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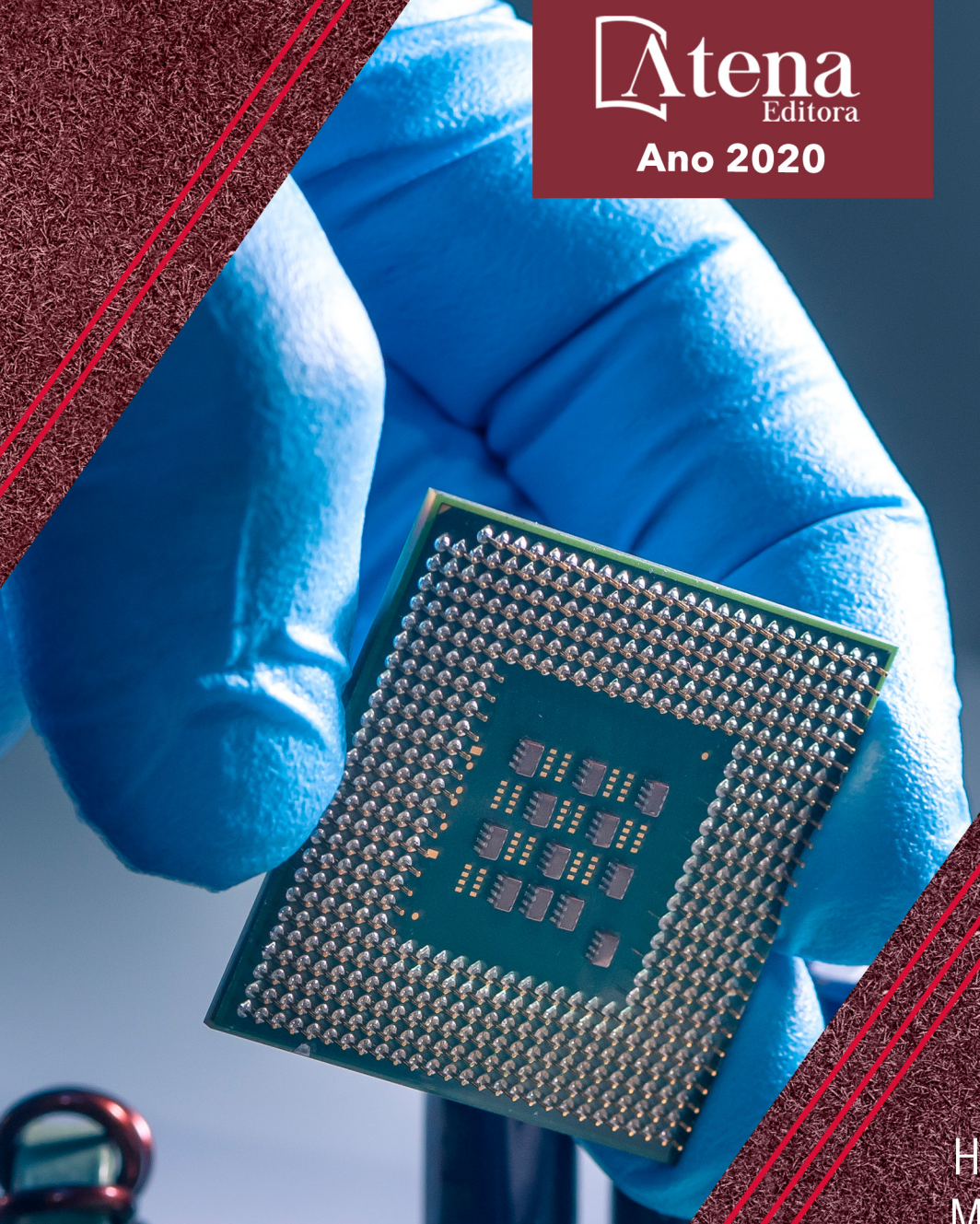

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Engenharia Elétrica e de Computação: Atividades Relacionadas com o Setor Científico e Tecnológico

