Renewables Now

Wind & Solar Energy Assets in South America: Capacity & O&M Practices

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Harvesting wind and solar energy in South America - the challenge and the opportunity

With the exception of Brazil, wind and solar power generation is still something relatively new in South America, so the companies that seek to enter local power markets face unique challenges in developing and managing green energy assets there.

Image by peiklapic via Flickr[2]

There may be issues with permitting, financing, lack of adequate transmission infrastructure, or economic and political unrest. Specific weather conditions in South America also pose a significant challenge for renewable energy operators, who have to deal with high humidity and thunderstorms in Uruguay, extreme heat in parts of Brazil, an arid climate in desert areas such as the Atacama, or unexpected weather events such as hail storms. Even if one has taken all possible measures to prepare for the local climate, the impossible happens and the Chilean desert is hit by torrential rains. That happened on May 12, 2017 and, as Enel Green Power describes it, "it was like 14 years of rainfall came down in one day". The company had to deal with rain, mud and debris, damaged panels and reduced power generation at several solar farms in the Atacama.

Antonio Scala, Head of Renewable Energies South America at Enel, the Italian energy major which has 1.67 GW of wind and 1.49 GW of solar capacity on the continent, points out that extreme conditions can occur in any climate and while they certainly pose a challenge, they can open opportunities, as well.

"South America is a vast territory within which you can find all the possible climates: from desert to glaciers, from the Amazon rainforest to Patagonia.

"In Chile, in the Atacama Desert, where we have almost 500 MW of solar plants, the strong heat and the dust can impact working conditions and panel productivity, but it also features the world's highest irradiation levels and equivalent hours, allowing the plant to produce like nowhere else in the world.

"In Brazil, working in the Bahia area is complicated logistically due to its isolated location, but it is also one of the windiest areas in the country, guaranteeing a very high production.

"We can therefore say that the unique conditions that we face must be managed in such a way as to transform them into endless opportunities and not just threats," Scala told Renewables Now when we were preparing this report for the Green Assets, O&M Asset management conference.

In the following few pages, the report will show you how companies active in Argentina, Brazil, Chile and Uruguay have stood up to the challenge to harvest the ample wind and solar resources these hot markets offer. You will see examples of what can be done in the design, construction or operation phases to prepare for the unique site conditions in South America.

Design, Equipment, Big data - leveraging technology to bring down the OPEX

In many parts of South America, companies need to take into consideration, as early as the design stage, the challenges of operating a power plant under unique conditions. Obtaining as much data as possible for conditions on the site and selecting the most suitable equipment can reduce O&M costs and performance losses significantly.

Even as tenders are getting very competitive, focusing too much on the CAPEX is not the best course of action when starting work on a project, especially in harsh climates. Once the equipment has been purchased and installed, there is not much space for change. According to NEXTracker, the maker of a tracker that functions as a smart platform allowing operators to optimise the overall asset management and lower O&M costs, the optmised design of a plant is based on LCOE rather than CAPEX only analysis.

In a recent interview[3] with Renewables Now, Utopus Insights, a company acquired by Danish wind turbine manufacturer Vestas Wind Systems in early 2018, explains that the renewable energy industry is transitioning from an era of tariff-aided growth to an era of efficiency-aided growth.

"There has been a dramatic drop in CAPEX pricing in recent years, but now cost-cutting focused on CAPEX has hit a plateau. Long-term power purchase agreements (PPAs) are slowly becoming a thing of the past. Contract terms are now shorter and revenue maximizing options are becoming mainstream everywhere. This would not be possible unless you remove uncertainty and improve predictability of generation. This is where data comes in," Balki Iyer, Co-founder and Chief Growth Officer at Utopus, said. According to him, the next phase of the industry development is logically turning to leverage technology to bring down the OPEX and maximize revenue from assets.

Solar industry embracing advanced analytics

GTM Research is observing that the global solar industry is already "letting go of its tunnel vision on dollar-per-watt metrics, to embrace dollar-per-megawatt-hour metrics as more important data points to consider when making design and purchase decisions." The market share of technologies that allow power plant operators to gather data at the string and module level, such as string inverters, microinverters and power optimisers, is growing, GTM says.

The market research company also found out that both O&M providers and independent software vendors are investing in advanced data analytics. **"**Buzzwords like 'big data' and 'deep machine learning' were mentioned by most O&M professionals interviewed for the Global Solar PV O&M 2017-2022 report, released in December 2017 as some of the key innovations that will help them become more efficient and increase plant performance.**"**

A key application of advanced analytics is to predict a future problem. This technology, known as condition monitoring in the wind industry, has finally entered the solar industry too as a differentiated software feature. This allows the operator to resolve the problem before it affects production, or to cut maintenance costs if the O&M provider can replace or repair the component during a scheduled maintenance visit instead of reacting when something breaks.

