Investments in wind energy in the State of Bahia: an analysis using input-output indicators*

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RESUMO

The Brazilian electricity matrix is mainly based on renewable energy sources. In the year 2017, the growth of sources of electric power generation was led by hydroelectric and wind power sources. The states of the Northeast are the most representative in wind generation. In 2017, the five states with the largest generation were Rio Grande do Norte, Bahia, Rio Grande do Sul, Ceará and Piauí, respectively. The state of Bahia occupies a prominent role in the national scenario due to its significant potential for wind power generation. In Bahia, more than 30% of the energy produced is wind energy. The implementation of renewable sources, such as wind power, is characterized as a development potential for the State. In this sense, it is questioned which sectors have the greatest capacity to promote the regional development from the investments in the wind power source? Thus, this work seeks to evaluate the impacts of investments in the wind power chain in Bahia, aiming to provide information on the sector for economic agents. To do so, it uses the input-output matrix Bahia estimated by the Superintendency of Economic and Social Studies of Bahia (SEI) for the year 2015. The analysis will be based on a study of the sectors of economic activities of the State, as well as the investments made in the wind sector, using traditional input-output indicators (key sector, analysis of employment, income and output multipliers) in order to investigate job creation and the economic production associated with the wind energy production chain. The results of this article will allow a better understanding of the role of wind energy in Bahia.

Keywords: Wind energy; Investments; Input-output

1 INTROCUTION

Renewable energies have been growing rapidly and conquering more and more space in the world's electrical matrix in recent years. In 2015, the estimated share of renewable energy in the world Renewable energies have been growing rapidly and conquering more and more space in the world's electrical matrix in recent years. In 2015, the estimated share of renewable energy in the world's electricity production was 23.7% (REN 21, 2016). With regard to the world total of renewable energy produced in the same year, the most significant sources were hydroelectric, wind and solar with 61.5%, 21.2% and 11.4%, respectively (IRENA, 2016). These sources of

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renewable energy generation are almost entirely free of emission of greenhouse gases (GHGs), do not contribute to acid rain and radioactive pollution.

The Brazilian electricity matrix is mainly based on renewable energy sources. Considering all the country's sources, in 2017, renewable energy was responsible for more than 80% of the country's electricity matrix (ABEEÓLICA, 2018). Hydroelectric and wind power sources led growth by source of electricity generation in 2017. With regard to wind power, Brazil already has more than 500 wind farms implanted, surpassing 12 GW of installed power (EPE, 2018). The wind power source already accounts for 8.1% of the Brazilian electricity grid (ABEEÓLICA, 2018). In terms of the world, in 2017 Brazil was ranked 8th in the world ranking in installed capacity and represented the 6th largest number of new investments (GWEC, 2018).

Given this promising scenario for the wind sector, the investments made are decisive factors for the continuity of its growth. According to the Brazilian Association of Wind Energy (ABEEÓLICA), de 2010 a 2017, were invested in the country's wind energy sector about 32 billion dollars (ABEEÓLICA, 2018). And in 2017, US$ 3.57 billion was invested, which represented 58% of the investments made in renewable energy. In the case of the State of Bahia, it has been receiving a large volume of investments, either through wind auctions to contract energy, or through the implementation of an industrial park focused on the production of equipment and components, such as towers wind turbines, blades, nacelles and turbine assemblies. The state's production chain already has large enterprises installed by GE / Alstom, Gamesa, Acciona, Wobben Widpower, Tecsis, Torrebras and Torres Eólicas do Nordeste. In this sense, it is questioned which sectors have the greatest capacity to promote the regional development from the investments in the wind power source?

Thus, this work seeks to evaluate the impacts of investments in the wind power chain in Bahia, aiming to provide information on the sector for economic agents. To do so, it uses the Bahia Matrix estimated by the Superintendency of Economic and Social Studies of Bahia (SEI) for the year 2015. The analysis will be based on a study of the sectors of economic activities of the State, as well as the investments made in the wind sector, through the use of classical input-output indicators (key sector, analysis of employment, income and output multipliers), investigating the creation of jobs and the economic production associated with wind energy in the state.

Using the input-output method, it is possible to analyze the interdependence between the sectors of the Bahian economy, their productive linkage and, in turn, the impact of the investments of the wind sector in the State of Bahia. Thus, some studies have been carried out with the aim of measuring the impact of wind energy in the economy using the input-output model. Simas and Pacca (2014) verified the contribution of wind energy to the generation of jobs in Brazil; Avelino and Guilhoto (2009) estimated the economic and environmental impacts (CO2 emissions) involved in the construction phase of wind farms and the time of return to offset the emissions during the operation phase.

Ribeiro, Pereira and Oliveira (2018) analyzed the impacts of wind projects in the semi-arid region of Bahia. Markaki et al. (2013) explored the effects of "green" energy investments and their macroeconomic impacts on Greece during the period 2010-2020. Loomis and Hinman (2010) studied the economic impacts of wind power in Illinois in the United States to direct, indirect and induced impacts of wind power projects in the State. The work of Okkonen and Lehtonen (2016) and Thomas and Patrik (2015) also used the input-output model applied to the socioeconomic analysis of wind power projects[4].

In addition to this introduction, the present study is divided into four further sections. The next section presents an overview of wind energy in Bahia, followed by the methodology used. The fourth section presents the results and discussions and the fifth section brings the final conclusions of the paper.

