



ELSEVIER

Contents lists available at ScienceDirect

## Renewable and Sustainable Energy Reviews

journal homepage: [www.elsevier.com/locate/rser](http://www.elsevier.com/locate/rser)

# Assessment of the potential of small hydropower development in Brazil



Jacson Hudson Inácio Ferreira <sup>a,\*</sup>, José Roberto Camacho <sup>b,1</sup>, Juliana Almansa Malagoli <sup>b,2</sup>,  
Sebastião Camargo Guimarães Júnior <sup>b,3</sup>

<sup>a</sup> Instituto Federal do Triângulo Mineiro, Campus Ituiutaba, R. Belarmino Vilela Junqueira s.no, Novo Tempo 2, Ituiutaba, MG CEP 38.305-200, Brazil

<sup>b</sup> School of Electrical Engineering, Universidade Federal de Uberlândia, Av. João Naves de Ávila, 2121, Santa Mônica, Uberlândia, MG CEP 38.408-100, Brazil

## ARTICLE INFO

## Article history:

Received 30 December 2014

Received in revised form

16 July 2015

Accepted 21 November 2015

## Keywords:

Energy

Small hydropower

Renewable

Electric sector

## ABSTRACT

This paper aims to show the current context of Small Hydro Power Plants (SHPs) in Brazil, presenting and discussing the institutional acts, regulations for growth of the SHP, public and private policies for the sector and growth prospects. After the restructuring of the Brazilian electricity sector, a series of laws, decrees and resolutions were developed with the purpose of regulating the sector in favor of SHPs. In 2001, the number of SHPs in Brazil was 303 with an installed capacity of 855 MW. Over the years, with the changes in the sector and, in 2010, the number of buildings has reached 387, with an installed capacity of 3428 MW. Today, they are 475 SHPs in operation with the generation capacity in the country, around 4799 MW, representing 3.49% of all Brazilian energy matrix. It is estimated that in 2020 the installed capacity will be approximately 6500 MW, but there is more potential available in the country for SHPs, that has great technical and environmental characteristics. It is concluded that more attention must be given by the government policies of the electricity sector to reach in the future the full the potential of SHPs available in Brazil.

© 2015 Elsevier Ltd. All rights reserved.

## Contents

1. Introduction	380
2. Small hydropower as a choice	382
3. Small hydropower in Brazil	383
4. Brazil regulatory environment for SHPs	384
5. Financial reality for SHP's enterprises	386
6. Conclusion	387
References	387

## 1. Introduction

Energy is considered to be a key factor in the generation of wealth, social development and improved quality of life in all

developed and developing countries in the world. Therefore, produced and consumed energy resources and especially renewable energy sources have a very important value [1].

The use of renewable source is the most valuable solution to reduce the environmental problems associated with fossil fuels based energy generation and achieves clean and sustainable energy development. Hydro, wind, biomass, solar and geothermal are among the most important renewable sources for energy generation. All nations of the world are shifting the focus to extract energy from renewable sources [2]. Table 1 shows the list of top 10 renewable electricity producer nations of the world.

\* Corresponding author. Tel.: +55 34 3268 4259; fax: +55 34 3271 4001.

E-mail addresses: [jacson@iftm.edu.br](mailto:jacson@iftm.edu.br) (J.H.I. Ferreira),

[jrcamacho@ufu.br](mailto:jrcamacho@ufu.br) (J.R. Camacho), [juliana.malagoni@gmail.com](mailto:juliana.malagoni@gmail.com) (J.A. Malagoli),

[scguimaraes@ufu.br](mailto:scguimaraes@ufu.br) (S.C.G. Júnior).