GTM, however, found for its report that just 13% of monitoring solutions by independent software vendors declare full support for inverter condition monitoring, while 28% offer partial support. “Only the largest and most advanced O&M players such as First Solar and SMA have been performing predictive maintenance to date. We can expect the practice to spread as predictive analytics become more broadly available in monitoring solutions in the next five years,” Cedric Brehaut of GTM said in a market overview earlier this year.

Big data, automation and AI for wind O&M

Wind project companies have had to deal with harsh climates and unique conditions for decades. Very good wind conditions are often found at locations where there is not much else to do except harvest the wind and produce power. Many leading wind turbine manufacturers offer models and services for specific conditions in different parts of the world, so the right technology is there.

How to operate and maintain wind farms in order to minimise both costs and losses, however, remains a topic of significant discussion and many technology companies have introduced or are working on innovative solutions. Controlling or reducing the O&M cost is important for cutting the cost of energy, especially as every auction is resulting in even tighter margins. A lot of work is also taking place in the field of big data, automation and AI for wind and some clever on-field solutions to reduce human labour are currently under development.

For example, Siemens Gamesa Renewable Energy (SGRE), which at the end of 2017 had more than 55 GW under operation and maintenance in 55 countries, is partnering with Rope Robotics for a robot that can move along the blade of a wind turbine to monitor its condition and even carry out basic servicing, such as cleaning and polishing. It could be launched commercially in 2019, SGRE programme manager Allan Møller Larsen told Windpower Monthly[5] in May.

Image by Rope Robotics [6]

Drones have also been increasingly used in the wind and solar industry to inspect the installed equipment.

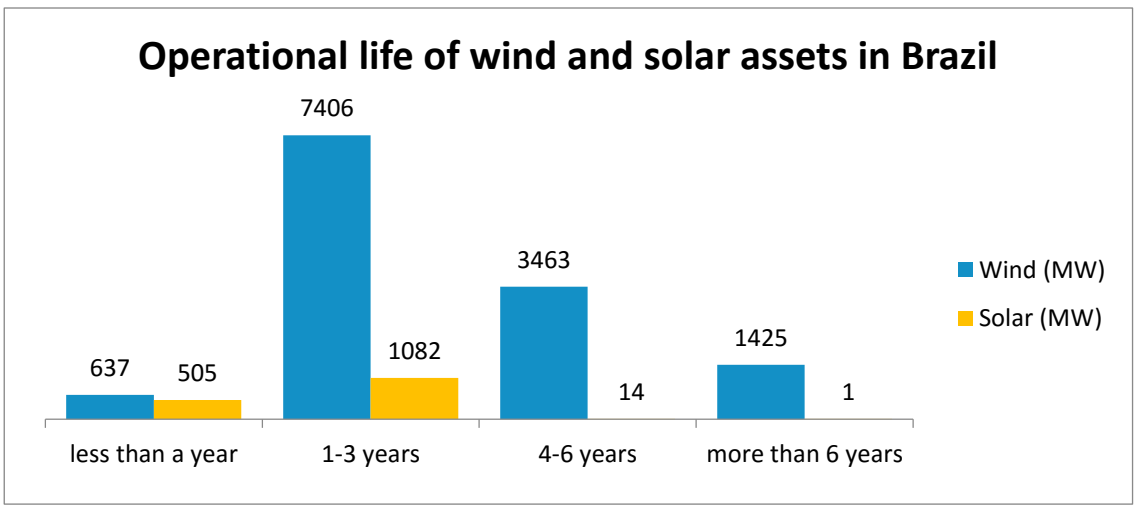
A company called Raptor Maps has developed a machine-learning/artificial intelligence (AI) software solution for post-inspection analysis and it has attracted the attention of Enel Green Power North America (EGPNA)[7]. The latter in August announced that it has teamed up with Raptor Maps to co-develop utility-scale solar asset management technologies with the purpose of optimising field operations and maintenance. The partners will configure Raptor Maps' solution, called Raptor Solar, and embed it directly into EGPNA's drone hardware. This would facilitate the identification of faults at solar plants and thus streamline the detection-to-repair process from days to hours, EGPNA explained.

Wind & Solar Capacity Build-up in South America

South America had 15.8 GW of onshore wind energy capacity and 3.7 GW of solar photovoltaic (PV) parks at the end of 2017, according to statistics by the International Renewable Energy Agency (IRENA)[8]. Hydropower remains the number-one green energy source on the continent, but wind and solar power are growing at a significant pace.

