 235U is the 233U, through the radioactive decay of thorium.

Thorium, around the years 1940-1950, was the object of studies. Since that time, the possibility of using nuclear fuels in a cycle was proposed [3]. Incentives for deployment come from concerns about proliferation risks and the possibility of reducing long-lived radioactive waste [4]. Its fertile property allows its use as fuel in nuclear reactors [5].

This work aims to qualitatively analyze a proposal for a nuclear reactor using Thorium as fuel called AP-Th 1000 using SWOT/FOFA analysis

The AP1000 Reactor is a commercial light water reactor (PWR) that, due to the implementation of passive safety systems, makes it easier to operate, maintain and, with its construction being modular, we have transport and assembly advantages. Uranium-235 is used as fuel and has similarities with the reactors used in Brazil to generate electricity. The AP-Th 1000 Reactor differs from the use of U-Th mixed fuels [6]. It is a theoretical reactor in our country.

SWOT/FOFA analysis is a management tool that aims to assess scenarios before starting a project. Its methodology allows its use in projects in different areas, serving as a basis for decision making [7]. As such, it is a useful tool in the area of nuclear energy.

The term swot is an abbreviation, in English, of the dimensions evaluated. So we have: strengths (S), weakness (W), opportunities (O) and threats (T). In Portuguese, the translation to SWOT matrix was popularized by FOFA, with the analysis of dimensions: Fortalezas (F), oportunidades (O), Fraquezas (F) and ameaças (A).

The SWOT matrix can be used to guide a strategic planning, observing vulnerable points and predicting situations that neutralize weaknesses and threats. Thus, it is intended to evaluate the strengths and weaknesses for the implementation of an AP-Th 1000 Reactor in Brazil.

2. Methodology

As a methodology, we highlight the qualitative character involved. Since the AP-Th 1000 Reactor does not exist in our country, there was a need for an in-depth study of the national literature, which involves computational modeling, and especially international modeling of its main characteristics, linked to the Brazilian reality in relation to national policy, common sense in the nuclear area, among other factors. The aspects listed in 4 categories were classified: Strengths (S), Weaknesses (W), Opportunities (O) and Threats (T). Then, a ranking of priorities was made, in descending order. Weaknesses and threats were suggested to neutralize them. Finally, the data obtained were analyzed.

3. Resulted e Discussion

Strengths (S)	
Ranking	Aspects
1.	Generation of electricity free from greenhouse gases
2.	Continuous and climate-independent electric power generation
3.	Reduction of nuclear proliferation risk
4.	Generation of more fissile material than consumption (Breeder)
5.	Reduced environmental impacts in the electricity generation sector
6.	Possibility of meeting the three pillars of sustainability
7.	Design safer and more modern the current Generation III
8.	Reduced construction time due to modular construction
9.	Using thorium cycle in thermal reactors

Weaknesses (W)	
Ranking	Aspects
1.	High source of neutrons for the production of fissile material.
2.	Relatively long time of fissile material creation due to long half-life of intermediate radioactive material (Pa – 27 days)
3.	Fear of nuclear accidents on the part of the population and government in Brazil
4.	State laws prohibiting the installation of nuclear reactors
5.	Lack of practical research on APTh -1000 reactors in the country
6.	Lack of a practical route for the thorium fuel cycle that is economically viable in Brazil

Opportunities (O)	
Ranking	Aspects
1.	Brazil has large reserves of thorium
2.	Recognition by the Federal Government for investing in the nuclear area
3.	Recognition that the nuclear area is up to the union to legislate and not the states
4.	Existence of qualified labor due to advanced programs in the nuclear area in Brazil
5.	Institutional resumption of Nuclear Research and Development in Thorium.
6.	Direct and indirect generation of jobs

Threats (T)	
Ranking	Aspects
1.	Change in the policy to encourage the nuclear area due to the change of governors
2.	Financial cuts in the research area
3.	Increased unpopularity of nuclear energy due to sensationalism by some media outlets
4.	External interference contrary to the development of the country's nuclear area

4. Conclusions

Weaknesses and threats can be overcome by practical research of the AP-Th 1000 Reactor, finding an economically viable route; for the dissemination of the benefits of electric power generation through nuclear energy and the awareness of government officials and candidates for government in all spheres. Following all international measures in the nuclear area in a transparent manner, leaving no doubt about the peaceful activities of the use of nuclear energy and proliferation of nuclear weapons.
Thus, through the SWOT/FOFA analysis, we observed several benefits of using the AP-Th1000 in the development of nuclear energy generation technologies, in order to avoid rationing, tariff increases, the emission of greenhouse gases, and the development of scientific knowledge.

Acknowledgment

We thank CAPES for the financial support of the research carried out and the Nuclear Energy Program (PEN) of the Federal University of Rio de Janeiro - Brazil.

References

[1] RIBEIRO, D. **Fissão nuclear**. *Revista de Ciência Elementar*, v. 2, n. 4, p. 108, 2014

[2] NEA, 2010. **Uranium 2009: Resources, production and Demand**, s.l.: OECD.

[3] INTERNATIONAL ATOMIC ENERGY AGENCY 2005. **Thorium fuel cycle – Potential benefits and challenges**. IAEA-TECDOC 1450, Viena, 2005

[4] Paul R. Kasten (1998) **Review of the Radkowsky Thorium reactor concept , Science & Global Security: The Technical Basis for Arms Control, Disarmament, and Nonproliferation Initiatives**, 7:3, 237-269, DOI: 10.1080/08929889808426462

[5] Silva JG. **Estudo da confiabilidade do reator AP1000 para o cenário de grande LOCA no contexto de uma APS Nível 1.** Tese, M.Sc em Engenharia Nuclear, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 109 páginas, 2005

[6] de Stefani GL, Maiorino JR, de Lousada Moreira JM. The AP-TH 1000 – **An advanced concept to se MOX of thorium in a closed fuel cycle**. *Int J Energy Res 2020*; 1-14. https://doiorg/10.1002/er5421

[7] SANTOS mc, fernandes meba. **A ferramenta análise swot no processo de formulação das ações estratégicas nas pequenas empresas. um estudo de caso na empresa empreiteira magnu jd são paulo ltda**. R*evista fatec sebrae em debate: gestão, tecnologias e negócios.* v. 2, n. 2, p. 11-126, 2015