

# A Review of the October 2019 Renewable Auction in Colombia

A note from AFRY Management Consulting

May 2020

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AFRY Management Consulting provides leading-edge consulting and advisory services covering the whole value chain in energy, forest and bio-based industries. Our energy practice is the leading provider of strategic, commercial, regulatory and policy advice to European energy markets. Our energy team of over 250 specialists offers unparalleled expertise in the rapidly changing energy markets across Europe, the Middle East, Asia, Africa and the Americas.

AFRY is the leading market advisor for the financing of renewable projects in Europe, with over 25 years of experience in Europe's liberalised energy markets. We provide market advisory and commercial due diligence services to project acquisitions and financing of renewable and conventional generation assets across Europe. Our reports and projections are frequently relied upon by investors and lenders in these transactions.

AFRY has worked extensively in Europe on renewables and conventional generation transactions. Working as lenders market advisor or directly on buy-& sell-side transactions AFRY has valued ~310GW capacity worth over €360bn in the last decade.

In Latin America, and especially in Mexico, we have been present since 2012, building up our reputation in Management Consulting services through our market projections.

In 2018, on request of several clients, we decided to extend our offer to Colombia. Our learning curve have been strong thanks to our extensive knowledge of Power markets globally and also thanks to the support of Colombian associates.

Also, AFRY as an international corporation has already been involved in significant projects in Colombia. Our hydro engineers have been contracted by EPM to prepare an expert opinion to determine whether the works carried out within the Ituango 2.4GW hydro project do comply with the requirements imposed by the ANLA, the Colombian environmental authority. AFRY also worked for IDB Invest on the hydro project Los Molinos, acting on the technical side. This specific know-how is highly valuable and is incorporated in our modelling activities. Our first edition of the Colombian AFRY Independent Market Report has been available since mid-April 2019.

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# Introduction

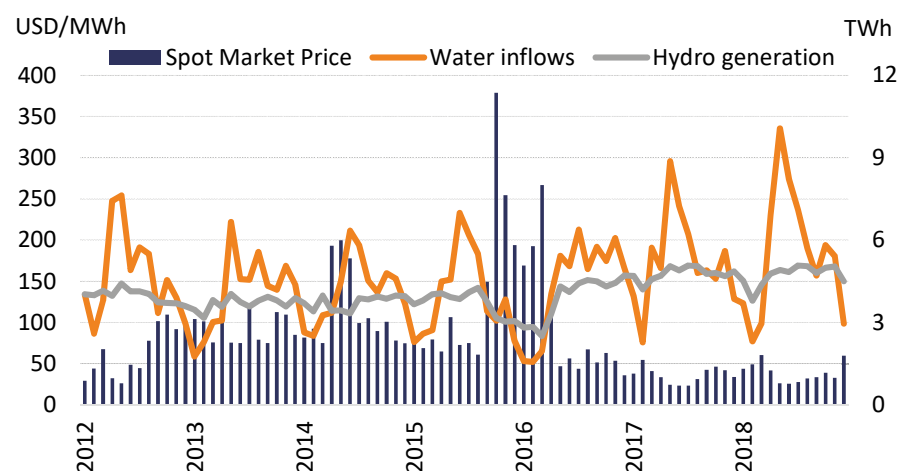
Colombia's generation mix is greatly concentrated on Hydro. As of 2018, hydro installed capacity was 68% of total and, between 2010 and 2018, the monthly proportion of demand supplied by this generation source was, on average, 76%. This dependence on rainfall makes Colombia heavily exposed to extreme weather-related events like 'El Niño', a periodic anomaly in ocean temperatures over the tropical East Pacific, which leads to strong reductions in precipitation in the country. During 'El Niño' episodes, e.g. the last quarter of 2015 and first quarter of 2016, hydro share in the generation mix can drop to nearly 50%, and electricity prices rise substantially (see Figure 1).

Colombia has also abundant renewable resources. Average wind speeds on the Caribbean Coast are much higher than world average, in the region of 10m/s<sup>1</sup>, and irradiation on the north and centre of the country is around 1,680kWh/kWp<sup>2</sup>. In energy terms, these figures can be translated into average load factors of 60% for onshore wind in la Guajira and 20% for solar PV (fixed tilt).

