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# Risk of Electricity Rationing and Impact on IPCA

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July 14th, 2021

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# Risk of energy rationing and impact in the IPCA

**Rationing –** the risk of short-term rationing is still quite low. The two main variables for determining the reservoir level for the rest of the year will be economic growth and the level of rainfall. Our simulations suggest that a shortage would occur only with the combination of unfavorable hydrology (rainfall below 60% of the historical standard) and/or resumption of activity far above expectations. This is a scenario that has never occurred since at least 1931.

**Comparison with 2001 and 2015 –** the current scenario is considerably better than those seen in mid-2001 and 2015. Similar simulations show that a pretty dry climate, but compatible with what was seen on 21 occasions since 1931, would have brought the reservoirs below the minimum to ensure a proper operation of the hydroelectric plants.

**Energy matrix –** Brazil's energy matrix is much more diverse today than at the beginning of the decade. Hydraulic energy represents 60% of total generation compared to 90% in 2001. In addition, the extension of the transmission lines has tripled since then, making the system much more integrated.  Therefore, the situation today is more beneficial than in 2001, although the levels of the reservoirs of the S/CO/SE regions were not very different from the current ones.

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# Risk of energy rationing and impact in the IPCA

**Risk of Blackouts 1 –** in addition to the risk of rationing, there is also the risk of temporary shortages. In the last decade, we have seen several cases where problems in transmission equipment have led to temporary blackouts. This risk increases significantly with the use of transmission lines closer to their limit.

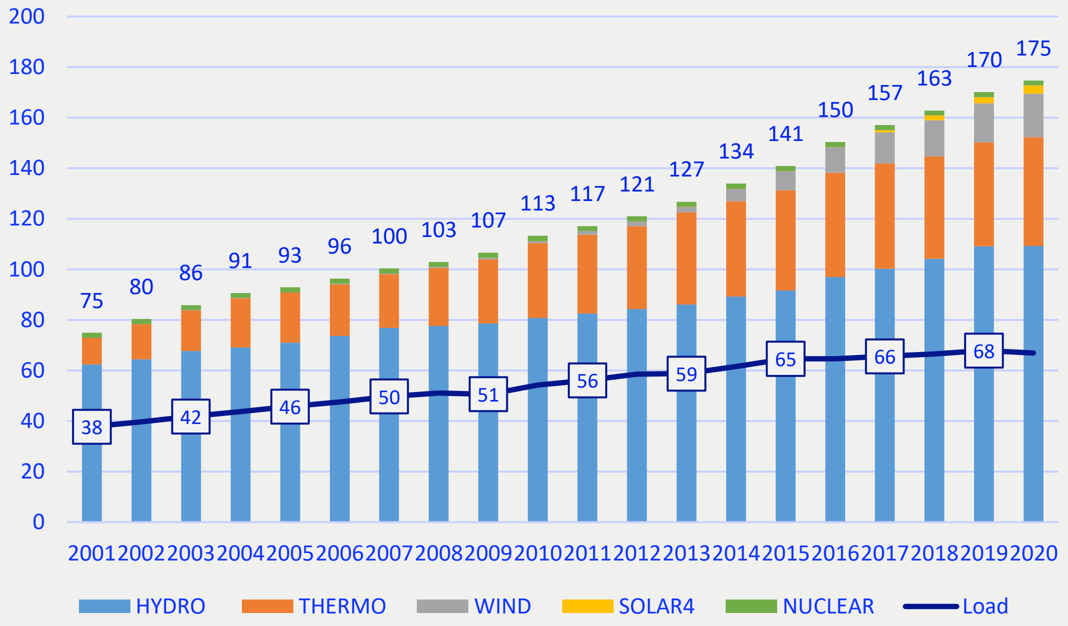
**Risk of Blackouts 2 -** in January 2015, the ONS had to cut the energy supply during the peak schedule because the load was higher than demand at that moment. The monitoring of *Reserva Girante* helps us qualify the risk of the occurrence of a similar situation.

**Readjustment of energy tariffs –** the maintenance of the hydrologic scenario may have a relevant impact on the IPCA. Aneel revised its tariff flag values. The Red Flag Level 2, the most critical one, increases the tariffs of energy by R$ 9,49/100MWh, with a total impact on the IPCA of 0,68pp compared to the Green Flag, the milder one. Even with this adjustment, generation costs would not be fully covered if the use of thermal plants remains at the current level.

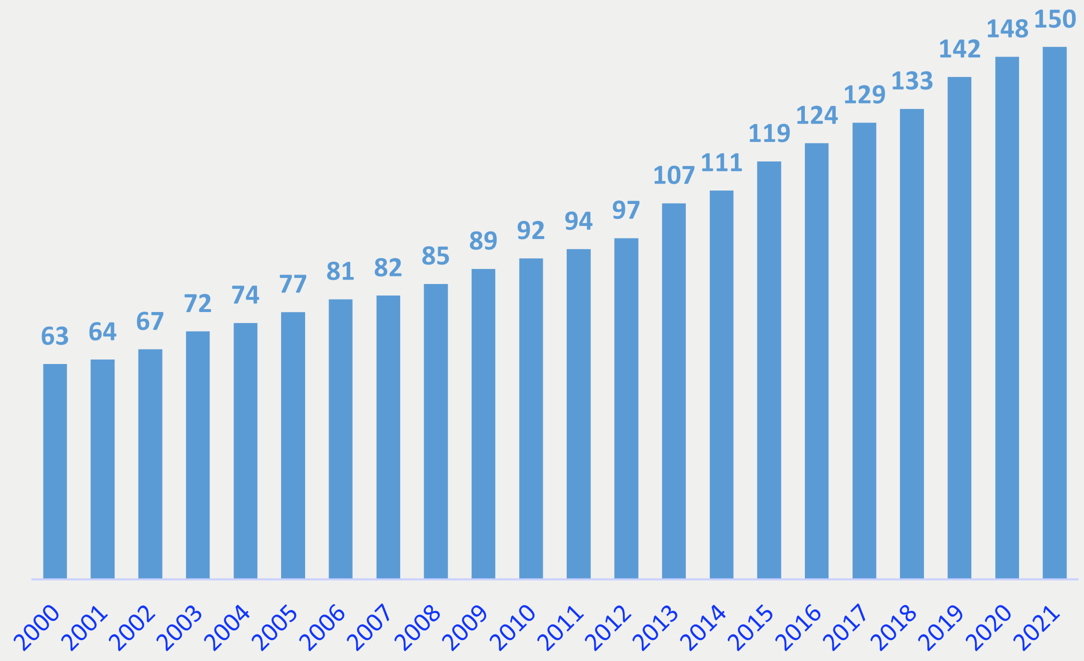
# Brazil's energy matrix has changed a lot since 2001

- Since 2001, installed electricity capacity has increased by more than 100,000 MWmed, an increase of 133%. In the same period, the energy demand increased much by much less, by 60%.
- In addition, the system today is well more integrated. The extent of distribution networks is almost three times what it was in 2001.

**Composition of the generation matrix in Brazil (Installed capacity, MWMed)**




**Extension of transmission lines in Brazil (thousand Km)**




Source: EPE, Mar Asset Management

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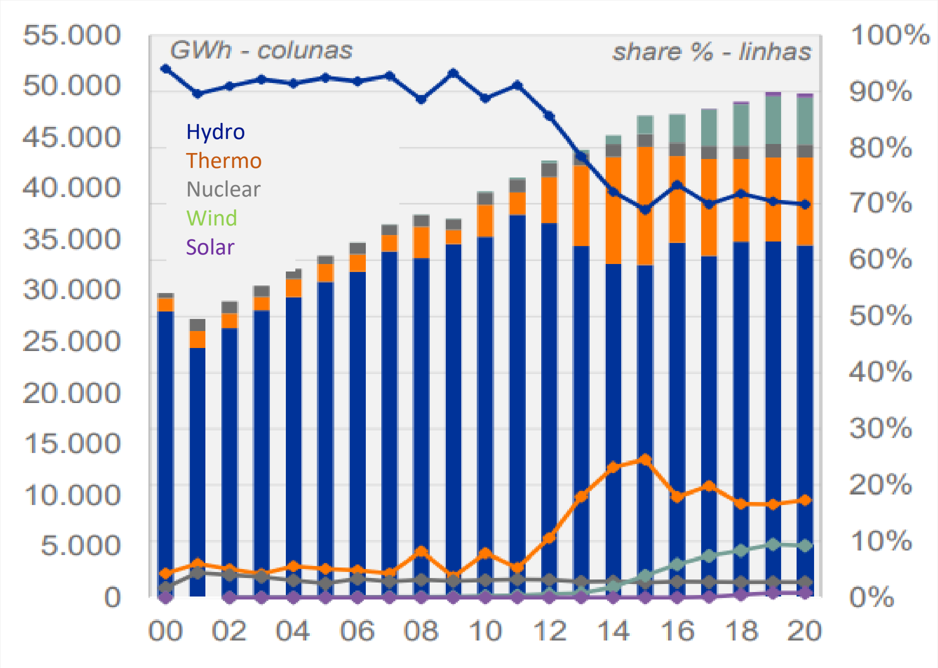
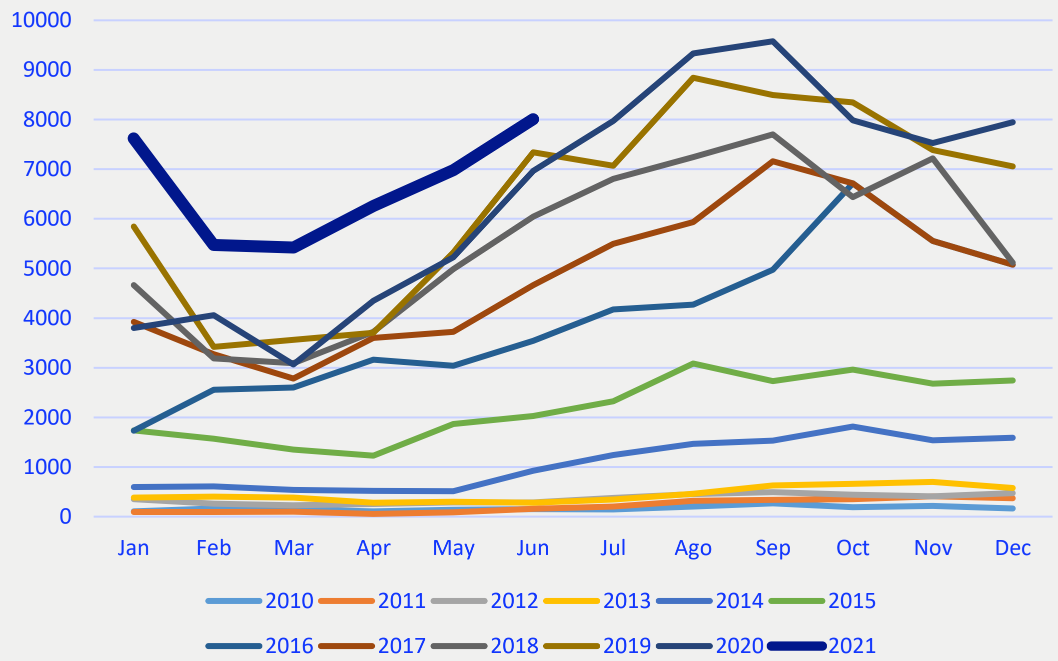
# Hydroelectric plants represent 60% of total generation

- With Brazil's energy matrix change, the composition of energy generation sources has also changed a lot. Until the 2000s, hydroelectric plants accounted for 90% of total energy generation. Today, they represent just over 60%.
- In the margin, the growth of energy generation was concentrated in wind energy, representing about 10% of the total energy generated. One of the benefits of wind power is that its seasonality is contrary to that of hydroelectric power plants – generation is higher in the second half of the calendar year, which is the period of low rainfall.

