Generation

November/2022

1. General Concepts

What you need to know...

- ✓ Which institutions determine the direction of the sector?
- ✓ What are the main variables for the Brazilian electricity sector?
- ✓ What are the characteristics of each generation source?

1.1 Sector Overview

Institutional Framework

Policies

National Congress
Laws

Presidency of the Republic - Decrees

CNPE
Defines energy policy to ensure supply stability

MME
Planning, management and development of legislation. Supervision and control of policy execution

CMSE
Oversees supply continuity and reliability

EPE - Generation and transmission expansion planning

Regulation and Inspection

ANEEL – Regulates and supervises generation, transmission, distribution and commercialization

Institutional Agents

ONS
Controls the operation and dispatch of the SIN (National Interconnected System) plants

CCEE
Manages market transactions in the ACR and ACL (clearing house) and conducts official auctions

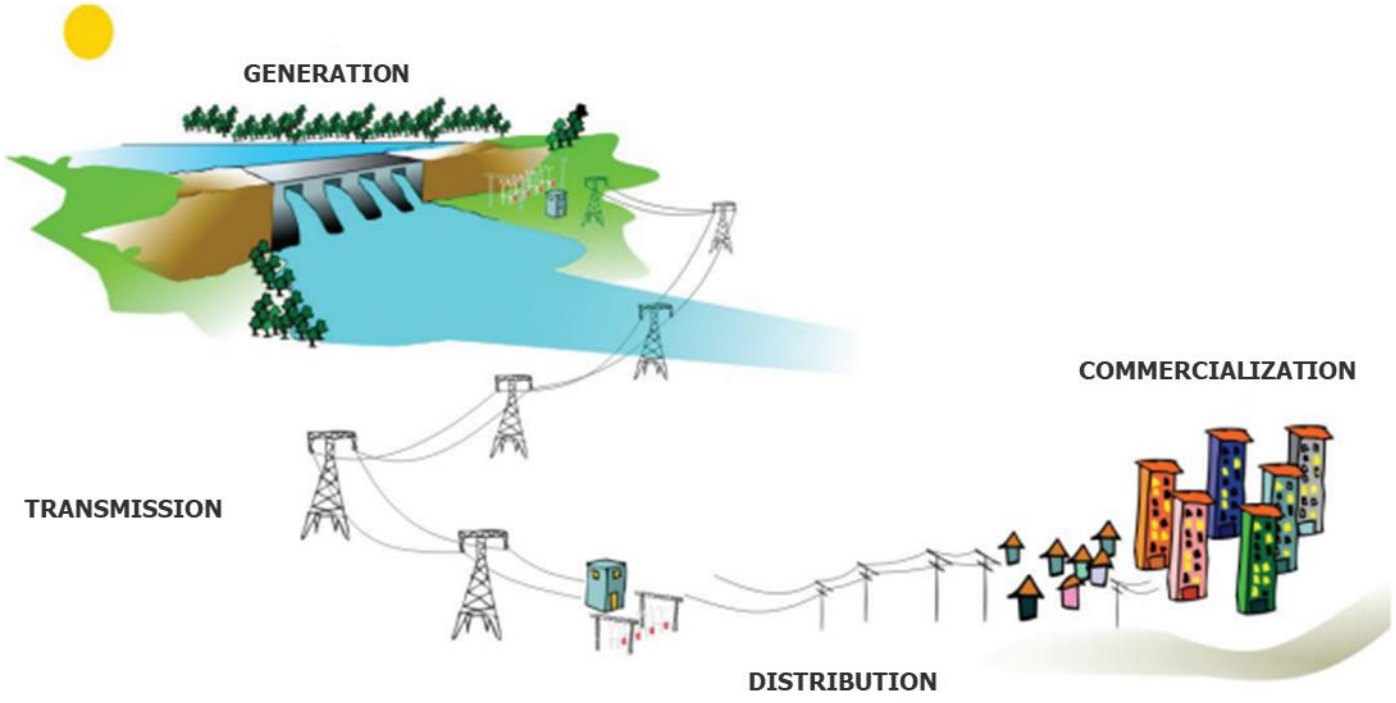
Segments

Generation | Transmission | Distribution | Commercialization

CONSUMER

CPFL ENERGIA

Overview: Generation in the Electric Sector



Source: ANEEL

Generation Sources

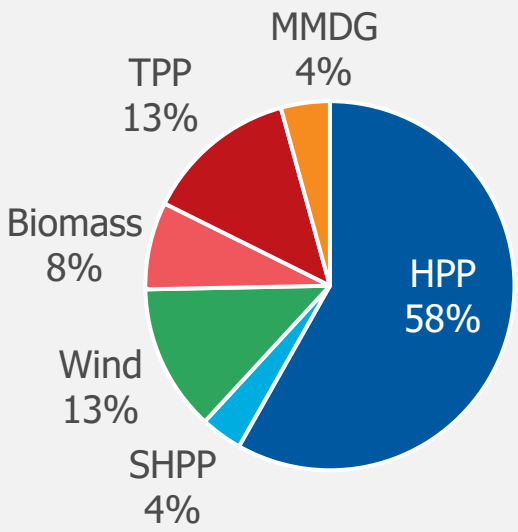
The generation of electrical energy involves the transformation of primary sources (gravitational, thermal and kinetic potential energy) into electricity.

Among the sources of energy generation in Brazil are: **hydroelectric, wind, solar, biomass, fossil fuels and nuclear**.

Brazilian Electrical Matrix

Evolution of Installed Capacity (GW)[1]

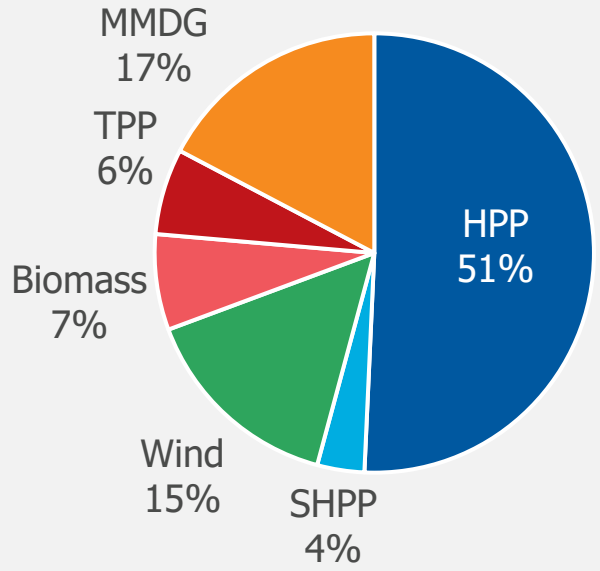
Dec/21



187 GW

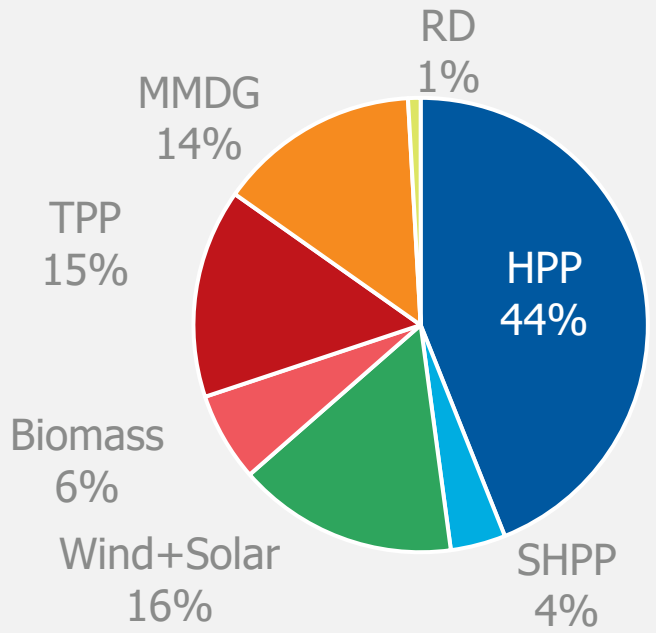
Contracted

Dec/31



215 GW

Reference Scenario



260 GW

A growth of **1.6%** per year is already **contracted**, driven mainly by MMDG (+29 GW) and wind (+9 GW).
EPE estimates in its reference scenario an even greater expansion, of **3.7%** per year, mainly due to thermal plants, according to energy policy guidelines.

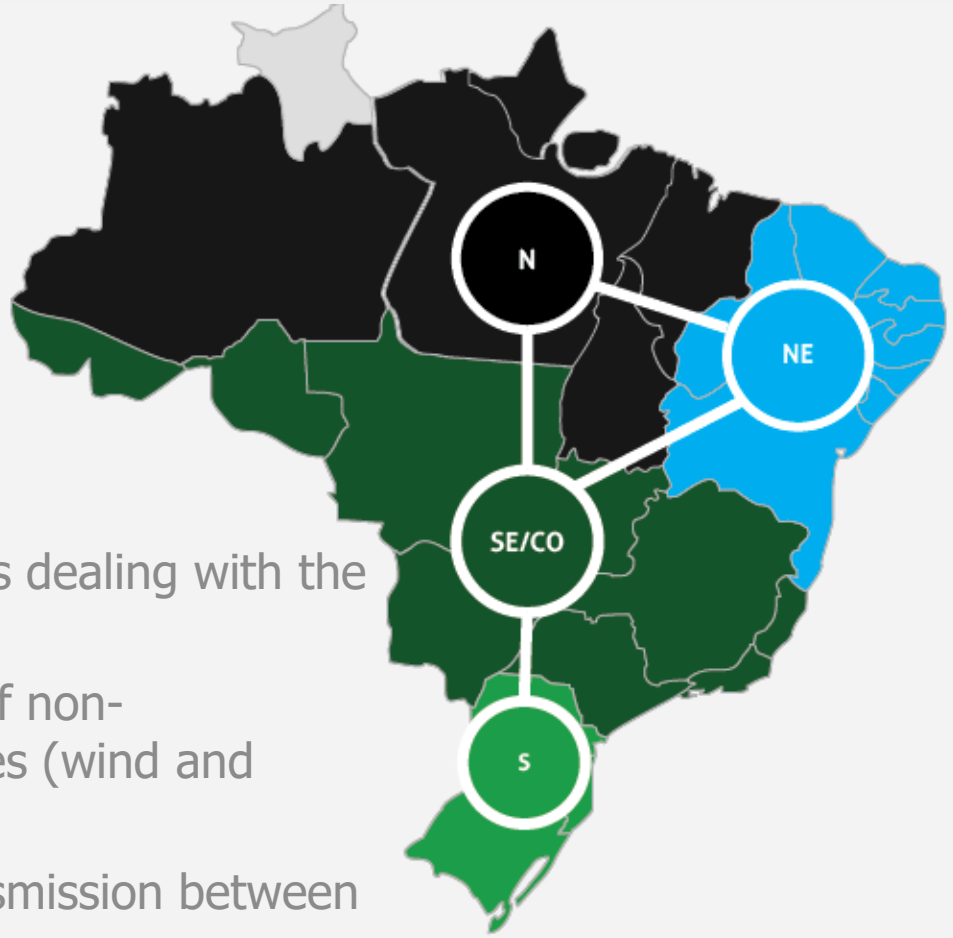
1) Source: EPE - Ten Year Plan 2031 – p. 70 and 106.

ONS Dispatch

It is up to the ONS to operate the SIN in an integrated, equitable, transparent and neutral way to **ensure the security and continuity of the power supply**, always at the lowest possible cost.

For this, ONS acts on 3 fronts:

- Transmission administration
- Operation planning and scheduling
- Real-time operation



In practice, this means dealing with the complexity of:

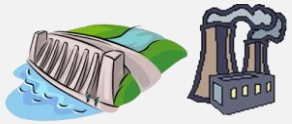
- Strong expansion of non-dispatchable sources (wind and solar)
- Limitations on transmission between subsystems
- Run-of-the- river Hydroelectric plants
- High costs in thermal dispatch

Electric Sector Model - Contracting Environments

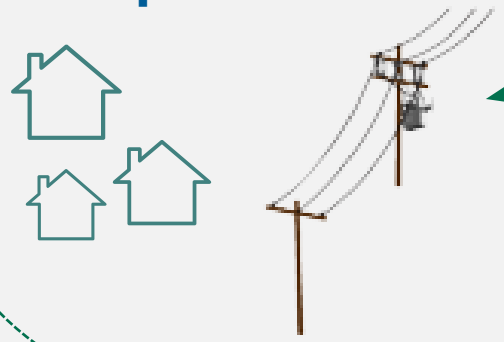
Free Contracting Environment (ACL)

Regulated Contracting Environment (ACR)