Wind and solar capacity in Brazil

Brazil is currently Latin America's largest renewable energy market. Its wind power capacity reached 12.3 GW at end-2017 and by mid-2018 it grew further to 12.93 GW, according to preliminary data[9]. Up till the end of 2016 solar installations were negligible, but last year the country deployed about a gigawatt, reaching 1,097 MW of cumulative solar power generation capacity. That number is quickly growing with around 500 MW added in the first half of 2018 alone.The following chart shows for how long wind and solar farms in Brazil have been operational.



Source of data: Monthly Energy Bulletins by Brazil's Ministry of Mines and Energy (MME).[10]

Significant volumes of new large-scale wind and solar power generation capacity in Brazil have been contracted through tenders organised by the government. The auctions started back in 2009 and took place regularly up until the end of 2015. The pace of tendering was disrupted in 2016, but continued the next year.

Brazil is expected to reach 17,645 MW of wind and 3,660 MW of solar capacity by 2020, according to the Ten Year Energy Plan 2026 (PDE 2026) [11]. Based on that forecast, wind and solar capacity additions between 2018 and 2020 would amount to roughly 5,350 MW and 2,560 MW, respectively.

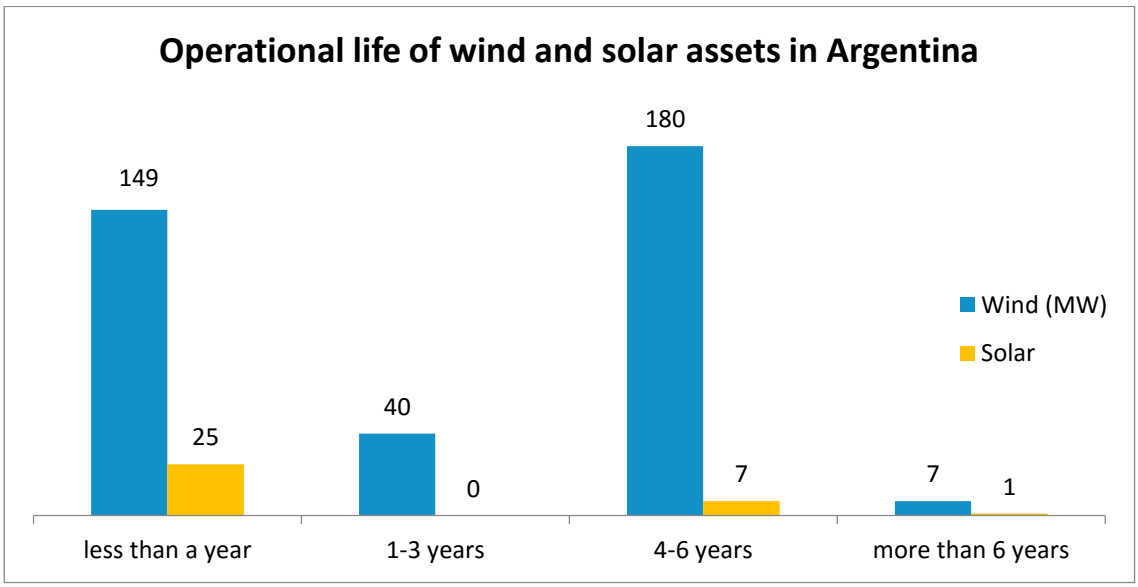
The country's renewable power sector is expected to grow enormously, especially in the wind, biomass, and solar energy segments, as a result of government initiatives and increased private sector participation. According to GlobalData [12], Brazil's onshore wind capacity is to expand at a Compound Annual Growth Rate (CAGR) of around 15% between 2015 and 2025, although no contribution from offshore wind is expected. The CAGR for solar photovoltaic (PV) capacity over the same period is expected to be 47%.

Wind and solar capacity in Argentina

Unlike Brazil, Argentina is still in its infancy in terms of wind and solar power generation capacity. Annual wind power capacity installations have ranged between zero and just a couple of megawatts up to the end of 2017, when the country had total of 227 MW installed.

The first successful tenders for large volumes of renewable power in Argentina were held in 2016 under the RenovAr programme. Some of the contracted capacities are now starting to come on stream, with mid-year statistics showing 100 MW of new wind power capacity for 2018.

The chart below shows for how long wind and solar power assets in Argentina have been operational.



Source of data: [Compañía Administradora del Mercado Mayorista Eléctrico (CAMMESA)](). [13]

The solar power sector is just taking off. The first grid-connected solar plant, a pilot 1.2-MW project in Ullum department, was built in 2010 and there has been no significant progress in seven years. The country had just 9 MW of large solar power plants at the end of 2017, including 6 MW installed in 2012. CAMMESA's report for July 2018 shows that capacity has grown to 33 MW in the first seven months of this year.

Argentina's solar capacity is expected to jump by at least 1,732.5 MW this and next year if the solar projects awarded in the RenovAR tenders from 2016 and 2017 get completed without significant delays.