2 WIND ENERGY IN BAHIA

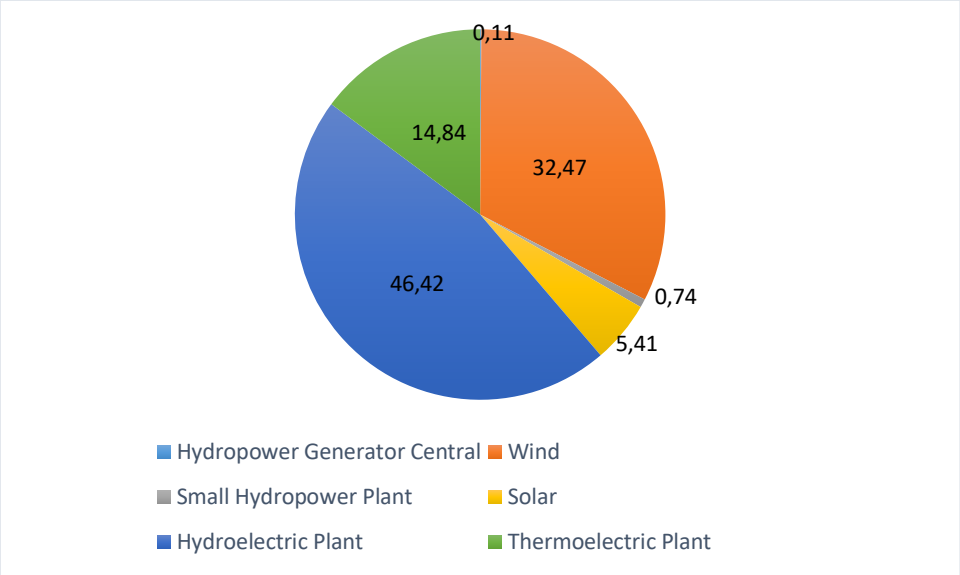
The State of Bahia occupies a prominent role in the national scenario due to its significant potential for wind power generation. In Bahia, more than 30% of the energy produced is wind energy. In Figure 1 it is possible to observe the composition of electricity generation in the State, according to the percentage of the power (installed capacity) of the enterprises in operation. It can be noticed that the Bahian electrical matrix is composed mainly by renewable sources and, in turn, presents significant participation of wind energy.

The states of the Northeast region of Brazil are the most representative in the generation of Brazilian wind energy and due to their favorable winds, concentrate the largest number of wind

[4] For other papers, see: Greene e Geisken (2013), Tegen et al (2014), Brown et al. (2012), Halvatzis and Keyser (2013), Ejdemo and Soderholm (2015), Reategui and Tegen (2008) and Costanti (2004).

farms in the country. By 2017, the five states with the largest generation were Rio Grande do Norte, Bahia , Rio Grande do Sul, Ceará and Piauí, respectively.

Figure 1 – Wind farms operating in Bahia by source - Power (%)



Source: Own elaboration based on data from the BIG-ANEEL,2019.

Unlike the other states in the Northeast, which has a higher incidence of coastal winds, Bahia concentrates its wind potential in the interior, more specifically in the semi-arid. The State of Bahia has more than 66% of its territory within the semi-arid, that is to say, of the 417 existing municipalities, 278 belong to the region, comprising a 446.021km^2 (BRASIL, 2018).

In terms of the participation of the Gross Domestic Product (GDP) at current prices, the service sector was the most representative with 43.5%, against 19.5% of the industrial sector (BAHIA, 2016).

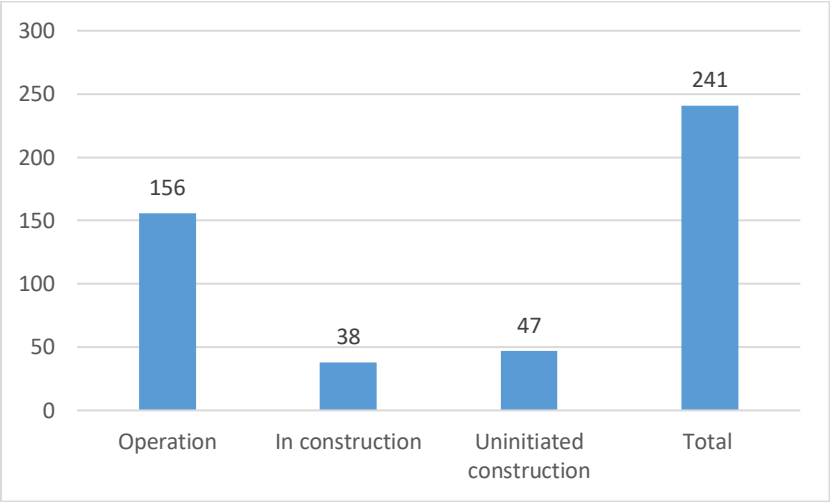
Table 1 - Gross Domestic Product of the State of Bahia, 2015, in billions of Reais

GDP at current prices	Bahia
Agropecuária	17.835.813.855
Industry	47.767.545.346
Services	106.058.638.006
Public administration, defense, education and health and social security	44.305.294.395
Total	215.967.291.610
Taxes, net of subsidies, on products	29.057.570.507
GDP	245.024.862.122

Source: BAHIA, 2016.

Figure 2 shows the state of wind projects in the State, where the 156 are in operation and 85 are under construction and have not started construction. The state's wind projects are located in 23 municipalities.

Figure 2 - Situation of wind farms in Bahia



Source: Own elaboration based on data from the BIG-ANEEL, 2019

The growth of wind energy in Bahia is notorious, when compared to other states in the country. According to the EPE (2018), in terms of participation in auctions of wind power, among the states of the country, Bahia stands out for the quantity of registered projects. Considering the auctions already made, Bahia was responsible for about 30% of the energy contracted in auctions by State (EPE, 2018). The auction mechanism is used in Brazil to sell electric energy, using the lowest tariff criterion.

In addition to the auctions mechanism, it is worth highlighting the factors driving wind generation in the country and, in turn, in Bahia, such as: the Alternative Sources Incentive Program[5](PROINFA); tax breaks; the role of the National Bank for Economic and Social Development (BNDES), as a public company, in inducing the development of the country's wind energy production chain; the increase of the national industrial park for equipment manufacturing; among others. Due to these factors and the volume of investments received for the production of equipment and components, Bahia's production chain currently has large enterprises installed, as can be seen in Table 2.

[5] Established in 2002, with the objective of increasing participation in the energy system produced by wind power, biomass and small hydroelectric power plants.

Table 2 - Wind power production chain in the State of Bahia

Municipalities	Company	Components and equipment
Camaçari	GE/Alstom	Naceles
Camaçari	Gamesa	Naceles e motores
Simões Filho	Acciona Windpower	Naceles, pás e torres eólicas
Jacobina	Torres Eólicas do Nordeste (TEN)/Andrade Gutirrrez/Alstom	Torres eólicas
Camaçari	Torrebras	
Juazeiro	Wobben Windpower	Torres eólicas

Source: Own elaboration, 2018.

Investments in the wind sector in Bahia, implementation of wind companies and ventures, have impacts on the Bahian economy. These impacts will be observed in the analyzes through the input-output indicators used in this work.