**Power generation by source (GWh and % of total)**




**Power Generation - Wind (MWMed)**




Source: ONS, Itaú, Mar Asset Management

# Basic model for reservoir dynamics

**Model for subsystem reservoir dynamics**

$$Reservoir_t = Reservoir_{t-1} + ENA_t - GHydro_t - Losses_t$$

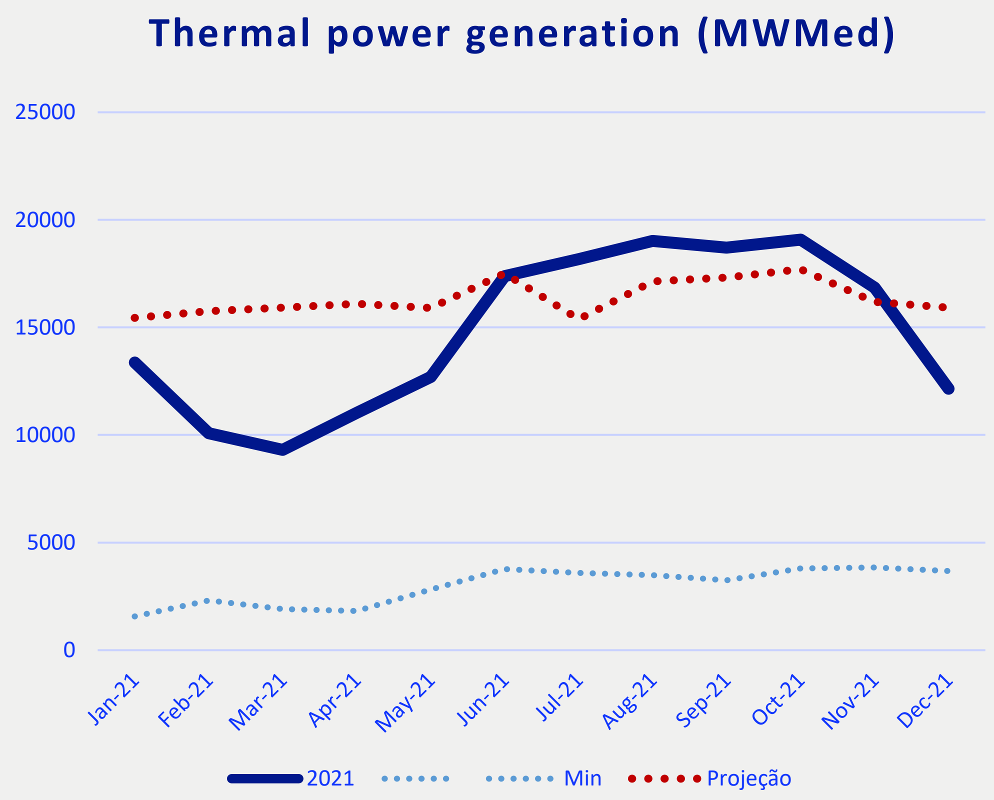
$$GHydro_t = Load_t - GOthers_t - Interchange_t$$

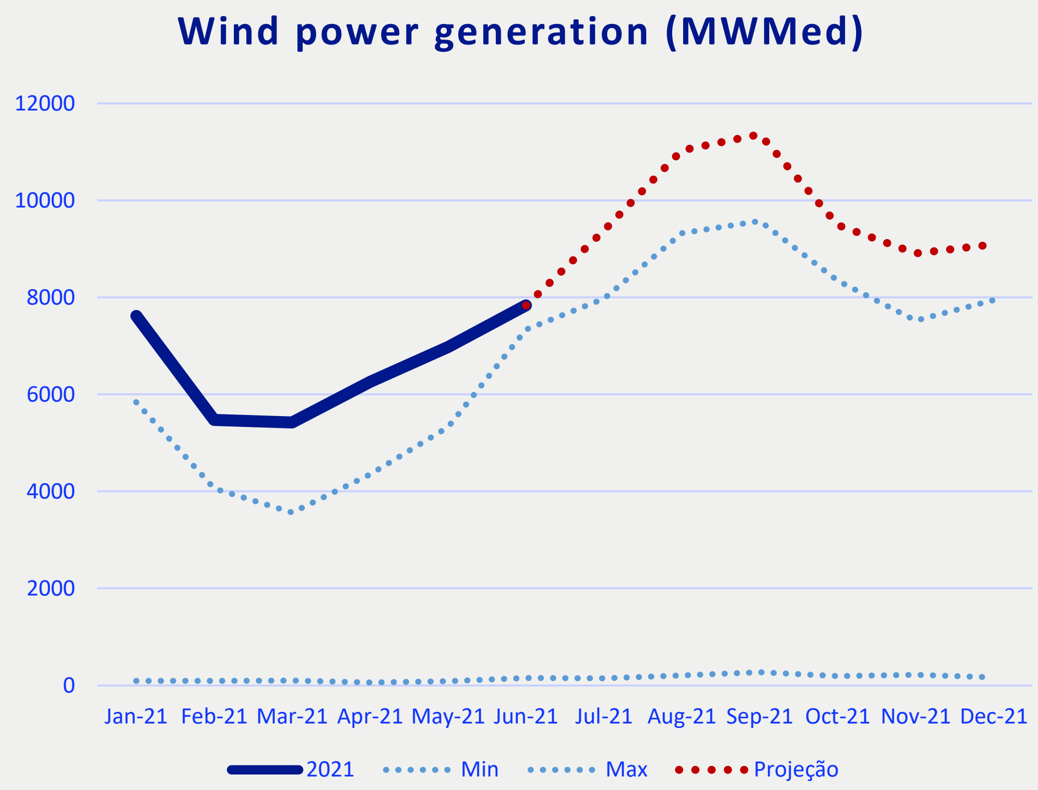
- The level of the reservoirs depends on the demand for energy, transmission capacity, energy generation by other sources, losses, and, mainly, the level of rainfall. The increase/decrease in reservoir levels is given by balancing the amount of inflow, hydraulic generation, and system losses.
- Within the framework of the simplified model of reservoir dynamics presented above, some hypotheses on the following variables might be considered.
    i. $GOthers_t$ and $Interchange_t$ – energy generation by other sources and export or import of energy between subsystems, respectively.
    ii. $ENA_t = f(Capacity_t/Rain_t)$ - total affluence in the reservoirs.
    iii. $Load_t = f(GDP_t, Temperature_t, Load_{-1})$ - demand for energy.
- In the following slides, we will discuss our assumptions for these variables and the result of simulations for the reservoir level in the coming months.

Source: ONS, Mar Asset Management

# *GOthers:* Thermal generation increased in June

- In our base scenario, we consider that power generation by thermal plants will remain at the same level of June 2021. Despite being the highest level for the month, it is still below the installed capacity. For the wind energy scenario, we used the CCEE projectionS of generation for the rest of the year.




Source: ONS, Mar Asset Management

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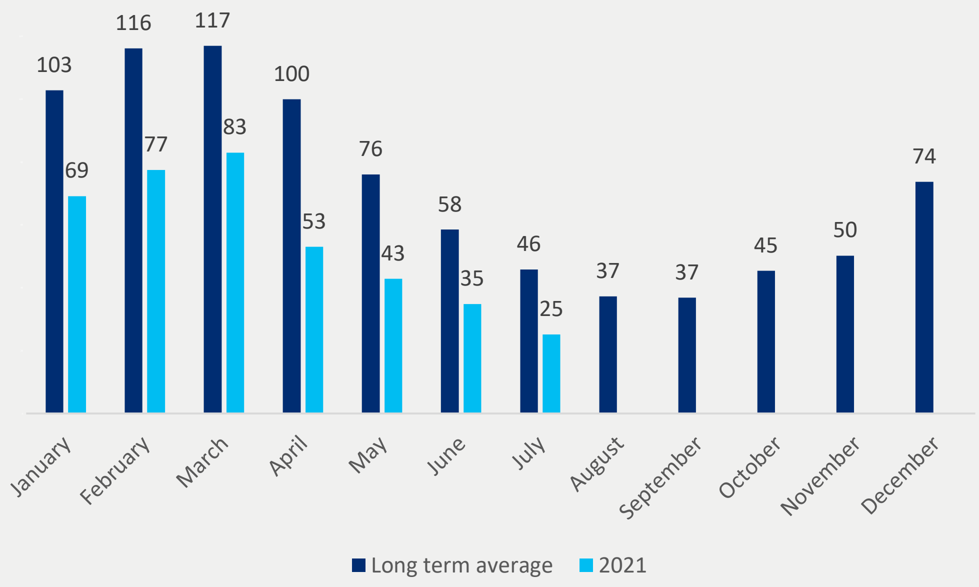
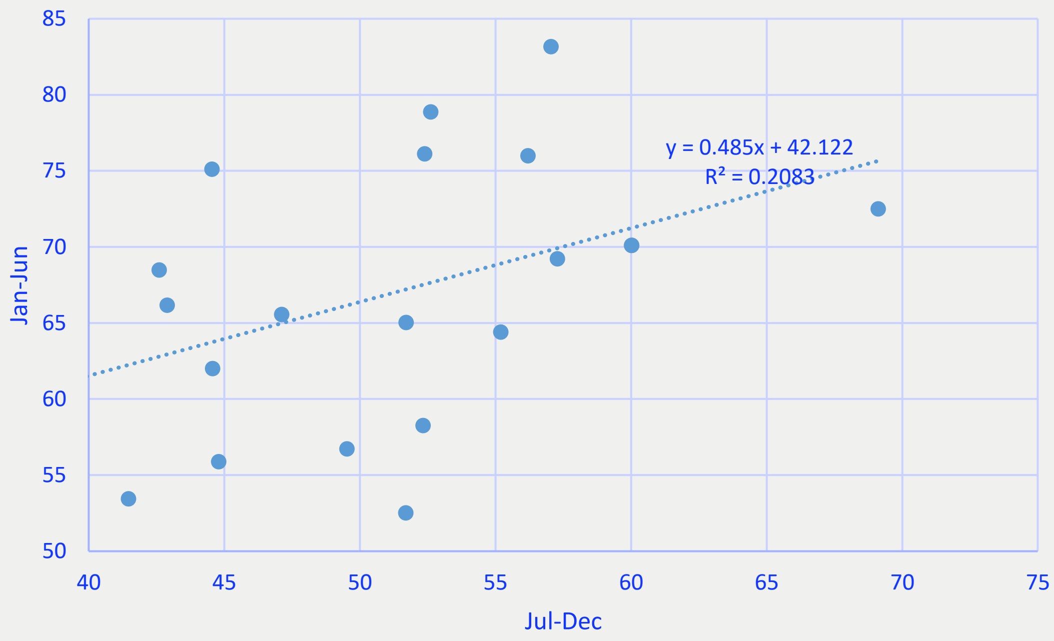
# *ENA:* Rainfall is well below the historical average

- Brazil is experiencing the worst drought in 91 years. The Affluent Natural Energy (ENA) that reaches the reservoirs in the 2021 rainy season was well below the historical standard.
- Although there is a positive relationship, the correlation is not very high between ENA in the first semester and ENA in the second semester. The rest of the year may present an improvement in the rainfall pattern with an impact on the level of the reservoirs.

