

# EXTREME WEATHER

## El Niño | Colombia | 2015/16

This case study is part of an extreme weather impact project, in partnership with Swiss RE Corporate Solutions and Marsh & McLennan Companies, which aims to identify and share best practice within the energy sector to enable more agile and adaptive response to extreme weather and natural hazard impacts on energy systems and supplies.

### CASE STUDY AT GLANCE



#### WEATHER EVENT

El Niño and associated hydrological drought



#### ORGANISATION

La Asociación Nacional de Empresas Generadoras (ANDEG)



#### INDUSTRY SUB-SECTOR

Not-for-profit, Generation Association



#### RESILIENCE RESPONSE

Financial (Incentives)



#### RESILIENCE COSTS

USD \$250 million (thermal back-up)



#### RESILIENCE BENEFITS

Avoided blackouts  
Increased network capacity

The 2015/16 El Niño event (and associated drought) brought Colombia to the verge of series of programmed blackouts. Despite sufficient installed capacity, a series of unforeseen events and operational problems with backup thermal plants and hydro dams left the system barely able to meet power demand. This put tremendous stress on both the system and the electricity market: production prices rose, transferring most of the costs to the end-user.

The uncertainty brought by climate variability and insufficient diversification was seen to be the main stress on the system. Colombia's dependence on hydrological resources, and the uncertainty about possible intensification of the El Niño-Southern Oscillation (ENSO) phenomenon is preventing the available energy system from keeping pace. This case study explores the context of the power shortage and the role of thermal generators in addressing dynamic system resilience.

### CONTEXT

#### ORGANISATIONAL PROFILE: ANDEG

- Private non-profit organisation (created in 2010), which brings together 13 Colombian thermal electricity generation companies.
- Represents 3,868 MW of effective generation capacity (24% of the national total).
- Analyses policies and regulation to support the Colombian government in decision-making.

#### EL NIÑO EVENT OF 2015/16

El Niño-Southern Oscillation (ENSO) is the Earth's most important weather-producing phenomenon. During an El Niño event, the surface waters in the central and eastern Pacific Ocean become significantly warmer; during La Niña, the opposite occurs. Usually dry regions of Peru, Chile, Mexico, and the southwestern United States experience rain and snow; wetter regions of the Brazilian Amazon, Colombia and the north-eastern United States plunge into months-long droughts.

The 2015/16 drought was a 1 in 50-year event and the second strongest in the history of Colombia.

Rainfall dropped by 40% below usual, generating severe hydrological drought which persisted until March 2016.

#### ENERGY IMPACTS



Water levels in hydropower dams decreased by 60-70% compared to normal years.



There was increased demand from cooling and refrigeration during the hot El Niño months.



An unforeseen fire incident at the largest hydroelectric plant (Central Guatapé) further reduced capacity.



Cumulatively, there was about 200 MW shortage by April 2016.



Electricity spot prices rose to more than US\$400 per MWh (from US\$30-50). This particularly impacted generation and distribution companies that were not hedged properly (market failure).

The Colombian energy mix is made up of hydro-generation plants (77%) and a minor proportion from thermal-generation plants (18%). For resilience during El Niño years, the Colombian grid needs to have enough generation plants with firm energy (e.g. thermal backup capacity) to supplement the low hydraulic productivity during the exceptionally dry seasons. Without these alternative resources, demand would have to be rationed, implying high economic and civilian costs.

The typical rainy season between September and December is a critical period for hydropower generators as they depend on precipitation to refill water reservoirs. However, during El Niño, low rainfall can result in hydrological drought and in turn, can lead to high energy price volatility.

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**YOU CAN HAVE THE BEST MECHANISM IN PLACE, BUT YOU ALWAYS NEED TO HAVE FLEXIBILITY AND BE ABLE TO ACT FAST DURING EL NIÑO. YOU HAVE TO DEAL ON A DAY-BY-DAY BASIS AND REACT FAST**

- ANDEG -

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## INITIAL RESILIENCE: THE CAPACITY MARKET

Recognising the energy system’s vulnerability to the seasonal climate, the periodic occurrence of El Niño and fluctuating fossil fuel prices, the Colombian Ministry of Mines and Energy (or MEM), in its role as Commission for the Regulation of Energy and Gas (CREG), introduced a hedging mechanism. The mechanism comprises Firm Energy Obligations (OEFs) that commit generators to supply given amounts of energy (called firm energy) at a predetermined situational Scarcity Price (SP). In return, generators receive a fixed annual option fee – the Reliability Charge (RC) – for each kilowatt hour contracted, paid by consumers in their electricity tariff and determined via auction. The hedging mechanism is designed to avoid uncertainty of the market. The charge helps generators recover a portion of the fixed costs for peaking power plants, which do not deliver energy during regular weather conditions.