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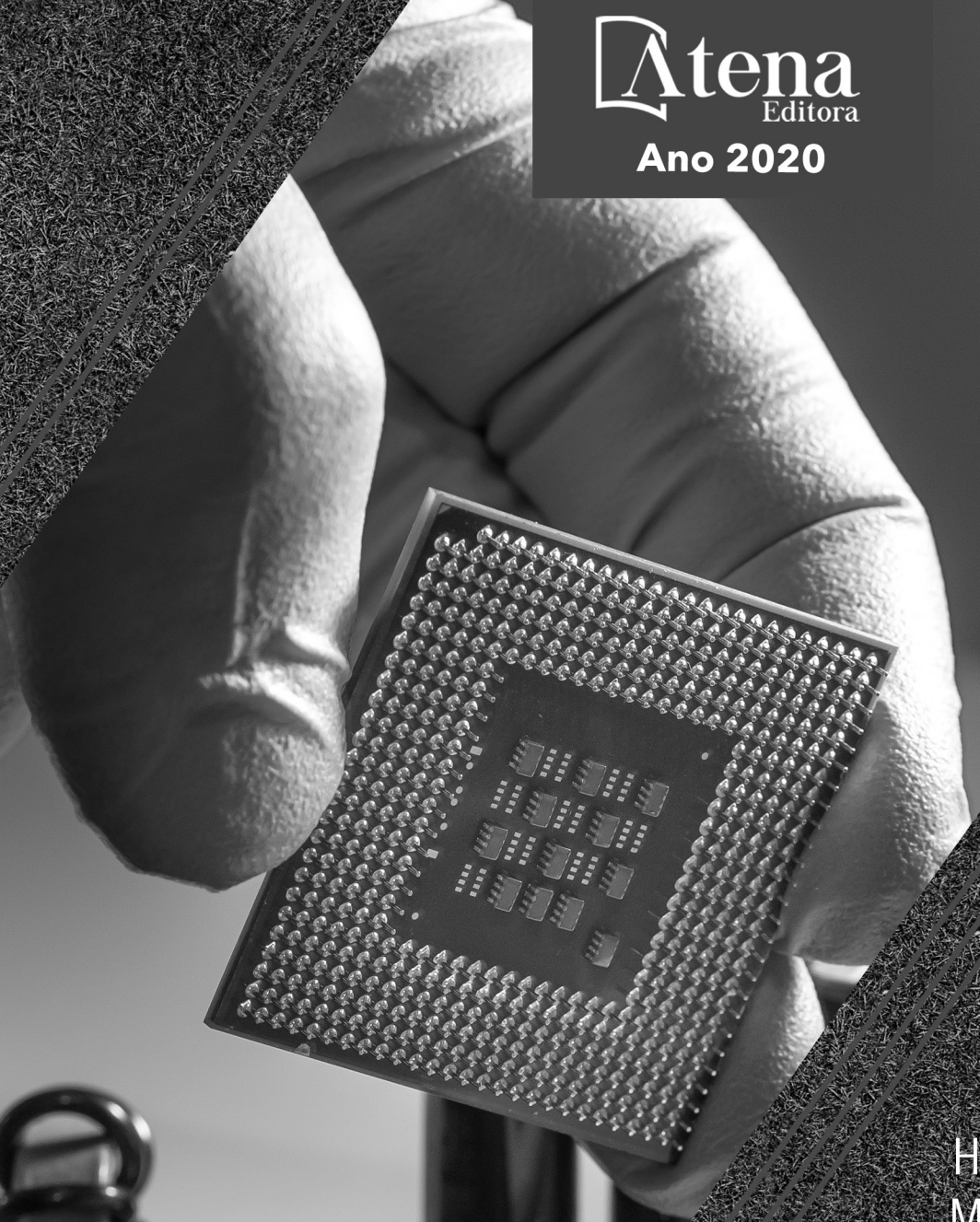

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APRESENTAÇÃO

Não há padrões de desempenho em engenharia elétrica e da computação que sejam duradouros. Desde que Gordon E. Moore fez a sua clássica profecia tecnológica, em meados dos anos 60, a qual o número de transistores em um chip dobraria a cada 18 meses - padrão este válido até hoje – muita coisa mudou. Permanece porem a certeza de que não há tecnologia na neste campo do conhecimento que não possa ser substituída a qualquer momento por uma nova, oriunda de pesquisa científica nesta área.

Produzir conhecimento em engenharia elétrica e da computação é, portanto, atuar em fronteiras de padrões e técnicas de engenharia. Algo desafiador para pesquisadores e engenheiros.

Neste livro temos uma diversidade de temas nas áreas níveis de profundidade e abordagens de pesquisa, envolvendo aspectos técnicos e científicos. Aos autores e editores, agradecemos pela confiança e espirito de parceria.

Boa leitura!

João Dallamuta
Henrique Ajuz Holzmann
Marcelo Henrique Granza

SUMÁRIO

CAPÍTULO 6

IMPACT OF HOURLY PRICES ON FUTURE WIND FARM CONTRACTS IN BRAZIL

Data de aceite: 01/06/2020

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The implementation of the hourly prices, scheduled for 2021, will result in significant impacts on market framework. Clearly, it is a natural enhancement, once it will allow an explicit representation and a more detailed of the operational constraints associated with hydro and thermal generation, and the temporal impact of variability of non-dispatchable sources.

The role of the hourly price is to bring more credibility to the price signal that is currently offered by load steps with weekly update. The change in the Brazilian matrix with the increasing entry of renewable sources of "zero marginal cost" substantially alter the price signal over the daily load curve. However, the fact is that some wind power projects have very different production standards from other sources, depending on your location, which reflects the pattern of incidence of winds. A large set of long-term bilateral contracts from wind farm projects were sold at public auctions to distribution utilities, and for final free users, with a different price profile.