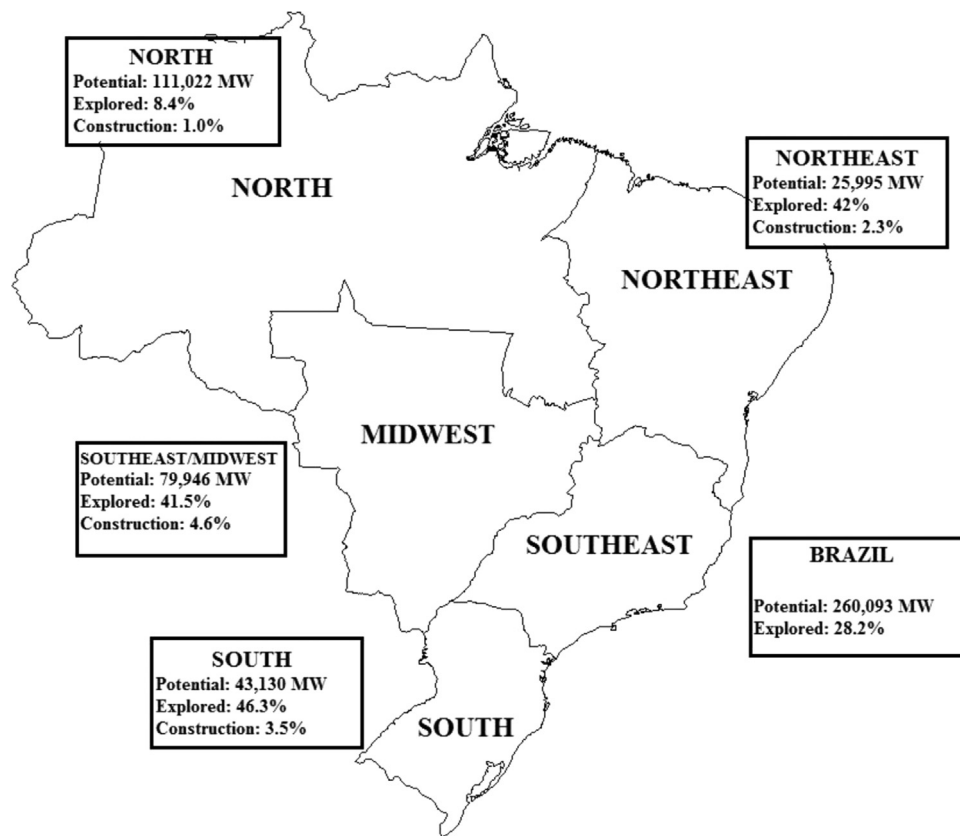
<sup>1</sup> Tel.: +55 34 3239 4734; fax: +55 34 3239 4704.

<sup>2</sup> Tel.: +55 34 3239 4538; fax: +55 34 3239 4704.

<sup>3</sup> Tel.: +55 34 3239 4750; fax: +55 34 3239 4704.

**Table 1**  
World's top renewable electricity producer nations (units in TW h).  
Source: Energy Information Administration [3].

Rank	Country	1	2	3	4	5	6	7	8	9	10
		China	United States	Brazil	Canada	Russia	India	Norway	Germany	Japan	Venezuela
Hydropower	2010	713.8	260.2	399.3	347.8	164	113.3	115.6	20.22	81.39	76.01
	2011	690.6	319.4	424.1	371.9	164.2	129.4	119.6	17.1	82.36	82.83
	2012	856.4	276.2	411.2	376.2	161.6	114.5	140.4	21.2	76.9	80.9
Wind power	2010	44.6	94.7	2.2	9.6	0.004	19.9	0.9	37.8	4.0	–
	2011	73.2	120.2	3.0	19.7	0.0	26.0	1.3	46.5	4.3	–
	2012	–	141	–	23	–	–	2	46	5	–
Solar	2010	0.94	1.21	–	0.16	–	0.02	0.02	11.68	3.80	–
	2011	3.00	1.80	–	0.40	–	1.00	0.02	19.00	3.80	–
	2012	–	4.33	–	0.507	–	–	0.03	28.0	4.19	–
Biomass	2010	11.41	68.94	31.5	8.710	2.77	2.06	0.45	39.87	23.45	–
	2011	34	70.8	32	6.4	2.8	4.0	0.48	43.6	23.15	–
	2012	43.56	71.41	34.0	6.38	2.8	4.13	0.48	44.25	23.15	–
Geothermal	2010	0.16	15.22	–	–	0.51	–	–	0.03	2.63	–
	2011	0.16	15.3	–	–	0.51	–	–	0.02	2.65	–
	2012	0.16	15.56	–	–	0.51	–	–	0.02	2.92	–
Other sources	2010	–	–	–	0.03	–	–	–	–	–	–
	2011	–	–	–	0.03	–	–	–	–	–	–
	2012	–	–	–	0.03	–	–	–	–	–	–
Total	2010	770.9	440.2	432.9	366.3	167.3	135.3	116.9	109.6	115.2	76.0
	2011	801.0	527.5	459.1	398.4	167.5	160.4	121.4	126.2	33.9	82.8
	2012	900.1	508.4	445.2	406.2	164.9	118.6	142.6	139.5	112.0	80.9



**Fig. 1.** Brazilian hydropower potential by region.  
Source: Adapted from Ministry of Mines and Energy [6].

The Brazil belongs to the group of countries where electricity production is massively from hydroelectric plants. These plants account for 67.5% of the installed capacity in the country [4].

The importance of hydroelectricity is based on vast hydro-potential in Brazil and it has resulted in a strategic option since made in the 50s of last century, despite the increased

competitiveness that petroleum represented as a primary energy source [5].

However, only about 30% of the national hydroelectric potential has been exploited, proportionally less than the amount observed in industrialized countries (Fig. 1). The low utilization of hydro-electric potential in northern Brazil is due to the predominant

Download English Version:

<https://daneshyari.com/en/article/8114737>

Download Persian Version:

<https://daneshyari.com/article/8114737>

[Daneshyari.com](https://daneshyari.com)