Decree-law 570 from 2018<sup>3</sup> laid the foundations for the diversification of the country's energy matrix. It established long-term auctions as the policy tool to enable the materialization of renewable projects capable of harnessing the abundant resources mentioned before.

A first renewable auction was held in February 2019 but it was deemed void. Although there were 8 sell offers and 12 buying offers, two of the three competition criteria weren't met.

**FIGURE 1 – HISTORICAL MONTHLY WATER INFLOWS, HYDRO GENERATION AND MARKET PRICES**



Source: XM, AFRY

The first one, the one that was met, established that more than 50% of the offers couldn't come from a single company. The second one, not met, referred to market concentration and was measured according to the Herfindahl-Hirschman Index<sup>4</sup>; the maximum was set at 2,800 and the outcome of the auction led to an index of 7,836. The third one, not met either, stipulated that a single project couldn't represent more than 12% of the total amount of allocated energy; however the outcome of the auction led to one project being awarded 88% of the total allocated energy. According to several stakeholders, this auction failed due to insufficient demand-side participation. It should be noted that, in Colombian renewable auctions, participation of demand is voluntary and there isn't a firm guarantee that the generation projects will have an off-taker. The competition criteria were also seen as too restrictive.

The government changed the auction rules and a second auction was held in October 2019. It successfully matched 9 generation projects, totalling 1.3GW of generation capacity, with 41 electricity retailers whose combined market share in 2018 was 83% (100% in the regulated segment). Total assigned energy amounted to 12.1GWh/day, 6.4% of the country's total demand in 2018 (9.4% of regulated demand).

1 <https://vortexfdc.com/knowledge/wind-map-world/>

2 <https://solargis.com/maps-and-gis-data/download/colombia>

3 <https://bit.ly/2Jt9i4D>

4 Herfindahl-Hirschman Index (HHI) is a measure of market concentration. It is calculated by squaring the market share of each firm competing in a market and then summing the resulting numbers. It can range from close to zero to 10,000.

# Auction rules

The design of the October 2019 auction was disclosed in Resolutions 40590<sup>5</sup> and 40591<sup>6</sup>, both of 2019. The main characteristics were:

- It was a double-sided auction, which meant that both buyers (Colombian electricity retailers) and sellers (generators) participated simultaneously in the bidding process.
- Participation was voluntary although there was a complementary mechanism for automatic and mandatory assignation in case the target for total assigned energy (12.05GWh/day) wasn't met.
- Allocated energy is due to be contracted under 15-year power purchase agreements (PPAs) in Colombian pesos, updated with inflation, with delivery starting on the 1st January 2022.
- PPAs are take-or-pay, meaning that generators must settle the contract regardless of actual generation and retailers must accept the settlement regardless of actual demand.
- Retailers bid a maximum amount of packs of energy (0.5MWh each) to be purchased at a given price for each of the 24h hour of a day.
- Generators bid a minimum amount of packs of energy (0.5MWh each) to be sold at a given price during all hours of one of the three following blocks (the amount of energy must be the same for each hour of a same block):
  - Block 1: 7 hours, from 00:01 to 07:00
  - Block 2: 10 hours, from 07:01 to 17:00
  - Block 3: 7 hours, from 17:01 to 00:00
- Bidders could build complex bidding strategies using mutual exclusiveness, inclusiveness and simultaneity between different bids.
- Objective was to maximise consumer surplus on an hourly basis.

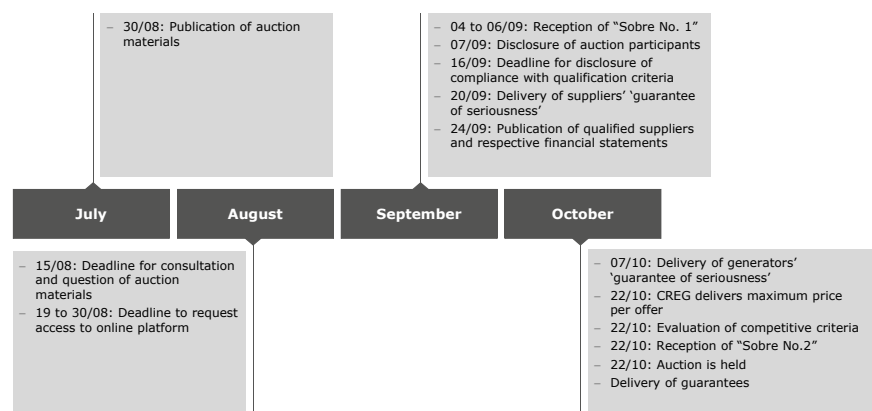
## Qualification process and technologies

The different stages of the qualification process are indicated in Figure 2.