**ENA Storable - Historical Average (MWMed, thousands)**




**Relationship between ENA in the 1st and 2nd semester (MWMed, thousand)**

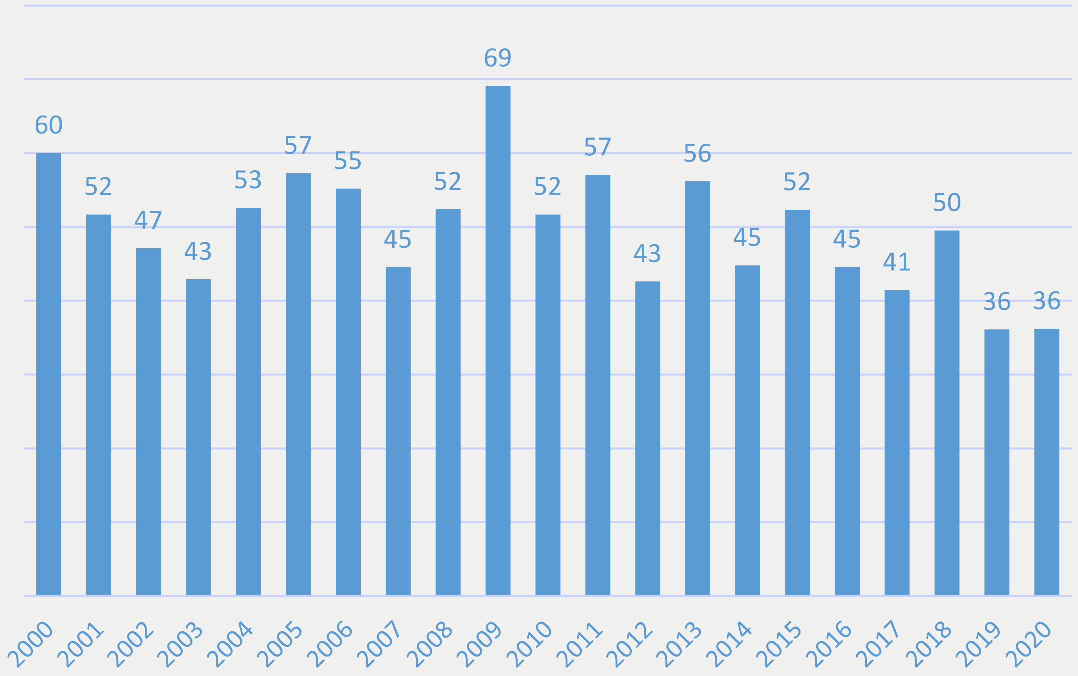



Source: ONS, Mar Asset Management

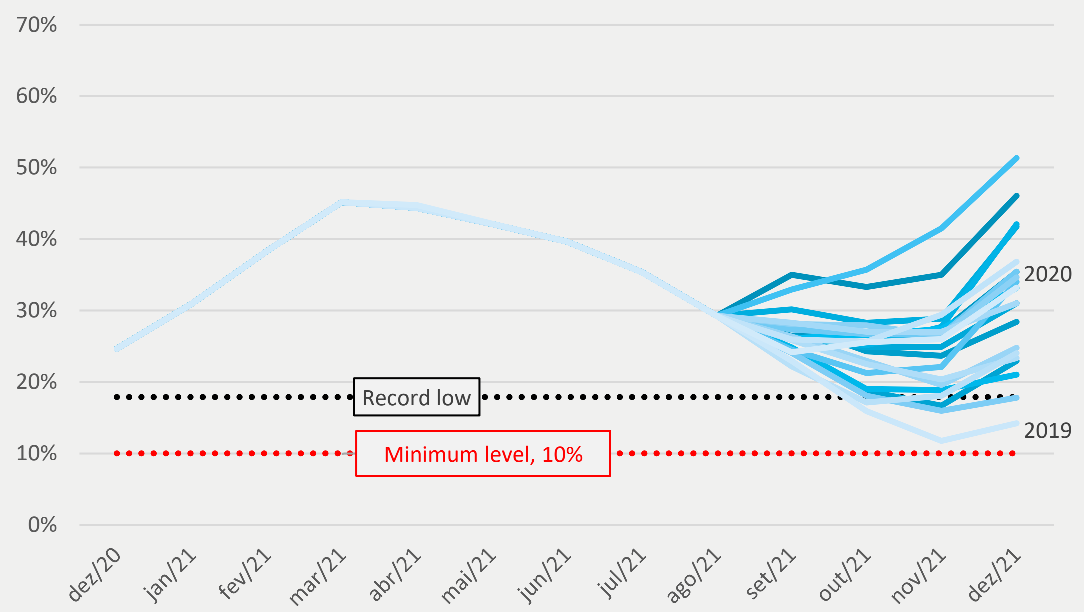
# *ENA:* Low risk of rationing even with drought

- According to our simulations, the rationing risk is low. Considering the water flow to the reservoirs over the last 20 years and the above assumptions for the generation of energy through other sources, the level of the reservoirs on December 21 would be very similar to that seen in December 2020.

**Storable ENA between July and December of previous years (MWMed, thousand)**




**Projection for the Level of the SIN Reservoirs (% of capacity)**

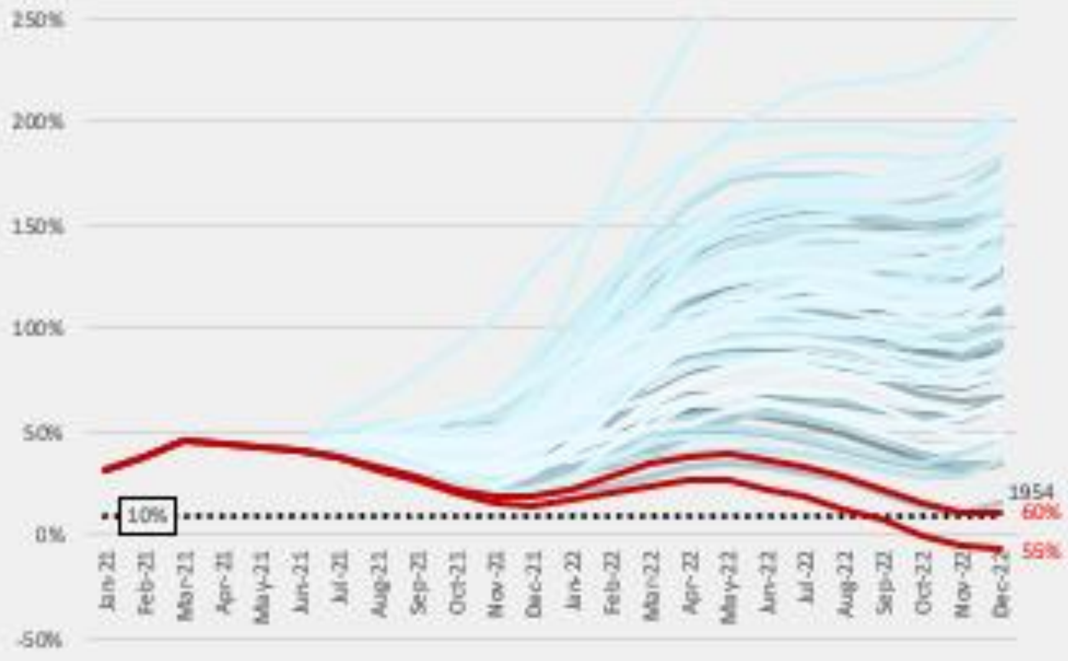



Source: ONS, Mar Asset Management

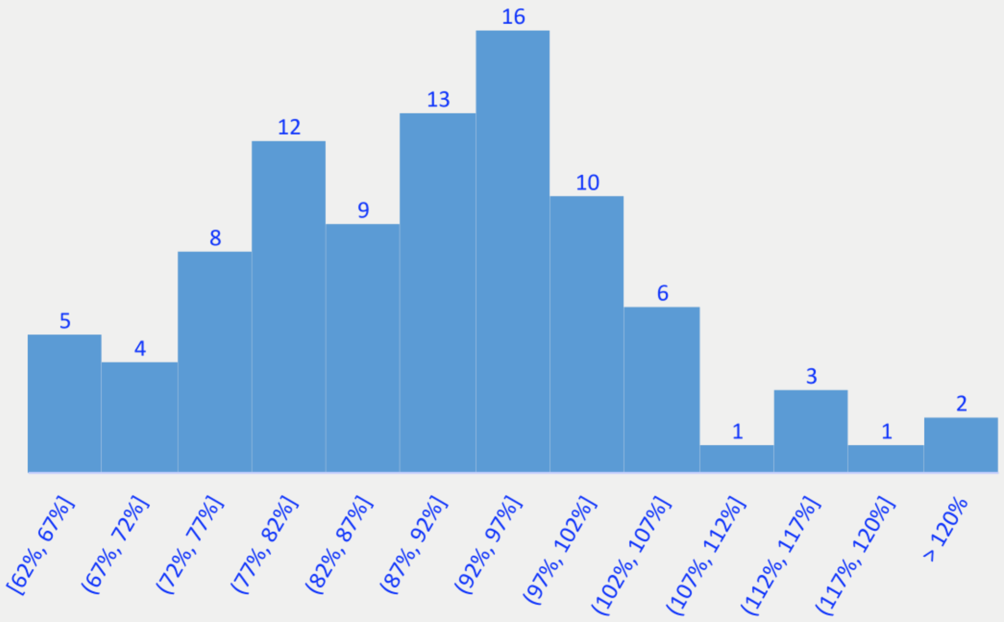
# *ENA:* Rainfall at 60% would push reservoirs to the limit

- A rainfall level of 60% in 12 months, which was necessary to bring us to a situation similar to that of 2001, would be compatible with the lowest ENA observed since 1931. Even at this level, the reservoirs would be above 10% by the end of 2022. Once the thermal plants are turned on at their highest capacity, and there are no big surprises in the growth of the load and generation from other sources, there is a low risk of a rationing scenario. Since 1931, not a single year has had ENA 60% below the historical average.

