



IFSOLAR: the Innovative IFSULDEMINAS Program for the Acquisition of Solar Photovoltaic Plants

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Abstract. IFSOLAR is the project for the bidding, acquisition and installation of photovoltaic plants for the production of solar energy at IFSULDEMINAS, used by public institutions throughout Brazil, and involves SDG 7, 8, 9, 11, 12 and 13. Acquisition of photovoltaic solar plants conducted by IFSULDEMINAS are considered the largest ever carried out in Brazil, with a significant impact on the national energy matrix. The project began in 2016, with the bidding, acquisition and installation of photovoltaic panels on the campuses of 15 Federal Institutes in the country, with a capacity of 5,470 MWp. In 2018, 94 federal agencies participated or adhered to the new tender, moving BRL 220 million, with a capacity of 56 MWp. By the end of 2019, Brazil had approximately 2,100 MWp of distributed generation, and with just the last bid, IFSULDEMINAS contributed to the expansion of 2.7% of the total installed capacity in the country. The performance of IFSULDEMINAS in these innovative bidding processes led to the cost of bidding being reduced by 9% in the final value, for RDC 1/2016, and 41% for RDC 3/2018, reducing the cost for public coffers at BRL 162 million. The IFSOLAR project helped transform IFSULDEMINAS into a reference in the bidding, generation and research of photovoltaic solar energy in the public sector in Brazil.

Keywords:

Public Institutions, Sustainable Development, Photovoltaic Solar Energy, Economy, Energy Efficiency

1. Introduction

In 2016, IFSULDEMINAS launched a project to acquire photovoltaic solar plants, with the aim of investing in renewable energy generation and reducing electricity costs: IFSOLAR. The project received participants on a national scale. Institutions across the country joined the process of acquiring photovoltaic solar plants. The solar generation capacity contracted in the process was 9.24 MW, which in December 2016 represented approximately 15% of the national installed solar distributed generation capacity.

With the success of the project, IFSULDEMINAS launched the second phase of the IFSOLAR project in 2018, further expanding the scope of the project. The total contracted solar generation capacity in the second phase of the project was 57 MW, which in December 2018 represented approximately 10% of the national distributed solar generation capacity.

The success of the IFSOLAR project brought impacts not only on the economy of public resources, but its scope also impacted the national installed capacity of distributed photovoltaic solar generation.

1.1 The acquisition processes of photovoltaic systems for federal public institutions

The Differentiated Contracting Regime - RDC 1/2016 was a national purchase, with the objective of establishing a price record for contracting companies specialized in sustainable energy to produce solar energy, including the elaboration of projects, supply of materials, construction, tests and delivery of 82 solar energy generator modules with 18.48 kWp of power to IFSULDEMINAS and other participating bodies, which were grouped by state, taking into account the logistics required to execute the object of the public notice. The global amount was previously estimated at BRL 41,663,002.80, with the reference unit value being BRL 508,085.40. IFSULDEMINAS and other fourteen Federal Institutes participated in the RDC 1/2016. Thirteen other institutions adhered to the RDC 1/2016, for the acquisition of another 50 modules.

The Differentiated Contracting Regime - RDC 3/2018 aimed to hire companies specialized in sustainable energy production to supply materials, equipment, build, assemble and put into operation photovoltaic solar energy generators in full operation, including the preparation of basic and executive, carrying out tests and operations necessary for the final delivery of the object. IFSULDEMINAS and 22 other public agencies participated in the RDC 1/2018, for the acquisition of 804 photovoltaic energy generator modules with 70 kWp of power. RDC 1/2018 was joined by over 71 public bodies, which purchased over 2,268 modules. The unitary reference value for the execution of the services was BRL 122,630.67.

1.2 Photovoltaic solar energy generation

Photovoltaic solar energy is a clean, renewable source of energy that uses solar cells made of semiconductor materials, such as silicon, to convert sunlight into electricity. Sunlight falls on the solar cells, releasing electrons that generate an electric current. This current is collected and transported to an inverter, which transforms it into alternating current, ready to be used in homes or businesses.

Photovoltaic solar energy does not emit greenhouse gases and does not pollute the environment. It is an inexhaustible source of energy available worldwide. However, power generation is affected by seasonality and weather conditions, and installation can be expensive, although costs are coming down as technology advances and demand increases. It is expected to become more competitive with conventional energy sources and an important part of the global energy mix.