For generators to be able to submit “Sobre No. 1”, they had to comply with three sets of qualification criteria (article 30 of Resolution 40590 of 2019<sup>5</sup>):

1. Legal;
2. Financial – mainly to constitute the ‘seriousness guarantee’<sup>7</sup>, equal to USD39.4/MWh<sup>8</sup> times 10% of the maximum amount of energy to be sold in a given year;
3. Technical
  - 3.1 Being considered non-conventional renewable generators<sup>9</sup> – wind, solar, small-scale hydro, geothermal, tidal or biomass;
  - 3.2 Having reached the second of the three regulatory registration phases for generation projects – i.e. the following should be completed: in-depth analysis of conditioning factors, preliminary engineering design, cost estimation, economic feasibility study, basic project formulation, financial study and environmental study;
  - 3.3 Having an approved grid injection request, issued by UPME<sup>10</sup>. The plant’s COD<sup>11</sup> must take place no later than the 31st of December 2023;
  - 3.4 Installed capacity above 5MW. If installed capacity is less than 20MW, plants must opt for central dispatch, i.e. they cannot benefit from the non-centrally dispatched regime usually applicable to plants under 20MW in Colombia;

**FIGURE 2 – OCTOBER 2019 RENEWABLES AUCTION TIMELINE**



Source: UPME

<sup>5</sup> <https://bit.ly/2X2jx8a>

<sup>6</sup> <https://bit.ly/2Jy6wuZ>

<sup>7</sup> "Garantía de seriedad"

<sup>8</sup> COP135/kWh converted to USD/MWh using exchange rate from Thomson Reuters Eikon from the auction date: on 22/10/2019, 1 USD = 3,429 COP

<sup>9</sup> According to point 17 of article 5 of Law 1715 of 2014 (<https://bit.ly/2JlzRTT>)

<sup>10</sup> UPME – Government's Mining and Energy planning unit ("Unidad de Planeación Minero-Energética")

<sup>11</sup> COD – Commercial Operation Date

3.5 Having a detailed schedule until the project's COD<sup>12</sup> ('the S curve') containing (i) granting of the environmental license, (ii) start of construction, (iii) acquisition of main equipment, (iv) test period, (v) environmental licenses or permits associated with the connection point, (vi) commissioning of the connection point, (vii) completion of connection construction and (viii) start of commercial operation.

For retailers to be able to submit "Sobre No. 1", they had to comply with two sets of qualification criteria (article 31 of Resolution 40590<sup>5</sup> of 2019):

1. Legal; and
2. Financial – mainly to constitute the 'seriousness guarantee'<sup>7</sup>, equal to USD42.5/MWh<sup>8</sup> times 5% of the maximum amount of energy to be bought in a given year.

#### Competition and other conditions

In the October 2019 auction, the competition criteria were substantially relaxed compared to February 2019. According to the regulator<sup>12</sup>'s Resolution 106 of 2019<sup>13</sup>, the only competition criteria was that a single generator couldn't be allocated more than 40% of the total allocated energy.

Resolution 40590 of 2019<sup>5</sup> established two additional conditions:

1. Generators – total amount of energy offered could not be greater than project's average daily output. This limit was calculated using load factors per technology published by UPME (57% for onshore wind and 26% for solar PV).
2. Retailer – total amount of buying offers per supplier could not be greater than average daily demand supplied by agent in 2018. Limits were published by UPME for each retailer.

#### Demand and complementary mechanism

On the demand side, it should be noted that, although participation was voluntary, the National Development Plan, enacted by Law 1955 of 2019<sup>14</sup>, set a mandatory target for electricity retailers to have 8% to 10% of their energy purchases covered by long-term contracts with non-conventional renewable energy sources.

The costs of these long-term PPAs can be passed-through to end-users in the regulated market according to what is established in Resolution 129 of 2019<sup>15</sup>.