**Projection for the level of SIN reservoirs based on ENAs between 1931 and 2020 (% of capacity)**



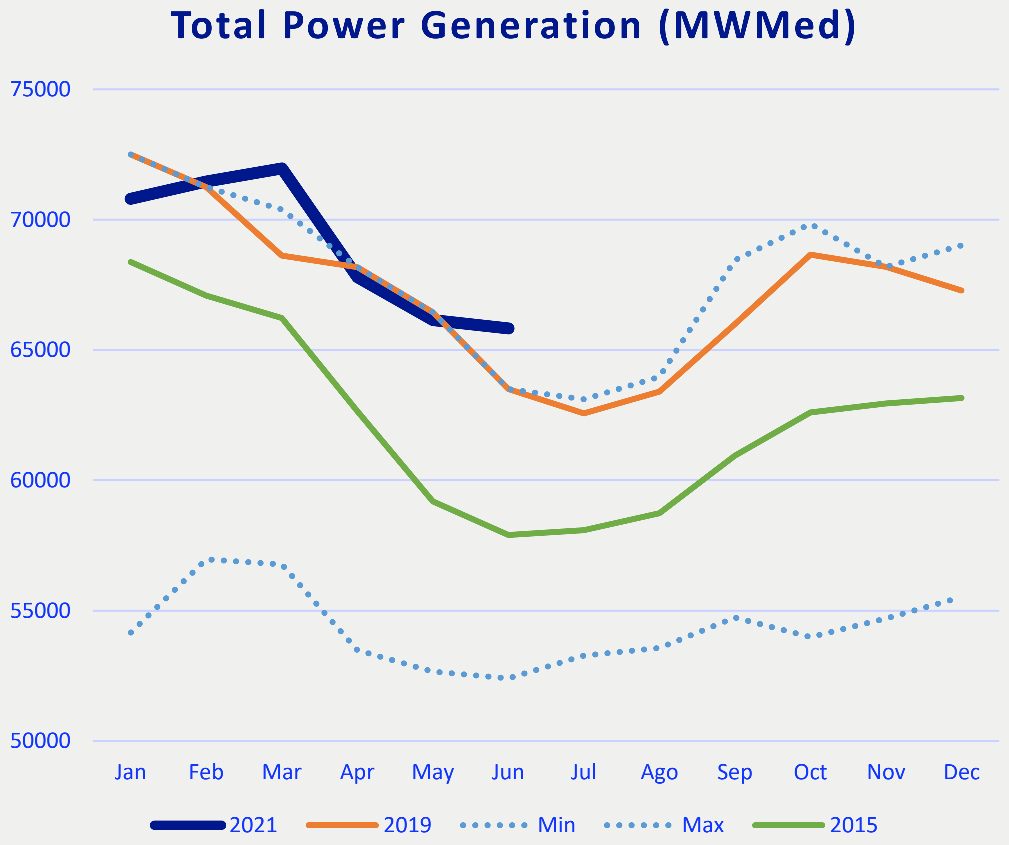

**Distribution of ENAs in relation to % of the long-term average between 1931 and 2021 (frequency)**

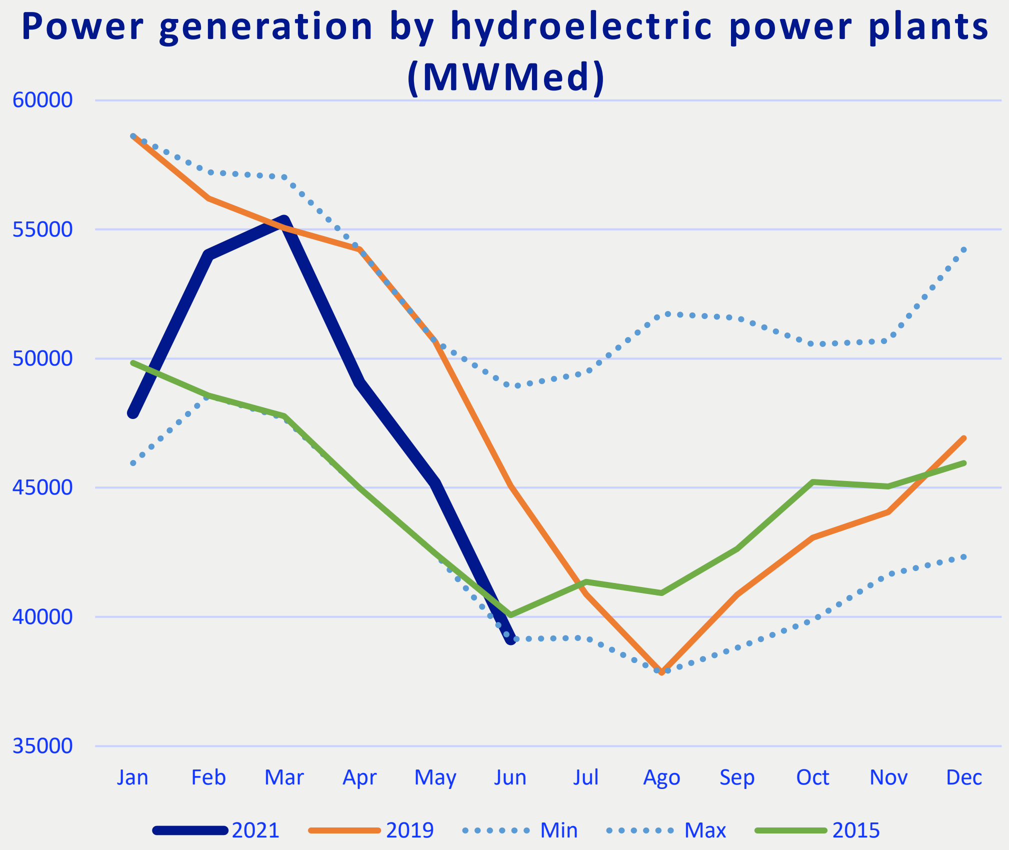



Source: ONS, Mar Asset Management

# *Load:* Energy demand in early 2021 was record

- Demand for energy between January and June 2021 was the highest for the period in the historical series. At the same time, the generation by hydroelectric plants was not very high. In June, in particular, the generation by this source was the smallest in the last ten years.




Source: ONS, Mar Asset Management

# *Load:* Energy demand increases with activity

- There is a direct relationship between GDP growth and electricity consumption. Our growth projection of ~6.0% for 2021 is compatible with growth in energy demand of 5.0%. In the second half of 2021, growth would be 2.5% compared to the same period in 2020.
- One of the reasons why the demand for energy at the beginning of this year should be pretty high is the growth in the industrial sector. Industry accounts for 35% of total energy consumption, while it accounts for ~20% of GDP. With the recovery of the economy concentrated in this sector, the energy demand increased more than the load/GDP ratio would suggest.

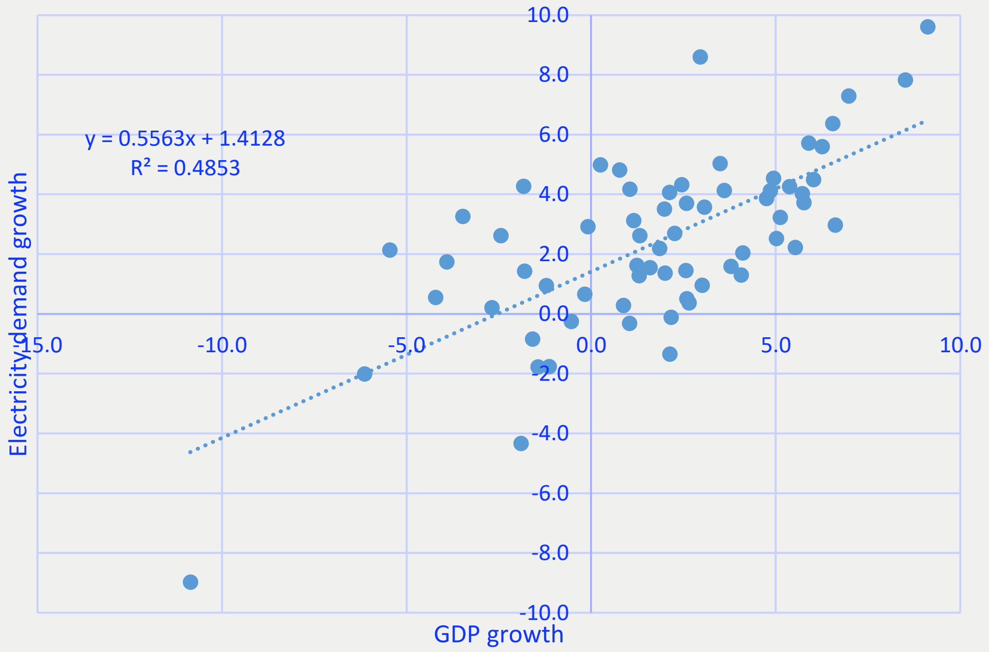
## Energy consumption per sector (GWh)

| | Part. % (2012) | 2012 | 2019 | 2020 | Part. % (2020) |
|---|---|---|---|---|---|
| **Brazil** | **100%** | **448.126** | **482.226** | **475.648** | **100%** |
| Residential | 26.3 | 117.646 | 142.781 | 148.173 | 31.15 |
| Industrial | 40.9 | 183.425 | 167.684 | 166.335 | 34.97 |
| Comercial | 17.7 | 79.226 | 92.075 | 82.522 | 17.35 |
| Rural | 5.1 | 22.952 | 28.87 | 30.908 | 6.50 |
| State | 3.1 | 14.077 | 15.752 | 12.764 | 2.68 |
| Streetlights | 2.7 | 12.196 | 15.58 | 15.463 | 3.25 |
| Public Services | 3.2 | 14.525 | 15.958 | 16.345 | 3.44 |
| Own Consumption | 0.7 | 3.36 | 3.257 | 3.138 | 0.66 |

## Relationship between energy demand growth and GDP growth before 2020 (millions)

| Growth vs. 2020 | | | | | | |
|---|---|---|---|---|---|---|
| **GDP** | 4.5% | 5.0% | 5.5% | 6.0% | 6.5% | 7.0% |
| **Energy** | 4.4% | 4.6% | 4.8% | 5.0% | 5.1% | 5.3% |

GDP vs. electricity demand

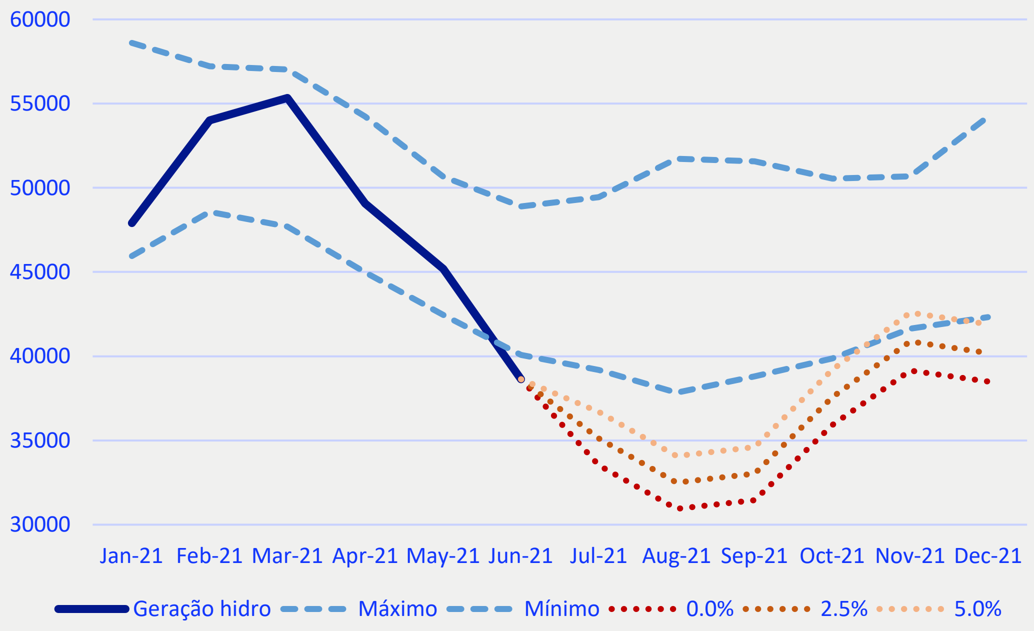



Source: IBGE, CCEE, ONS, Mar Asset Management

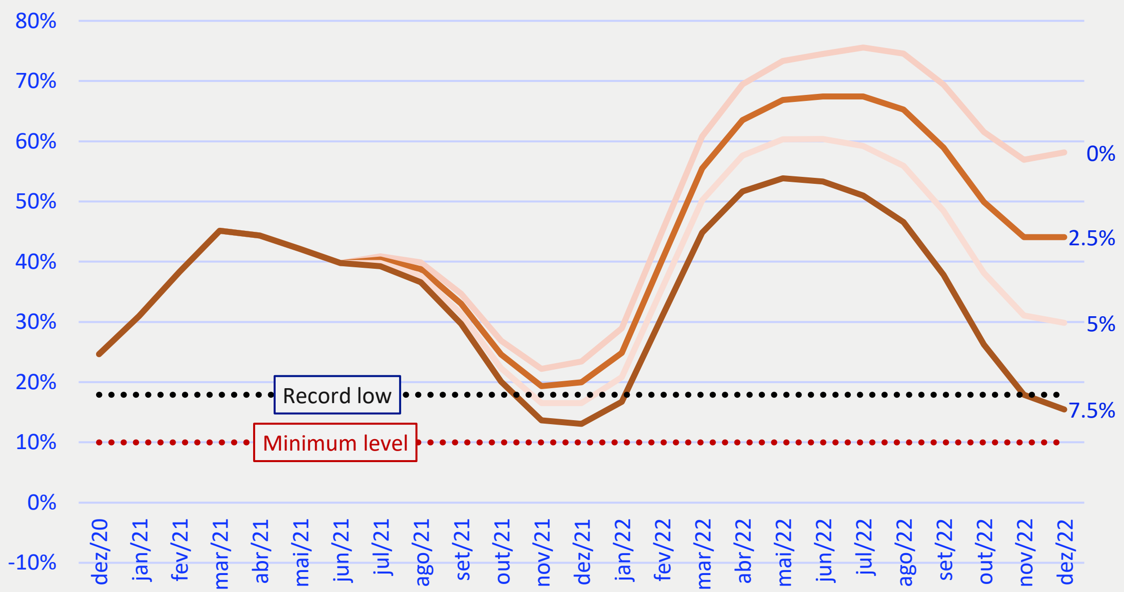
# *Load:* Reservoirs will not limit growth

- Assuming hydrology is equal to that of 2020, which was quite negative, the reservoir level would reach lows only if there is a very high demand growth for energy. Our GDP growth projection of 6.0%, which implies an estimated growth of 2.5% in load in the second half of the year compared to the same period in 2020, is compatible with reservoirs still above the historical minimum level. Even if growth is much stronger, reservoirs would remain above the minimum level.