3 METHODOLOGY AND DATA

In order to obtain sectoral indexes, multipliers and the impact of investments in the wind power chain in the economy, the input-output model developed by Leontief is derived first. The input-output model counts the contributions of the entire production chain to a given demand (MILLER, BLAIR, 2009). In matrix terms, the intersectoral flow in an economy can be represented by:

$$x = Ax + y \quad (1)$$

Where:

x and y are order columns vectors *(n x 1)*, with values, respectively, of the total production and the final demand of each sector.

A is the matrix of technical coefficients, order *(n x n)*.

Since the final demand is exogenous to the system, it has to be:

$$(I - A)^{-1} = B \quad (2)$$

$$x = By \quad (3)$$

Where:

$B = (I - A)^{-1}$ is the inverse matrix of Leontief or matrix of direct and indirect coefficients, order *(n x n)*, in which the element b_{ij} should be interpreted as the total production of the sector i which is required to produce a final sector demand unit j.

3.1 KEY SECTORS

In order to identify the key sectors of the Bahian economy, the following methods were adopted: the Rasmussen-Hirchman linkage indices together with the dispersion indices, and the fields of influence that deal with the internal structure of the economy.

3.1.1 Rasmussen-Hirschman linkages indices

The chaining of each specific sector with the rest of the economy is measured from the inverse matrix of Leontief, $B = (I - A)^{-1}$, through the backward and forward effects known as the Rasmussen-Hirschman binding indices from Rasmussen (1956) and Hirschman (1958).

Backward linkage rates quantify how much a particular industry demands from other sectors.

Backward linkage (backward chaining):

$$U_j = \frac{(\frac{B_{*j}}{n})}{B_*}, \qquad j = 1,2,\dots,n \qquad (4)$$

Already the indexes of forward linkage reveal how much the sector under analysis is demanded by other sectors of the economy.

Forward linkage (forward chaining):

$$U_i = \frac{(\frac{B_{*i}}{n})}{B_*}, \qquad i = 1,2,\dots,n \qquad (5)$$

Where:B_* is the average of all elements of B; B_{*j} is the sum of a column j of B; B_{*i} is the sum of a line i of B; *n* is the number of sectors of the economy. The calculation of these indices is also found in Guilhoto *et al*. (2010).

The indices have unit (1) as the reference threshold for interpretation. Thus, if the backward linkage index is greater than 1, it means that the sector under analysis has a strong dependency on the other sectors in the economy in the demand for inputs. If the forward bond ratio is greater than 1, it means that the sector is important in supplying inputs in the economy. In summary, according to Prado (1981), when: $U_j > 1$ the industry has strong backward chaining power; $U_j < 1$ the sector has weak backward linkage; $U_i > 1$ the industry has strong forwarding power; $U_i < 1$ the sector has weak forward chain.

Sectors that have both high values ($U_j > 1$ *e* $U_i > 1$) of the Rasmussen-Hirschman indices are considered key sectors for economic growth because they have a strong relationship with other

sectors. However, since the values of the bond indices treat a relationship between averages and these are sensitive to extremes, the dispersion coefficients proposed by Rasmussen are used in conjunction with these indices.

Rasmussen dispersion coeficiente backward:

$$v_{*j} = \frac{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left[b_{ij} - \frac{1}{n}\sum_{i=1}^{n} b_{ij}\right]^2}}{\frac{1}{n}\sum_{i=1}^{n} b_{ij}}, \qquad i,j = 1,2,\dots,n \tag{6}$$

Rasmussen dispersion coefficient forward:

$$v_{i*} = \frac{\sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left[b_{ij} - \frac{1}{n}\sum_{j=1}^{n} b_{ij}\right]^2}}{\frac{1}{n}\sum_{j=1}^{n} b_{ij}}, \qquad i,j = 1,2,\dots,n \tag{7}$$

These coefficients reflect a measure of variation or dispersion, verifying the sector's spreading power over the other sectors of the economy. The lower the value of the coefficient, the relation of the sector with other sectors is homogeneous, that is, the power of chaining is more spread. On the other hand, high values indicate a strong link with few sectors.

3.1.2 Fields of influence

In order to complement the Rasmussen-Hirschman linkage analysis, Sonis and Hewings (1989, 1994) developed field-of-influence analysis. The concept of fields of influence shows how changes in the direct coefficients are distributed in the economic system, making it possible to determine which relationships between sectors would be more important within the productive process (GUILHOTO, 2011). For more details see Sonis and Hewings (1989, 1994). In order to obtain the influence fields, the following matrices are considered:

$A = [a_{ij}]$, matrix of direct coefficients;

$E = [\varepsilon_{ij}]$, matrix of incremental variations in direct input coefficients;

$B = (I - A)^{-1} = [b_{ij}]$, Leontief inverse matrix;

$B(\varepsilon) = (I - A - E)^{-1} = [b_{ij}(\varepsilon)]$, Leontief inverse matrix after the changes.

According to Sonis and Hewings (1989, 1994), if there is a small variation and in only one technical coefficient, that is, $\varepsilon_{ij} = \varepsilon, i = i_1, j = j_1 \; e \; \varepsilon_{ij} = 0, i \neq i_1, j \neq j_1$, then, under these

conditions, the influence field of this variation will be approximated by the following expression:

$$F(\varepsilon_{ij}) = \frac{[B(\varepsilon_{ij}) - B]}{\varepsilon} \quad (8)$$

Where $F(\varepsilon_{ij})$ é na matrix $(n\ x\ n)$ of the coefficient influence field a_{ij}. Thus, in order to identify which technical coefficients have a greater field of influence, a value is associated with each matrix $F(\varepsilon_{ij})$, given by:

$$S_{ij} = \sum_{k=1}^{n}\sum_{l=1}^{n}[f_{kl}(\varepsilon_{ij})]^2 \quad (9)$$

In this way, the highest values of S_{ij} indicate the sectors that have the greatest influence in the economy as a whole. Therefore, it is possible to identify the sectorial relations that promote greater impacts on the economy.

3.2 MULTIPLIERS

The multipliers allow estimating the direct and indirect impact of each sector of the economy on employment, income, imports, added value, among others, based on an increase in final demand (GUILHOTO, 2011). Multipliers help both in the decision-making process of development policies, as in the case of the employment multiplier, and as an indicator of growth, in the case of the production multiplier.