This resolution foresees a weighting mechanism to ensure that long-term contracts are "in the money": all contracts are benchmarked against a market average which limits the possibility for an individual retailer to recover all costs incurred under excessively high-priced PPAs. As reference, demand from the regulated market amounts to around two thirds of Colombia's total electricity demand.

In other words, there is an obligation for suppliers to enter into long-term PPAs with non-conventional renewable generators, and for these contracts to be as price competitive as possible.

Following what was established in Resolution 40591 of 2019<sup>6</sup>, the target demand and maximum contract prices were published on the day of the auction by the Ministry of Mining and Energy, after receiving all offers from interested parties. Target demand was set at 12.05GWh/day, 6.4% of the country's total demand in 2018 (9.4% of regulated demand), the maximum price per individual contract set at USD58.3/MWh<sup>16</sup> and maximum average price for all contracts set at USD46.7/MWh<sup>17</sup>.

After the initial (voluntary) allocation of contracts between generators and suppliers, if the total allocated energy was less than the target demand, a complementary mechanism<sup>18</sup> was to be activated. In this auction aftermath, retailers that were allocated a total energy below 9.4% of their 2018 regulated demand during the initial round were automatically allocated additional energy, corresponding to a pro-rata of the gap between target demand and energy allocated in the voluntary phase (in MWh/day). This administrative assignation of contracts could only take place if there were unmatched offers by generators which were below the maximum contract price and, if allocated, didn't result in the breach of the maximum average contract price.

In summary, regardless of the number of retailers who voluntarily participated in the auction, this mechanism extended the participation base to all companies active in the regulated market. This was a way to ensure that the objective set out in the National Development Plan is met.

12 CREG – Commission for the Regulation of Energy and Gas ("Comisión de Regulación de Energía y Gas")

13 <https://bit.ly/2JuMdyF>

14 <https://bit.ly/39B3ReK>

15 <https://bit.ly/2UTeDHN>

16 COP200/kWh converted to USD/MWh using exchange rate from Thomson Reuters Eikon from the auction date: 22/10/2019, 1 USD = 3,429 COP

17 COP160/kWh converted to USD/MWh using exchange rate from Thomson Reuters Eikon from the auction date: 22/10/2019, 1 USD = 3,429 COP

18 See resolution 40725 of 2019 – <https://bit.ly/3bMqfU6>



# Participation

27 generators with 56 projects (totalling 4.7GW) and 26 retailers met the qualification criteria and submitted “Sobre No. 1”.

From these, 50 projects and 24 retailers complied with the technical, legal and financial requirements.

From these, 25 projects (totalling 2.8GW) and 23 retailers submitted the ‘seriousness guarantee’ and participated in the voluntary auction.

As opposed to the February 2019 auction, this was a massive improvement in demand participation.

In fact, these 23 retailers supplied 54.2TWh of electricity to end-consumers in 2018 (44.5TWh of which in the regulated market), which represents a combined market share of 79% in national demand and 95% in the regulated segment.

Figure 3 shows the geographical distribution of the generation projects which participated in the voluntary auction, split by generation type.

**FIGURE 3 – GENERATION PROJECTS THAT PARTICIPATED IN THE VOLUNTARY AUCTION**



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# Auction results

Before analysing the auction results, it is worth saying that the contract price excludes the CERE – Energy Equivalent Real Cost. This is defined as the real cost paid by generators in order to remunerate the Firm Energy Obligations (OEF). It is calculated as the total real remuneration given monthly to all the plants with assigned OEF, divided by the real generation of the month. Although the CERE usually amounts to around USD20/MWh, the effective value received by individual generators depends on their ENFICC – Firm Energy for the Reliability Charge. For onshore wind and solar PV projects, this figure is in the region of 10% (varying per project). All in all, in order to assess the profitability of the winning projects, one should add around USD2/MWh to the contract price assigned through the auction procedures.

Table 1 summarises the auction results and Table 2 provides the details per project. The weighted average price in the voluntary round was USD279/MWh<sup>22</sup> and in the complementary round was USD31.1/MWh<sup>23</sup>. This was seen a success by governmental entities as the prices were 50% lower than the maximum established. Besides, this auction process led to 260 PPAs signed between generators

and electricity retailers, which is a great achievement for the nascent renewable sector in Colombia.