Generators



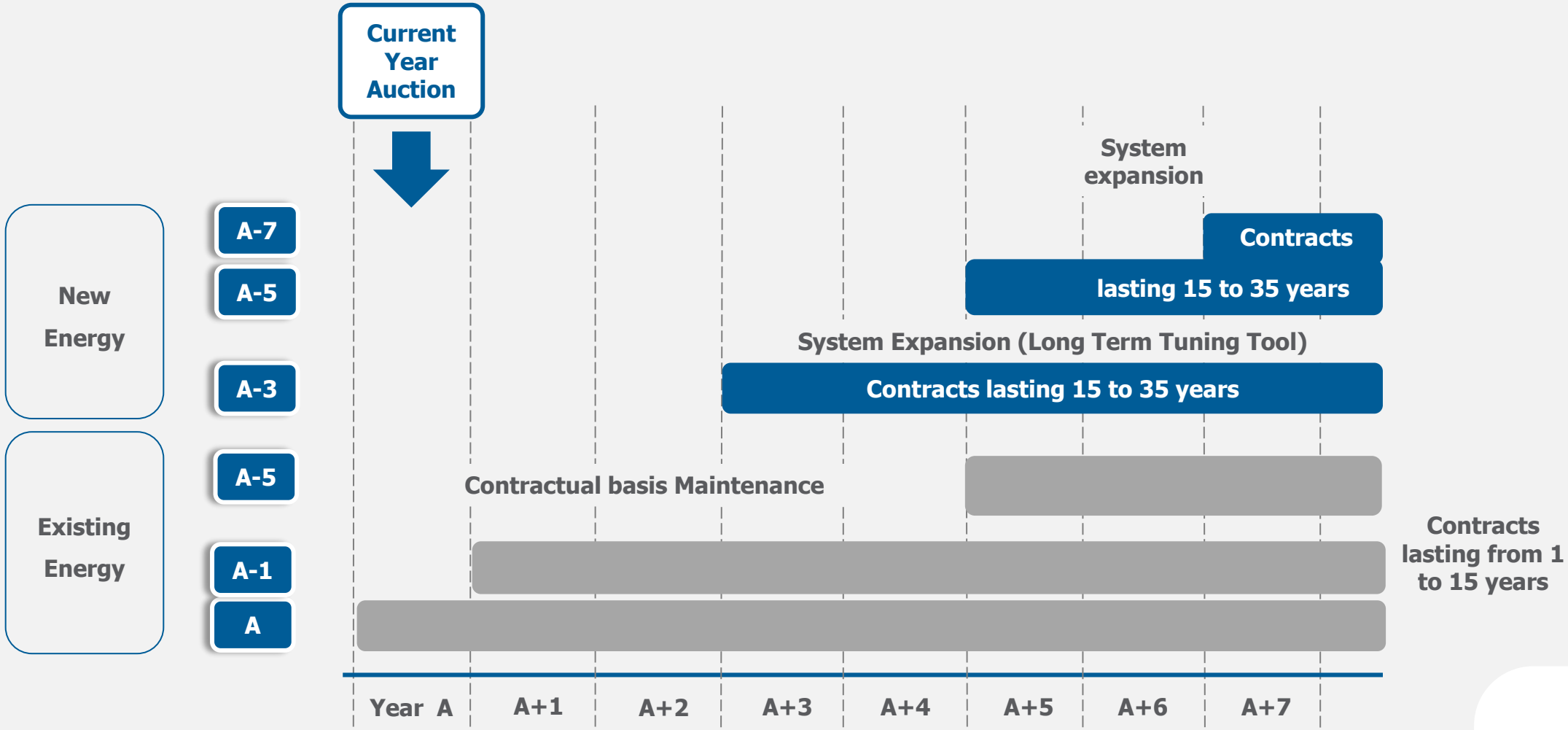
Distribution Companies



Trading companies

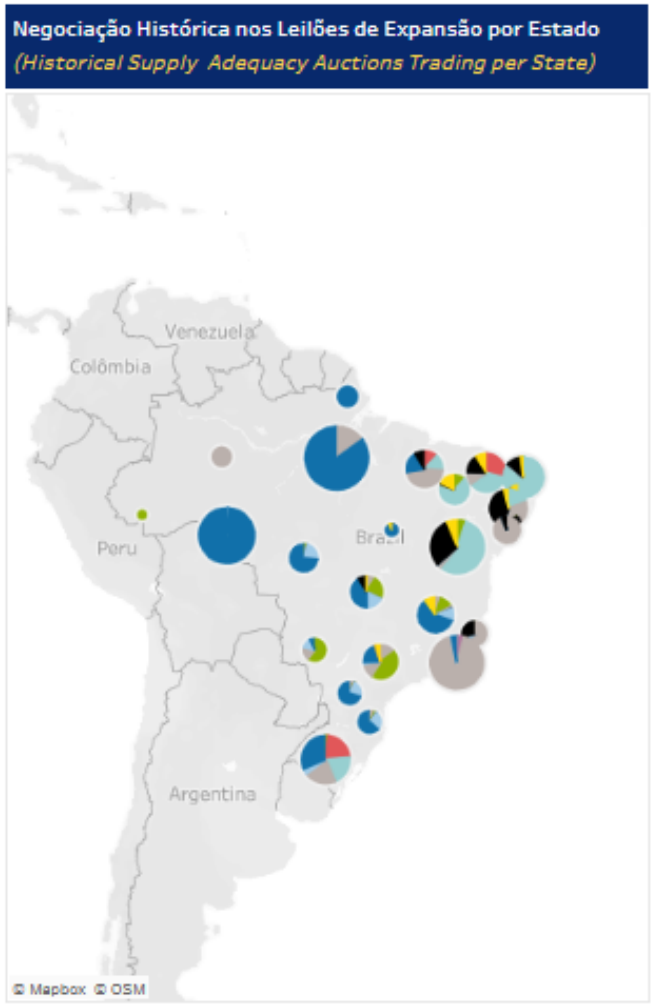
Free Consumers

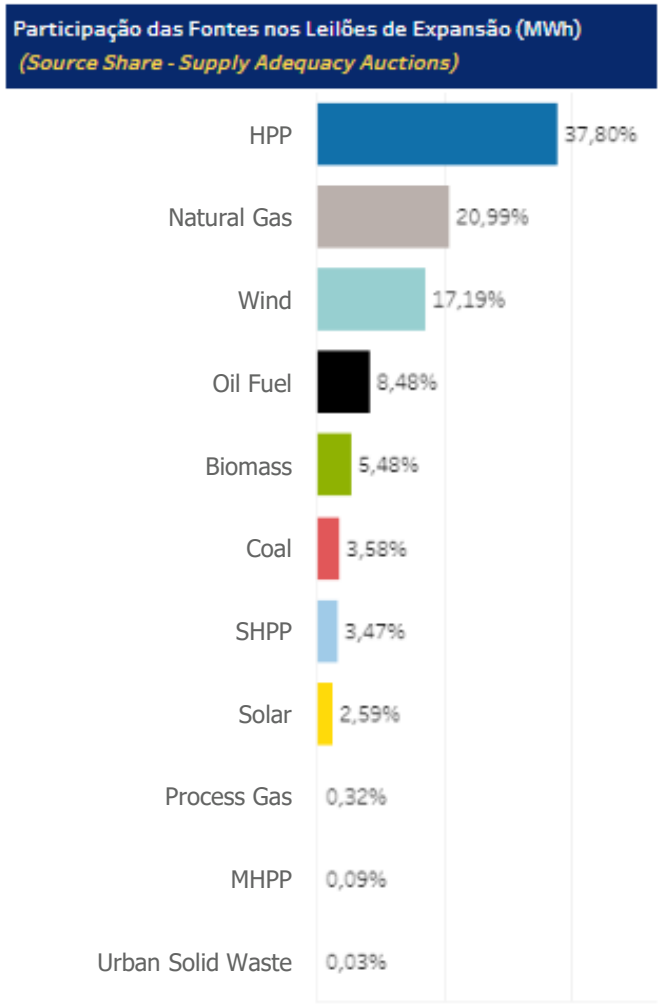
Energy auctions

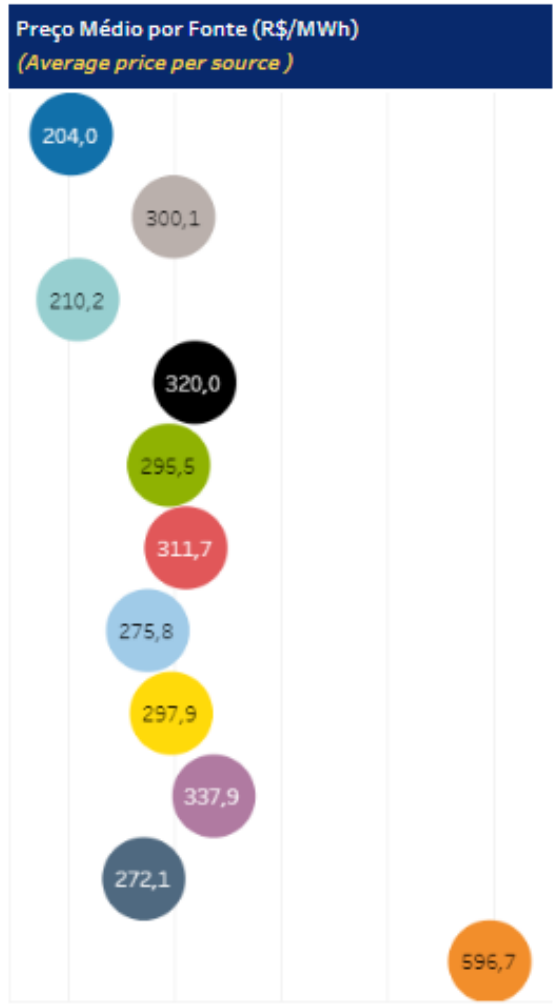


Energy auctions

The CCEE, Chamber of Commercialization of Electric Energy, provides information on the auctions on its website, such as participation in the expansion and average prices.







Source: https://www.ccee.org.br/web/guest/mensal

Auction Contracts: Quantity or Availability

Energy purchase agreement in the regulated market (CCEAR)

Concept

Quantity

- Generation companies undertake to supply a defined amount of energy Q (MWh) for a certain period of time, at a defined price P (R$/MWh)

Availability

- Generation companies commit to supply a defined volume of Q energy (MWh), depending on the availability of their generation capacity and will receive a fixed monthly revenue
- If there is a dispatch, the buyer pays the CVU[1] (R$/MWh) of generation G (MWh)

Revenue

Revenue = Q x P

Q: Amount of Energy (MWh)

P: Price (R$/MWh)

- Plant without dispatch:

Revenue = Fixed Revenue

- Plant with dispatch:

Revenue = Fixed Revenue + G x CVU

1) Unit Variable Cost

1.2 Hydro Source

Energy Reallocation Mechanism – MRE[1]

The "condominium" of HPPs and SHPPs: 2 main goals

1) **Enable Centralized and Optimized Operation** of the SIN, under the coordination of the ONS

2) **Share Hydrological Risk** between its plants, which are located in different river basins and subject to different hydrological regimes

Mandatory Participation:

- **Centrally dispatched hydroelectric projects** (generation dispatch coordinated, established, supervised and controlled by the ONS)
- Performance is assessed by monthly application of the Assured Energy Reduction Mechanism – **MRA** (Prolonged unavailability reduces the Physical Guarantee for the purposes of apportionment in the MRE)

Optional Participation:

- **Hydroelectric projects not centrally dispatched**
- Every August, the average electricity generation of each project in recent years is evaluated.
- If this average is lower than the values stipulated by ANEEL, the enterprise is excluded from the MRE (operating time ≥ 120 months → ≥ 85% of the PG)
- Meeting the values is a requirement to return to the MRE

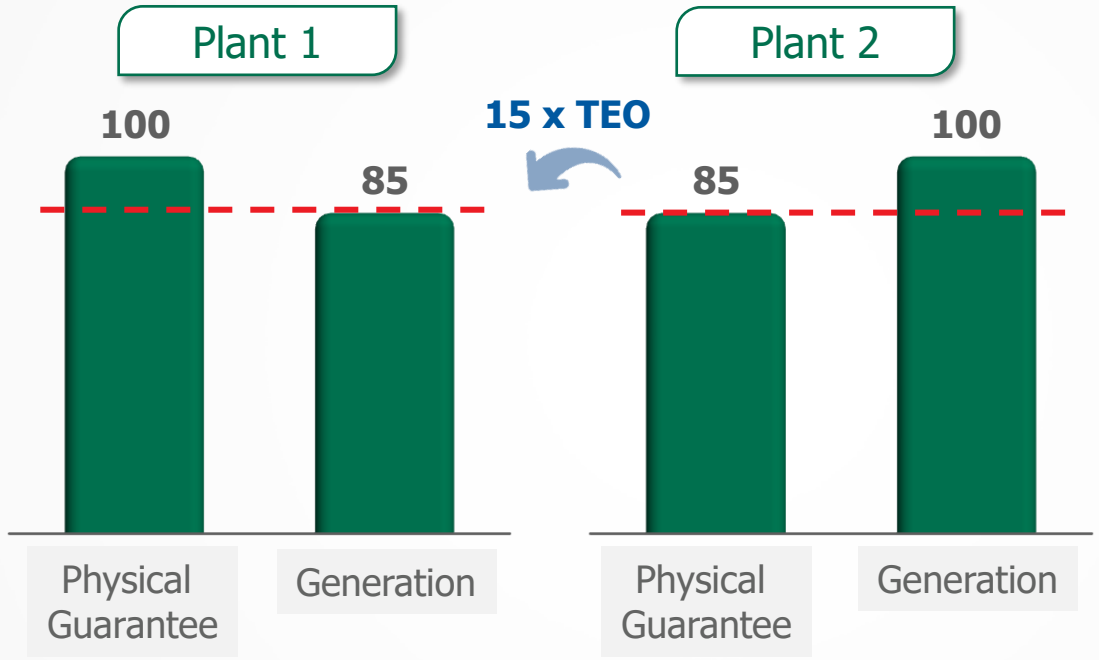
1) Created by Decree 2,655/1998 and regulated by ANEEL Resolution 249/1998.

MRE and the operation optimization

Goal 1: Centralized and Optimized Operation of the SIN

The energy transferred between the MRE plants must be valued by the Optimization Energy Tariff (TEO)

Theoretical example



In 2022

TEO: R$ 14,04/MWh

TEO Itaipu: R$ 55,70/MWh

TAR: R$ 83,78/MWh

Curiosities

- TEO is made up of O&M costs and TAR (7%) and updated annually by the IPCA.
- For HPP Itaipu, a specific TEO is calculated annually, established by the variable cost of the plant (calculated in dollars per GWh), converted by the geometric average of the dollar in the last twelve months.
- The **TAR** (reference tariff) is used in the calculation of the amount to be paid by hydroelectric generators to the Union, states and municipalities as Financial Compensation for the Use of Water Resources - CFURH. The value is obtained from the costs of the distributors with the purchase of hydraulic energy, carried out directly with generators.