The production multiplier indicates how much is produced for each monetary unit spent on final consumption and is defined as:

$$PM_j = \sum_{i=1}^{n} b_{ij} \quad (11)$$

Where PM_j *the production multiplier of the j-th* sector and b_{ij} it's the *ij-th* element of the Leontief inverse matrix.

The employment multiplier indicates the number of jobs created, directly and indirectly, for each direct job created and is defined by the expression:

$$EM_j = \sum_{i=1}^{n} b_{ij}\, e_i \quad (12)$$

where $e_{i=}\frac{E_i}{GVP_i}$ represents the ratio of total employees to the gross value of production in the sector i.

Analogously, we find the income multiplier by the ratio between the value added and the gross value of production, that is:

$$IM_j = \sum_{i=1}^{n} b_{ij}\, v_i \qquad (13)$$

where $v_{i=}\frac{VA_i}{GVP_i}$.

3.3 DATA

. The Matrix Bahia 2015, prepared by the Superintendency of Economic and Social Studies (SEI), was used, based on the Resource and Usage Table (TRU) 2012, still unpublished and of the Intermediate Consumption and Gross Production Value vectors of the activity sectors for The Matriz Bahia 2015 was constructed by SEI using the RAS methodology, originally described by Stone (1962) and Bacharach (1970), modified by Silveira (1993). For the data on investment impacts, the database of investment intensification protocols of the State of Bahia Economic Development Secretariat (SDE), systematized for the wind chain in this work was used.

4 RESULTS

The analysis of the indicators below shows the relationships between the sectors of economic activities that make up the productive structure of Bahia, the impacts (direct and indirect) of variations in components of final demand (investments in the wind chain, for example) behavior of each sector of the economy.

4.1 STRUCTURAL INDICATORS

4.1.1 Rasmussen-Hirschman linkages indices and dispersion index

Through Rasmussen-Hirschman's linkage indices it is possible to understand the linking power of sectors of economic activity in relation to the average of the Bahian economy, both backwards and forwards. That is, those with coefficient values greater than 1. In Table 3, the sectors that demand more inputs and are more dependent on other sectors, that is, they have a strong backward linkage (Uj) are “Alcohol and Biofuels”, “Automotive Industry and Parts for Vehicles”, “Other Equipment for Transportation”, “Machinery and Electrical Materials”, “Perfumery, Hygiene and Cleaning”, “Cotton Cultivation”, “Food, Beverage and Tobacco”,

“Other Non-Metallic Mineral Products”, “Pulp, Paper, Newspapers, Magazines and Disks”, “Textiles, Clothing and Leather Goods”, “Office Machines, Electronic, Optical and Hospital Supplies”, “Furniture and Miscellaneous Industries”, “Accommodation and Food Services” and “Soybean Growing”.

Agribusiness has a strong influence in the state economy, with sectors such as "Cotton Cultivation", "Pulp, Paper, Newspapers, Magazines and Disks" and "Soya Culture". Located in the western region of the state, soybean cultivation has presented records of production over the years due, among other factors, to climatic conditions, which has abundant rains and favorable soil for cultivation. Because they are dependent on intersectoral supply, a stimulus to the production of these sectors will have an impact on more sectors of the economy of Bahia. These also have a more homogenous link in the economy and lower values of dispersion, with emphasis on "Alcohol and Biofuels", "Automotive Industry and Parts for Vehicles" and "Other Transport Equipment".

On the other hand, the most dynamic sectors, important in the supply of inputs in the economy, that is, with strong forward linking (Ui) were "Business Services", "Civil Construction" and "Financial Intermediation and Complementary Pension Plans".

Table 3 - Rasmussen-Hirschman linkage indices and dispersion indices, Bahia, 2015

Code	Sectors of economic activity	Rasmussen-Hirschman Indices				Índex dispersion			
		Ui	Rank	Uj	Rank	Vi	Rank	Vj	Rank
1	Cereal crops	0,4382	35º	0,7893	29º	5,6839	33º	3,1713	28º
2	Cotton cultivation	0,6203	27º	1,1695	11º	4,1688	24º	2,3281	9º
3	Growing Sugarcane	0,4189	38º	0,7591	30º	5,9469	35º	3,3179	29º
4	Soybean Growing	0,5342	29º	1,0092	23º	4,9019	28º	2,7055	21º
5	Other Temporary Farming	0,521	30º	0,7376	31º	4,9733	29º	3,4951	31°
6	Orange cultivation	0,4219	37º	0,517	40º	6,1763	40º	4,9159	40º
7	Coffee Growing	0,409	40º	0,9015	27º	6,1016	38º	2,8104	23º
8	Other Permanent Crops	0,4291	36º	0,6126	39º	5,9513	36º	4,0966	37°
9	Animal Breeding	0,8632	18º	0,7095	34º	3,0446	16º	3,7197	34º
10	Forest Production	1,0002	12º	1,2881	7º	5,4481	32º	4,2055	38º
11	Extraction of Oil and Natural Gas	2,3332	3º	1,0105	22º	1,0579	3º	2,7140	22º
12	Other Extractive Industries	1,3611	8º	1,1529	12º	1,9983	8º	2,5015	18°
13	Food, Beverages and Tobacco	0,938	15º	1,1369	13º	3,5312	21º	2,9260	25°
14	Textiles, Clothing and Leather Goods	0,7897	21º	1,098	16º	3,1277	18º	2,3243	8º
15	Pulp, Paper, Newspapers, Magazines and Disks	0,9297	16º	1,1043	15º	2,6501	12º	2,3745	13°
16	Oil Refining	3,9466	1º	1,4731	2º	0,8614	2º	2,6707	20°
17	Alcohol and Biofuels	0,6223	26º	1,629	1º	4,3764	27º	1,7440	1º
18	Chemicals	3,0794	2º	1,2609	8º	0,8435	1º	2,4114	14°
19	Perfumery, Hygiene and Cleaning	0,4855	31º	1,3489	6º	5,0596	30º	1,8966	3°
20	Pharmaceutical products	0,4534	32º	0,9938	24º	5,3923	31º	2,4809	17°
21	Rubber and Plastic Industry	1,265	9º	1,2423	10º	2,0311	9º	2,2249	6º