**Hydraulic power generation in different load growth scenarios (MWMed)**




**Level of SIN reservoirs growths other than energy demand (% of total)**

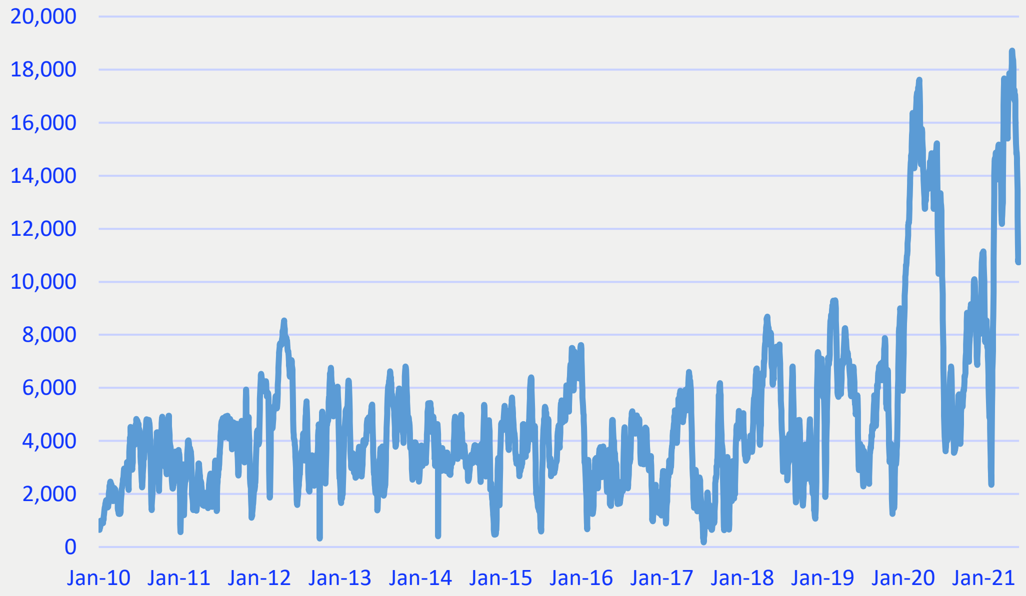



Source: ONS, Mar Asset Management

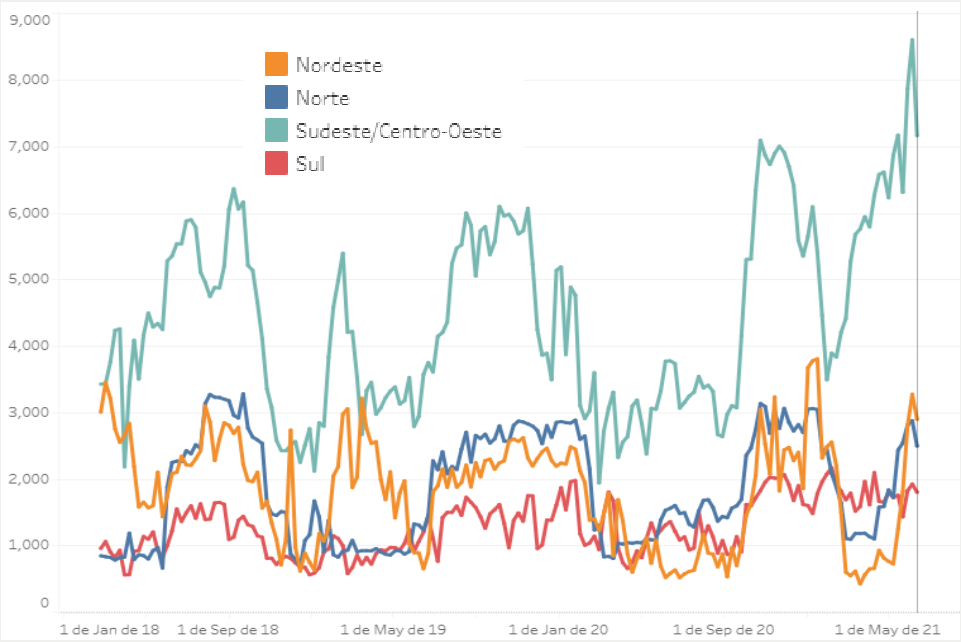
# Energy *exchange* has decreased in recent weeks

- The energy exchange was the largest in history in mid-May. At the beginning of this year, as well as at the beginning of 2020, the exchange towards the SE/CO subsystem was much higher than the historical average. This led many specialists watchful for the possibility of blackouts, as the system was operating close to its limit.
- As most of the increase in thermal generation occurred in the SE/CO subsystem, the exchange of energy between systems has decreased in recent weeks.

**Energy exchange with SE/CO subsystem as final destination (MWMed)**




**Thermal power generation (MWMed)**




Source: ONS, Mar Asset Management

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# *Losses:* we assumed 8% losses for the rest of 2021

- In the model we used to simulate the level of the reservoirs, we had to make hypotheses about energy losses (residue from the reservoir model on Slide 6). Within these losses, any other factors not considered in our central model are included. For example energy import, water evaporation in reservoirs, friction, lower than expected power, etc. We adopt a hypothesis that the losses will continue to be about 8% of the monthly ENA.

## Basic model for reservoir dynamics

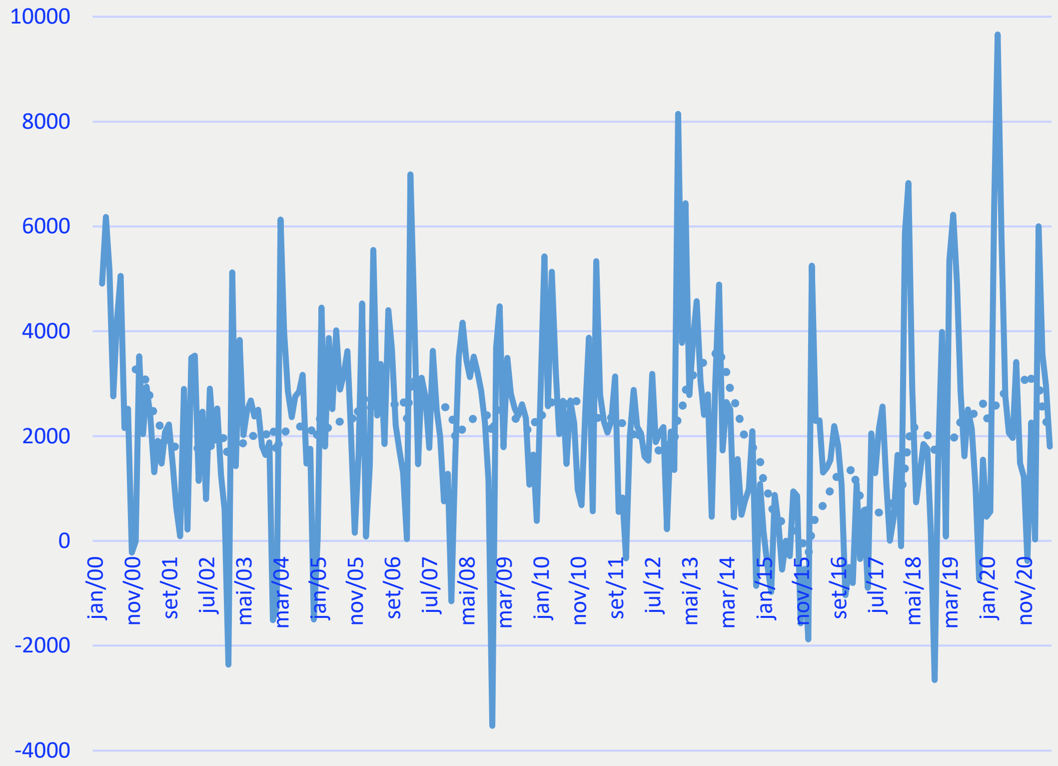
| 2021 Scenario | MLT (Storable) | ENA estimates (Storable) | ENA (Storable) | Other Generation Sources: Thermal | Other Generation Sources: Wind | Other Generation Sources: Solar | Other Generation Sources: Nuclear | Demand* | Hydro Friction Factor | Energy Balance | Reservoirs @ Max Capacity | Balance / Reservoir | Reservoirs Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | MWavg. | % | MWavg. | MWavg. | MWavg. | MWavg. | MWavg. | MWavg. | -8.0% | MWavg. | MWavg. | % | % |
| Jan-21 | 102,472 | 67.3% | 68,931 | 13,436 | 7,618 | 705 | 1,850 | 72,427 | (5,514) | 14,598 | 290,231 | 5.0% | 31.0% |
| Feb-21 | 115,774 | 66.7% | 77,213 | 10,133 | 5,474 | 621 | 1,846 | 73,044 | (945) | 21,298 | 290,231 | 7.3% | 38.3% |
| Mar-21 | 116,854 | 71.0% | 82,919 | 9,364 | 5,421 | 752 | 1,848 | 72,810 | (7,611) | 19,882 | 290,231 | 6.9% | 45.2% |
| Apr-21 | 99,866 | 53.0% | 52,954 | 10,137 | 6,260 | 733 | 1,542 | 68,960 | (4,940) | (2,274) | 290,231 | -0.8% | 44.4% |
| May-21 | 75,984 | 56.4% | 42,849 | 11,845 | 6,980 | 746 | 1,450 | 66,383 | (3,990) | (6,503) | 290,231 | -2.2% | 42.1% |
| Jun-21 | 58,426 | 60.4% | 35,274 | 16,774 | 7,977 | 789 | 851 | 65,936 | (2,498) | (6,769) | 290,231 | -2.3% | 39.8% |
| Jul-21 | 45,833 | 80.0% | 36,666 | 18,500 | 9,374 | 921 | 1,750 | 64,351 | (2,933) | (73) | 290,231 | 0.0% | 39.8% |
| Aug-21 | 37,269 | 80.0% | 29,815 | 18,500 | 11,036 | 997 | 1,750 | 65,289 | (2,385) | (5,576) | 290,231 | -1.9% | 37.9% |
| Sep-21 | 36,873 | 80.0% | 29,499 | 18,500 | 11,363 | 1,104 | 1,750 | 68,128 | (2,360) | (8,272) | 290,231 | -2.9% | 35.0% |
| Oct-21 | 42,876 | 80.0% | 34,300 | 18,500 | 9,486 | 947 | 1,750 | 70,889 | (2,744) | (8,649) | 290,231 | -3.0% | 32.0% |
| Nov-21 | 50,194 | 80.0% | 40,155 | 18,500 | 8,911 | 896 | 1,750 | 70,527 | (3,212) | (3,526) | 290,231 | -1.2% | 30.8% |
| Dec-21 | 73,633 | 80.0% | 58,907 | 18,500 | 9,094 | 899 | 1,750 | 69,453 | (4,713) | 14,984 | 290,231 | 5.2% | 36.0% |

Source: BTG, Mar Asset Management

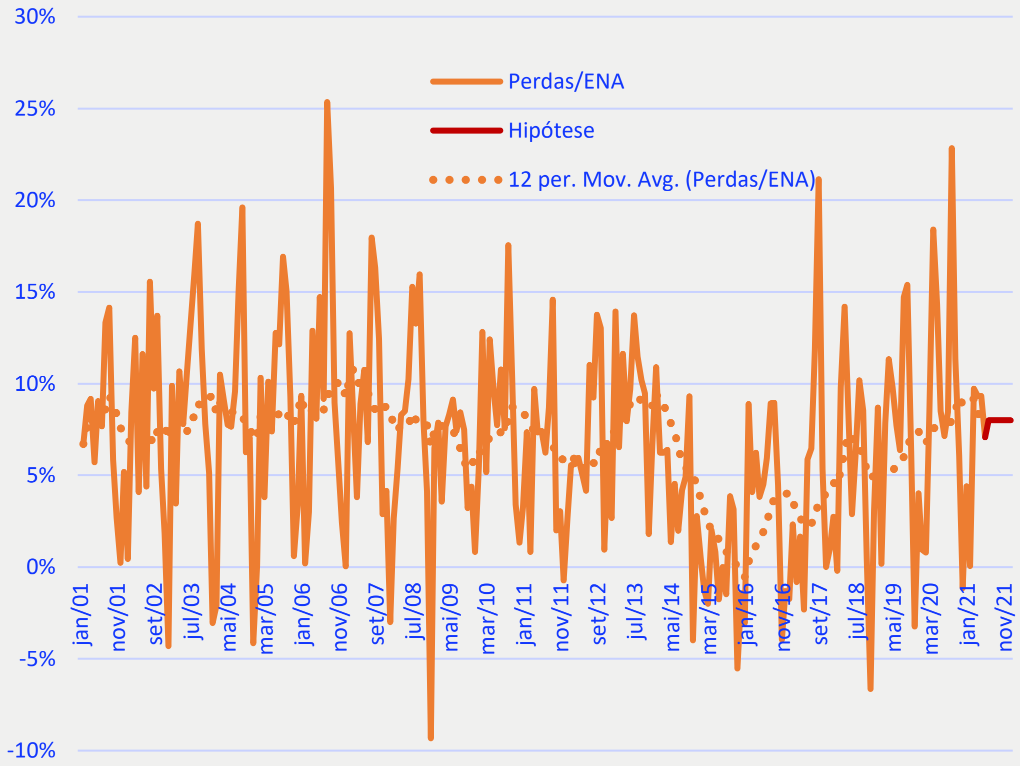
# *Losses:* we assumed 8% losses for the rest of 2021

- The losses of the reservoirs (reduction of the reservoirs that were not transformed into power generation) were, on average, just above 2 thousand GWh per month between 2000 and the beginning of 2014. This loss was greatly reduced between 2015 and 2019 and, more recently, returned to the 2,000 level. In our scenarios, we consider that losses remain close to the recent level.