The Brazil appears among the countries with the one of the highest installed capacity in wind farms and is on an upward trajectory of investments in this type of source. This growth

has been driven by strong investor interest to the characteristics of the winds, especially in the Northeast region, seen by many experts as one of the world's best for the production from the winds. The prospect of implementing the hourly price, which offers extremely dynamic characteristics when compared with the price format for weekly levels, currently practiced, many enterprises will be subject to additional risks increasing the importance of evaluating the time marketing to risk management.

In this context, this CIGRE market disturbance approach proposes to assess factors that are important, such as seasonality and modulation to provide an understanding of the risks and impacts of wind projects. In this regard, the modulation will have a significant impact when implemented the hourly price, taking into account that the spot market price follows a varied profile throughout the year due to the influence of hydro inflows.

Usually, for direct sales to free consumers have clear goals on the issue of risk. Consumers wishing to legitimately purchase bilateral contracts with low risk, including modulation risks and seasonality. On the other hand, wind generators are difficult to incorporate these risks, especially with the hourly rates that can expose a lot of the generators at higher price points during the day. A large set of wind farm production profile is have

A prudent risk management by the generators is required focusing on purchase and sale of portfolios with a sufficient plurality risk mitigation. This is not yet widespread practice in Brazil and the structuring of new trading companies belonging to a group of generators can be a good alternative.

This is a problem that already exists without the adoption of PLD time. In the graphs ofFigure 32015 compares the profile generation of 24 wind farms located in Bahia. The annual generation in each series and the delivery of energy has been considered as the P90 (not shown annual exposure). By reading the graphs below, considering the delivery of contracts as load seasonality or typical generation profile in the Northeast you can check that with PLDs 2015 monthly average, there would be a high exposure to such price if the contractual seasonal adjustments were made according to charge generating material exposure to sellers.