22	Other Non-Metallic Mineral Products	0,799	20º	1,1111	14º	3,1336	19º	2,3709	12º
23	Metallurgy and Stell Industry	1,7841	6º	1,259	9º	1,447	6º	2,2506	7°
24	Maq. Office, Electronics, Optics & Hospitality	0,6931	24º	1,094	17º	3,5965	23º	2,3528	11°
25	Machinery and Electrical Materials	0,9494	14º	1,3704	5º	2,6862	13º	1,9886	4°
26	Machinery and Equipment and Maintenance	0,8859	17º	0,8238	28º	2,7963	14º	3,0768	26º
27	Automotive Industry and Vehicle Parts	0,7243	23º	1,4	3º	4,1906	25º	2,2092	5º
28	Other Transport Equipment	0,3845	41º	1,385	4º	6,6342	41º	1,8445	2º
29	Furniture and Miscellaneous Industries	0,5676	28º	1,0639	19º	4,2842	26º	2,3352	10º
30	Electricity, Gas, Water, Sewer and Urban Cleaning	2,0004	5º	1,0937	18º	1,2147	5º	2,4667	16º
31	Construction	1,5285	7º	0,9161	25º	1,7748	7º	3,1238	27º
32	Trade and Maintenance and Repair Services	0,7399	22º	0,7324	32º	3,378	20º	3,4294	30º
33	Transport, Storage and Postal Services	1,0643	10º	1,0212	20º	2,328	10º	2,6014	19º
34	Accommodation and Food Services	0,681	25º	1,0131	21º	3,5948	22º	2,4649	15º
35	Information Services	0,9688	13º	0,9046	26º	2,609	11º	2,8910	24º
36	Financial Intermediation and Prev Complementary	1,0254	11º	0,6744	37º	2,8049	15º	4,3127	39º
37	Real Estate and Rentals	0,8385	19º	0,4556	41º	3,105	17º	5,6794	41º
38	Business Services	2,2038	4º	0,6756	36º	1,0872	4º	3,8821	35º
39	Pub. Adm., Health and Educ. Pub and Social Security	0,4444	33º	0,6381	38º	5,7322	34º	3,9253	36º
40	Health and Business Education	0,4386	34º	0,7246	33º	6,1548	39º	3,6252	33º
41	Services Provided to Families	0,4188	39º	0,6992	35º	6,0799	37º	3,5580	32º

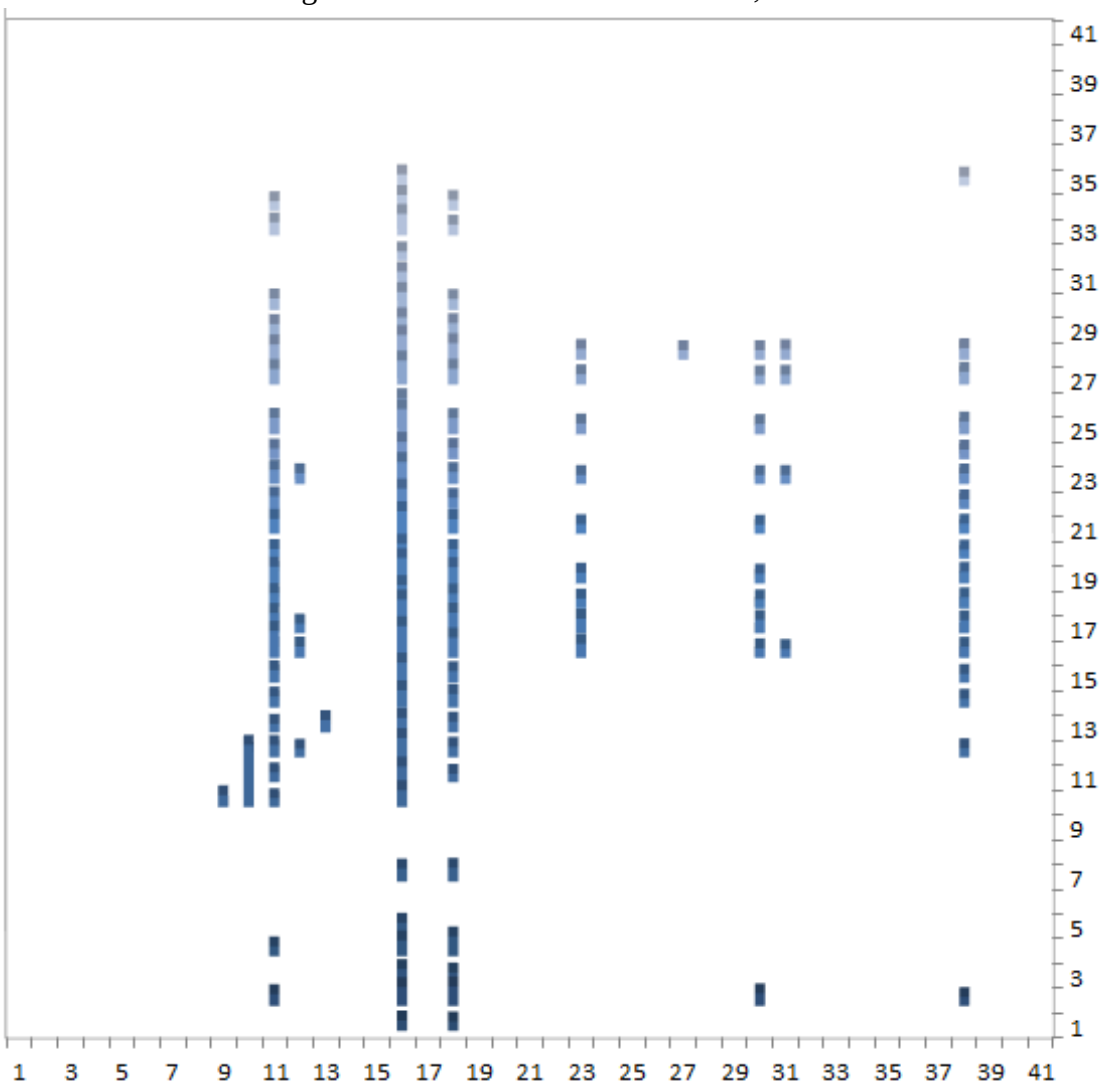
Source: Prepared by the authors from the Bahia matrix, 2015.