**Reservoir losses (GWh)**




**Losses as % of storable ENA (%)**

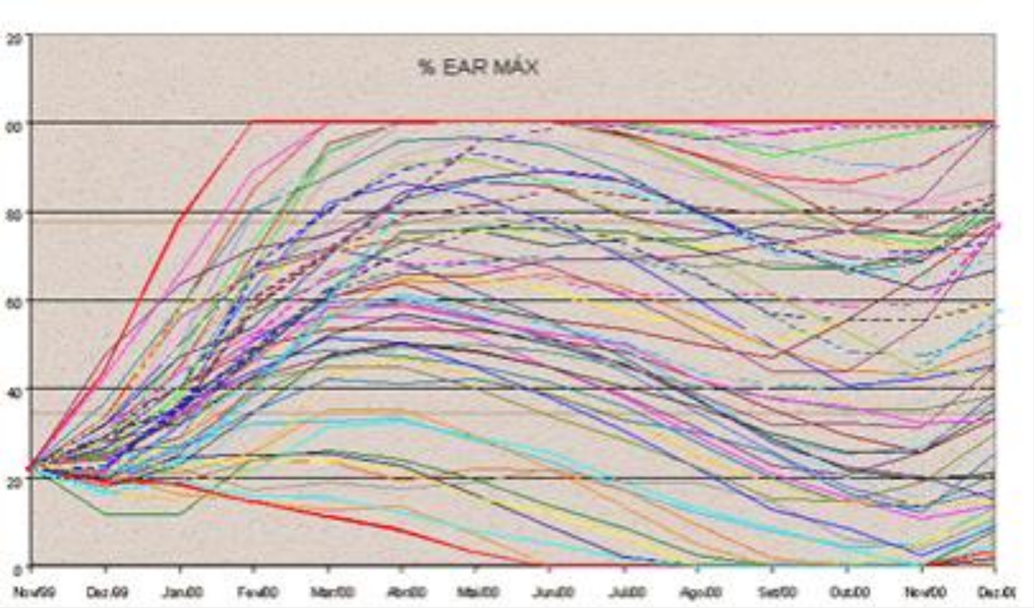



Source: ONS, Mar Asset Management

# Chronology of the 2001 rationing

- **End of 1999:** The National System Operator (ONS) simulates hydrological scenarios for 2000 based on the level of the reservoirs on November 30, 1999. **The report concludes that reservoir levels would reach *zero* in 14% of these scenarios.**
- **Feb-2000:** The Ministry of Mines and Energy (Mme) creates the Priority Thermal Program (PPT) to increase the generation capacity of thermoelectric plants as the "single solution" for a possible system collapse
- **Jul-2000:** In a meeting with the president and his economic advisors, the Mme minister dismisses the chances of any energy crisis in the 2000-2003 period.
- **Dec-2000:** ONS projects a scenario for 2001 without an energy crisis.
- **Feb-2001:** Hydrological conditions reach 70% of the long-term average, and ONS radically changes the forecast for 2001.
- **Mar-2001:** ONS officially asks for an intervention from the federal government to ensure the reduction of 20% of the load.
- **Apr-2001:** PPT fails, and Mme starts designing an incentive-based load reduction program.
- **May-2001:** The government announced a temporary energy saving program to be implemented on June 4th. This announcement gets a lot of media attention.
- **Jun-2001:** The temporary energy saving program is implemented and, from the beginning, should last until February 2002, the end of the next rainy season (Veja, July 19, 2001).
- **Feb-2002:** Domestic fines and threats of power cuts have been lifted.

**Simulation carried out by ONS in 1999 for hydroelectric reservoirs (% of total)**




Source: Costa e Gerard (2020), Mar Asset Management

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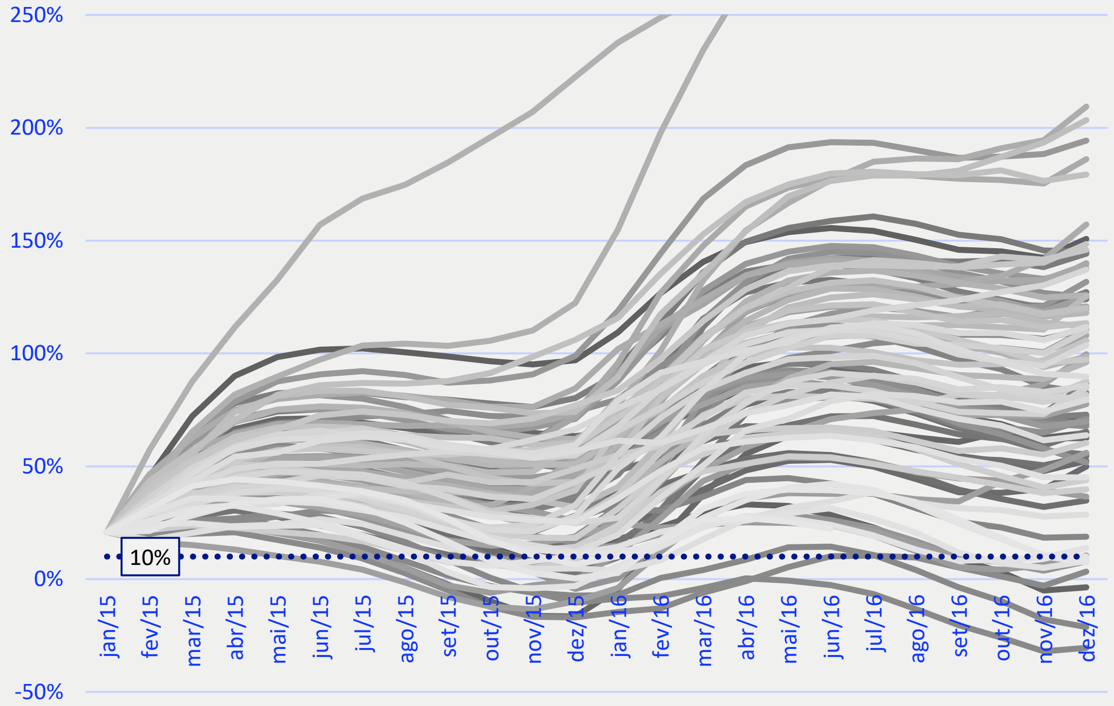
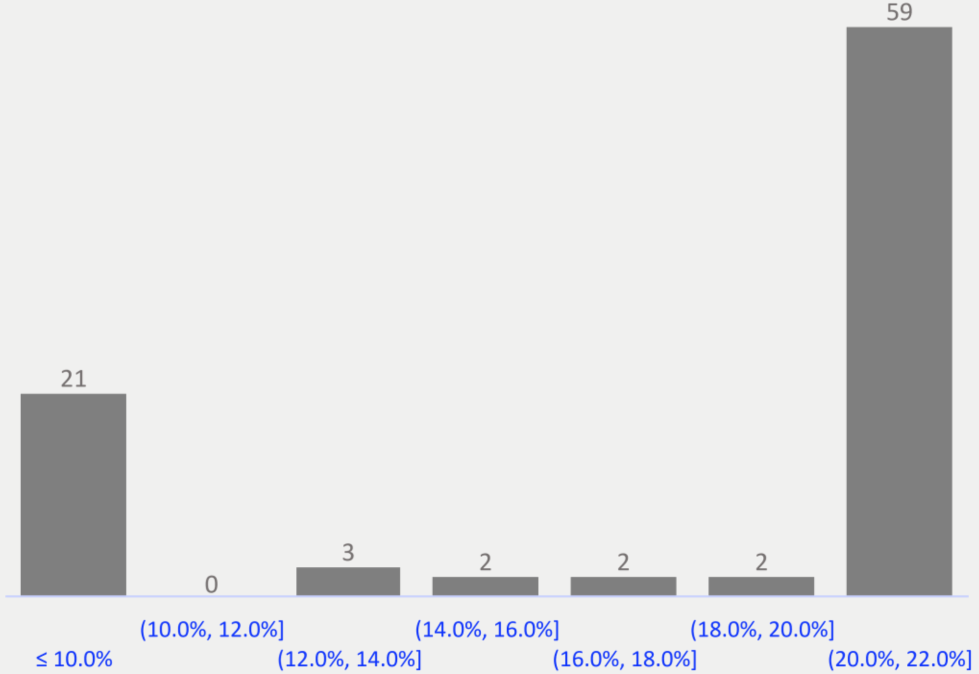
# Situation in January of 2015 was worse

- Similar simulations made from January 2015, taking into account the observed reservoir level and differences in installed capacity, show that the probability of rationing in that period was very high. Considering the historical ENAs, in 21 situations (24% of the total), reservoirs would have reached below 10% between 2015 and 2016.