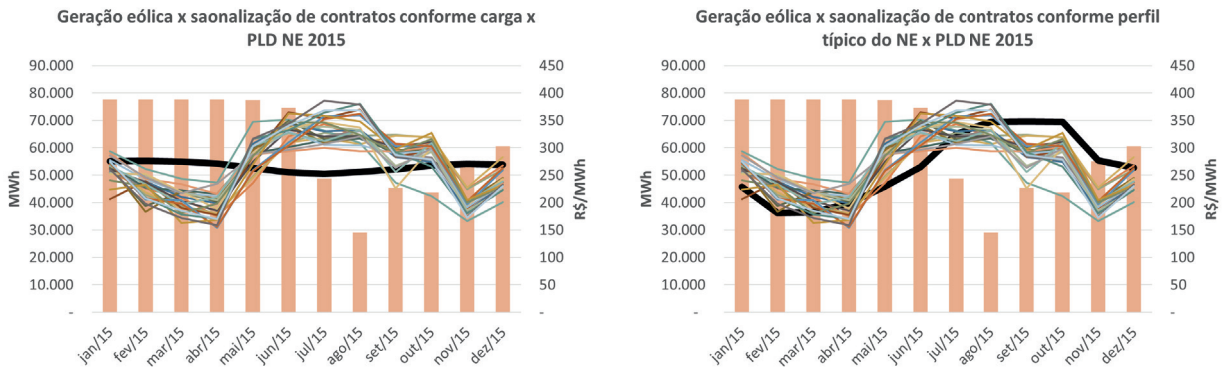

Figure 3 - MCP Risks - Profile PLD 2015

In the graphs of Figure 4 observing the behavior of generation in 2017 of these

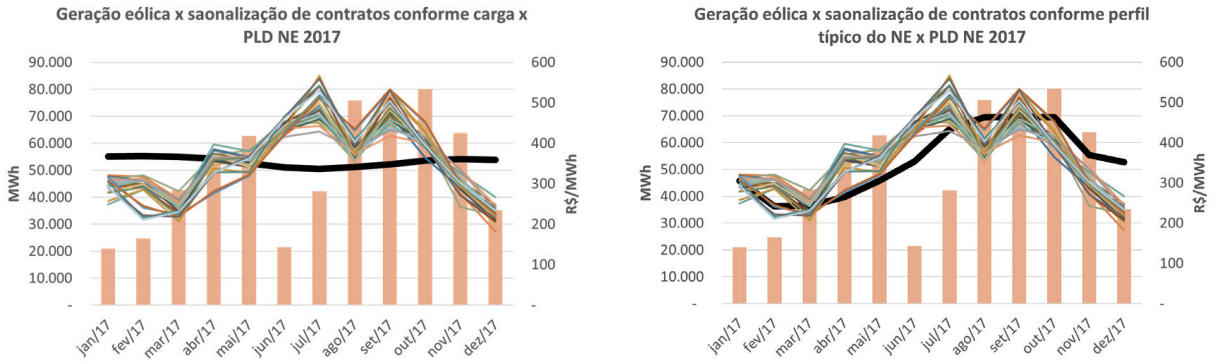

Figure 4 - MCP Risks - Profile PLD 2017

24 wind farms located in Bahia to find that this year the monthly exhibitions of contracts compared to the seasonal adjustments to both the load and that typical of the Northeast generators would have a very different behavior from the year 2015 Figure 3. This is due to the behavior of PLDs of this year, with much higher values in the second half. Thus, the monthly allocation of the contracts as typical profile would generate a higher exposure. Thus, the risk of pricing with a number of contract with the ACL should be another. In short, even without the LDP schedule already exists the monthly risk of exposure to MCP.

With the PLD time, the shadow simulations conducted by the ONS / CCEE, show that PLDs average monthly change slightly, but mainly the values throughout the day the change is large, since instead of the 3 values level exposure will be confronted with the 24 hour values. Therefore, the time modulation in the contracts with the ACL is what can cause greater risk to wind generators.

An interesting view is shown on hourly variations of wind generation, obtained from the ONS [3]. AtFigure 5They are presented for the month of March 2018 the wind power fluctuations throughout the day, considering all wind generators of SIN, the Northeast, and those located in Bahia and Rio Grande do Norte. In these graphs is shown in wind generation hourly basis for all days of the month, with, highlighted, is shown the minimum, maximum and mean time for each generation. The interesting thing to note is the dispersion in the generation profile of wind projects, depending on your location.

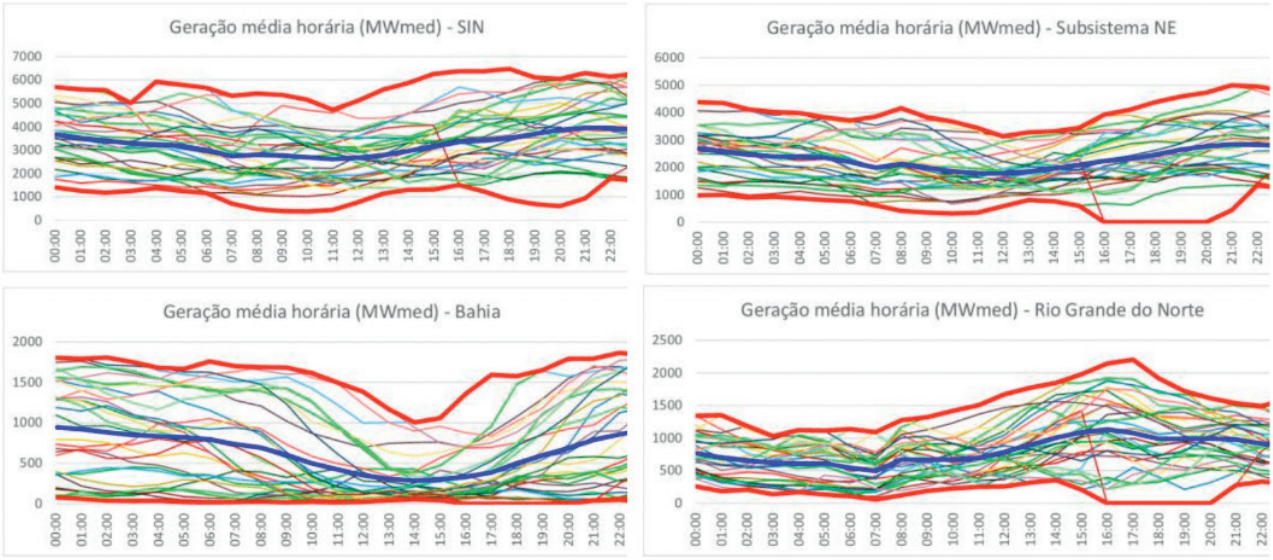

Figure 5 - Wind Generation Hourly - SIN, Northeast, Bahia and Rio Grande do Norte - March 2018 [3]

1 I RISK ASSESSMENT - CASE STUDY

To display so very objective the impact of PLD time was carried out in this work a specifically risk assessment for a wind project in Rio Grande do Norte. The project was then simulated time before the price profile of the year 2018. The simulation was performed in October 2018 considering the “decks” shadow operation and future simulation from October to December. All input data for mounting the “decks” referring to DESSEM model (time) for these periods were obtained with the help of DECODESS converter asFigure 6. They have always been considered the cases with and without transmission network, since there is no definition yet of the method to be adopted officially. Due to the cases of network conversion impossibility it was made a comparative analysis of approximately 7000 official timetable published values with and without network (eliminating the ceiling values and floor) in order to obtain an hourly price behavior with network x LAN for the Northeast submarket for each day of the week, as inFigure 7. The differences with and without network are located in a band -20% / + 60%, and most prices are lower network with the first 12 hours of the day and is higher in others.