The other sectors are considered independent (Ui<1, Uj<1), have weak linking power, having links with few sectors, since the Vi and Vj são altos, conforme Tabela 3. Among these, there are sectors belonging to agriculture, such as "Grain Cultivation", "Sugarcane Cultivation", "Other Temporary Crops", "Cultivation of Orange", "Coffee Growing", "Other Crops Temporary "and" Animal Breeding ", demonstrating the importance of agribusiness in the State.

4.1.2 Fields of influence

The analysis of the influence fields complements that of the linkage indices, identifying the most important sectorial relations in the economy in the Bahian economy for the year 2015. In Figure 3, in the columns we have the perspective of the buying sectors and in the optical lines of the sectors. Thus, of the 41 sectors of the economy, "Extraction of Oil and Natural Gas", "Refining of Petroleum", "Electricity, Gas, Water, Sewage and Urban Cleaning" and "Business Services" the other sectors. From the point of view of the sales of inputs there was little interaction.

Figure 3 - Field of influence of Bahia, 2015



Source: Prepared by the authors from the Bahia matrix, 2015.

4.1.3 Comparison of key sectors by indicators

The Rasmussen-Hirschaman indices and fields of influence are not considered to be exclusive but complementary. Because of this, the divergent results found are not considered a problem. Thus, in Table 4, a synthesis of results by index can be observed.

Table 4 - Synthesis of the key sectors, Bahia, 2015

Indicators	Code	Key sectors
Rasmussen-Hirschmann Indices	10	Forest Production
	11	Extraction of Oil and Natural Gas
	12	Other Extractive Industries
	16	Oil Refining
	18	Chemicals
	21	Rubber and Plastic Industry
	23	Metallurgy and Stell Industry
	30	Electricity, Gas, Water, Sewer and Urban Cleaning
	33	Transport, Storage and Postal Services
Field of Influence	11	Extraction of Oil and Natural Gas
	16	Oil Refining
	23	Metallurgy and Stell Industry
	30	Electricity, Gas, Water, Sewer and Urban Cleaning
	38	Business Services

Source: Prepared by the authors from the Bahia matrix, 2015.

The sectors "Extraction of Oil and Natural Gas", "Oil Refining", "Miscellaneous Chemical Products", "Metallurgy and Steel" and "Electricity, Gas, Water, Sewage and Urban Cleaning" appeared as key sectors in the two methods used . The "Forest Production", "Transport, Storage and Mail" and "Miscellaneous Chemicals" sectors stood out only as key sectors in the Rasmussen-Hirschman Index. While the "Business Services" sector appeared only in the Field of Influence.

4.2 IMPACT INDICATORS

4.2.1 Impact multipliers: production, employment and income

The multipliers of impacts on production, employment and income (Table 5) were constructed from the Bahia Matrix, from 2015. Through these it is possible to observe, among the 41 sectors of activity in Bahia, the sectors with the greatest influence on the economy in these variables, for the year 2015.

The largest production multiplier is the "Alcohol and Biofuels" sector, however it has the worst income multiplier. For, in the year 2015 its Value Added was negative. In other words, the intermediate consumption (costs) was higher than the gross value of the production (billing), thus generating, not an added value (industry profit), but a negative value (industry loss).

The interpretation for the "Alcohol and Biofuels" sector is that for each increase of 1 monetary unit in the final demand of the sector requires 4.31 monetary units of the product of all sectors

of the economy of Bahia in 2015. The sectors of "Refining of Petroleum and "Automotive Industry and Vehicle Parts" respectively have the second and third largest production multipliers, that is, they had the greatest impact on the economy of Bahia in that year.

Already in the sectors with greater Employment multipliers, one can make the relation that for each 1 million monetary units spent in the final demand what is the quantity of jobs generated[6]. Thus, for Bahia, in 2015, the "Textile, Clothing and Leather Goods" sector has the greatest potential to generate formal jobs in the economy, with 27 total jobs (direct and indirect). This is followed by the "Health and Business Education" sector that would generate 25 total jobs with the multiplier. On the other hand, the "Business Services, Public Health and Public Education and Social Security" sector with the multiplier would generate 23 total formal jobs in the economy.

Table 5 - Multipliers of impacts, Bahia, 2015

Code	Sectors of economic activity	Production		Employment		Income	
		Unit variation (R$)		Each R$ 1 million in final demand		Unit variation (R$)	
		PMj	Rank	EMj	Rank	IMj	Rank
1	Cereal crops	2,09	*29°*	8,09	*19°*	1,35	*2°*
2	Cotton cultivation	3,09	*11°*	3,88	*33°*	1,03	*24°*
3	Growing Sugarcane	2,01	*30°*	3,69	*34°*	1,40	*1°*
4	Soybean Growing	2,67	*23°*	2,09	*37°*	1,32	*5°*
5	Other Temporary Farming	1,95	*31°*	3,94	*32°*	1,32	*4°*
6	Orange cultivation	1,37	*40°*	1,51	*38°*	1,20	*15°*
7	Coffee Growing	2,38	*27°*	11,23	*16°*	1,34	*3°*
8	Other Permanent Crops	1,62	*39°*	12,09	*15°*	1,29	*9°*
9	Animal Breeding	1,88	*34°*	7,61	*20°*	1,31	*7°*
10	Forest Production	3,41	*7°*	20,13	*6°*	0,79	*31°*
11	Extraction of Oil and Natural Gas	2,67	*22°*	2,38	*36°*	1,15	*17°*
12	Other Extractive Industries	3,05	*12°*	12,40	*13°*	0,83	*30°*
13	Food, Beverages and Tobacco	3,01	*13°*	7,14	*22°*	0,62	*35°*
14	Textiles, Clothing and Leather Goods	2,90	*16°*	26,76	*1°*	1,01	*26°*
15	Pulp, Paper, Newspapers, Magazines and Disks	2,92	*15°*	5,42	*24°*	0,94	*27°*
16	Oil Refining	3,90	*2°*	0,16	*41°*	0,38	*38°*
17	Alcohol and Biofuels	4,31	*1°*	6,34	*23°*	-0,42	*41°*
18	Chemicals	3,33	*8°*	1,15	*40°*	0,66	*33°*
19	Perfumery, Hygiene and Cleaning	3,57	*6°*	17,67	*8°*	0,56	*36°*
20	Pharmaceutical products	2,63	*24°*	13,98	*11°*	1,06	*22°*
21	Rubber and Plastic Industry	3,29	*10°*	8,49	*18°*	0,69	*32°*
22	Other Non-Metallic Mineral Products	2,94	*14°*	21,52	*5°*	0,90	*28°*
23	Metallurgy and Stell Industry	3,33	*9°*	4,70	*26°*	0,55	*37°*

[6] For purposes of account, it is recommended to deal with whole numbers, since these are jobs, but since they are jobs for monetary values, this conversion can be done when dealing with the results of the impacts.