MRE and Hydrological Risk (GSF)

Goal 2: Share the Hydrological Risk among its plants

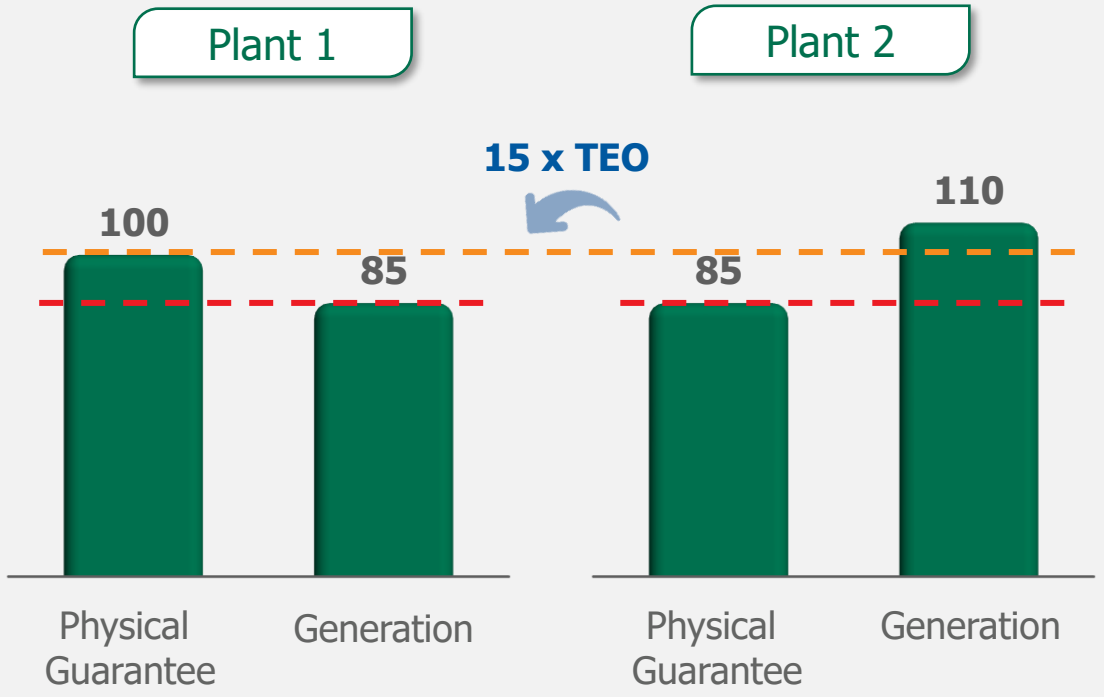
Total generation > Total Physical Guarantee

- Surplus generation → **Secondary Energy**
- Allocated Energy for each HPP = Physical Guarantee + fraction of Secondary Energy

Total generation ≤ Total Physical Guarantee

- Deficit → **Generation Scaling Factor (GSF)**
- Energy allocated to each HPP = a fraction of the physical guarantee

Theoretical example



Secondary Energy

Total physical guarantee = 185
Total generation = 195
Variation = +10

(10 x PLD) ÷ 2 plants

MRE and Hydrological Risk (GSF)

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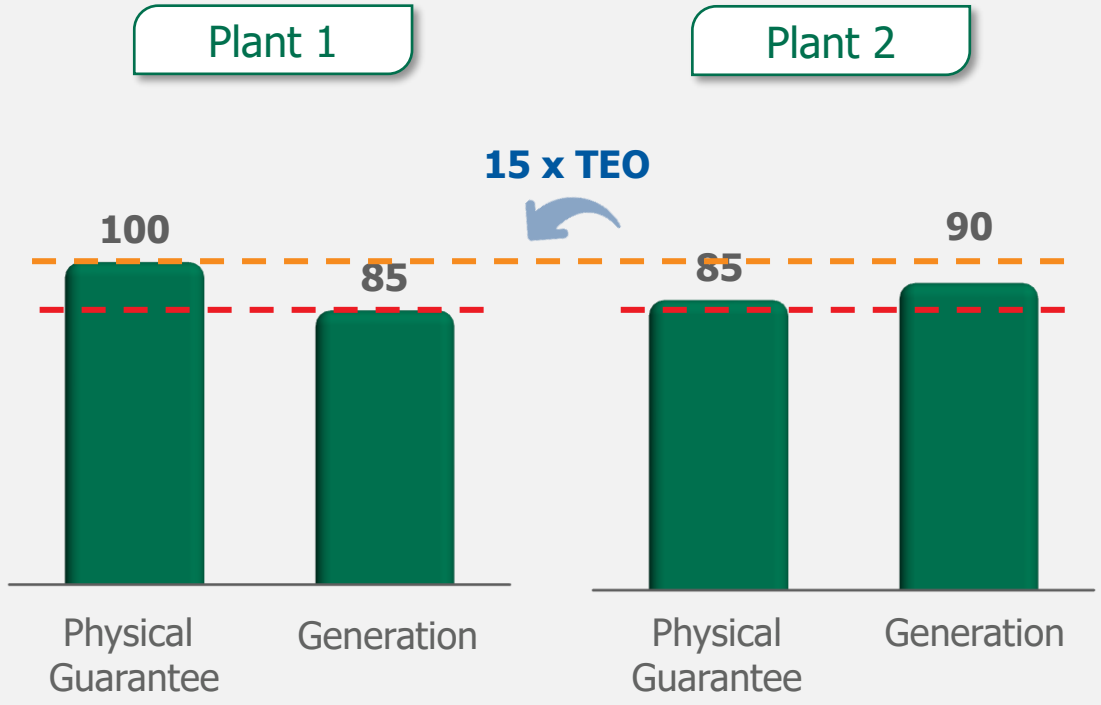


GSF

Total physical guarantee = 185
Total generation = 175
Variation = -10

(-10 x PLD) ÷ 2 plants

Did you know?!

Renegotiation of the GSF is the transfer of the hydrological risk from the generator to the consumer through the payment of a monthly premium (insurance)

Seasonalization of Physical Guarantee

Process that always takes place in December, when hydro plants can allocate their physical guarantee on a monthly basis

- Changes **contractual exposure** (difference between allocated energy and sales contract), generating surpluses or deficits
- The monthly allocation can **mitigate the loss risk**, depending on the PLD curve
- There are **3 basic types** of seasonalization:
  - MRE profile (average of all MRE plants)
  - Flat profile
  - Contract profile

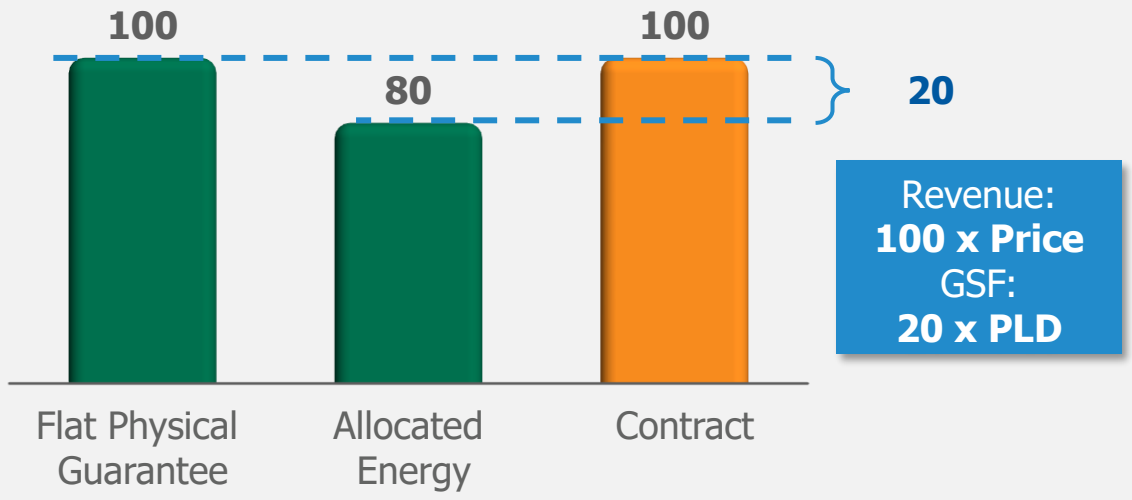
Did you know?!

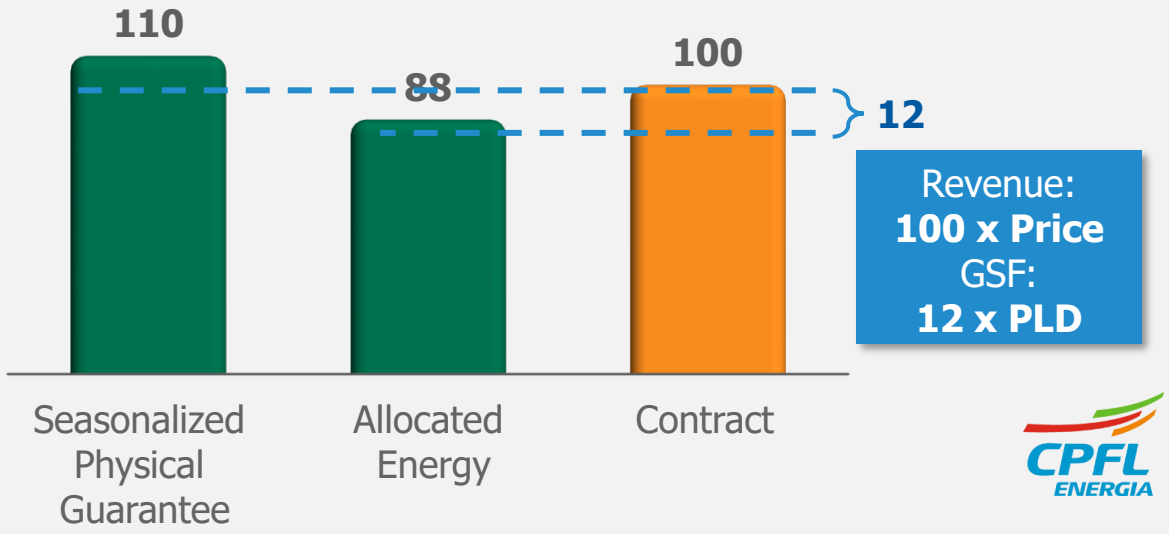
CPFL uses a statistical tool to forecast results and risk of losses for the different seasonality profiles, for each of its plants.

Generally, our plants **use the MRE profile**, which minimizes the risk of loss to the plant throughout the year.

Assuming:
GSF = 20%
Contract = Physical guarantee

Theoretical example





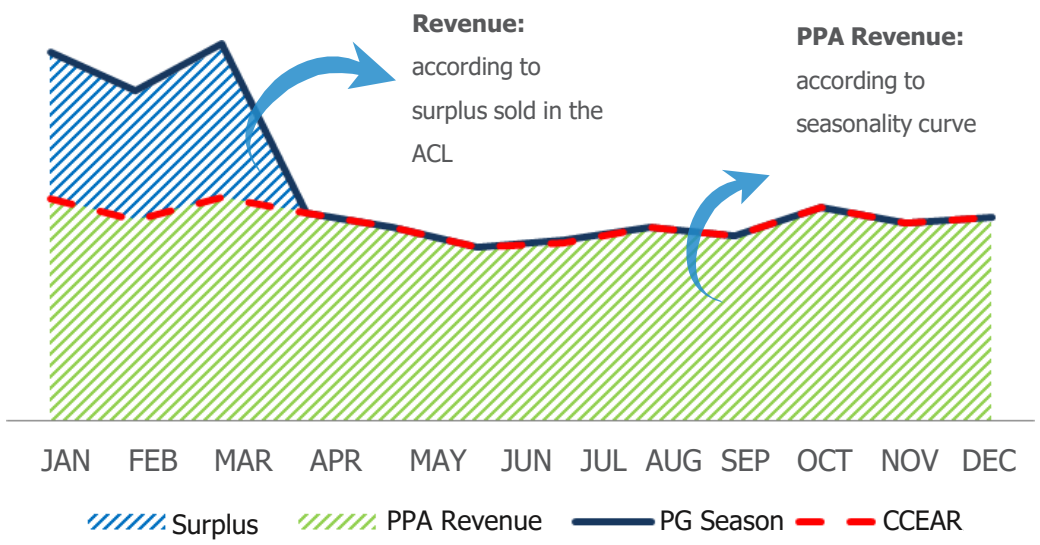
Physical Guarantee Review (centrally dispatched plants - HPPs)

- The generation of hydroelectric plants depends on unpredictable **hydrological conditions**
- The physical guarantee is defined by the MME, through a **statistical approach** through computational models that use **historical rainfall data**
- It can be reviewed **every five years**, limited to a maximum variation of 5% per review or 10% over the entire period of the concession contract[1]

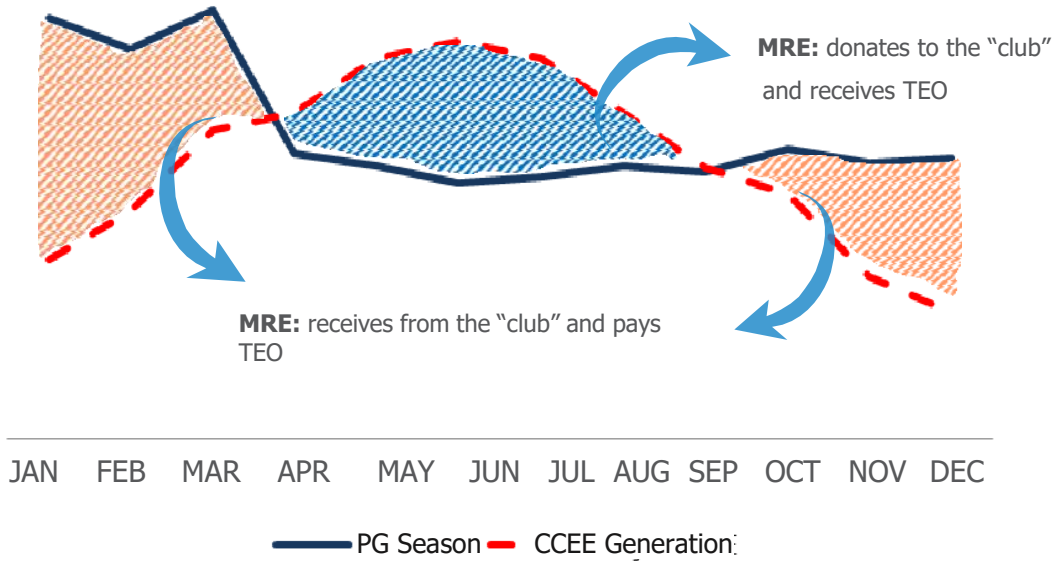
1) Pursuant to Decree No. 2,655 of July 2, 1998.