Distributed generation is a form of small-scale energy production, connected directly to the electrical distribution network, which can bring financial, socio-environmental and self-sustainability benefits. With a cap of 5 MW, it is a more sustainable and efficient alternative to large hydroelectric plants and can allow consumers to produce as much energy as they consume, in addition to reducing costs for utilities (Knopki, R. H; Scheidt, P; 2019).

There are some energy efficiency measures that can be implemented in educational institutions. Infrastructure measures are measures that deal primarily with lighting, air conditioning and electrical equipment often found in these institutions. Analyzing the type of contract and the different tariffs that you have with the energy concessionaire can also bring about a reduction in electricity costs (Zucchi, L. A. et al; 2020).

An energy diagnosis must be part of an energy management and measurement system, with constant evaluation of effectiveness (Zucchi, L. A. et al; 2020). Energy management, based on Business Intelligence, helps in making strategic decisions and improving energy efficiency (Mori, G. K. et al; 2020).

Finally, the self-generation of energy through distributed generation, in which the most used is photovoltaic solar energy, with panels installed on the roofs of buildings or on the ground. The electricity generated can be used instantly (off-grid), stored in batteries or injected into the electrical grid through the on-grid connection (Zucchi, L. A. et al; 2020).

The EnergIF Program encourages Federal Institutes to invest in energy efficiency and renewable energy generation, expand infrastructure and offer courses in the area. The objective is to obtain gains in efficiency and excellence in the institutions' energy management, in addition to training professionals who are more in tune with the needs of the job market in renewable energy and energy efficiency (Zucchi, L. A. et al; 2020).

1.3 Photovoltaic solar energy and the Sustainable Development Goals (SDGs)

Photovoltaic solar energy is related to United Nations SDG 7, which aims to ensure universal, reliable and sustainable access to energy. Photovoltaic solar energy plays an important role in this goal, as it is a renewable and clean energy source that helps to reduce greenhouse gas emissions. It also contributes to SDG 13, which deals with climate action, as it is a renewable source that helps reduce greenhouse gas emissions. It is also related to SDG 12, which aims to promote sustainable patterns of production and consumption, as it is a sustainable option for the conscious consumption of electricity in homes and businesses.

Photovoltaic solar energy contributes to SDG 8, related to decent work and economic growth, by creating jobs and stimulating economic growth in regions with a demand for clean and renewable energy. It is also related to SDG 9, innovation and infrastructure, as its constant evolution and cost reduction can stimulate innovation in other areas and contribute to the development of cleaner and more sustainable energy infrastructure. Finally, it is related to SDG 11, which deals with sustainable cities and communities, as it can help reduce dependence on polluting energy sources in urban areas, contributing to a more livable city.

1.4 The Federal Institute of Education, Science and Technology of the South of Minas Gerais - IFSULDEMINAS

The Federal Institute of Education, Science and Technology of the South of Minas Gerais (IFSULDEMINAS), created by Law 11.892/2008, is a federal public educational institution, linked to the Ministry of Education (MEC) through the Secretariat of Professional Education and Technological, and is part of the Federal Network of Professional, Scientific

and Technological Education. IFSULDEMINAS has sustainable development in its mission, vision and values (IFSULDEMINAS Management Report 2022, 2023).

IFSULDEMINAS has a multi-campus formation, consisting of the Inconfidentes, Machado, Muzambinho, Passos, Poços de Caldas and Pouso Alegre campuses; by the advanced campuses Carmo de Minas and Três Corações; by 62 centers supporting Distance Learning; by the Technological Validation Center in Guaxupé/MG; by the Embrapii Coffee Agroindustry Hub in Machado/MG; and by the Rectory in Pouso Alegre/MG (IFSULDEMINAS Management Report 2022, 2023).

2. Points of Results and Discussions

2.1. Result of the national processes for the acquisition of photovoltaic systems

Table 1 shows the result of RDC 1/2016, in which three companies were the winners, with a total value of BRL 38,173,979.74, a saving of BRL 3,489,023.06 in relation to the reference value.