**Projection for the level of SIN reservoirs in 2015 based on ENAs between 1931 and 2020 (% of capacity)**




**Distribution of the minimum level of the reservoirs in each historical ENA scenario (frequency)**

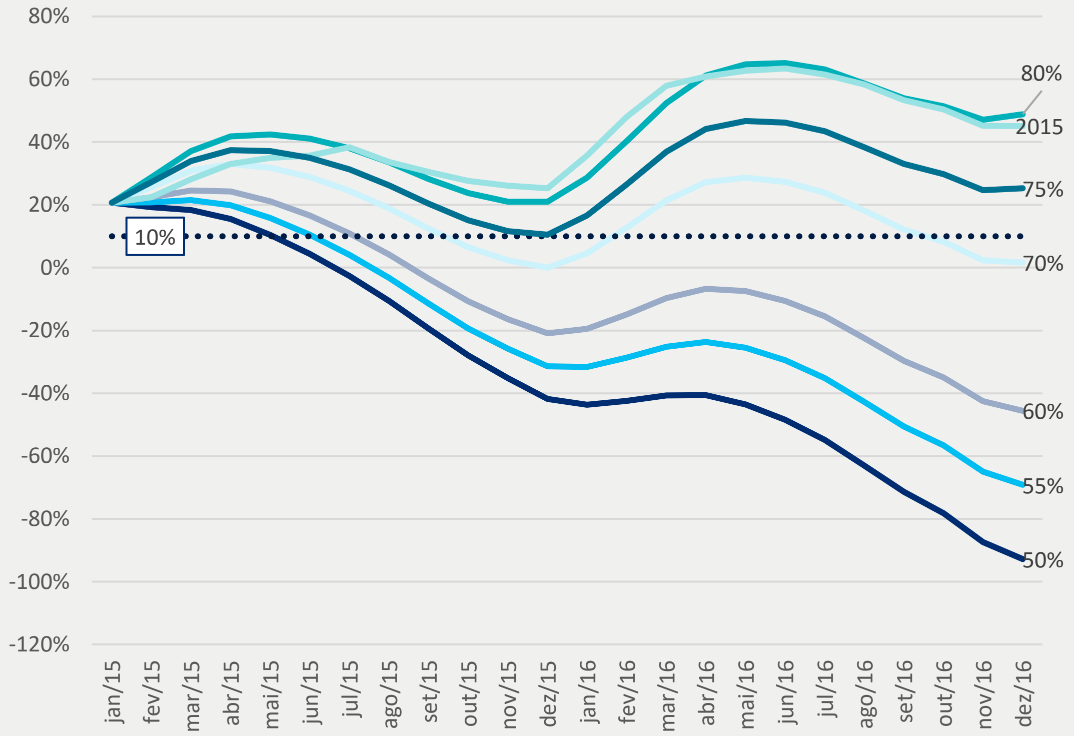



Source: ONS, Mar Asset Management

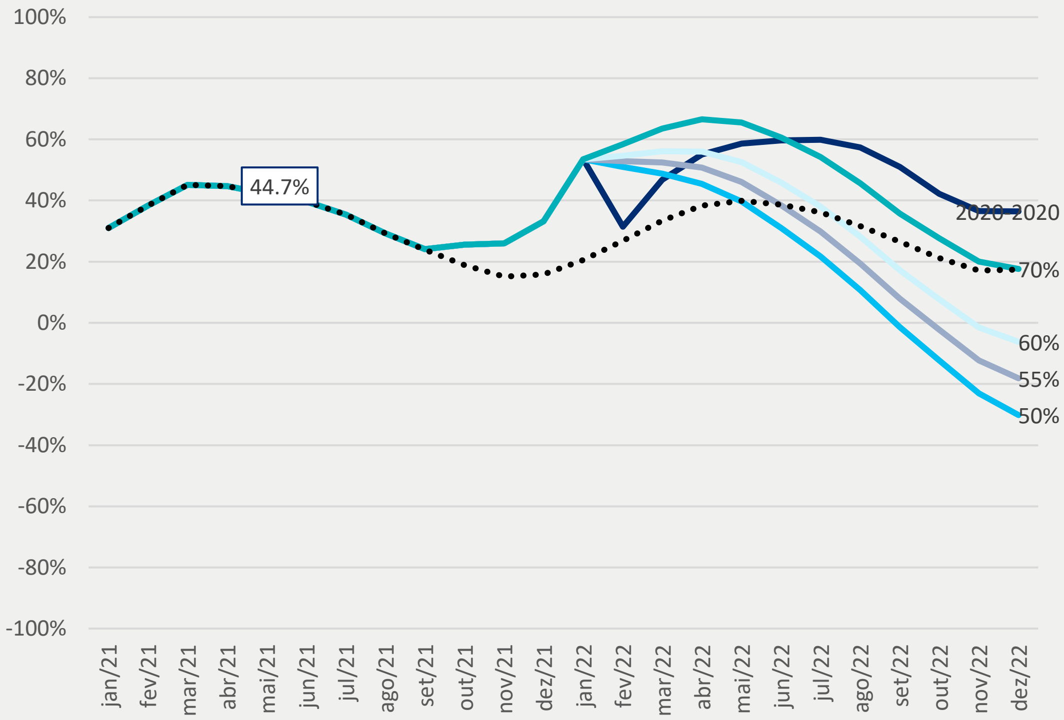
# Situation in January of 2015 was more challenging 2

- An ENA of 60% of the historical average by the end of 2022 would be sufficient to keep the reservoirs above the 10% level. In 2015, an ENA above 75% of the historical average would be required. In the end, the rains that came in 2015 and 2016 were close to 80% and the load fell more than expected due to the strong contraction of GDP in the biennium.

**Level of SIN reservoirs in 2015 with different scenarios for ENAs (% of capacity)**




**Level of SIN reservoirs in 2021 with different scenarios for ENAs (% of capacity)**




Source: ONS, Mar Asset Management

# 60% of average rainfall would lead to a situation similar to 2001

- Brazil has been through several water crises in the last two decades. However, only in 2001 did the government decree an energy rationing. The situation in 2001 was quite different regarding the diversification of the energy matrix and SIN integration.
  - In June 2001, when the rationing was decreed, (a) the reservoirs of the S and SE/CO subsystems were at 30.1% at the time (60.3k MWMed) of their total capacity, (b) the maximum energy import was about 3.6k MWMed and (c) the generation of other energy sources was 4.5k MWMed. Under these conditions, the reservoirs could supply the energy load for 2.4 months.
  - In June 2021, (a) SIN reservoirs are at 40.8% of their total capacity (118k MWMed); (b) energy exchange is no longer a *binding* restriction for the reservoir level exercise, so our simulations are for the risk of rationing the entire SIN and not a subsystem; (c) generation from other sources is at 30.4k. Under these conditions, the reservoirs can supply the energy load for 3.1 months. This is a low level but has already been seen recently. We saw similar situations in June 2014, 2015, 2017, and 2018.
- We simulated scenarios for different levels of ENAs and load increase for the next 12 months to know which combinations would lead to a situation in Jun-2022 similar to that observed in Jun-2001, when rationing was necessary. For example, if the load increases by 3% and the ENA is 60% of the long-term average, then the total months covered by the reserves in the reservoir would be only 2.5.

## Load, interchange, generation by other plants and Stored Energy (thousands, MWMed)

| | Jun-01 | Jun-14 | Jun-15 | Jun-17 | Jun-18 | Jun-21 |
|---|---|---|---|---|---|---|
| Load | 32.8 | 60.2 | 63.3 | 64.8 | 66.0 | 68.1 |
| Max interchange | 3.7 | N/A | N/A | N/A | N/A | N/A |
| Max Others Generation | 4.5 | 21.8 | 23.0 | 26.3 | 27.0 | 30.5 |
| EAR | 60.3 | 127.6 | 112.6 | 124.8 | 122.1 | 118.1 |
| **Covered months** | **2.4** | **3.3** | **2.8** | **3.2** | **3.1** | **3.1** |

## Simulation of months covered by reservoirs in June 2022 for different scenarios of ANSD and load growth

| Load / ENA | 0% | 1% | 2% | 3% | 4% | 5% |
|---|---|---|---|---|---|---|
| **55.0%** | 2.2 | 1.9 | 1.7 | 1.5 | 1.3 | 1.0 |
| **57.5%** | 2.7 | 2.5 | 2.2 | 2.0 | 1.8 | 1.5 |
| **60.0%** | 3.2 | 3.0 | 2.7 | 2.5 | 2.3 | 2.0 |
| **62.5%** | 3.7 | 3.5 | 3.2 | 3.0 | 2.8 | 2.5 |
| **65.0%** | 4.3 | 4.0 | 3.8 | 3.5 | 3.3 | 3.0 |
| **70.0%** | 5.3 | 5.0 | 4.8 | 4.5 | 4.3 | 4.0 |
| **80.0%** | 7.4 | 7.1 | 6.8 | 6.5 | 6.3 | 6.0 |

Source: ONS, Mar Asset Management

# Rotating reserve is indicative of occasional blackouts

- Most of the blackouts in recent years have been due to issues in power generation or transmission equipment. Only in 2015 there was a blackout, ordered by ONS, due to the lack of energy production capacity in the country. In January, the load is always higher due to higher temperatures and greater use of air conditioning.
- In the days around the 2015 blackout, the Girante Reserve of energy was below the recommended level, historically something very rare to occur. A drop in this indicator would be an indication that the system is operating close to its limit.

## Recent history of blackouts in Brazil

| Date | Description |
|---|---|
| 22/01/05 | A failure at the Furnas substation in Cachoeira Paulista, São Paulo, caused a one and a half hour blackout in Rio de Janeiro, Espírito Santo and in some cities of Minas Gerais. |
| 07/09/07 | The two states were again hit by power shutdown caused by problems in Furnas. |
| 10/11/09 | A short-circuit in Furnas system transmission lines, caused by a storm, brought down three high-voltage lines and caused a shut down on Itaipu plant. 18 states were hit, with São Paulo, Rio de Janeiro, Espírito Santo and Mato Grosso do Sul being completely without energy during the night. In some places, the interruption lasted more than seven hours. |
| 04/02/11 | Issues in the transmission line of Companhia Hidrelétrica de São Francisco (CHESF) caused Paulo Afonso, Xingó and Luiz Gonzaga plants shutdown. Eight states in the Northeast ran out of power for approximately three hours. |
| 03/10/12 | A new blackout due to failure in the Itaipu transformer affected five states. The blackout affected areas of Paraná, Rio de Janeiro, Minas Gerais, Acre, Rondônia and part of the Midwest.[13] |
| 04/10/12 | Due to the general shutdown of the Brasília Sul Substation, controlled by Furnas Centrais Elétricas, Brasília also faced a power outage around 1:15 pm on October 4, 2012 that lasted for more than 2 hours. |
| 25/10/12 | Due to a fire in an equipment, 9 states of the Northeast Region and part of the Region North ran out of power during 3 hours. |
| 12/12/12 | A blackout hit municipalities in at least six states of the country, leaving 2.7 million consumers without energy only in Rio de Janeiro and São Paulo. The blackout was caused by an issue at the Itumbiara hydroelectric plant in Goiás, owned by Furnas. It was the fifth blackout since September 2012 |
| 28/08/13 | An electricity blackout hit areas in the Northeast of the country at 3:03 pm on Wednesday (28), as reported by ONS (National Electric System Operator). There are reports of power outages in Salvador (BA), Fortaleza (CE), Recife (PE), João Pessoa (PB) and Natal (RN). |
| 04/02/14 | About 6 million consumers were affected by the lack of energy in the Southeastern, Central-Western and Southern states, according to the ONS director's estimates. The blackout that hit at least 11 states in the country originated from a short circuit in a transmission line in the state of Tocantins |
| 11/02/14 | More than 40 cities ran out of power in the ES, including the capital Vitória, due to a failure in a Furnas substation. |
| 19/01/15 | A blackout hit part of 10 states (SP,RJ, ES, PR, SC, RS, GO, MG, MS, RO) and the DF causing electricity shortages to more than 3 million consumer units. The causes, according to the energy concessionaires, were an order from ONS to reduce the load due to a peak of energy that exceeded the country's production capacity. Around 3:45 p.m. the situation began to normalize. The low level of hydroelectric power plants reservoirs and the excessive heat contributed to the event. |

## Generation at rush hour on 1/19/15 and on 7/13/21 (MWMed)

| Submarket | Synchronized Available Generation | Verified Generation | Rotating Reserve | Recommended Power Reserve |
|---|---|---|---|---|
| SE/CO | 44,875 | 44,594 | 281 | 1,529 |
| S | 16,850 | 16,352 | 228 | 402 |
| NE | 10,424 | 10,073 | 351 | 356 |
| N | 9,223 | 8,535 | 688 | 272 |
| SIN | 81,102 | 79,553 | 1,549 | 2,559 |

Synchronized Available Generation = Installed Power - Power Lost due maintance, restriction of generation units and units switched off for operating convenience.

| Operating Area | Synchronized Availability (a) | Verified Generation (b) | Rotating Reserve | Hour |
|---|---|---|---|---|
| COSR-NE | 17,091 | 16,129 | 963 | 18:44:00 |
| COSR-N | 20,563 | 18,923 | 1,640 | |
| COSR-SE | 30,509 | 27,339 | 3,170 | |
| COSR-S | 18,121 | 17,442 | 678 | |
| SIN | 86,284 | 79,833 | 6,451 | |

Source: ONS, Mar Asset Management

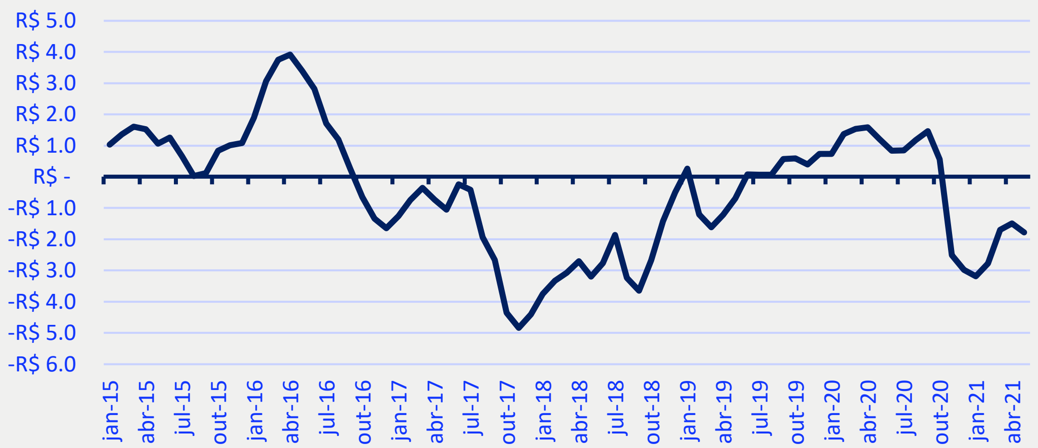
# Readjustment of the flags with an impact of 0.2pp on IPCA

- The cost of energy generation depends on how many thermal plants are being used. Aneel adopts a system of flags, which implements tariff adjustments to accommodate times when the cost of generation in the system is high. The balance of the tariff flag account allows us to monitor the balance between the current tariff and the operating costs.
- Aneel revised its tariff flag values at the end of June. Red flag 2 went to R$9,49/10MWh. With this adjustment, the total impact on the IPCA of the flag went from 0.45pp to 0.68pp. The new level of red flag 2 is enough to increase the monthly collection to 2.3 billion.