HPPs and SHPPs – Revenue x Generated Energy

Revenue (R$)



Generation x Contract Curve



ACL Revenue:

- Surplus not committed to the auction are traded in the ACL via bilateral contracts
- Monthly revenue from surplus, as agreed in the contract

ACR Revenue:

- Revenue from CCEARs is proportional to the commercialized energy multiplied by the adjusted selling price

Energy Reallocation Mechanism

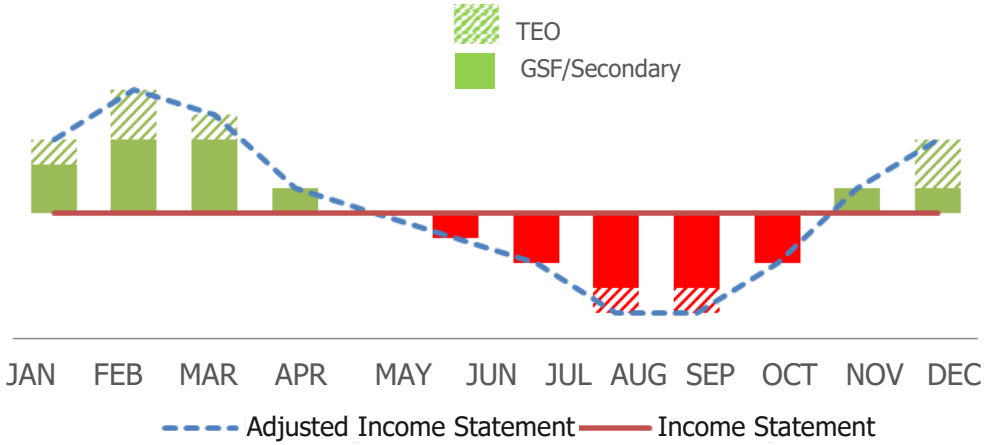
Generation lower than the seasonalized PG is covered by other MRE plants and TEO* is paid for each MWh received

Generation higher than the seasonal PG is donated to other MRE plants and is received by TEO for each MWh donated

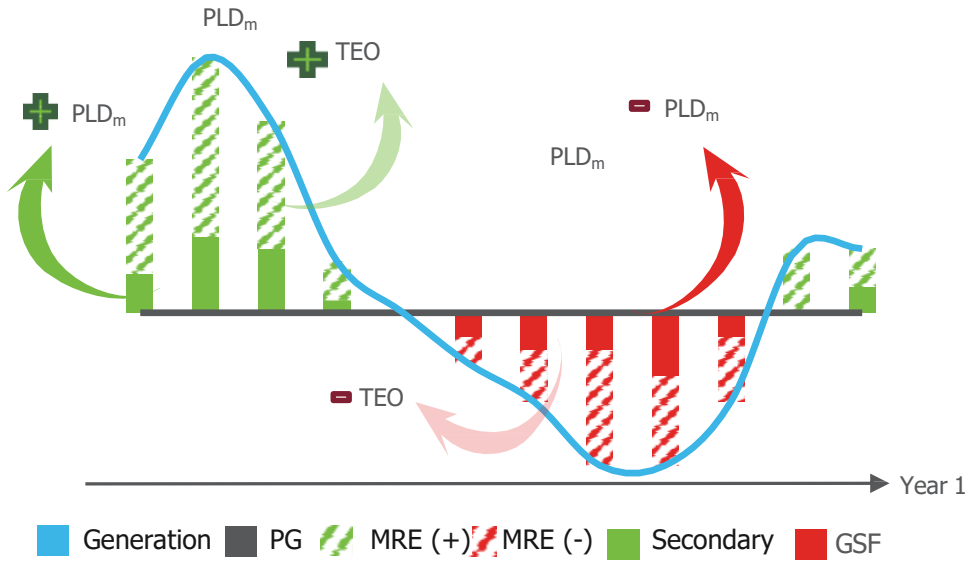
*TEO = Optimization Energy Tariff
TEO: 14.04 R$/MWh
TEO Itaipu: 55.70 R$/MWh

PROINFA – Revenue x Generated Energy

Revenue (R$)



Generation x Contract Curve



Billing

Fixed

1/12 of the contract value

discounted (or added) the adjustments resulting from accounting in the CCEE referring to the previous year, divided into 12 installments.

Accounting

Flat contracted energy x contract price plus MCP

(TEO, Secondary/GSF, Reimbursement due to GSF renegotiation and PG exposures - contract)

Cash

Billing recorded according to Invoice of the month

1/12 current

discounting the adjustments resulting from the previous year in 12 installments.

PROINFA – Annual assessment of the contract

Contract review:
If the physical guarantee is revised, there will be a change in the contracted energy, which will be applied to the subsequent year.

The review takes place as PRT 463/09:

- **Reduction**: average generation < 90% of PG for 5 years (or 80% for 4 years of operation);
- **Increase**: average generation > 110% for 5 years (or 120% for 4 years of operation).

CCEE effects: considered GSF and TEO

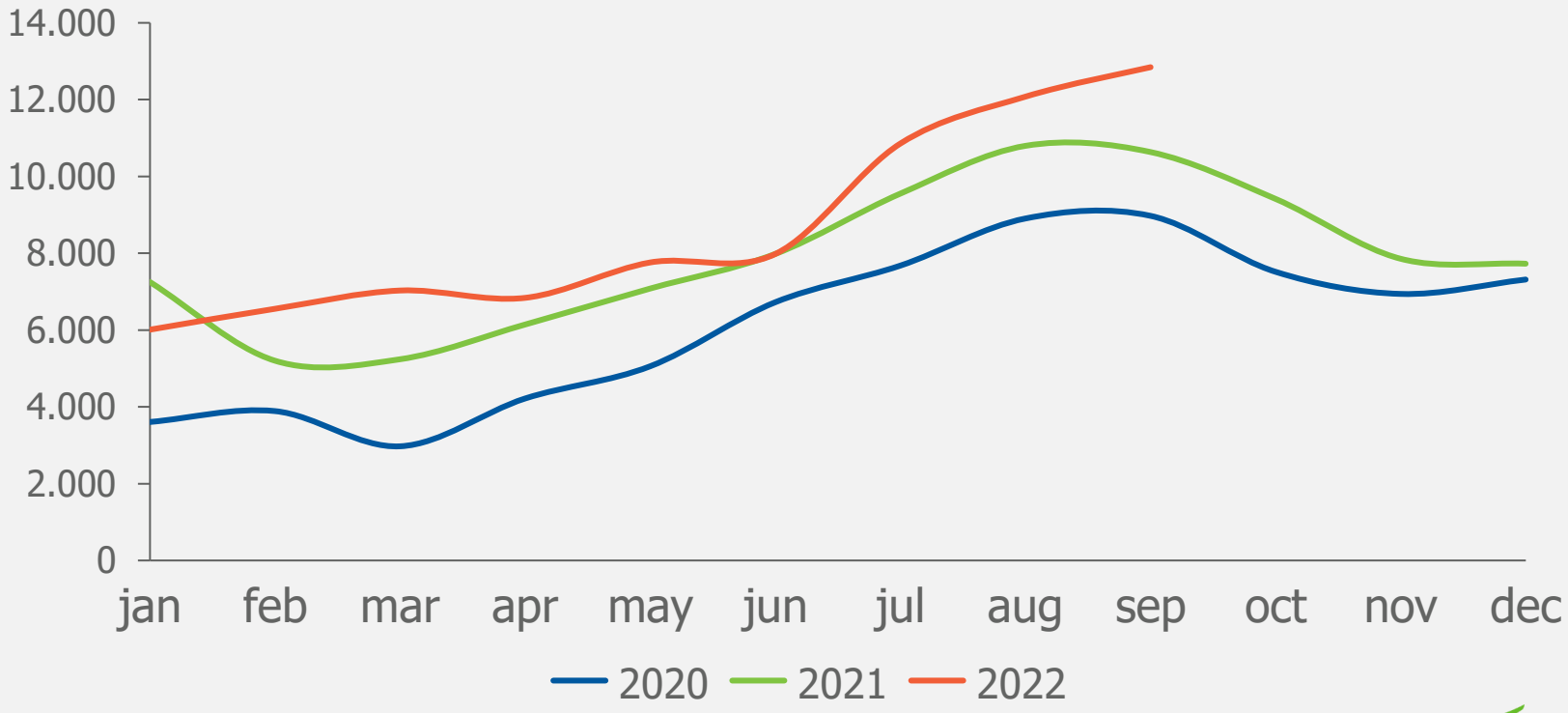
Annual assessment

1.3 Wind Source

Seasonality

Wind farms show strong seasonality, concentrating around 2/3 of their generated volume – and consequently of their revenue – in the 2nd half of the year.

Brazil - Wind Energy Generated (average MW)



Source: ONS

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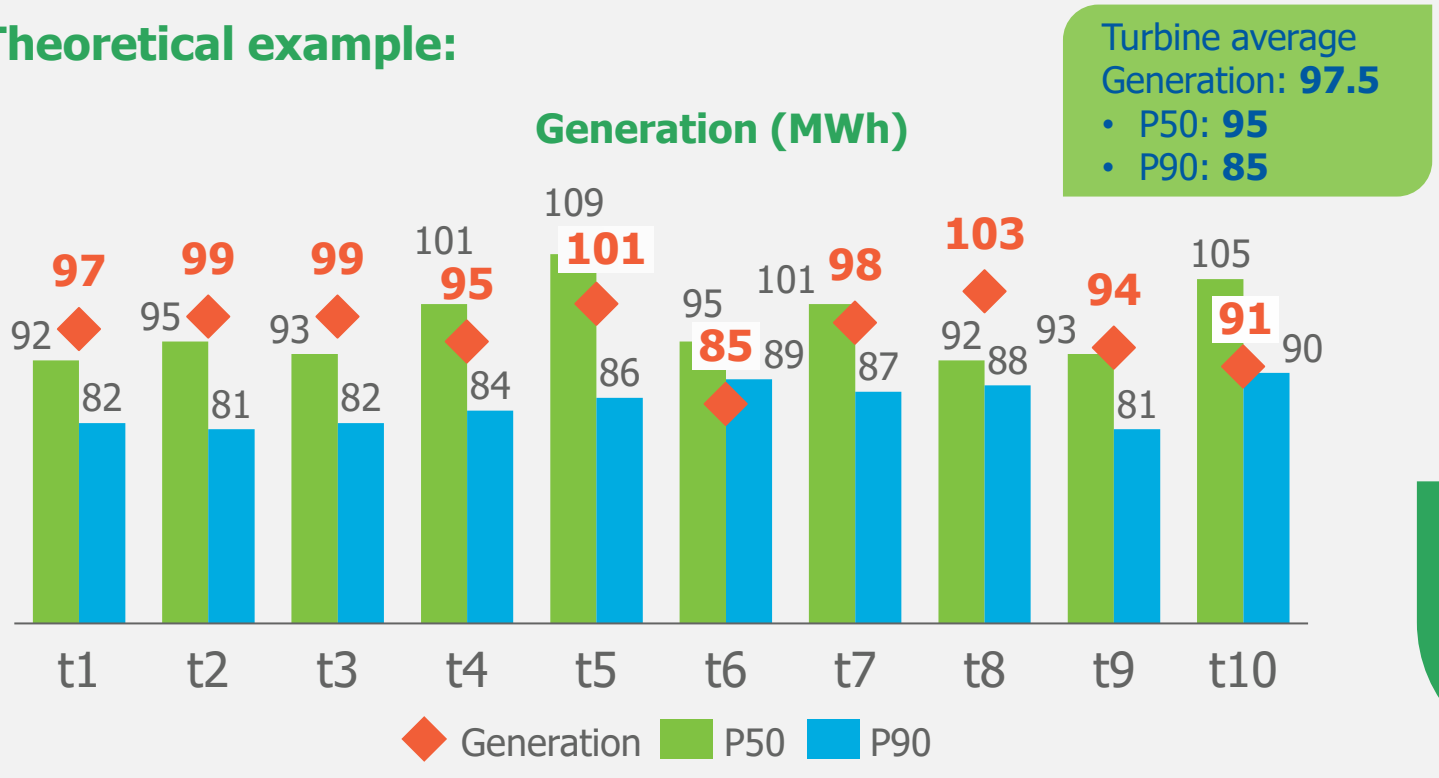
P50 and P90 certifications

A certified value of "P50" or "P90" describes an annual energy production value of the intermittent resource with a probability of 50% or 90%, respectively:

- **P50** is the most likely value and can be exceeded with 50% probability
- **P90** must be exceeded with a 90% probability and is considered a conservative estimate

Theoretical example:



In this example, the farm formed by 10 turbines had energy generated above P50 in the period

Capacity Factor

- Capacity Factor is the indicator that defines how much a plant generates in relation to the maximum it could generate
- In other words, it is **the ratio between the Generated Energy and the Installed Capacity** of a power generation system
- Therefore, the maximum energy that a system can generate is its power multiplied by the analyzed time window.

$$CF = \frac{E_t}{P \times t} = \frac{Energy_{annual}}{Capacity \times 8760}$$

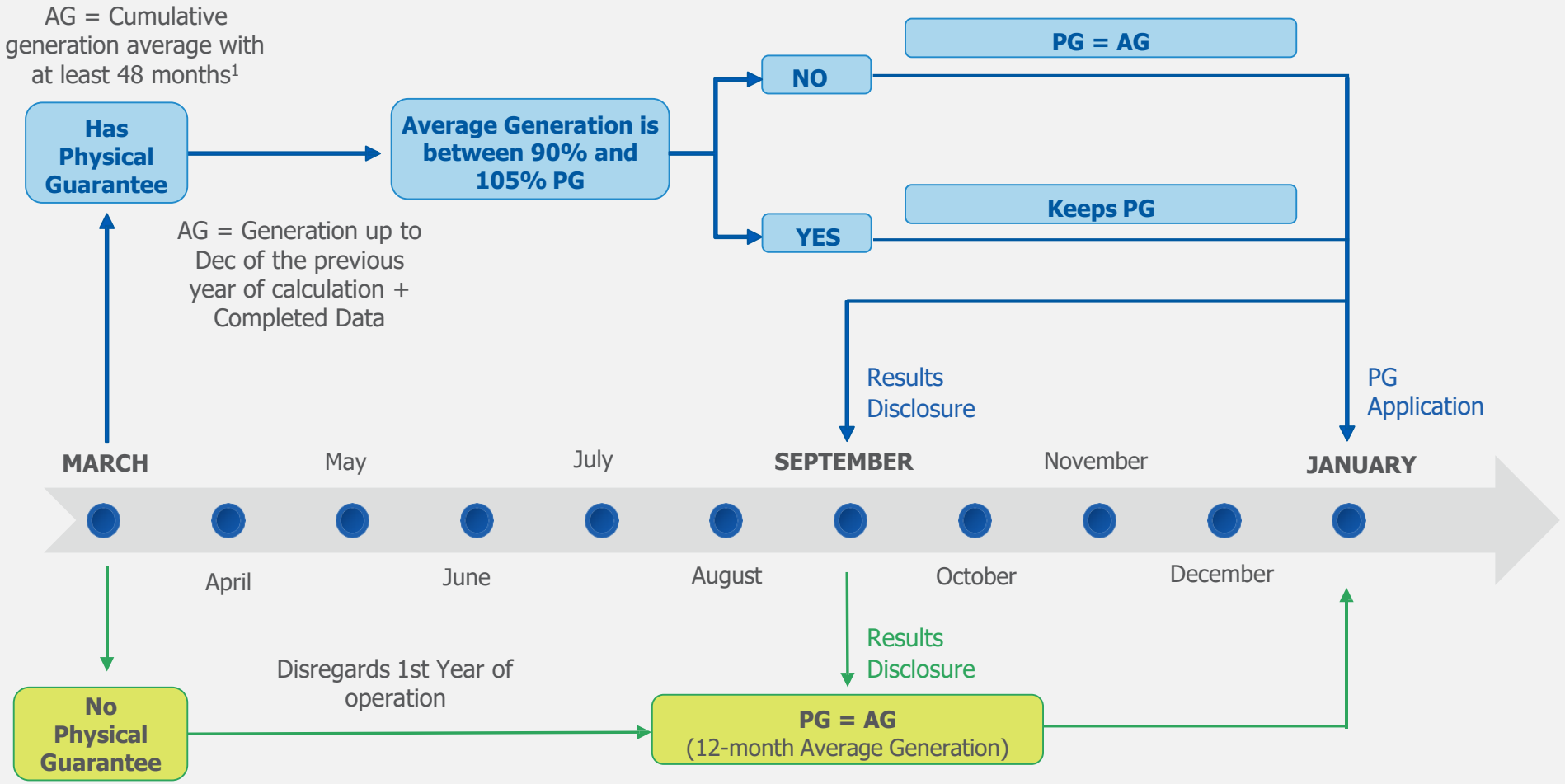
Eannual **[MWh]** is the energy generated in a period of time t (in this case 1 year)