Table 1. Total photovoltaic solar energy generator modules bid by RDC 1/2016. Nine companies participated in the bidding, only three were the winners. Source: RDC 1/2016

#	Institution	Units	Company	Reference Value (R\$)	Total Reference Value (R\$)	Bid Value (R\$)	Total Bid Value (R\$)	Total Saved Value (R\$)
1	IFSULDEMINAS	9	3	508.085,40	4.572.768,60	467.438,56	4.206.947,04	365.821,56
2	IFES	2	3	508.085,40	1.016.170,80	467.438,56	934.877,12	81.293,68
3	IFTO	2	2	508.085,40	1.016.170,80	466.930,48	933.860,96	82.309,84
4	IFBAIANO	2	3	508.085,40	1.016.170,80	467.438,56	934.877,12	81.293,68
5	IFSUL	2	3	508.085,40	1.016.170,80	467.438,56	934.877,12	81.293,68
6	IFBAIANO	2	2	508.085,40	1.016.170,80	466.930,48	933.860,96	82.309,84
7	IFG	3	2	508.085,40	1.524.256,20	466.930,48	1.400.791,44	123.464,76
8	IFPR	2	1	508.085,40	1.016.170,80	442.034,29	884.068,58	132.102,22
9	IFMS	2	3	508.085,40	1.016.170,80	467.438,56	934.877,12	81.293,68
10	IFMT	10	3	508.085,40	5.080.854,00	467.438,56	4.674.385,60	406.468,40
11	IFRO	3	3	508.085,40	1.524.256,20	467.438,56	1.402.315,68	121.940,52
12	IFSP	29	3	508.085,40	14.734.476,60	467.438,56	13.555.718,24	1.178.758,36
13	IFRR	3	3	508.085,40	1.524.256,20	467.438,56	1.402.315,68	121.940,52
14	IFNMG	7	3	508.085,40	3.556.597,80	467.438,56	3.272.069,92	284.527,88
15	IFMG	4	1	508.085,40	2.032.341,60	442.034,29	1.768.137,16	264.204,44
	Total	82			41.663.002,80		38.173.979,74	3.489.023,06

Table 1: Total photovoltaic solar energy generator modules bid by RDC 1/2016. Nine companies participated in the bidding, only three were the winners. Source: RDC 1/2016.

Table 2 shows the result of adhesions to RDC 1/2016, managed by IFSULDEMINAS, with a total value of BRL 22,962,919.28, a saving of BRL 2,441,350.72 in relation to the reference value.

Table 2. Total adherence to RDC 1/2016. Thirteen institutions were authorized (LNA, IFPB, IFBA, IFSC, IEMA, UEMA, PM Três Corações-MG, JFCE, IFES, IFTM, FGD Mossoró -RN, JFPR and JFPB). Source: RDC 1/2016

#	Institution	Units	Company	Reference Value (R\$)	Total Reference Value (R\$)	Bid Value (R\$)	Total Bid Value (R\$)	Total Saved Value (R\$)
1	IFSULDEMINAS	16	1	508.085,40	8.129.366,40	442.034,29	7.072.548,64	1.056.817,76
		5	2	508.085,40	2.540.427,00	466.930,48	2.334.652,40	205.774,60
		29	3	508.085,40	14.734.476,60	467.438,56	13.555.718,24	1.178.758,36
	Total	50			25.404.270,00		22.962.919,28	2.441.350,72

Table 2: Total adherence to RDC 1/2016. Thirteen institutions were authorized (LNA, IFPB, IFBA, IFSC, IEMA, UEMA, PM Três Corações-MG, JFCE, IFES, IFTM, FGD Mossoró-RN, JFPR and JFPB). Source: RDC 1/2016.

Table 3 shows the result of the RDC 3/2018, in which six companies were the winners, with a total value of BRL 57,783,800.03, a saving of BRL 40,811,258.65 in relation to the

reference value.

Table 3 Total photovoltaic solar energy generator modules bid by RDC 3/2018. Fourteen companies participated in the bidding, only six were the winners. Source: RDC 3/2018