As mentioned in the participation section, only 23 retailers constituted the ‘seriousness guarantee’ and participated in the voluntary auction. However, as the target demand had not been reached and there were offers by generators at a price below the maximum, the complementary mechanism was activated. This resulted in the pro-rata allocation of the remaining demand to all retailers with regulated consumers. In the end, 9 projects entered into PPA contracts with 41 retailers.

Table 3 and Table 4 present the results split by daily block. It is interesting to note that the energy allocated in Block 3 (17:01 to 00:00) is significantly lower than in the other Blocks. Although it is natural that the energy bidding from solar plants were limited to Block 2 (7:01 to 17:00), the substantially lower bids from wind generators in Block 3 was surprising.

Some stakeholders commented that the wind speeds in the Guajira region decrease after 17:00 and that this explained the reduced level of participation. However, analysing 2019 real generation data from the

only wind farm in Colombia, also located in La Guajira (see Figure 4), and assuming this is representative of the region, there does not seem to be a significant difference in terms of resource between Block 3 and Block 1 (00:01 to 07:00).

On the other hand, analysing the average hourly wholesale electricity price shape for 2019 (see Figure 5) it is clear that prices during the hours of Block 3 are higher than daily average. Therefore not committing to sell energy in this block provides a double upside for generators:

- Minimising the risk of being short and having to purchase the difference between contracted volume and actual generation at high prices.
- Owning the potential upside of selling generation in these hours at prices higher than the average market prices and higher than the clearing price of this auction.

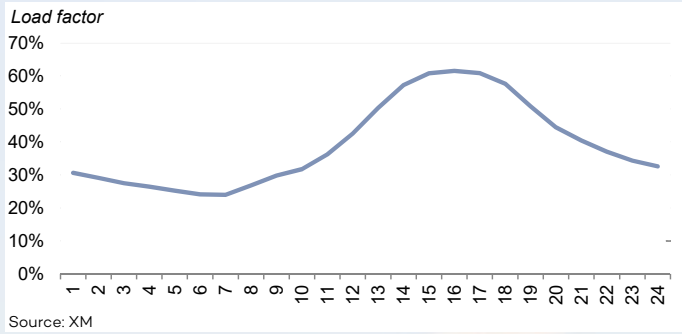
**TABLE 1 – SUMMARY OF AUCTION RESULTS**

Auction	Number of participants		Inst. Capacity [GW]	Allocated Energy [GWh/day]	Energy split per technology		Weighted average price	
	Retailers	Projects			Solar	Wind	[COP/kWh]	[USD/MWh] <sup>24</sup>
Voluntary	22	8	1.29	10.186	174%	82.6%	95.65	27.89
Compl.	28	3	0.25	1.864	13%	98.7%	106.67	31.11
Total	41	9	1.365	12.05	14.9%	85.1%	97.36	28.39

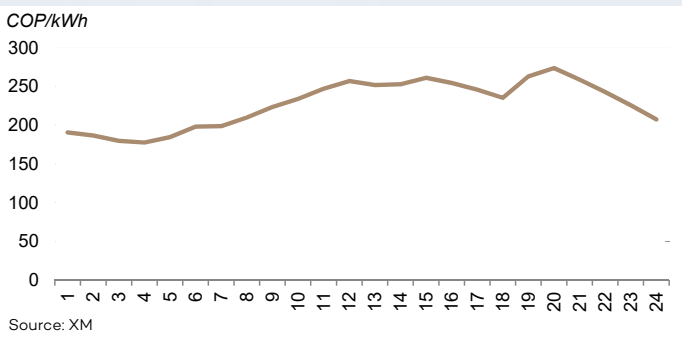
<sup>22</sup> COP95.65/kWh converted to USD/MWh using exchange rate from Thomson Reuters Eikon from the auction date: 22/10/2019, 1 USD = 3,429 COP  
<sup>23</sup> COP106.66/kWh converted to USD/MWh using exchange rate from Thomson Reuters Eikon from the auction date: 22/10/2019, 1 USD = 3,429 COP  
<sup>24</sup> Converted to USD/MWh using exchange rate from Thomson Reuters Eikon from the auction date: 22/10/2019, 1 USD = 3,429 COP