P [MW] Is the Installed Capacity

t [h] Is the considered timeframe (in this case 1 year or 8760 hours)

Physical Guarantee Review - Ordinance 416/2015

Valid for wind farms (except PROINFA and LER contracts)



Important

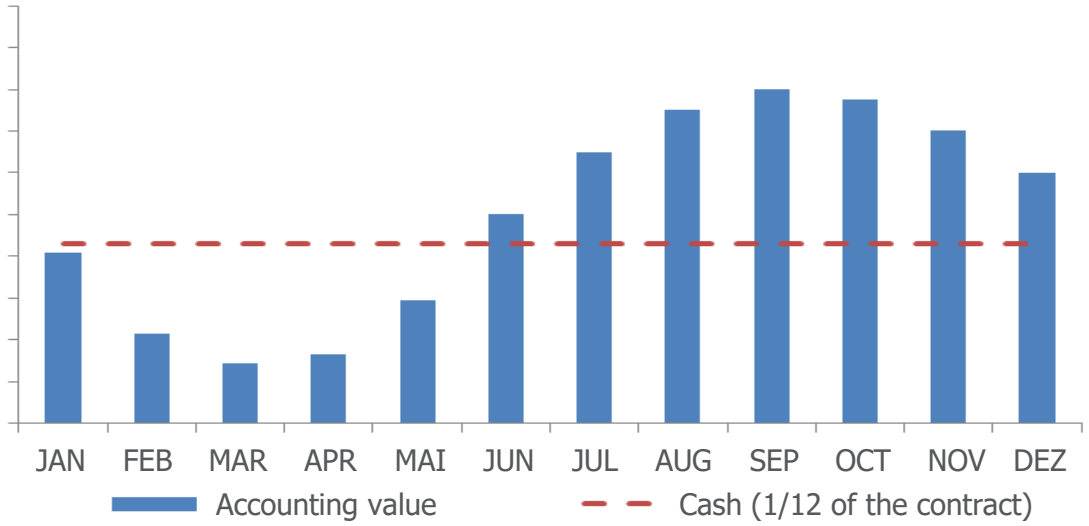
The **commercial operation entry** of the first machine is important for the calculation

The plants **first year of commercial operation** is always **discarded**

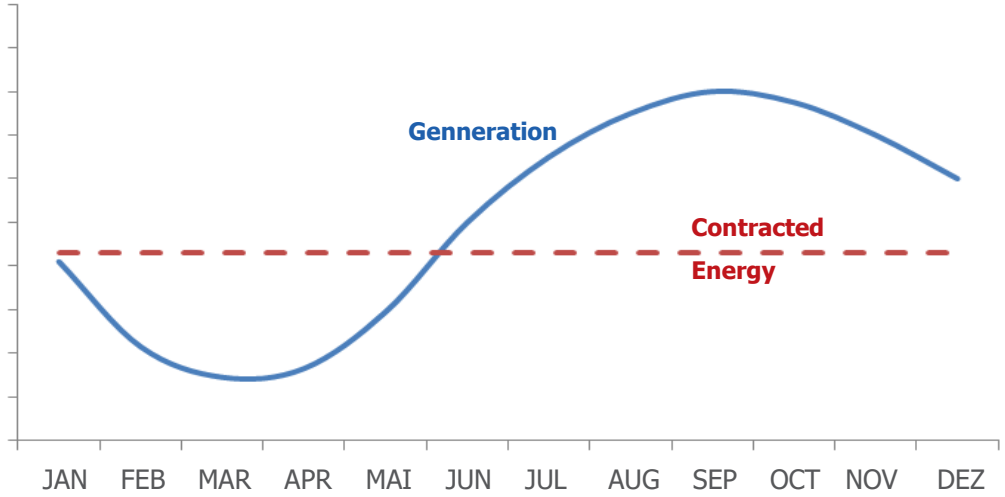
1) If the wind farm does not have a generation history of 48 months, it is completed with a Seasonal Physical Guarantee by the EPE. If you have more than 48 generation data, they must be multiples of 12 (60,72,84...).

Wind Farm – Revenue x Generated Energy

Revenue (R$)



Annual Generation



Accounting

G (MWh) x P (R$/MWh) +
Adjustments

Cash

Fixed
1/12 of the contract value
+ refunds
+ receipts

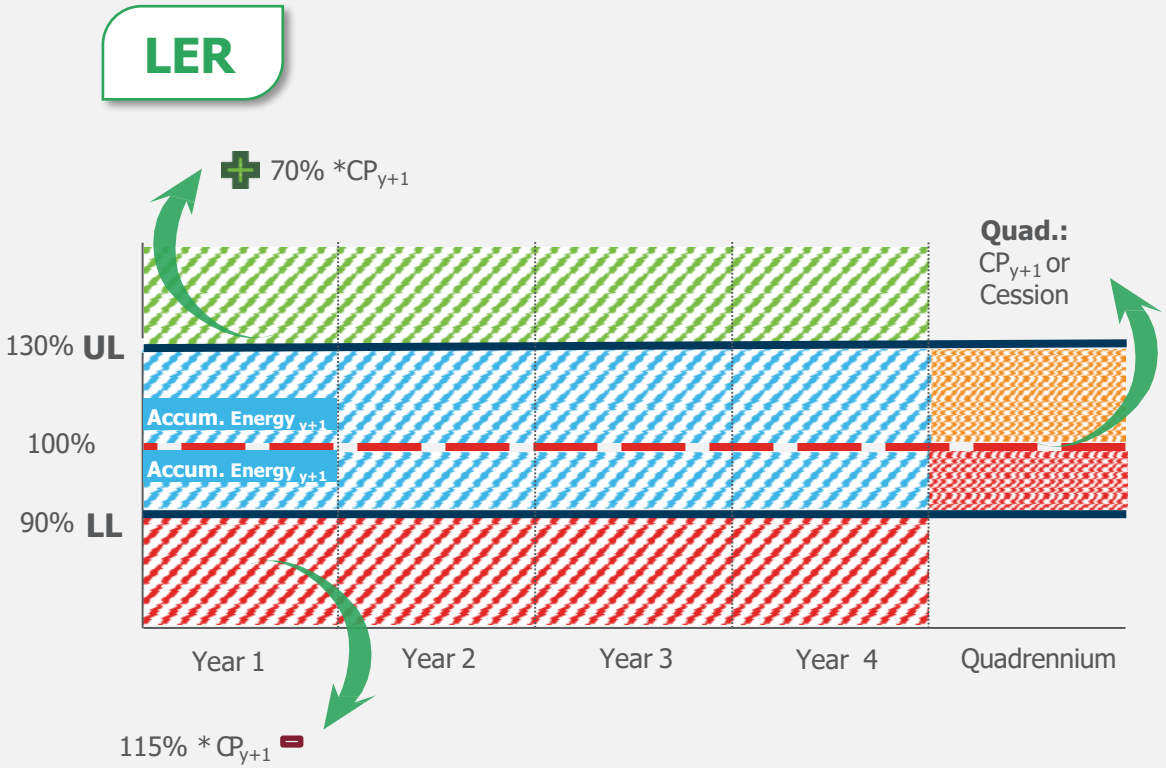
WF – Contract calculation

Annual calculation:

- **Generation < 90%:** reimbursed with a 15% increase in the updated contract price in the subsequent year;
- **Generation > 130%:** received 70% of the updated contract price in the subsequent year.

Quadrennial calculation:

- **Generation between 90% and 100%**
  - Payment of the energy required to attend the updated contract price.
- **Generation between 100% and 130%**
  - Difference as credit for the next period;
  - Receipt at the updated contract price;
  - Cession of another enterprise of the same auction, same source and same submearket.
- **Quadrennial reconciliation**: calculation of the energy delivered in the 4 years in relation of contracted energy and possible revision of this.



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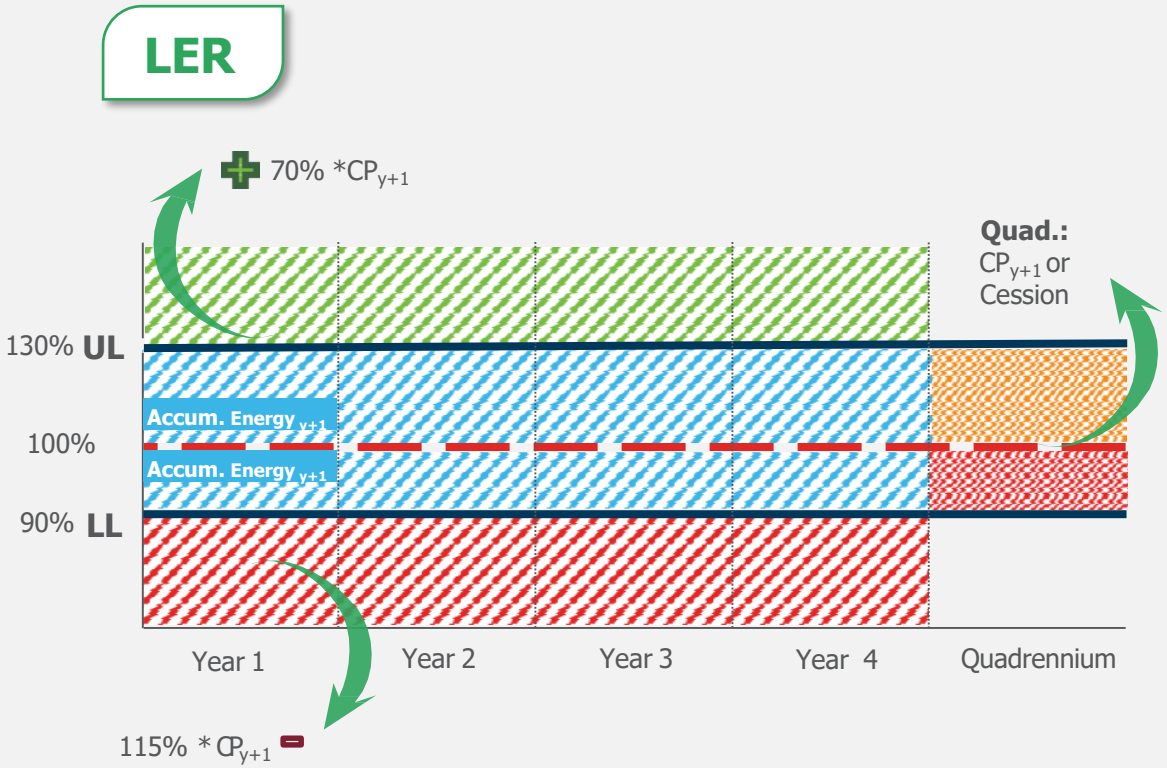
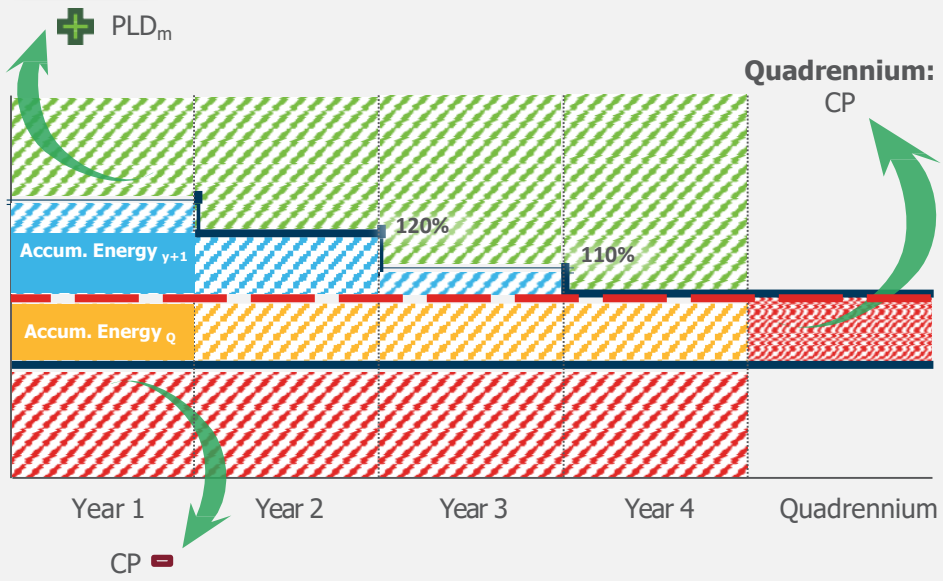


Annual	Quadriennial
G < 90%	90% < G < 100%
115%*CP_{y+1}	CP_{y+1}
G > 130%	100% < G < 130%
70%*CP_{y+1}	Cred. / CP_{y+1} / Ces.