#	Institution	Units	Company	Reference Value (R\$)	Total Reference Value (R\$)	Bid Value (R\$)	Total Bid Value (R\$)	Total Saved Value (R\$)
1	IFSULDEMINAS	24	2	122.630,67	2.943.136,08	72.965,24	1.751.165,76	1.191.970,32
2	IFSUDESTEMG	22	2	122.630,67	2.697.874,74	72.965,24	1.605.235,28	1.092.639,46
3	IFNMG	5	1	122.630,67	613.153,35	85.951,83	429.759,15	183.394,20
4	IFMG	11	2	122.630,67	1.348.937,37	72.965,24	802.617,64	546.319,73
5	IFTM	12	2	122.630,67	1.471.568,04	72.965,24	875.582,88	595.985,16
6	IFRJ	206	3	122.630,67	25.261.918,02	73.578,40	15.157.150,40	10.104.767,62
7	IFF	14	4	122.630,67	1.716.829,38	85.964,09	1.203.497,26	513.332,12
8	IFSP	10	3	122.630,67	1.226.306,70	73.578,40	735.784,00	490.522,70
9	IFCATARINENSE	9	3	122.630,67	1.103.676,03	73.578,40	662.205,60	441.470,43
10	IFSUL	25	3	122.630,67	3.065.766,75	73.578,40	1.839.460,00	1.226.306,75
11	IFMS	32	5	122.630,67	3.924.181,44	64.994,25	2.079.816,00	1.844.365,44
12	IFGOIANO	21	5	122.630,67	2.575.244,07	63.767,94	1.339.126,74	1.236.117,33
13	IFB	22	6	122.630,67	2.697.874,74	85.951,83	1.890.940,26	806.934,48
14	IFMT	67	5	122.630,67	8.216.254,89	64.994,25	4.354.614,75	3.861.640,14
15	IFTO	42	5	122.630,67	5.150.488,14	63.767,94	2.678.253,48	2.472.232,66
16	IFRR	18	1	122.630,67	2.207.352,06	85.964,09	1.547.353,62	659.998,44
17	IFAP	61	1	122.630,67	7.480.470,87	74.792,44	4.562.338,84	2.918.132,03
18	1º GACSL	6	3	122.630,67	735.784,02	74.792,44	448.754,64	287.029,38
19	IFRO	13	1	122.630,67	1.594.198,71	85.473,57	1.111.156,41	483.042,30
20	IFBAIANO	52	4	122.630,67	6.376.794,84	85.964,09	4.470.132,68	1.906.662,16
21	IFSERTAPOE	53	5	122.630,67	6.499.425,51	61.928,48	3.282.209,44	3.217.216,07
22	IFRN	72	5	122.630,67	8.829.408,24	61.928,48	4.458.850,56	4.370.557,68
23	IFPI	7	3	122.630,67	858.414,69	71.113,52	497.794,64	360.620,05
Total		804			98.595.058,68		57.783.800,03	40.811.258,65

Table 3: Total photovoltaic solar energy generator modules bid by RDC 3/2018. Fourteen companies participated in the bidding, only six were the winners. Source: RDC 3/2018.

Table 4 shows the result of adhesions to the RDC 3/2018, managed by IFSULDEMINAS, with a total value of BRL 162,766,141.90, a saving of BRL 115,360,217.66 in relation to the reference value.

Table 4 Total adherence to RDC 3/2018. Seventy-one institutions were authorized. Source: RDC 3/2018