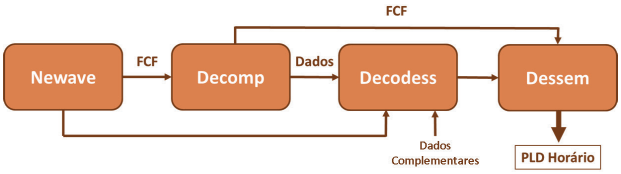

Figure 6 - Simulation Models

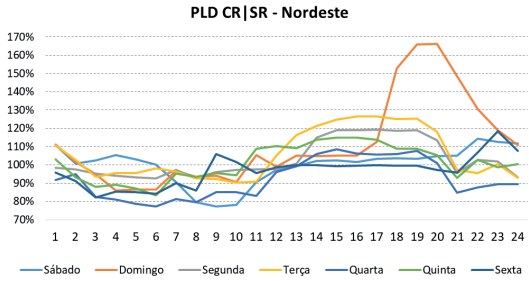

Figure 7 - PLD Time With and Without Network - Northeast

The curve of hourly generation refers to a wind farm in Rio Grande do Norte region that has the capacity to generate about 160 MW.médios a year. The curves daily generation of each month and the seasonality of the total energy delivered for each month are shown inFigure 8. It adopted a loss factor of 4% (~ 151.7 MW.médios lossless). They considered two recruitment scenarios - Scenario 1 with no contract - typical closing in the short term and only scenario 2 with delivery “flat” - typical of the industrial consumer. Comparisons are made using the current PLD patamarizado and PLD time with and without network. Of course, comparing the pattern of the wind farm generation curve (Figure 8) With a delivery contract with “flat”, exposure to MCP will be positive even 19 hours at 5 o’clock the following day and will be negative in the remaining hours.

This effect of different exposures MCP throughout the day will bring different results clearly with PLD time.

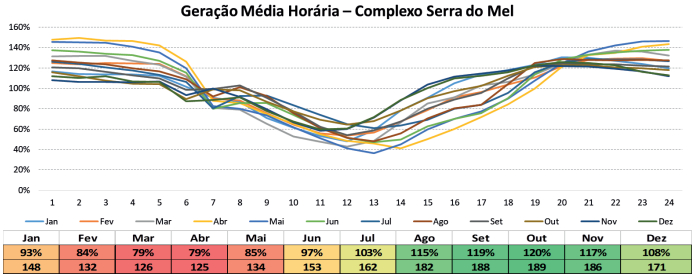

Figure 8 - Generation Standard - Wind Energy Complex (RN)

THE Figure 9 illustrates a sample of the PLD time (January to October 2018) in the Northeast used in the comparisons of the PLD versus weekly schedule impact.

The curves illustrate the PLD absolute time values with and without network and weekly PLD, and in addition, the difference between the time and week.

Note that the monthly average values are very close in all cases, however differences over the days and hours are visible. This difference is that it brings the impact of hourly rates in wind projects.

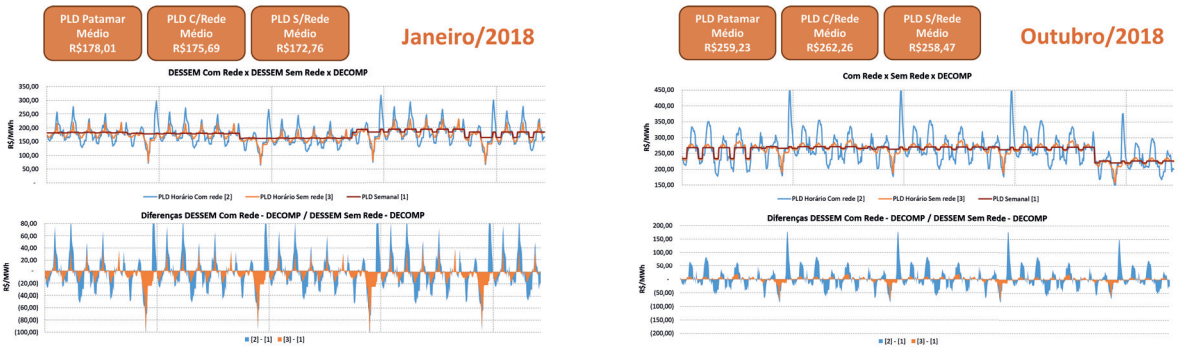

Figure 9 - Sample of Prices and times Considered Weekly - Northeast (January and October 2018)

1.1 Results

The results comparing the impact of PLD time with and without network versus the weekly spot price in terms of exposure to MCP wind project for two scenarios - all MCP and sales "flat" is shown in Figure 10. Note that in the two scenarios there are differences over years and months in the PLD values reached the ceiling or near it (May and June) are the major differences.