WF – Contract Calculation

LFA



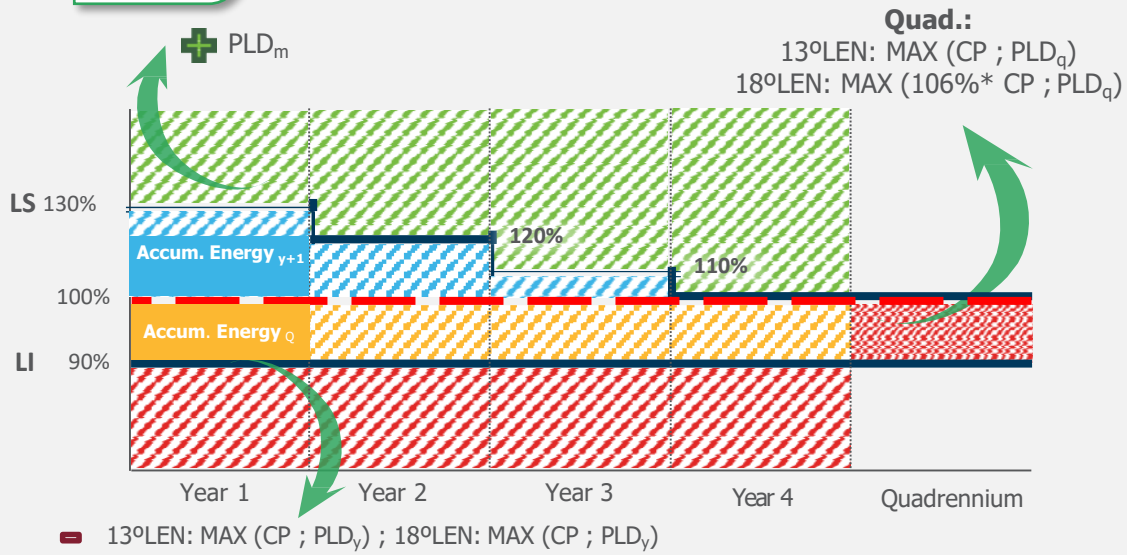
Annual calculation:

- Generation < 90% of the CE: reimbursed at the contract price of the last effective month of the year;
- Generation > higher bandwidth: paid the monthly PLD.

Quadrennial calculation:

- Generation between 90% and 100% of the CE will be accumulated over the quadrennium (deficit) and will be valued at the contract price of the last month of the quadrennium, when the quadrennial calculation occurs;
- Generation between 100% and the limit of the higher bandwidth of the contracted energy will be allocated of the next year (positive balance).

LEN



Annual calculation:

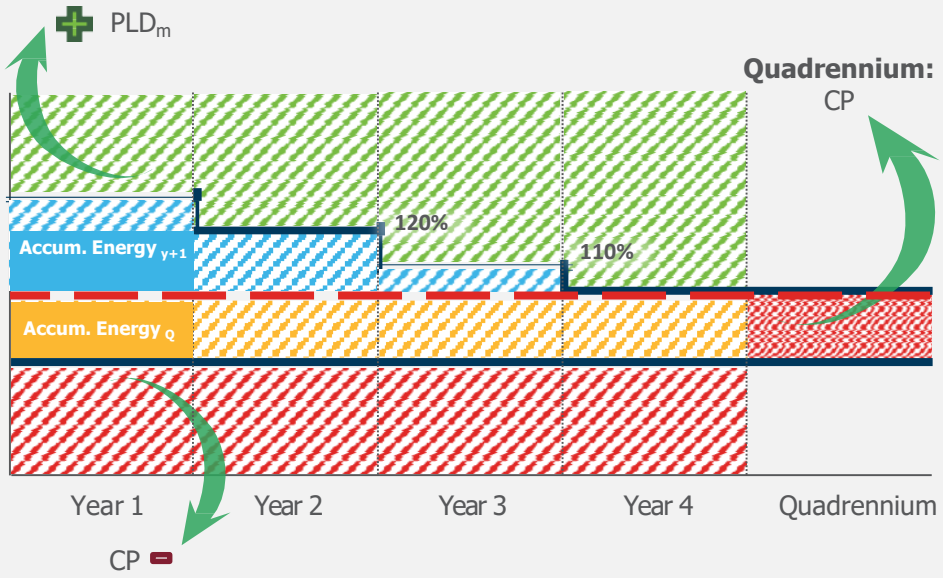
- Generation < 90% of the CE: reimbursed at the high value between medium annual PLD and contract price of the last effective month of the year;
- Generation > higher bandwidth: paid the monthly PLD.

Quadrennial calculation:

- Generation between 90% and 100% of the CE will be accumulated over the quadrennium (deficit) and will be valued at the high value between medium quadrennium PLD and contract price of the last month of the quadrennium, when the quadrennial calculation occurs;
- Generation between 100% and the higher bandwidth of the contracted energy will be allocated of the next year (positive balance).

WF – Contract Calculation

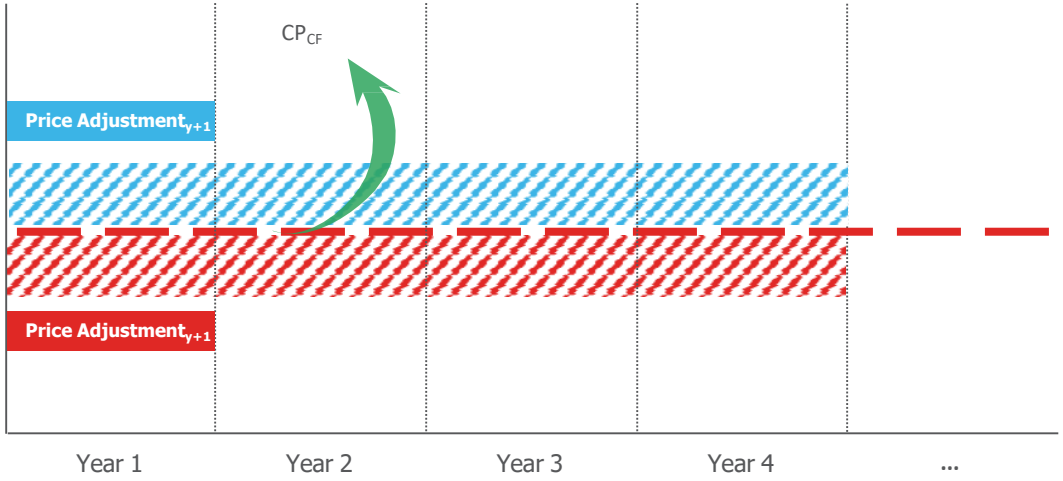
LFA LEN

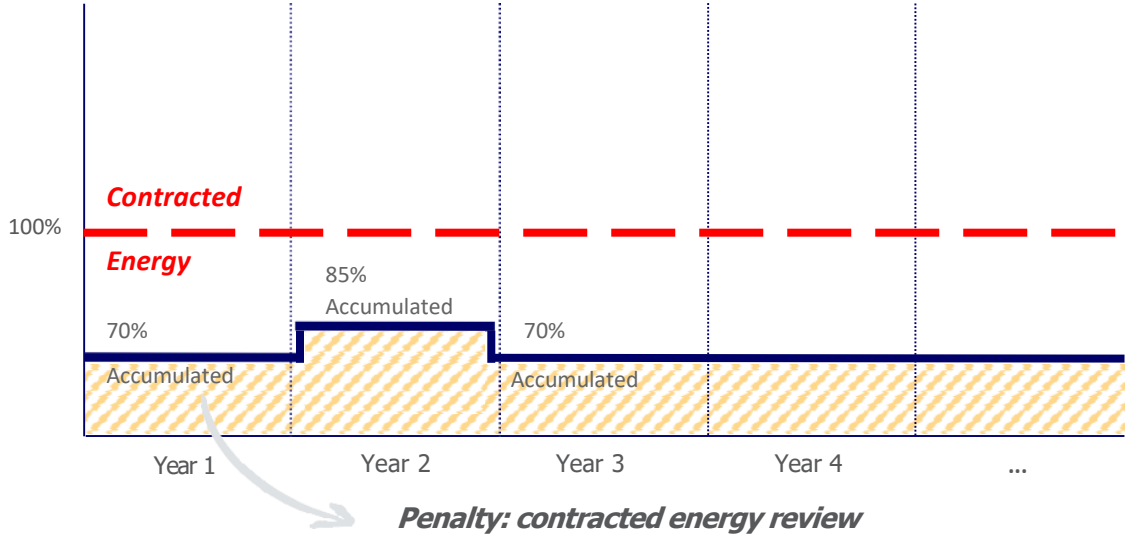


Annual	Quadrennial
G < 90%	90% < G < 100%
CP / Max (CP; PLD_y)	CP_q / Max (CP_q; PLD_q)
G > UL	100% < G < UL
PLD_m	Positive Balance

WF - PROINFA

Annual calculation and Contract revision





Contract calculation:

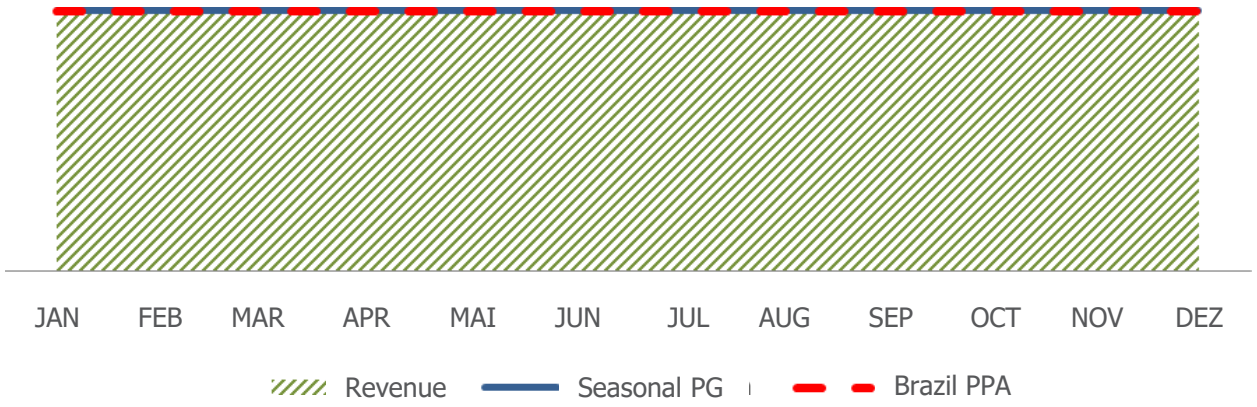
- Calculation carried out annually;
- Generated Energy higher/lower the contracted: receives/pays the difference in the next year through of inversely proportional adjustment in energy tariffs due to the production presented (capacity factor);
- Revenue guarantee of 70% of the contracted energy.

Contract revision:

- The contracted energy is revised side down if your accumulated generation is below 70% (except for year 2: 85%) and your tariff is corrected (Res. 62/2004);
- This movement there is the purpose of not penalize too much the investor, making with the recipes not vary much.

WF – Free Market (ACL)

Contract and Revenue Calculation (R$)



Contract calculation:

- The physical guarantee seasonality is realized by the generation agent
- The contract seasonality follows the profile of physical guarantee seasonality for the wind farms that have PG, and generation forecast for those that do not have
- Monthly revenue follows the seasonality profile defined in contract

Billing

CE (MWh) x P (R$)

Result

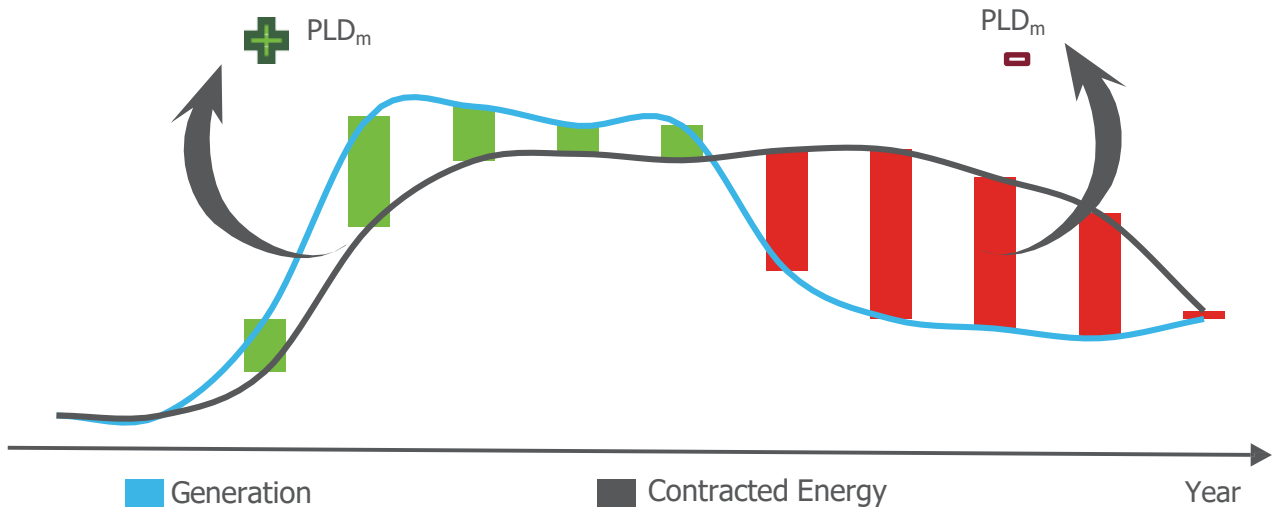
CE (MWh) x P (R$)+ Settlement PLD_{NE}

Cash

EC (MWh) x P (R$)+ Settlement PLD_{NE}

WF – Free Market (ACL)