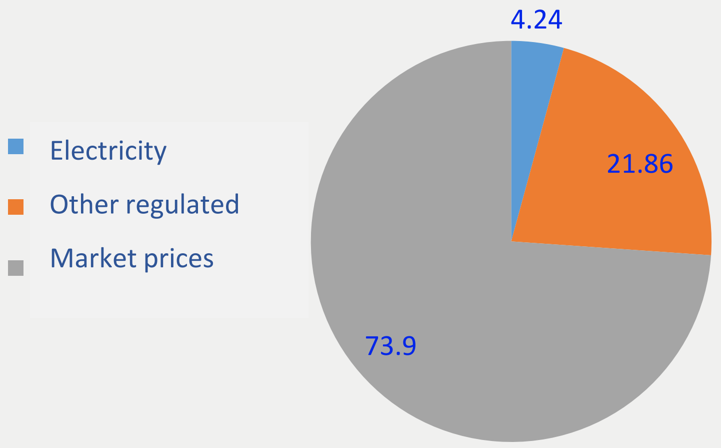
## Tariff flag, monthly collection and impact on IPCA (R$, p.p)

| | Values (R$/100MWh) | | Monthly Revenue (billion) | | Impact IPCA (p.p.) | |
|---|---|---|---|---|---|---|
| | Old | New | Old | New | Old | New |
| Green | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Yellow | 1.34 | 1.87 | 0.32 | 0.45 | 0.09 | 0.13 |
| Red 1 | 4.17 | 3.97 | 1.00 | 0.95 | 0.29 | 0.28 |
| Red 2 | 6.24 | 9.49 | 1.50 | 2.28 | 0.45 | 0.68 |

## Tariff flag account balance (R$, billions)




## Weight on IPCA

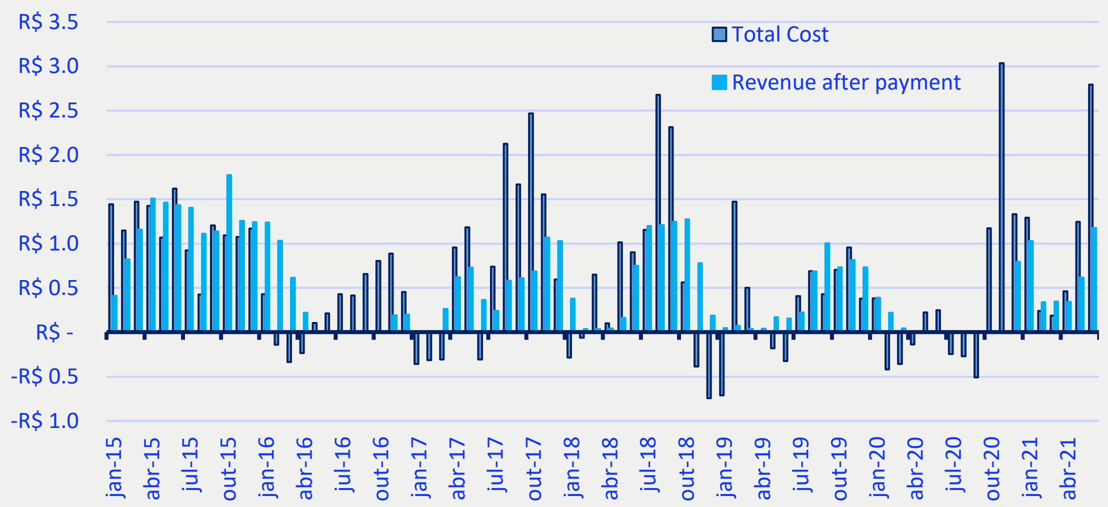



Source: IBGE, Aneel, Mar Asset Management

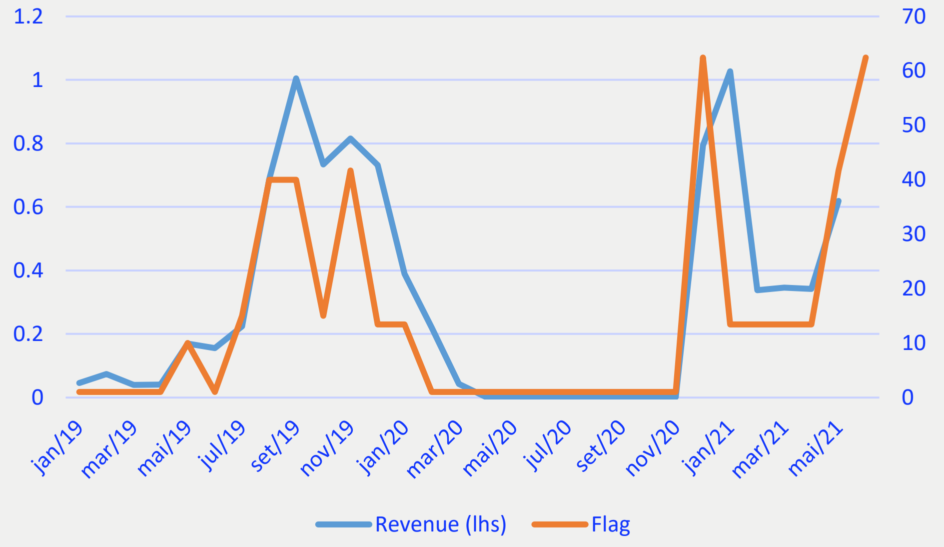
# Surplus for 2022 should not be greater than 0.1pp of the IPCA

- The impact on the IPCA in 2022 will depend on the costs not covered by the tariff flags. A spike in the expenses, as seen last November, for a very long period has a potential impact on the 2022 IPCA of up to 0.3pp:
  - In July, the red flag level 2 was triggered. This level is enough to increase the collection by ~2.3 billion per month.
  - In November 2020, when thermal generation was similar to today's, the additional cost with generation was 3 billion.
  - Each 1.25 billion more per month represents 10% more electricity tariffs. A deficit of 0.75 billion per month in the second half of 2021 would imply a negative tariff flag account balance of 4.5 billion at the end of 2021. This would mean a 3% increase in the energy tariff to be paid in a year, all the more constant. The impact on the IPCA would be 0,1pp.

**Monthly balance of the Tariff Flags Account (R$billion - link)**




**Tariff flag and monthly collection (R$billion, R$/MWh)**




Source: CCEE, ANEEL, Itaú, Mar Asset Management

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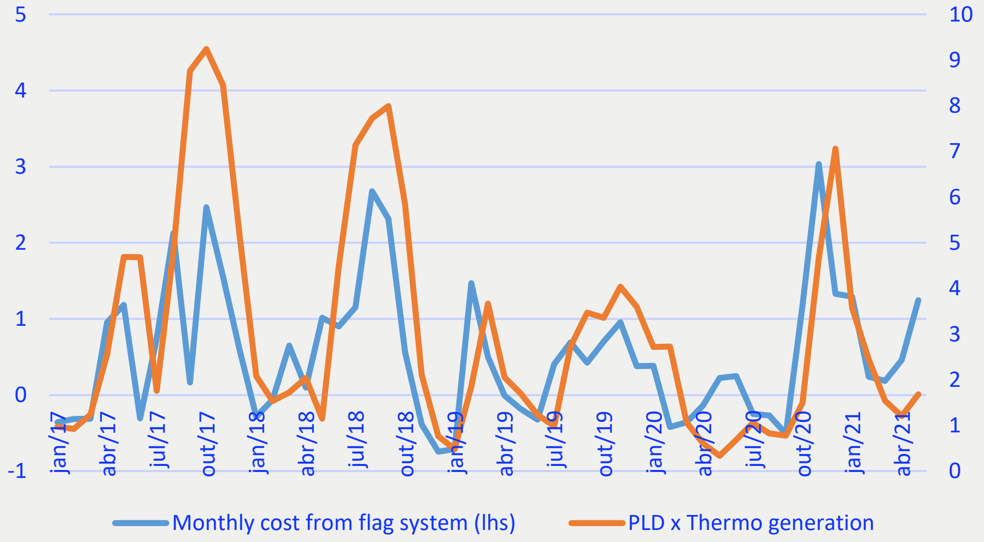
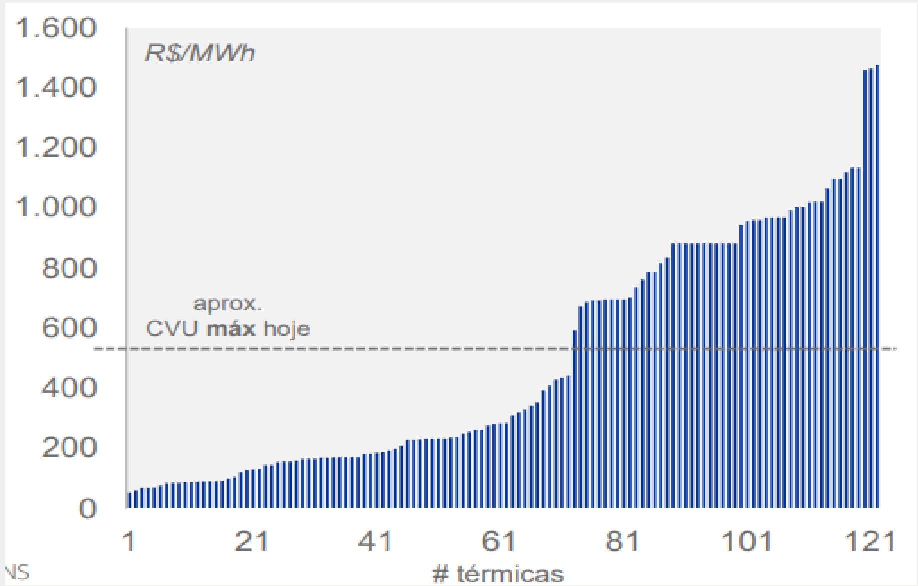
# PLD is a good proxy for generation costs

- The PLD seems to be the best proxy for estimating the size of the drought impact on the IPCA. The generation cost not covered by the standard electricity tariff follows the dynamics of this price a lot. At the beginning of July, for example, the PLD was at its maximum value (R$583/MWMed), compatible with a generation cost of more than 3 billion per month.
- The operating cost is non-linear concerning the use of thermal plants. Not all thermal plants have the same cost of energy production. Thermal plants that are more expensive are always left for use only in emergencies. This implies that a marginal worsening of the energy framework that requires the activation of the most costly thermal plants would lead the PLD to increase significantly.

**Additional generation cost and PLD (R$billion, R$MWh- link)**




**Thermal generation supply curve (R$billion, R$/MWh)**




Source: CCEE, ANEEL, Itaú, Mar Asset Management

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