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Energy Planning for Bahia in 2050: Scenarios and Discussion related to Renewable Energy for Eletricity Generation

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Abstract

Energy planning is strategic and fundamental for any country or region that aims to ensure development and prosperity for its people. The Brazilian Electric Matrix needs to expand and diversify to ensure national energy security and simultaneously maintain its predominance in renewable sources. This is possible only through a coherent energy planning and appropriate public policies. This work is an exploratory research about the electricity sector in the State of Bahia and in the rest of Brazil. It aims to assess electricity supply/demand scenarios for 2050, focusing on the potential growth of concentrated generation based on wind, solar photovoltaic and biomass renewable sources in Bahia while considering sustainability issues. This study was based on the National Plans (PNEs), prepared by the Empresa de Pesquisa Energética – EPE (Energy Research Company), as well as on other technical documents that guide the Brazilian energy planning. Three national demand scenarios were proposed, being two among them based in pre-existing PNEs scenarios while the last one is a projection of the original scenario. Three supply scenarios were also designed for Bahia, based on the potential growth of the new renewable sources mentioned above. Finally, there was a data crossing between national demand scenarios and supply scenarios for Bahia, producing nine possible general scenarios. As results, eight general scenarios point to Bahia as a future net exporter of renewable energy against one single scenario pointing Bahia as a future net importer of electricity. Bahia can have socioeconomic gains with investments, the creation/maintenance of jobs, environmental benefits with reduction of GHG emissions; besides water savings liters for CHESF´s hydroelectric reservoirs.

Introdution

With the enormous strategic importance to the planning and management of public policies for energy have in many aspects of modern society, the specific studies in this area to Bahia and Brazil are important to raise Increasingly positive prospects and energy security and economic development sustainability. In addition, the inclusion of new renewable sources in the energy mix of Brazil and of Bahia shouldn´t be better Understood, seeking to analyze the conditions for its implementation, and Develop a set of objective and comprehensive information on the use of These sources, covering the various dimensions Involved. Centralized generation was chosen because there is already a trend of Investments in progress in this generation mode for renewables and the potential it offers to Attract Investments for new expansion, strengthening and optimizing the SIN transmission infrastructure. The State of Bahia has great potential for generating electricity from renewable sources (Figure 1), Especially wind, solar and biomass, Which Could be high enough to meet its future demand in 2050 and still generate a surplus for the National Interconnected System. Thus, with adequate energy planning, public policy and ventures will be consistent significant economic, social and environmental gains.

The objective of this research is to conduct an exploratory study on the energy sector in Bahia and Brazil to assess supply scenarios / electricity demand by 2050, with the emphasis on the growth potential of the combined generation by wind renewable sources, solar photovoltaic and biomass Bahia and considering the pillars of sustainability.

Materials and Methods

- Primary data collection (Documentary Research; Bibliographical Research, etc.);
- Preparation of projections of electricity demand scenarios in Brazil and power supply in Bahia scenarios by means of specific equations and tables;
- Data crossing between national demand scenarios and supply scenarios for Bahia;
- Analysis of the information obtained.

Results and Discussions

- Three national demand scenarios were proposed: 1241.7 TWh, 1624.0 TWh and 2203.6 TWh (Figure 2).
- Three supply scenarios were also designed for Bahia: 109.8 TWh 142.9 TWh and 168.1 TWh (Figure 2).
- Data crossing produced nine possible general scenarios. As results, eight general scenarios point to Bahia as a future net exporter of renewable energy against one single scenario pointing Bahia as a future net importer of electricity (Table 1).
- The State of Bahia can have socioeconomic gains with investments between R$132 billion and R$240 billion, the creation/maintenance of jobs, estimated between 17,450 and 33,850; environmental benefits with reduction of GHG emissions from 13.0 to 20.8 Gt CO_2; besides water savings in a range of 90.9 to 152.9 trillion liters for CHESF´s hydroelectric reservoirs (Table 2).

Conclusion

This study confirms the significant potential for electricity generation from new renewable sources for the electricity sector in the State of Bahia and demonstrates the magnitude of the significant diversification that Bahia's energy matrix can be up to 2050. Thus, it is evident that Bahia has many concrete possibilities to develop economically and a surplus in terms of electricity in the Brazilian electrical system, according to modern sustainability criteria.

Bibliography

AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). Institutional information available at: <www.aneel.gov.br>. Accessed in 2014.

CÂMARA DE COMERCIALIZAÇÃO DE ENERGIA ELÉTRICA (CCEE). Institutional information available at: <www.ccee.org.br/>. Accessed in 2015.

DE JONG, Pieter, SANCHEZ, Antônio S., ESQUERRE, Karla, KÁLID, Ricardo Araújo, TORRES, Ednildo Andrade. *Solar and Wind energy production in relation to the electricity load curveand hydroelectricity in the northeast region of Brazil*, *Renewable and Sustainable, Energy Reviews*, Vol. 23, Pages 526–535, July 2013.