CCEE Settlement



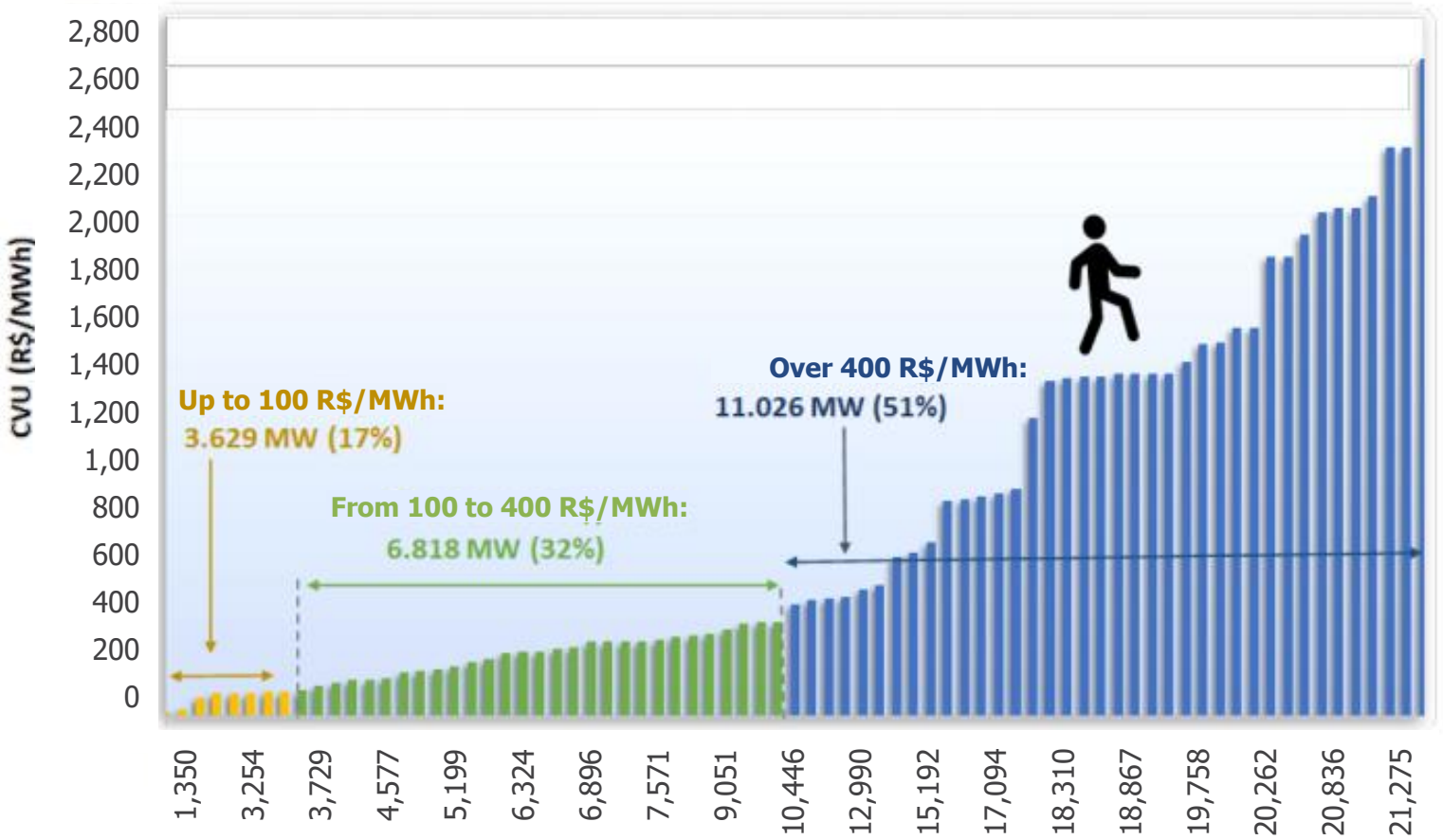
- Physical guarantee seasonality will not follow necessarily the generation profile
- All exposures, positive or negative, will be valued at PLD by the CCEE
- The contract defines that such exposures are assumed by the buyer up to a pre-established limit between the parties

1.4 Thermal Source

Thermal Generation in Brazil

In Brazil, **the thermoelectric generation has complementary role**, with operation determined by the necessity to reduce hydroelectric production, seeking to **preserve the reservoirs**.

Unit Variable Cost (CVU) and Thermic Dispatch



Unit Variable Cost (CVU) is the value expressed in reais per MWh, needs to **cover all variable operating costs** of a certain thermic plant.

CVU is the decisive factor for the thermoelectric order by ONS, cause from them, the **order of economic merit** (dispatch queue) of power plants is established by the ONS. The **higher the CVU, the lower the probability of thermoelectric dispatch**.

! The calculation is carried out by EPE based on informed parameters by the entrepreneur

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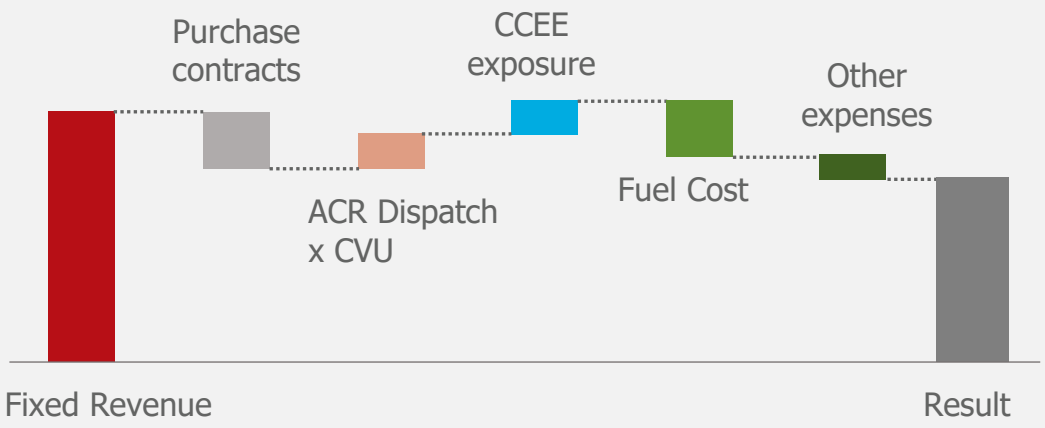
Thermal Dispatch Out of Merit Order

The optimization of generation by the ONS depends on several factors, and the mitigation of the risk of water scarcity can lead to the **Thermal Dispatch Out of Merit Order**

- The ONS dispatches thermal plants **in order of merit** to supply energy.
- However, there are conditions that may **prevent** certain plants from dispatching energy when requested.
- Whether due to **physical restriction, lack of connection or strategic decision by the ONS**, the dispatch can be carried out by another plant.
- The substitute plant may have a higher CVU than determined, thus it would be **out of merit order.**

TPP – Contract Mechanism

Main impacts



- The thermal power plant receives a fixed revenue from the availability auction (LEN)
- Linked to the contract, there is also a variable revenue subject to the generation dispatch in the ACR (valued at the CVU)
- Any ballast purchase needs, and other net needs, make up the balance that is settled at PLD.

1.5 Other Sources

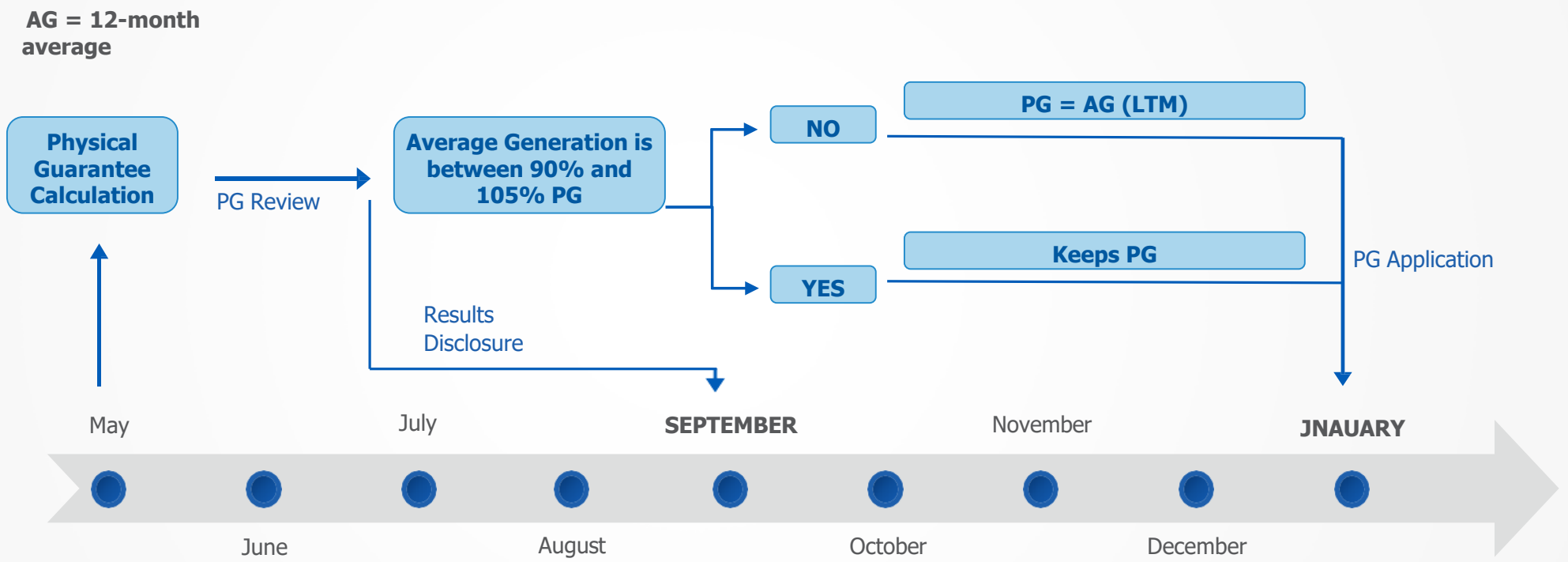
Biomass

Biomass

Bioenergy is supplied by renewable plant-based materials. There are several types of biomass supply, which can be traditional firewood from natural forests, sugarcane bagasse, wood cultivated exclusively for energy generation, residues from sawmill industries, agglomerates and cellulose, in addition to biogas, generated by the decomposition waste.

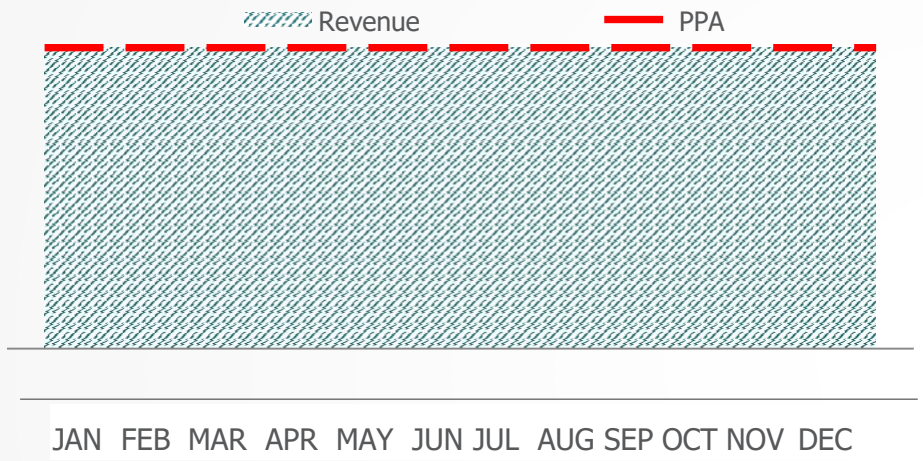
Physical Guarantee Review - Ordinance 564/14

Valid for all Biomasses

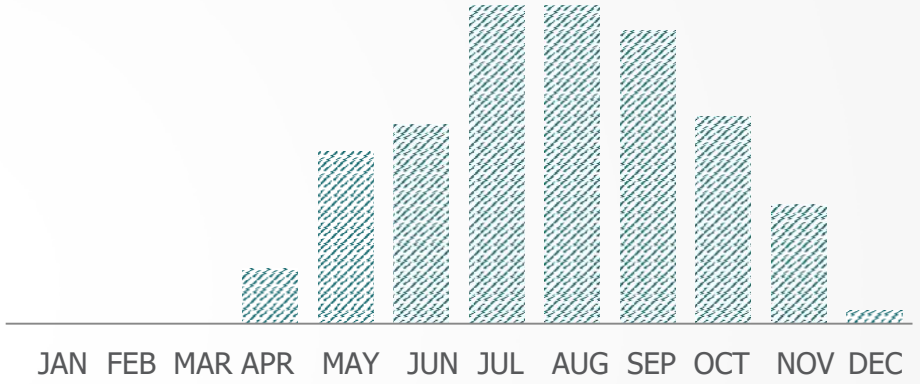


Biomass – Revenue x Generated Energy

Revenue (R$)



Annual Generation



Billing

Fixed
1/12 contract value

Accounting

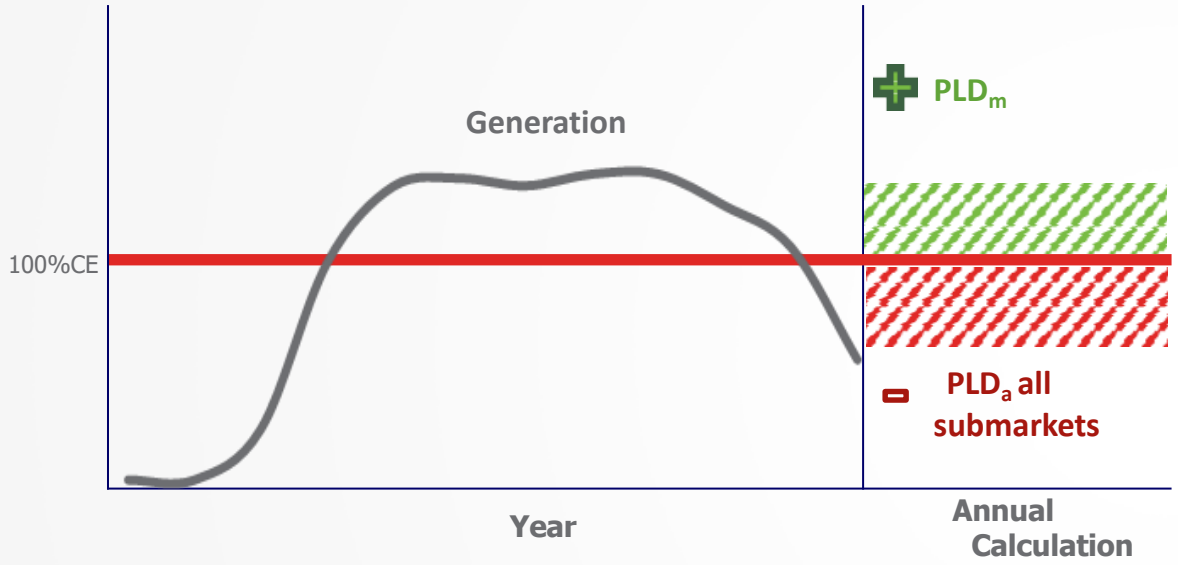
G (MWh) x P (R$)