24	Maq. Office, Electronics, Optics & Hospitality	2,89	*17°*	4,15	*30°*	0,88	*29°*
25	Machinery and Electrical Materials	3,62	*5°*	3,52	*35°*	0,29	*40°*
26	Machinery and Equipment and Maintenance	2,18	*28°*	4,46	*29°*	1,31	*6°*
27	Automotive Industry and Vehicle Parts	3,70	*3°*	4,50	*28°*	0,34	*39°*
28	Other Transport Equipment	3,66	*4°*	4,78	*25°*	0,63	*34°*
29	Furniture and Miscellaneous Industries	2,81	*19°*	20,02	*7°*	1,11	*19°*
30	Electricity, Gas, Water, Sewer and Urban Cleaning	2,89	*18°*	4,66	*27°*	1,01	*25°*
31	Construction	2,42	*25°*	10,79	*17°*	1,21	*14°*
32	Trade and Maintenance and Repair Services	1,94	*32°*	22,03	*4°*	1,29	*10°*
33	Transport, Storage and Postal Services	2,70	*20°*	12,51	*12°*	1,29	*8°*
34	Accommodation and Food Services	2,68	*21°*	16,39	*10°*	1,08	*20°*
35	Information Services	2,39	*26°*	7,39	*21°*	1,04	*23°*
36	Financial Intermediation and Prev Complementary	1,78	*37°*	4,11	*31°*	1,08	*21°*
37	Real Estate and Rentals	1,20	*41°*	1,21	*39°*	1,11	*18°*
38	Business Services	1,79	*36°*	23,36	*3°*	1,28	*11°*
39	Pub. Adm., Health and Educ. Pub and Social Security	1,69	*38°*	16,90	*9°*	1,25	*13°*
40	Health and Business Education	1,92	*33°*	25,36	*2°*	1,18	*16°*
41	Services Provided to Families	1,85	*35°*	12,12	*14°*	1,27	*12°*

Source: Prepared by the authors from the Bahia matrix, 2015.

Finally, income multipliers indicate the variation of income over the variation in the final demand component of a given sector. Therefore, the sectors of "Sugarcane Cultivation", "Cereal Cultivation" and "Coffee Cultivation" are the ones that present the greatest importance for Bahia (Table 5), in this variable, showing the importance and the strength of the agricultural sector in the state for income generation.

4.2.2 Impacts of investments in the wind power chain in Bahia on production and employment

From the data of the protocols of investment intensity captured by SDE, it was possible to obtain the impacts of investments. The results presented are a preliminary version based on the investments from 2016, carried out until 2018 and the protocols that have not yet been carried out. The total amount of investments in the wind power chain in Bahia, in this period, exceeded 8 billion reais in investment efforts and the generation of 1,400 jobs. However, in order to obtain the effects along the production chain, the input-output instruments were used to calculate the direct, indirect and total impacts of these investments. Thus, the results presented in Tables 6 and 7 can has interpreted as the total impact potential of Bahia's economic structure in 2015.

Table 7 shows that an investment of 8 billion reais in the wind power chain, in an initial analysis, has the possibility of generating a total of 34 billion reais in total direct and indirect impacts on the state economy. It is important to note that the sectors that receive the most impacts from these investments are "Cotton Crops" and "Alcohol and Biofuels" with the possibility of generating in total impacts (direct and indirect) more than 2.5 billion reais and more than 1, 5 billion reais, respectively.

All sectors of activity would receive direct and indirect impacts, caused by predicted wind investments, as shown in Table 6. The greater direct impact of the investment would be on the "Cotton Crops" sector and the greater indirect impact would be on the "Alcohol and Biofuels".

Table 6 - Impacts of investments in the Bahia wind power production chain, Bahia, 2015

Code	Sectors of economic activity	Direct impacts on production- DIPj	Indirect impacts on production - IIPj	Total impacts on production - TIPj
1	Cereal crops	723,70	357,19	1.080,89
2	Cotton cultivation	1.925,69	710,75	2.636,44
3	Growing Sugarcane	101,93	296,50	398,43
4	Soybean Growing	17,74	601,71	619,44
5	Other Temporary Farming	1.046,75	292,26	1.339,01
6	Orange cultivation	183,04	128,34	311,38
7	Coffee Growing	238,48	487,35	725,83
8	Other Permanent Crops	166,68	198,29	364,96
9	Animal Breeding	209,46	236,64	446,10
10	Forest Production	15,44	302,60	318,04
11	Extraction of Oil and Natural Gas	195,79	537,46	733,26
12	Other Extractive Industries	522,16	590,24	1.112,40
13	Food, Beverages and Tobacco	142,26	549,10	691,36
14	Textiles, Clothing and Leather Goods	355,31	809,36	1.164,66
15	Pulp, Paper, Newspapers, Magazines and Disks	368,26	514,11	882,37
16	Oil Refining	38,72	859,22	897,94
17	Alcohol and Biofuels	776,69	1.075,48	1.852,18
18	Chemicals	525,28	695,54	1.220,83
19	Perfumery, Hygiene and Cleaning	523,10	770,80	1.293,90
20	Pharmaceutical products	198,72	473,08	671,80
21	Rubber and Plastic Industry	593,99	683,54	1.277,54
22	Other Non-Metallic Mineral Products	661,52	528,08	1.189,60
23	Metallurgy and Stell Industry	605,09	678,59	1.283,68
24	Maq. Office, Electronics, Optics & Hospitality	306,03	535,79	841,81
25	Machinery and Electrical Materials	661,87	777,43	1.439,30
26	Machinery and Equipment and Maintenance	185,85	361,01	546,86
27	Automotive Industry and Vehicle Parts	274,35	792,80	1.067,15
28	Other Transport Equipment	290,24	801,66	1.091,90
29	Furniture and Miscellaneous Industries	320,88	554,27	875,15
30	Electricity, Gas, Water, Sewer and Urban Cleaning	248,66	588,49	837,14
31	Construction	133,70	431,41	565,11
32	Trade and Maintenance and Repair Services	205,60	258,63	464,23

33	Transport, Storage and Postal Services	108,40	441,47	549,87
34	Accommodation and Food Services	362,34	511,38	873,71
35	Information Services	271,96	373,55	645,50
36	Financial Intermediation and Prev Complementary	43,00	149,68	192,68
37	Real Estate and Rentals	29,70	61,56	91,26
38	Business Services	108,17	230,32	338,50
39	Pub. Adm., Health and Educ. Pub and Social Security	129,37	190,86	320,23
40	Health and Business Education	143,16	239,10	382,26
41	Services Provided to Families	113,35	266,93	380,28

Source: Prepared by the authors from the Bahia matrix, 2015.