#	Institution	Units	Company	Reference Value (R\$)	Total Reference Value (R\$)	Bid Value (R\$)	Total Bid Value (R\$)	Total Saved Value (R\$)
1	IFSULDEMINAS	54	2	122.630,67	6.622.056,18	72.965,24	3.940.122,96	2.681.933,22
2	IFSUDESTEMG	63	2	122.630,67	7.725.732,21	72.965,24	4.596.810,12	3.128.922,09
3	IFNMG	15	1	122.630,67	1.839.460,05	85.951,83	1.289.277,45	550.182,60
4	IFMG	33	2	122.630,67	4.046.812,11	72.965,24	2.407.852,92	1.638.959,19
5	IFTM	34	2	122.630,67	4.169.442,78	72.965,24	2.480.818,16	1.688.624,62
6	IFRJ	512	3	122.630,67	62.786.903,04	73.578,40	37.672.140,80	25.114.762,24
7	IFF	42	4	122.630,67	5.150.488,14	85.964,09	3.610.491,78	1.539.996,36
8	IFSP	30	3	122.630,67	3.678.920,10	73.578,40	2.207.352,00	1.471.568,10
9	IFCATARINENSE	27	3	122.630,67	3.311.028,09	73.578,40	1.986.616,80	1.324.411,29
10	IFSUL	75	3	122.630,67	9.197.300,25	73.578,40	5.518.380,00	3.678.920,25
11	IFMS	93	5	122.630,67	11.404.652,31	64.994,25	6.044.465,25	5.360.187,06
12	IFGOIANO	63	5	122.630,67	7.725.732,21	63.767,94	4.017.380,22	3.708.351,99
13	IFB	66	6	122.630,67	8.093.624,22	85.951,83	5.672.820,78	2.420.803,44
14	IFMT	201	5	122.630,67	24.648.764,67	64.994,25	13.063.844,25	11.584.920,42
15	IFTO	126	5	122.630,67	15.451.464,42	63.767,94	8.034.760,44	7.416.703,98
16	IFRR	50	1	122.630,67	6.131.533,50	85.964,09	4.298.204,50	1.833.329,00
17	IFAP	183	1	122.630,67	22.441.412,61	74.792,44	13.687.016,52	8.754.396,09
18	1º GACSL	18	3	122.630,67	2.207.352,06	74.792,44	1.346.263,92	861.088,14
19	IFRO	39	1	122.630,67	4.782.596,13	85.473,57	3.333.469,23	1.449.126,90
20	IFBAIANO	156	4	122.630,67	19.130.384,52	85.964,09	13.410.398,04	5.719.986,48
21	IFSERTAPOE	159	5	122.630,67	19.498.276,53	61.928,48	9.846.628,32	9.651.648,21
22	IFRN	216	5	122.630,67	26.488.224,72	61.928,48	13.376.551,68	13.111.673,04
23	IFPI	13	3	122.630,67	1.594.198,71	71.113,52	924.475,76	669.722,95
Total		2.268			278.126.359,56		162.766.141,90	115.360.217,66

Table 4: Total adherence to RDC 3/2018. Seventy one institutions were authorized (MPT-MT, IFAL, IFTM, IFG, CEFET-MG, IFGOIANO, IFSE, IFCE, UFOP, IFSC, UNIFAL, IFARROUPILHA, IFCATARINENSE, IFPA, UFG, IFPR, IFNMG, IFRO, IFF, IFAC, IFSP, IFRS, SEMED Imperatriz-MA, IFSULDEMINAS, IFAM, UFVJM, DF-MB Pirapora-MG, IFPB, UFJF, IFMG, IFES, IFBA, UNIPAMPA, CPSE, UNIFEI, UFRA, IFMA, UFT, UFAC, IFSUDESTEMG, UFMS, UFTM, CEFET-RJ, UFSC, UFC, UFS, UFPI, UFV, UNIFESP, IFSUL, UFFS, UFBA, UTFPR, UFPEL, UFU, UFCA, UFCSPA, UFPB, UNIFAP, UFPA, UFPR, UFRGS, IFPE, UFF, UFRR, UFRJ, UFRPE, UFPE, UNIVASF, UNIRIO and UFAM. Source: RDC 3/2018.

2.1. Energy consumption compensation

Since the first photovoltaic systems acquisition process, in 2016, the energy production by IFSULDEMINAS only reaches approximately 5.000 MWh, which is equivalent to a reduction of approximately 1.900 tons of CO₂ emissions (fig 1). The economic achievements at the moment this article is written (April 2023) is getting to around BRL 3.5 millions.

Figure 1 shows the monthly production evolution since 2017, emphasizing the production increase in 2021, along with the second process of photovoltaic systems acquisition.

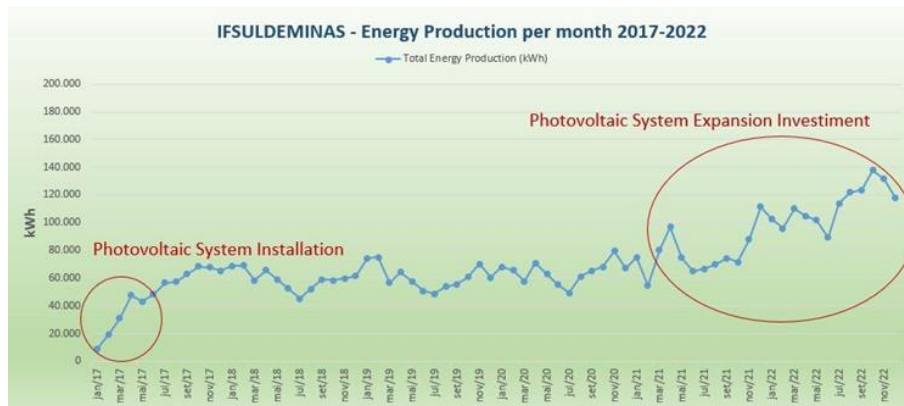


Figure 1 Energy production per month 2017 - 2022

The remaining energy consumption at IFSULDEMINAS is still significant, as the energy production capacity supplies approximately 50% of total energy consumption, although this result considers some maintenance outages during the evaluated period.