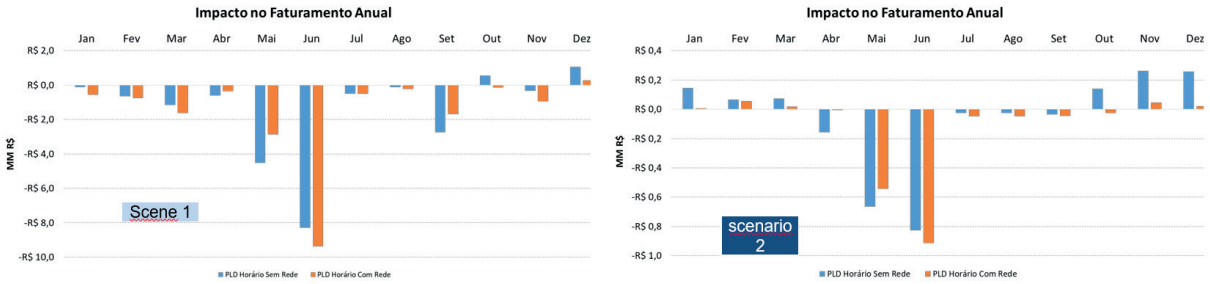

Figure 10 - Impact on Annual Revenue

The consolidated values are shown in Table 1 and Table 2. In scenario 1 with total exposure to MCP, project billing with PLD time loses 13-14 R $ / MWh - with and without network, respectively. They are important financial impact on project revenue profile. In scenario 2 with contract sales "flat" with the implementation of PLD time would require the pricing of new contracts of this type with a "premium" annual average of + R $ 0.59 / MWh in the case of PLD time considering the network and + R $ 1.11 / MWh in the case of PLD LAN.

Complexo Eólico RN – Resultado Anual			
	Geração x PLD Semanal	Geração x PLD Horário com rede	Geração x PL Horário sem r
Total [R$]	R$ 402,997,808.18	R$ 385,645,502.79	R$ 384,311,69
Total Geração (MWh)	1332815.00		
Total [R$/MWh]	R$ 302.37	R$ 289.35	R$ 288.35
Diferença [R$/MWh]		-R$ 13.02	-R$ 14.02
Média PLD [R$/MWh]	R$ 290.95	R$ 277.61	R$ 277.22
Diferença [MM R$]		-R$ 17.35	-R$ 18.69

Complexo Eólico RN – Resultado Anual			
	Geração x PLD Semanal	Geração x PLD Horário com rede	Geração x Pl Horário sem r
Total [R$]	-R$ 172,393.21	-R$ 962,547.62	-R$ 1,651,88
Média PLD [R$/MWh]	R$ 290.95	R$ 277.61	R$ 277.2
Diferença [MM R$]		-R$ 0.79	-R$ 1.48
Diferença [R$/MWh]		-R$ 0.59	-R$ 1.11

Table 1 - Consolidated Results - Scenario 1 Table 2 - Consolidated Results - Scenario 2

Evaluating Scenario 1, the month of June had the highest negative impact of the price schedule in relation to the price per level. What weighed more for this result is the difference - 70.26 R $ / MWh comparing the average monthly price per level with the case with network and - 79.65 R $ / MWh with no network case. Moreover, we can see a higher occurrence of lower hourly rates in the early hours of the day where the generation is high and higher prices in the middle of the day where the generation is low. Also in relation to Scenario 1, the month of December showed the highest gain (positive impact) due to the close proximity of the average prices per level and average monthly price schedules and presents several instances of PLD time peaks in the late afternoon, where the generation is found in high levels. Focusing the evaluation of Scenario 2, the justifications for the greatest negative impact in July and the biggest positive impact occurs at the end of the year is very similar to those presented for Scenario 1. In addition, we can see a small annual impact mainly due to compensation of low prices x generation high earlier in the day with high prices and high generation at the end of the day. In general, the hourly price tends to behave increasingly throughout the day. The contract modulation according to given load curve has the ability to change this significantly scenario. There are numerous possible configurations contracts on the open market.

The occurrence of major impacts of PLD without network time with respect to the PLD time with the network (on average PLD with <PLD LAN network) in a few months is due to the possibility of “impoundment” of wind generation in the Northeast system at times, due to a greater restriction to the flow of this energy with consideration of the network. The results presented here are the result of simulations using a model (DESSEM) has not finished and the possibility of significant changes to its full implementation.