**FIGURE 4 – AVERAGE HOURLY LOAD FACTOR OF JEPIRACHI WIND FARM IN 2019**



**FIGURE 5 – AVERAGE HOURLY MARKET PRICE (“PRECIO BOLSA INTERNACIONAL”) FOR 2019**



**TABLE 2 – AWARDED PROJECTS**

Project	Tech.	Inst. Capacity	Assigned Energy	Weighted average price	Owner	Developer	COD	Region
		[MW]	[GWh/day]	[USD/MWh] <sup>24</sup>				
Cartago	Solar	99	0.615	27.36	Trina	Continua Energías Positivas	Jan-22	Valle del Cauca
San Felipe	Solar	90	0.56	28.93	Trina	Continua Energías Positivas	Jan-22	Tolima
El Campano	Solar	99	0.62	29.14	Trina	Univergy International, S.L.	Jan-22	Cordoba
Alpha	Wind	212	2.04	25.8	EDPR	Renovatio	Nov-23	La Guajira
Beta	Wind	280	2.628	27.41	EDPR	Renovatio	Nov-23	La Guajira
Casa Electrica	Wind	180	2.461	28.54	AES	Jemeiwaa KA'I	Sep-23	La Guajira
Camelia	Wind	250	1.009	30.32	Celsia	Renovatio	Dec-23	La Guajira
Apotolorry	Wind	75	1.025	30.62	AES	Jemeiwaa KA'I	Sep-23	La Guajira
Acacia 2	Wind	80	1.092	31.26	Celsia	Renovatio	Aug-22	La Guajira

Source: UPME, XM for COD

**TABLE 3 – ENERGY ASSIGNED PER BLOCK**

Project	Tech.	Block 1	Block 2	Block 3	Total	Total	Capacity	LF
		[MWh/day]	[MWh/day]	[%]	[MW]	[%]		
Cartago	Solar	0	615	0	615	5.1%	99	26%
San Felipe	Solar	0	560	0	560	4.6%	90	26%
El Campano	Solar	0	620	0	620	5.1%	99	26%
Alpha	Wind	686	1,165	189	2,040	16.9%	212	40%
Beta	Wind	882	1,515	231	2,628	21.8%	280	39%
Casa Electrica	Wind	1,081	1,380	0	2,461	20.4%	180	57%
Camelia	Wind	24	960	24	1,009	8.4%	250	17%
Apotolorry	Wind	455	570	0	1,025	8.5%	75	57%
Acacia 2	Wind	318	455	318	1,092	9.1%	80	57%
Total		3,447	7,840	763	12,050		1,365	

Source: UPME

**TABLE 4 – ENERGY ASSIGNED PER BLOCK**

Project	Tech.	Block 1	Block 2	Block 3	Total	Total
		[COP/kWh]			[COP/kWh]	[USD/MWh] <sup>24</sup>
Cartago	Solar	0.00	93.81	0.00	93.81	27.36
San Felipe	Solar	0.00	99.21	0.00	99.21	28.93
El Campano	Solar	0.00	99.91	0.00	99.91	29.14
Alpha	Wind	88.48	88.48	88.48	88.48	25.80
Beta	Wind	93.98	93.98	93.98	93.98	27.41
Casa Eléctrica	Wind	97.88	97.88	0.00	97.88	28.54
Camelia	Wind	103.97	103.97	103.97	103.97	30.32
Apotolorry	Wind	105.00	105.00	0.00	105.00	30.62
Acacia 2	Wind	107.19	107.19	107.19	107.19	31.26
Total		96.86	97.47	98.45	97.36	28.39

Source: UPME

24 Converted to USD/MWh using exchange rate from Thomson Reuters Eikon from the auction date: 22/10/2019, 1 USD = 3,429 COP