In February, a fire damaged the largest (560MW) hydroelectric plant, Central Guatapé, representing 4% of the total generation capacity in Colombia. At the onset of El Niño, the water reserve in the dams was around 41%; the

Guatapé incident dropped this further to 26%. Hydropower was no longer able to meet electricity demand. The generation capacity in Rio San Carlos also dropped, leading to further water capacity loss of 14% in just one day. The thermal power plants – an essential solution during drought periods - began generating more energy, totalling 55% thermal backed power generation by April 2016.

However, the SP’s formula has a strong correlation with oil prices. Following a global crash in diesel prices the Colombian SP dropped. In September 2015, the Colombian regulator adjusted the SP permanently. The payment was set at US\$100/kWh, however, the cost to produce energy during the 2015/16 El Niño was almost 7 times higher (Figure 1). This resulted in an overall short-term financial loss for thermal companies of around US\$250 million and further financial impacts on distribution companies.

Cumulatively, El Niño, the Guatapé incident, the SP issue, and the increased energy demand from cooling and refrigeration, led to a 200MW of shortage by April 2016.

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**THE REGULATOR DID NOT FORESEE THE SEVERITY OF WHAT WAS GOING TO HAPPEN**

- ANDEG -

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## RESILIENCE: RESPONSE AND TIMELY RECOVERY

In order to avoid an energy crisis and blackouts, the Colombian government took the following steps:

- 1 Introduced a cap price on the spot market equal to 75% of the first level of Incremental Operational Cost of Energy Blackout.

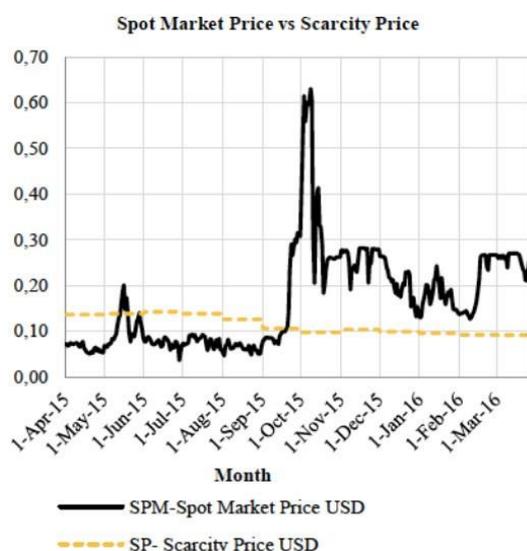


Figure 1. Comparison between the Scarcity Price and the Spot Market Price in Colombia, 2015. Note: The prices were converted into US\$.

- 2 Established a temporary (6 month) floor to the SP to help generators cover the costs, with extra floor prices fixed for oil and diesel generators.
- 3 Launched an energy saving campaign to decrease consumption called “Apagar paga” or “Turn off, pay off”. Promoting daily energy saving of at least 5%

in order to avoid possible blackouts, the programme remunerated those users who reduced consumption and penalised those that did not. The campaign impacted households across the country, however, thanks to frequent and effective communication campaigns, the public quickly realised the gravity of the problem and what needed to be done. Despite the late launch of the programme (March 2006), this was an effective strategy as indicated by the dramatic and rapid change in consumer behaviour, which in turn helped to avoid a blackout.

- 4 Other short-term measures:

- Increased the gas supply with liquefied natural gas (LNG) imported from the Caribbean.
  - Imported additional energy from Ecuador via an available interconnection, peaking at 5.6 GWh in March 2016.
  - Facilitated collaboration between the energy sector and the Institute of Hydrology, Meteorology and Environmental Studies (Spanish, IDEAM) - which monitors the weather in Colombia.
  - Facilitated coordination between the Colombian army and Empresas Públicas de Medellín (EPM) who owns the Guatapé dam to bring new transmission lines from Mexico.
  - Fast-tracked permitting/licensing to accelerate the expansion projects of thermal powerplants
- 5 Long-term measures include the addition of two new thermal power plants (100MW natural gas- and 260MW coal- powered) in 2018 and further renewable energy diversification (2019).

### BARRIERS



Government slow response to resolve the SP issue and address the concerns of energy generators.



Lack of information on pricing during El Niño.



Government initial unwillingness to share the financial burden associated with El Niño.



Unforeseen incidents (Guatapé fire incident).

### ENABLERS



System robustness due to the existence of the contingency capacity market.



Collaboration among authorities and neighbouring countries.



The availability of increased energy reserve and understanding of El Niño impacts.

## ANTICIPATION OF FUTURE EVENTS

The notion and perception of climate risk is changing. The awareness of ENSO and the associated impacts is growing while the uncertainty regarding the intensity and frequency of future El Niño and La Niña events remains a cause for concern in Colombian. Dynamic resilience to climate risk in the long term requires consideration of stored capacity in the system, without focusing on El Niño event characteristics exclusively. The weather agency, IDEM is increasingly able to monitor hydrological variables for dams. More precise models of rainfall and more accurate estimates of future water stored in reservoirs are becoming available.