EMPRESA DE PESQUISA ENERGÉTICA (EPE). Institutional information available at: <www.epe.gov.br>. Acessed in 2014 and 2015.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). Institutional information available at: Rio de Janeiro, 2013. Disponível em:<www.ibge.gov.br/>. Accessed in 2014.

SANTOS, José Alexandre Ferraz de Andrade, TORRES, Ednildo Andrade. *Wind Energy in the Brazilian Energy Matrix: Introduction in State of Bahia*, *XI Congreso Internacional sobre Innovación y Desarrollo Tecnológico* (CIINDET) do *Institute of Electrical and Electronics Engineers* (IEEE) – *Seccion Morelos*, Cuernavaca, México, 2014a.

MINISTÉRIO DE MINAS E ENERGIA (MME). Institutional information available at: <www.mme.gov.br>. Accessed in 2014.

ONS. Institutional information available at: <www.ons.org.br>. Accessed in 2014.

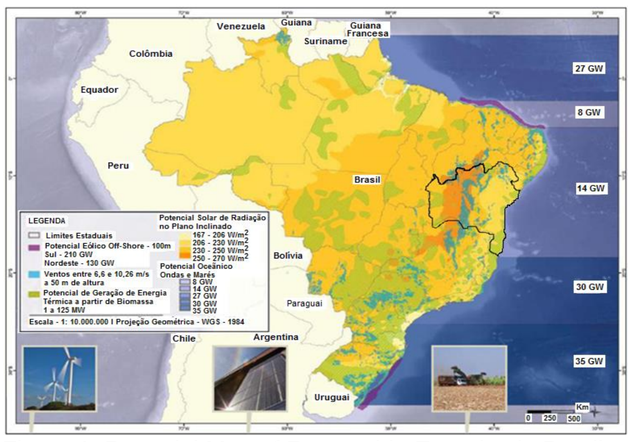

Figure 1: Potential Map of Renewable Energies in Brazil.
Source: http://cbem.com.br/wp-content/uploads/2011/12/COPPE.pdf

Table 1: Brazilian scenarios of demand and scenarios of Bahia supply electric energy by renewable sources to 2050.

Brazilian Demand for Eletric Energy in TWh		Maximum demand for eletricity in the Bahia (6,0 % of Brazilian demand) in TWh	Eletric Energy Supply in the BAHIA in TWh		Brazilian Demand percentage attended by Supply of Bahia	Situation of Bahia compared to SIN
2013 Reference	513,6	26,3	2013 Supply	24,5	5,1%	Déficit
Reference Scenario 2050	1.624,0	97,4	General scenario 1	168,1	10,4%	Superávit
			General scenario 2	142,9	8,8%	Superávit
			General scenario 3	109,8	6,8%	Superávit
Optimistic Scenario 2050	2.203,60	132,2	General scenario 1	168,1	7,6%	Superávit
			General scenario 2	142,9	6,5%	Superávit
			General scenario 3	109,8	5,0%	Déficit
Pessimistic Scenario 2050	1.241,7	74,5	General scenario 1	168,1	13,5%	Superávit
			General scenario 2	142,9	11,5%	Superávit
			General scenario 3	109,8	8,8%	Superávit

Figure 2: Three consumption projections in Brazil and three Bahia Supply projections for Eletric Energy by 2050.

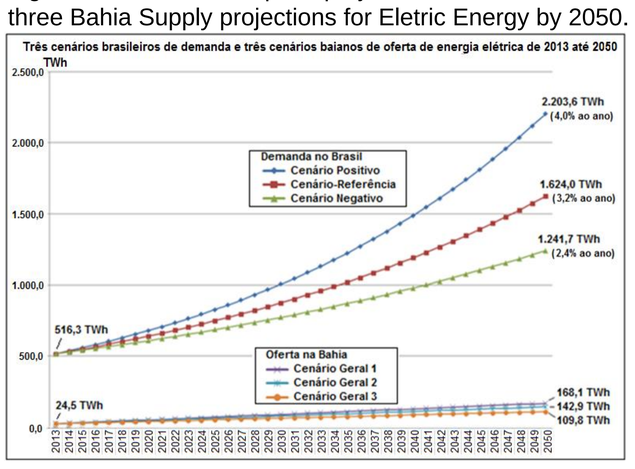

Table 2: Three General Scenarios for Renewable Energy In Bahia by 2050.

	General scenario 1	General scenario 2	General scenario 3
Total Installed Capacity (MW)	53.650,0	40.981,2	29.970,0
Added to generation SIN (MWh)	143,6	118,4	85,3
Total Electricity generation (TWh)	168,1	142,9	109,8
Investments (R $ million)	239.760	180.409	131.720
Number of Jobs / Year	33.850	23.514	17.450
Emission Reduction (Gt CO2)	20,8	17,5	13,0
Water saving (Trillions of liters)	153,0	126,1	90,9

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