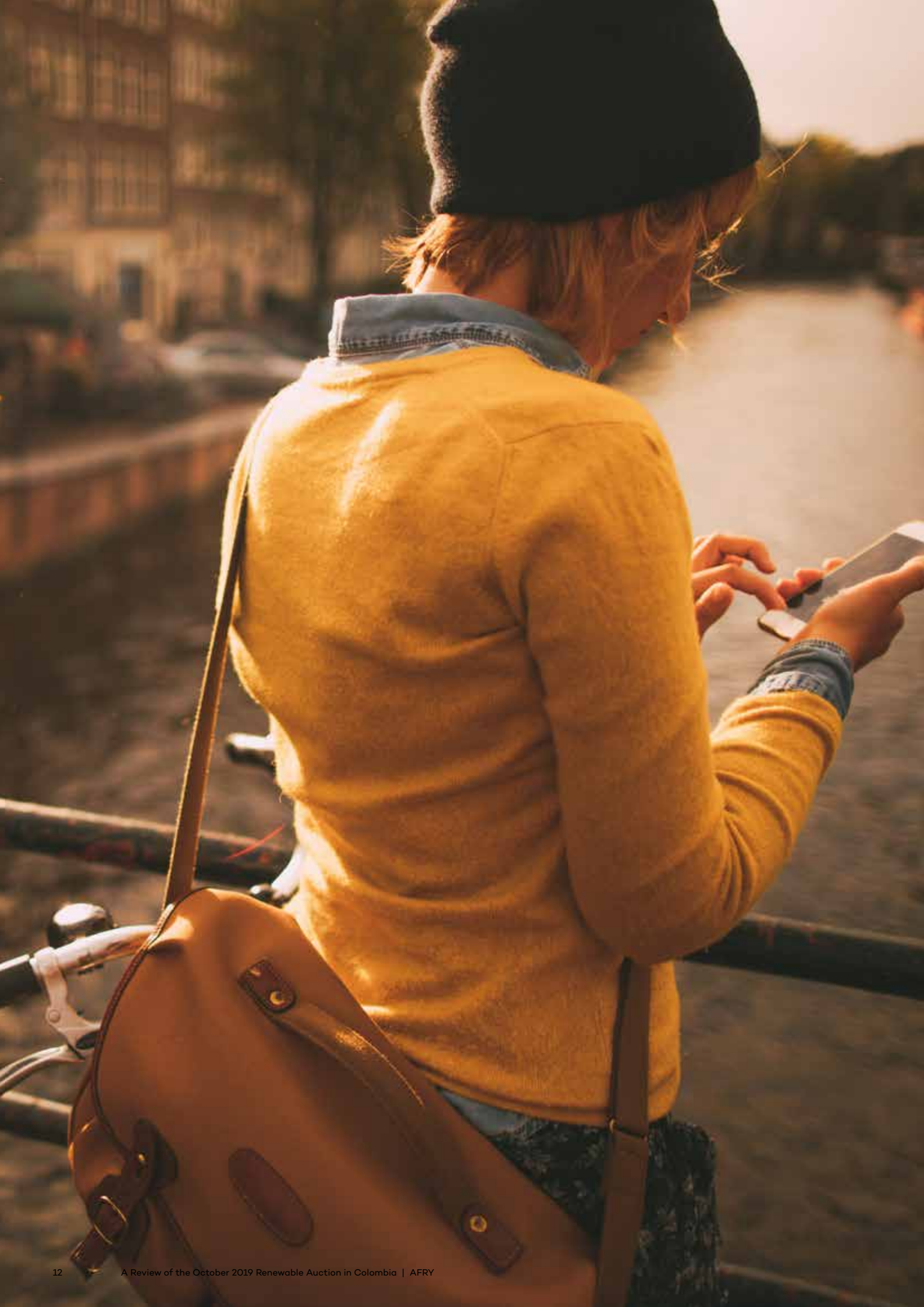
Another noteworthy result from the analysis of Table 3 is that 6 of the 9 winning projects ended up with contracts amounting to the maximum load factor defined by UPME10: 26% for solar PV and 57% for wind. As this auction resulted in the allocation of take-or-pay contracts, one might have expected more conservative strategies, with bids below the maximum allowed load factor for prices close to LCOE of solar and wind. Another argument in favour of lower level of generation commitment is risk minimisation; as an example, the bids from Beta and Alpha wind projects, with resulting load factors of 39% and 40% and clearing prices on the lower end of the range, seem to indicate that the goal was to cover a substantial amount of forecasted generation with long-term contracts but reduce the risk of failing to meet the contractual obligations – in other words, minimising the probability of being short under the take-or-pay contract, and be able to sell the excess energy in the day-ahead market or through other PPA agreements.