With regard to the possibility of maximum employment creation in the economy, given the current structure of the Bahia 2015 matrix, the impacts of investments in the wind chain planned for the State are capable of generating approximately 3,200 formal jobs in the economy. 1.2 thousand formal jobs in direct impacts and approximately 2 thousand formal jobs in indirect impacts on the economy. This can has seen in Table 7.

Table 7 - Impacts of investments in the wind power chain on employment, Bahia, 2015

Code	Sectors of economic activity	Direct Job Impacts - DJIj	Indirect Job Impacts - IJIj	Total Employment Impacts – TEIj
1	Cereal crops	40	33	72
2	Cotton cultivation	105	67	172
3	Growing Sugarcane	6	26	32
4	Soybean Growing	1	50	51
5	Other Temporary Farming	57	28	85
6	Orange cultivation	10	12	22
7	Coffee Growing	13	42	55
8	Other Permanent Crops	9	18	27
9	Animal Breeding	12	21	33
10	Forest Production	1	26	27
11	Extraction of Oil and Natural Gas	35	57	92
12	Other Extractive Industries	60	60	120
13	Food, Beverages and Tobacco	16	47	63
14	Textiles, Clothing and Leather Goods	27	67	94
15	Pulp, Paper, Newspapers, Magazines and Disks	30	52	83
16	Oil Refining	3	86	89
17	Alcohol and Biofuels	47	95	142
18	Chemicals	31	69	100
19	Perfumery, Hygiene and Cleaning	31	76	107
20	Pharmaceutical products	19	46	65
21	Rubber and Plastic Industry	78	68	146
22	Other Non-Metallic Mineral Products	102	56	158
23	Metallurgy and Stell Industry	44	70	114
24	Maq. Office, Electronics, Optics & Hospitality	44	55	99
25	Machinery and Electrical Materials	79	78	157
26	Machinery and Equipment and Maintenance	28	36	64
27	Automotive Industry and Vehicle Parts	42	84	126

28	Other Transport Equipment	44	85	129
29	Furniture and Miscellaneous Industries	19	54	72
30	Electricity, Gas, Water, Sewer and Urban Cleaning	37	63	100
31	Construction	20	45	65
32	Trade and Maintenance and Repair Services	17	26	43
33	Transport, Storage and Postal Services	11	46	57
34	Accommodation and Food Services	43	49	92
35	Information Services	27	38	65
36	Financial Intermediation and Prev Complementary	2	15	17
37	Real Estate and Rentals	2	6	8
38	Business Services	14	23	37
39	Pub. Adm., Health and Educ. Pub and Social Security	10	19	30
40	Health and Business Education	8	22	30
41	Services Provided to Families	15	27	42

Source: Prepared by the authors from the Bahia matrix, 2015.

As in production, the "Cotton Cultivation" sector also received the greatest direct and indirect impacts on employment generation, in addition to other sectors of activity. Thus, up to 105 new jobs are directly created by the investments in the wind power chain in the "Cotton Cultivation" sector and 67 new jobs as an indirect impact of these investments. It is emphasized that the generation of electricity, by convention, is an activity intensive in capital, therefore it does not have as its intrinsic characteristic the generation of many jobs. It is has observed that the investments in the wind chain led to the generation of jobs in all sectors of activity of the economy of Bahia.

5 CONCLUSION

The wind power source has presented a significant growth, over the years, in the electrical matrix in Bahia. The renewable energy sector has been consolidating in the State. Bahia has an industrial park dedicated to the production of equipment and components, and the productive chain has large enterprises installed.

In this sense, the use of input-output indicators made it possible to understand both the state's productive structure and to evaluate the socioeconomic impacts of investments in the wind power chain and its effects on the economy of Bahia.

In the structural analysis, the key drivers of the Bahian economy (via the Rasmussen-Hirschman Index and Influence Field) were: "Extraction of Oil and Natural Gas", "Oil Refining", "Miscellaneous Chemical Products", "Metallurgy and Siderurgia "and" Electricity, Gas, Water,

Sewage and Urban Cleaning "," Forest Production "and" Transportation, Storage and Mail "and" Business Services ".

In the analyzes of impacts through the multipliers, the "Alcohol and Biofuels" sector is the one that stands out most in production; in terms of job creation, the sector of greatest potential is "Textiles, Clothing and Leather Goods"; in terms of income generation, the sectors "Sugarcane Cultivation", "Cereal Cultivation" and "Coffee Cultivation" stood out, demonstrating the importance of agribusiness in the State economy.

As for the impacts of investments of the wind power chain in the economy of Bahia on production, it was has observed that an investment of approximately 8 billion reais in the wind chain has the possibility of generating of more than 34 billion reais in direct and indirect impacts in the economy. The sectors that receive the most impacts from these investments are "Cotton Crops" and "Alcohol and Biofuels". For the generation of jobs, the impacts of the planned wind energy investments can lead to the creation of approximately 3.2 thousand formal jobs in the economy, with 1.2 thousand formal jobs in direct impacts and approximately 2 thousand formal jobs in indirect impacts. The "Cotton Cultivation" sector has also received the greatest direct and indirect impacts on job creation, and it is possible that up to 172 direct and indirect jobs will be created by investments in the wind power chain in this sector.

From the above, it should be emphasized that the energy sector is fundamental for the development of the State. And, in turn, having a matrix based on renewable energies, which do not exhaust themselves and are not polluting, is of paramount importance both economically and environmentally. Thus, investments in the wind power chain in the State have the potential to promote regional development with impacts on the sectors of activity of the Bahian economy, either directly or indirectly.

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