2 I LIGHTENING THE RISK

In the test case study it was used a wind farm in Rio Grande do Norte, which has a different system of winds from other states in the Northeast. AtFigure 5You can compare the profile of Rio Grande do Norte (RN) with the State of Bahia (BA). Note that the highest incidence of winds in the RN occurs in late-night time and night-BA dawn occurs. With the PLD time the values in these periods are quite different. In this case, the RN projects take advantage over those in the BA. The specific project in NB has a production standard (Figure 8) Slightly different from the general pattern of newborns with increased production of the slight displacement for the night. An average loss in sales was around 5% in scenario 1 with all the energy sold in the short term, and as it was only computed the average, there is situation of greater and lesser impact as those illustrated inFigure 11 and Figure 12.

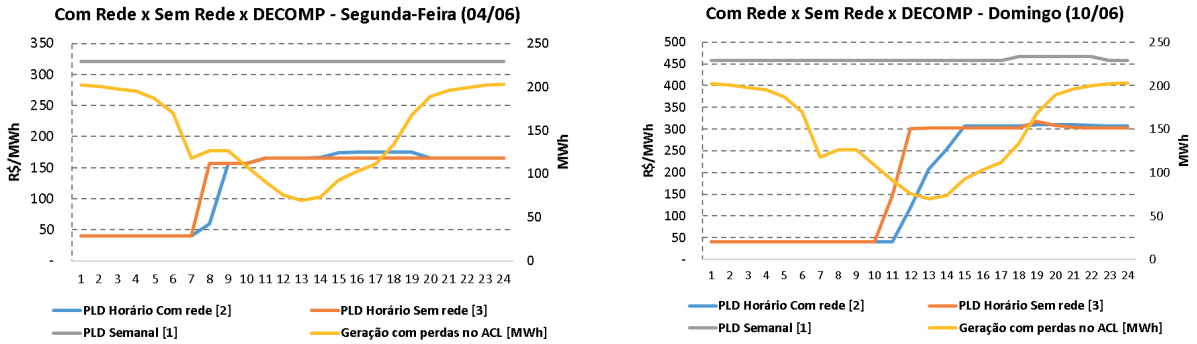

Figure 11 - Detailing Generation Standard and PLD Schedule and Week (June / 2018)

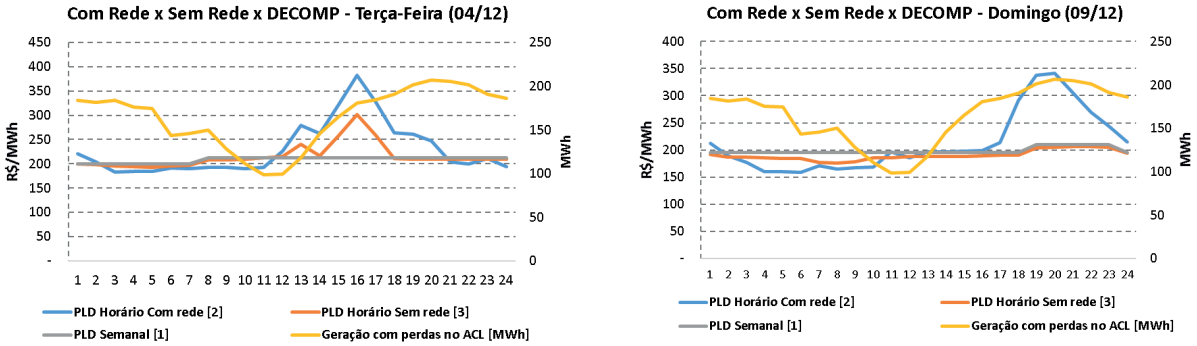

Figure 12 - Detailing Generation Standard and PLD Schedule and Week (December / 2018)

At Figure 11focusing on two specific days of June, the average PLD time was far below the level for PLD. This creates a situation of high PLD time with low generation and high generation PLD down earlier in the day. This effect takes project sales value. in theFigure 12, Focusing in December, the average PLD time was higher than the level for PLD and PLD notices a high time on day of the period with high generation. This effect creates a positive value in the wind project. Ie two different times and two different effects of PLD Time. Of course, this creates more uncertainty to future investors, and even those who are already operating projects. Similarly, a project in BA would have a slightly greater impact than the standard production of a project in RN (seeFigure 5).

2.1.1 Attention points

In the analysis of the time it was not implemented the Unit Commitment of heat that can accentuate the differences, particularly the effect that occurs when the spot price is higher.

2.1.2 Assessment of Impacts

Although it is expected a reduction of charges, the CCEE has not quantified this benefit in the operation shade when the implementation of the PLD time. In fact, the benefits to lower tariffs for consumers will depend on the evolution of the release of the ACL and the high volatility of hourly rates will not affect you at first.