Cash

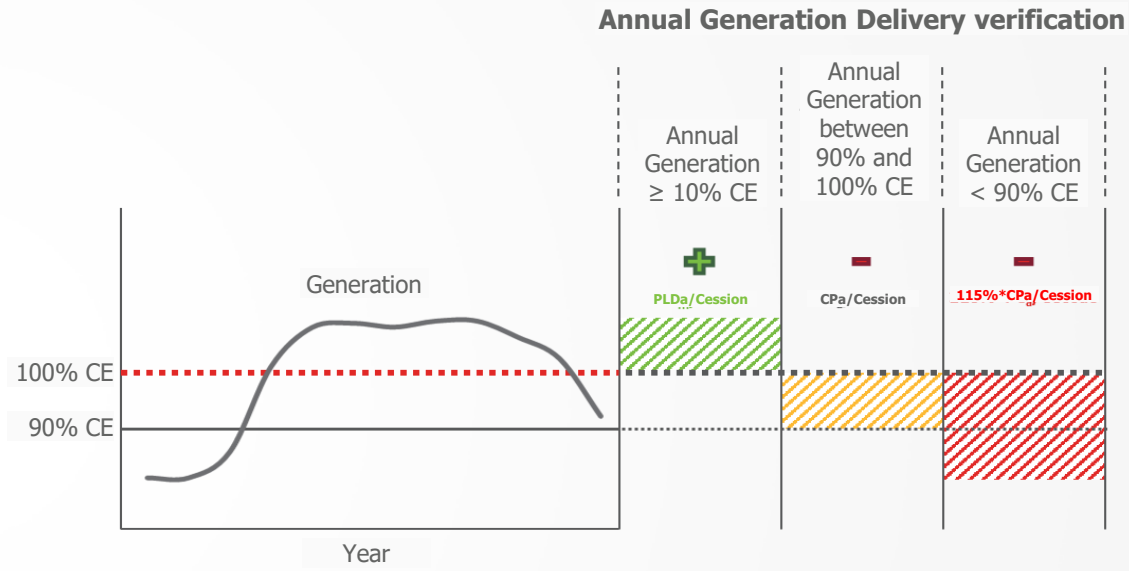
Same as Billing
1/12 contract value

Biomass – Contract Calculation

LEN / LFA



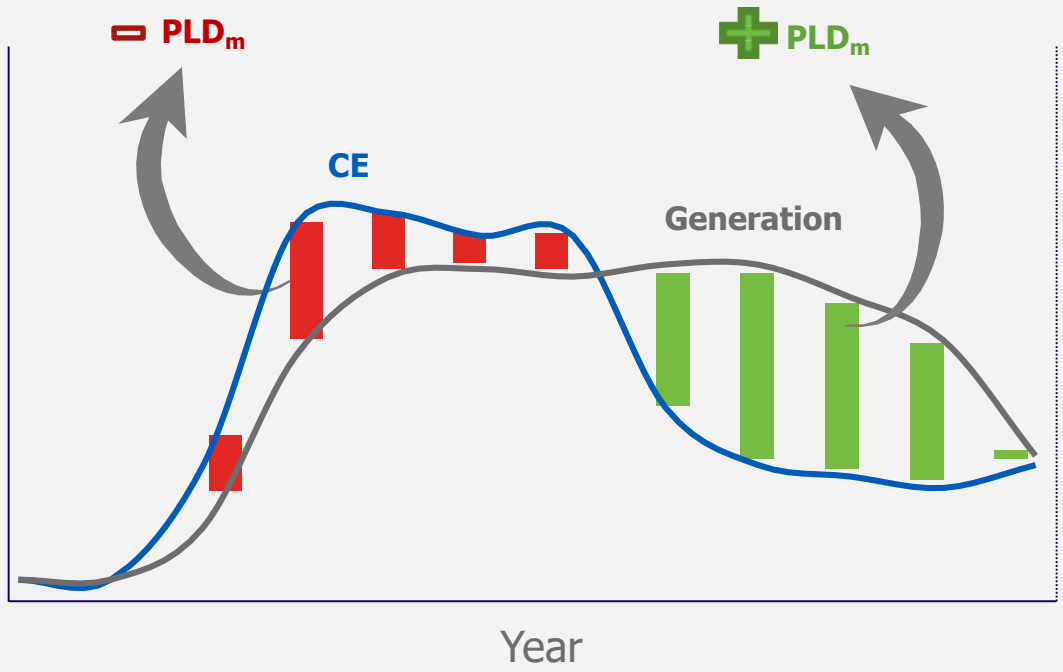
LER



When G > CE, after the fulfillment of the contract, surplus energy will be settled at PLD from the month of delivery

Biomass - ACL

Generation x Contracted Energy



G < CE	G > CE
Annual Reimbursement (PLDm)	CCEE Settlement (PLDm)
CCEE Exposure (PLD average)	Energy Assignment
Penalty (115% Price)	
Reimbursement (Price)	

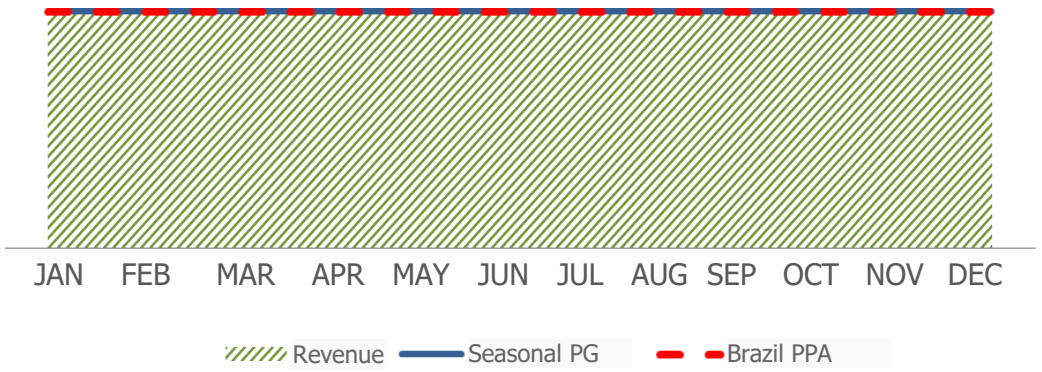
Solar

Solar

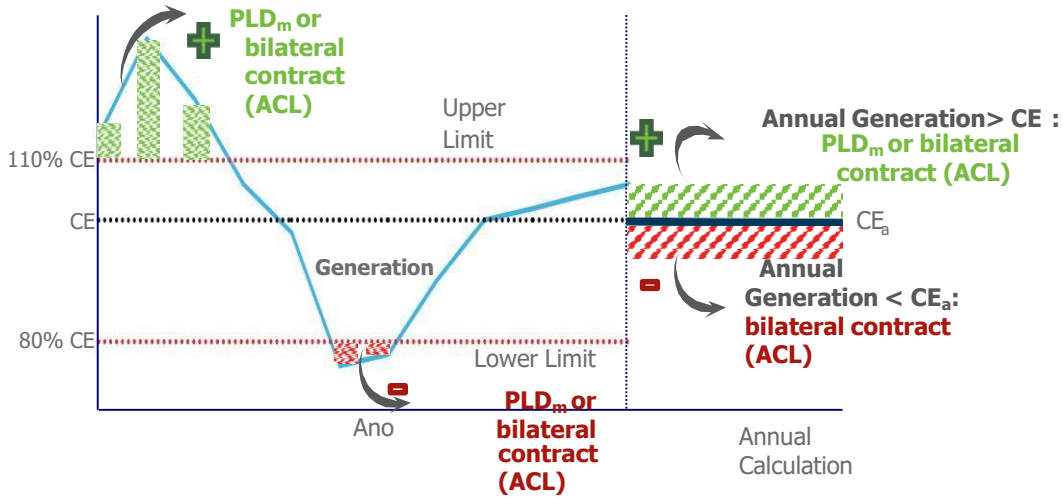
Solar energy is used on all continents and is increasingly used to generate electricity or heat. Photovoltaic (PV) cells, which can also be solar cells, are electronic devices that convert sunlight directly into electricity. Photovoltaics is one of the fastest growing renewable energy technologies.

Solar - ACL

Revenue (R$)



CCEE Settlement



Billing

Seasonal Contract
x
Contract Price

Accounting

Seasonal Contract
x
Contract Price
+
Sales over 10% of PG

Cash

Same as Accounting

2. Economic and Financial Aspects

- ✓ Besides income, what else should I worry about?

2.1 Sector Charges

Sector Charges – CFURH

Example: CPFL Geração Financial Statements (2Q22) – Portuguese only

CFURH (Financial Compensation for the Use of Water Resources)

Aneel Resolution No. 67/2001 establishes that hydroelectric generators must pay the amounts related to CFURH on a monthly basis for the purpose of Electric Energy Generation, calculated based on the monthly generation of their hydroelectric plants, observing the cases of exemption established by law.

15. RECEITA OPERACIONAL LÍQUIDA

	Controladora				Consolidado			
	2022		2021		2022		2021	
Receita de operações com energia elétrica	**2° Trimestre**	**1° Semestre**	**2° Trimestre**	**1° Semestre**	**2° Trimestre**	**1° Semestre**	**2° Trimestre**	**1° Semestre**
Fornecimento de energia elétrica	-	-	-	-	-	1.302	2.761	7.191
Furnas Centrais Elétricas S.A.	-	-	-	-	236.246	439.823	205.838	361.126
Outras concessionárias, permissionárias e autorizadas	70.412	102.040	14.039	27.925	696.320	1.342.788	682.084	1.293.377
Energia elétrica de curto prazo	-	-	481	1.019	8.027	16.626	20.286	45.485
Suprimento de energia elétrica	70.412	102.040	14.520	28.944	940.593	1.799.237	908.208	1.699.988
Receita de construção da infraestrutura de concessão	-	-	-	-	116.178	227.896	35.873	74.116
Outras receitas e rendas	7.206	13.059	10.863	14.658	30.862	63.385	27.524	45.462
Outras receitas operacionais	7.206	13.059	10.863	14.658	147.040	291.281	63.397	119.578
Total da receita operacional bruta	77.618	115.100	25.383	43.601	1.087.633	2.091.819	974.366	1.826.758
Deduções da receita operacional								
ICMS	-	-	-	-	1.164	(1.192)	(801)	(1.008)
PIS	(1.281)	(1.899)	(414)	(709)	(12.526)	(24.100)	(11.748)	(22.166)
COFINS	(5.899)	(8.748)	(1.907)	(3.267)	(57.729)	(111.070)	(54.138)	(102.147)
ISS	(128)	(250)	(111)	(218)	(128)	(250)	(111)	(218)
Reserva global de reversão - RGR	-	-	-	-	(63)	(127)	(19)	(33)
Programa de P & D e eficiência energética	-	-	-	-	(697)	(1.586)	(988)	(1.870)
Compensação financeira pela utilização de recursos Hídricos - CFURH	-	-	-	-	(3.309)	(3.907)	(741)	(2.584)
Outros	-	-	-	-	(2.490)	(4.610)	(2.058)	(4.245)
	(7.308)	(10.897)	(2.432)	(4.195)	(75.778)	(146.842)	(70.602)	(134.272)
Receita operacional líquida	70.310	104.203	22.951	39.407	1.011.855	1.944.977	903.764	1.692.486

For more information, click here.

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Connection and Transmission Charges

TUST-RB (National Grid)

Main portion of the TUST, refers to the transmission facilities that are part of the National Grid, with a voltage level equal to or higher than 230 kV, used to promote the optimization of the system's electrical and energy resources and, therefore, **is applicable to all users**.

TUSD-g

Charge referring to power plants connected at voltage levels from 88 to 138 KV (**Distribution Grid**).

Connection

Amount due by the system user **when connecting** to installations owned by the Distribution Company, calculated based on costs associated with the installations under the user's responsibility, defined in accordance with the regulation.

Connection and Transmission Charges

Example: 2Q22 CPFL Energia Earnings Release – p. 47

2Q22 CPFL Results

Cost of Electric Power

Cost of Electric Energy - R$ Million						
	2Q22	**2Q21**	**Var.**	**1H22**	**1H21**	**Var.**
Energy Purchased in the Spot Market	15	49	-69.8%	31	80	-61.9%
Energy Purchased Bilateral Contracts and ACL	63	35	81.7%	152	77	97.0%
PIS and COFINS Tax Credit	(5)	(3)	49.2%	(12)	(7)	81.2%
Cost of Electric Power Purchased for Resale	**74**	**81**	**-9.1%**	**171**	**151**	**13.2%**
Basic Network Charges	29	25	14.3%	61	54	13.7%
Connection Charges	3	3	5.0%	6	6	6.9%
Charges for the Use of the Distribution System	10	8	15.1%	19	15	25.5%
ESS/EER	0	4	-98.3%	0	0	85.6%
PIS and COFINS Tax Credit	(1)	(1)	5.7%	(3)	(3)	12.2%
Distribution System Usage Charges	**40**	**40**	**2.2%**	**83**	**72**	**15.7%**
Cost of Electric Energy	**114**	**121**	**-5.4%**	**254**	**223**	**14.0%**

Connection and Transmission Charges

Example: 2Q22 CPFL Energia Earnings Release – p. 47

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CPFL ENERGIA

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CPFL ENERGIA

UBP – Use of the Public Good

- Annual amount paid as a concession for the granting of a hydraulic enterprise
- It usually corresponds to a percentage of the annual revenue to be earned by the generator
- It is equivalent to the grant period and its payment is made in monthly installments by the entrepreneur (it does not consider extension of the concession or authorization)
- Can be corrected by IGP-M or IPCA, depending on the project

VPA = VP*GF*VR*8760/100

Onde:
VPA = amount of annual payment for the use of public property
VP = percentage value to be applied on the estimated annual revenue from hydroelectric use, equal to 2.5%
GF = physical guarantee of hydroelectric use, in average MW, defined by the granting power, and in the absence of this, the value obtained from the product between the installed power and the capacity factor equal to 0.55
VR = Annual Reference Value, in R$/MWh, in effect on the date of publication of the administrative act approving the modification of the concession's operating regime

Contact IR:

ri@cpfl.com.br