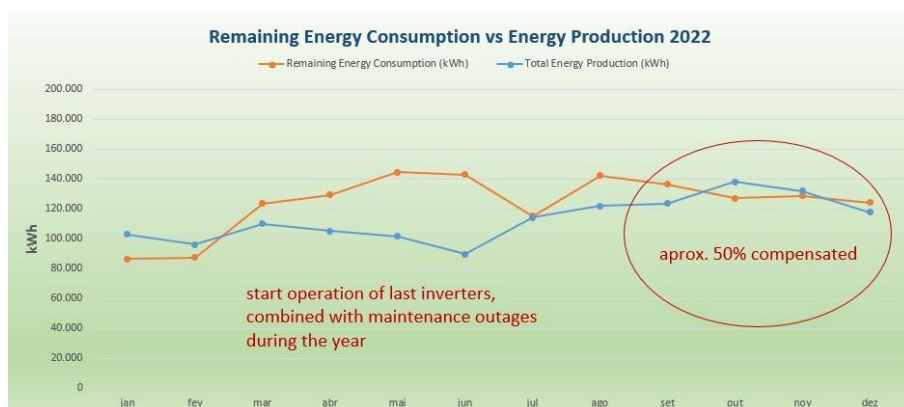


Figure 2 Remaining energy consumption vs energy production 2022

Graphic 3 demonstrates the full compensated energy consumption reached at some of the units (the Rectory in this case), with the photovoltaic systems acquired at the second acquisition process.

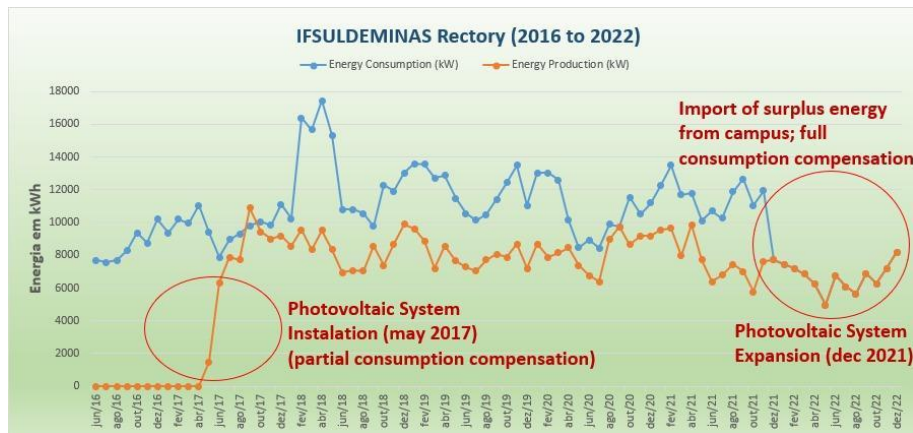


Figure 3. compensated energy consumption reached at Retory

3. Conclusion

The two acquisition processes of photovoltaic systems for federal public institutions conducted by IFSULDEMINAS, in 2016 and in 2018, allowed several Brazilian public institutions, mainly teaching institutions, to have access to efficient forms of clean energy, contributing to the fight against climate change and lowering their operating costs.

However, there is still much to be done towards a sustainable society. Specifically, in relation to these acquisitions, this initial study is not able to state that all amounts were executed. There are several problems for the fulfillment of contracts with the public administration, in this case the construction of facilities, according to the projects, and the relationship with the electric energy concessionaires, who do not look favorably on this competition in energy generation, demanding higher taxes for the transmission of surplus energy injected into the electrical grid.

In 2022, the Federal Government of Brazil spent BRL 2,384,206,489.00 on electricity expenses. The Ministry of Education alone was responsible for BRL 596,224,768.00. Of these, BRL 137,533,352.00 were spent by the Federal Network of Professional, Scientific and Technological Education. What would be the impact on these values if acquisition processes of photovoltaic systems for the production of electricity, such as those carried out by IFSULDEMINAS, reached all Federal Public Administration bodies, with the same efficiency and economy?

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