However, as the full list of offers isn't public (only the matched ones are), from Table 3 one cannot conclude that the owners of the projects didn't bid for the maximum load factor figure. It is although tangible that at least some projects submitted several bids at different price levels, indicating that they priced differently the risk of 'under-delivery' and/or the benefit of generating above the contract terms (having to sell that energy through other commercial arrangements).

Before the auction, stakeholders verbalised some concerns about different aspects of the auction design. The most common were:

- Currency – generators stated that USD denominated contracts would make the financing easier and cheaper which would result in lower prices.
- Grid reinforcements – La Guajira is characterised by excellent wind resource but the network infrastructure to connect the projects to the Colombian grid are suffering repeated delays, which could jeopardise the fulfilment of some of the auction deadlines.
- Block system and take-or-pay – having to offer the same amount of energy throughout a single block makes generators open to volume risk. An assessment of routes-to-market had to be made in order to analyse the risk of being short or long on the contract (i.e. generating less than required and having to purchase the missing energy from the market, or being long and having to sell the excess energy).
- Lack of visibility on the assigned retailers – some generators could end up with PPAs with less bankable retailers than others, which could result in worse financing conditions.

The fact that the target demand was met (85% of which voluntarily) and that the resulting prices were 50% lower than the regulated maximum suggests that the stable regulatory framework (15-year PPA) and the availability of resource (both solar and wind) outweighed the existing concerns.



# How can AFRY help

Take-or-pay contracts assign volume and price risk symmetrically to supply and demand, but individual participants, to properly assess the economics of projects, must answer the following questions:

- What is the volume risk associated with the allocated energy per block?
- What are the routes to market for shortages and excess of energy (when generators are short or long)?
- What will happen with my asset at the end of the 15-year contract?

AFRY is uniquely positioned to share insights on the three questions above. Our in-depth market knowledge and powerful modelling tools can help agents to quantify risks and forecast long-term market outlooks. This can be particularly helpful in a market facing substantial uncertainties like the Colombian one.

One of the key uncertainties in Colombia is the weather variability. Table 5 shows the variation of peak demand, intermittent generation and wholesale price with historical weather patterns (2012 to 2017), compared to average. As it is possible to infer, in Colombia, the range of potential outcomes varies widely which is translated in price and volume risk that need to be quantifiable.

Other uncertainties relate to the commissioning of the 2.4GW Hidroituango hydro plant, investment costs of renewables, evolution of the thermal capacity mix, demand growth and future cost of fuels.

AFRY has over 20 years' experience in energy markets and, since 2010, our consulting team has valued around 310GW of electricity generation capacity across Europe, the MENA region and the Americas with a combined value above USD390bn. In addition to transactions we have worked on directly, our independent market reports are relied upon and trusted by utilities, banks and independent players for use in numerous strategic and commercial valuations. In 2019, solicited by its global clients, AFRY Management Consulting enhanced its commercial offer with the release of a new reference source for long-term projections for the Colombian wholesale electricity market. The

Q1 2020 update of our Colombian report is available and encompasses a thoughtful analysis of the uncertainties mentioned before and of the overall renewable market outlook.

As indicated in Table 5, in Colombia, abundant solar and wind resources coincide with dry years. This means that renewables can play a significant role in making the Colombian system less exposed to price spikes in periods of low hydro generation. Besides, falling capex, increasing efficiency gains and availability of resource make onshore wind and solar PV the most economic options to meet increasing demand<sup>26</sup>. The high number of registered renewable projects with approved connection points (around 2.5GW of wind and 5.2GW of solar) seems to indicate that investments are gaining momentum and AFRY is eager to contribute for the materialization of such projects.

**TABLE 5 – VARIATION OF MARKET VARIABLES WITH HISTORICAL WEATHER PATTERNS V.S. AVERAGE VALUES**

	\$	Wind	Solar	Hydro	Peak demand
WY	WP	Wind LF	Solar LF	Hydro LF	Peak demand
2012	85%	89%	103%	105%	104%
2013	127%	99%	105%	93%	101%
2014	131%	112%	105%	90%	99%
2015	119%	120%	103%	91%	99%
2016	102%	93%	102%	99%	99%
2017	36%	88%	82%	123%	98%

Source: AFRY, with XM data

<sup>26</sup> They are effectively the technologies with lowest long-run marginal costs

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