It is emphasized that the implementation of the PLD hours may generate significant losses for wind projects already made possible, since part of the generation comes from the difference between the estimated production by P50 and P90. Thus, the projects sold energy in the ACR may be adversely affected. Thus, it must be seen by the regulator forms of compensation such entrepreneurs avoid a sector-like Judicialization to what happened with the SFM. In addition, the implementation of the hourly price will increase the risk of new projects as the increased uncertainty (high volatility, unpredictability and legal uncertainty) which will increase the cost of renewable sources due to the incorporation of new risks for these new projects.

2.1.3 Regulatory and Contractual advances

For those investors who are coming to build and operate new wind farms, the new profile of hourly rates is a lesson to be learned, and adjustments in the market contract prices will be at your own risk. On the contrary, for those investors who have already applied for wind farms based on business plans at the weekly price per level, the results of the projects in this new context schedules prices could suffer a negative impact of smaller and larger amounts, or in the ACR or even ACL. It is noteworthy that the regulation should protect the ACR projects sold energy in the current rule and shall refer to the ACL projects investment assumptions. In order to avoid a large litigation of wind generators against the adoption of the hourly price, the authors suggest that the government imagine some mitigation measures to mitigate the new risks in the sector. Among the measures to be considered are some very objective, how to adjust the price in the contracts of auctions at ACR, and also the extension of the term of the grant so that investors can accommodate the new uncertainties that the price schedule can bring.

2.1.4 Hybrid plants

Hybrid plants tend to be a “protection” against unwanted exposure in the MCP, which increase the efficiency of the set as whole. This scheme seeks complementarity of energy resources and the production of energy from sources involved in order to produce more efficient results, which are suitable and reliable for optimizing the use of the transport system for the transportation of energy [3]. The input of this storage is also a hybrid process technological advances expected in conjunction with wind power. Of course, this is a great outlet to avoid negative impacts of wind projects in the PLD time, yet the batteries still have high costs.

3 I CONCLUSIONS

The purpose of this paper seeks to discuss the impact of the price schedule in the Brazilian wind projects, always remembering that the commercialization of energy from wind farms is increasing in SIN. The fact is that wind is part of the sources of “zero marginal cost” and are dispatched with priority given to the system power requirement, not the power. Brazilian states in the Northeast and South are those with the highest incidence of winds suitable for the production of wind energy, and still wind production profile among these is different. The predictability of revenue from the wind power generation is challenging, since its production depends on a weather phenomenon, and its order is a priority. Using the PLD time as new pricing platform CCEE, uncertainty in revenues tend to increase. This can happen in contracts in the ACR, which from 2018 has adopted the Contracts Quantity, and where there may be unwanted exposure to higher PLD hours, or happen in the ACL with greater and lesser impact depending on the contractual standard. market measures to mitigate risks in SIN still have low liquidity, and beyond that, it is interesting that the government propose risk mitigation measures for those projects that set up their business plan in the pattern of weekly prices. These measures may include additives in contracts to accommodate differences in prices, or even the extension of the grant, establishing a deadline for projects already granted so that investors can have more time to recovery of the capital invested. and where there may be unwanted exposure to higher PLD hours, or happen in the ACL with greater and lesser impact depending on the contractual standard. market measures to mitigate risks in SIN still have low liquidity, and beyond that, it is interesting that the government propose risk mitigation measures for those projects that set up their business plan in the pattern of weekly prices. These measures may include additives in contracts to accommodate differences in prices, or even the extension of the grant, establishing a deadline for projects already granted so that investors can have more time to recovery of the capital invested. and where there may be unwanted exposure to higher PLD hours, or happen in the ACL with greater and lesser impact depending on the contractual standard. market measures to mitigate risks in SIN still have low liquidity, and beyond that, it is interesting that the government propose risk mitigation measures for those projects that set up their business plan in the pattern of weekly prices. These measures may include additives in contracts to accommodate differences in prices, or even the extension of the grant, establishing a deadline for projects already granted so that investors can have more time to recovery of the capital invested. market measures to mitigate risks in SIN still have low liquidity, and beyond that, it is interesting that the government propose risk mitigation measures for those projects that set up their business plan in the pattern of weekly prices. These measures may include additives in contracts to accommodate differences in prices, or even the extension of the grant, establishing a deadline for projects already granted so that investors can have more time to recovery

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REFERENCES

Technical Note 5/2017 / AEREG / SE - “Legal Framework of Improving Power Sector” - Public Consultation MME 33 - July 2017 - available in www.mme.org.br

F. Wolak - “Options for Short-Term Price Determination in the Brazilian Wholesale Electricity Market” - 2008 - Report prepared for the CCEE. - Available inhttps://web.stanford.edu/group/fwolak/cgi-bin/?q=node/3

ONS - “Generation Wind Power Monthly Bulletin - March / 2018”

EPE, “Hybrid Power Plants - A qualitative analysis of regulatory and trade issues relevant to planning” (No. EPE-DEE-NT-011/2018-r0)

ÍNDICE REMISSIVO

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