The combined wind power capacity awards in the RenovAR programme reach 2,467 MW. Completion of the 1,473 MW of projects awarded in the 2016 tenders, RenovAR Rounds 1 and 1.5, is expected in 2018 and 2019. The rest should be up and running by the end of the decade.

The table shows capacity awards for wind and solar in the RenovAR tenders.

Capacity in MW	Round 1 (October 2016)	Round 1.5 (November 2016)	Round 2, Part I (November 2017)	Round 2, Part II (December 2017)
Solar	400	516.2	556.8	259.5
Wind	708	765.4	665.8	328

In May [14], EconoJournal cited Esteban Perez Andrich, National Director for Renewable Energy at the energy ministry, as saying that the 5 GW of Round 1, 1.5 and 2 projects and resolution 202 legacy projects will be completed by 2020. This includes all wind and solar awards, and other renewable energy sources.

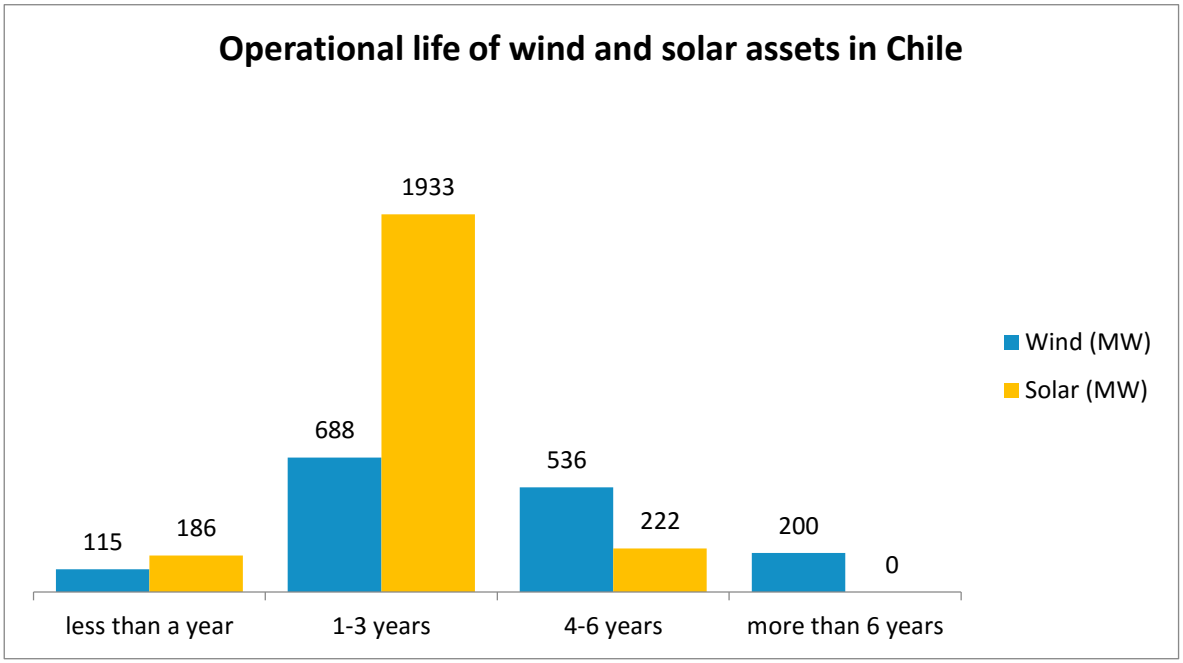
Until recently, the government planned to hold a new RenovAr round targeting some 1 GW between September and October. However, government officials said in early August that new RenovAr rounds will be temporarily suspended as grid constraints and difficult financing conditions may raise prices in the next bidding round. A new generation round is not going to be launched until the tender for the expansion of power transmission lines has advanced, the ministry told local media.

Argentine companies are installing smaller and large wind and solar farms outside tenders too, thanks to contracts for the supply of power to private large-scale consumers. These will translate into some extra megawatts installed.

Wind and solar capacity in Chile

Argentina's neighbour to the west – Chile, has more solar power generation capacity than wind. At the end of 2017, there were 2,155 MW of solar installed and 1,424 MW of wind. By mid-2018, the country's solar capacity had reached 2,341 MW, and wind stood at 1,539 MW.

As visible from the chart below, most of Chile's solar power assets have been operational for between one and three years. In 2016 alone, the country installed about 750 MW of solar as well as more than 500 MW of wind capacity.



Source of data: [Asociación Chilena de Energías Renovables (ACERA)](). [16]

According to data of the Chilean renewable energy association (ACERA), solar projects with a combined capacity of 388 MW are currently under construction. This includes 110 MW of concentrated solar power (CSP) capacity, while the rest is PV. The capacity of wind farms under construction exceeds 625 MW.

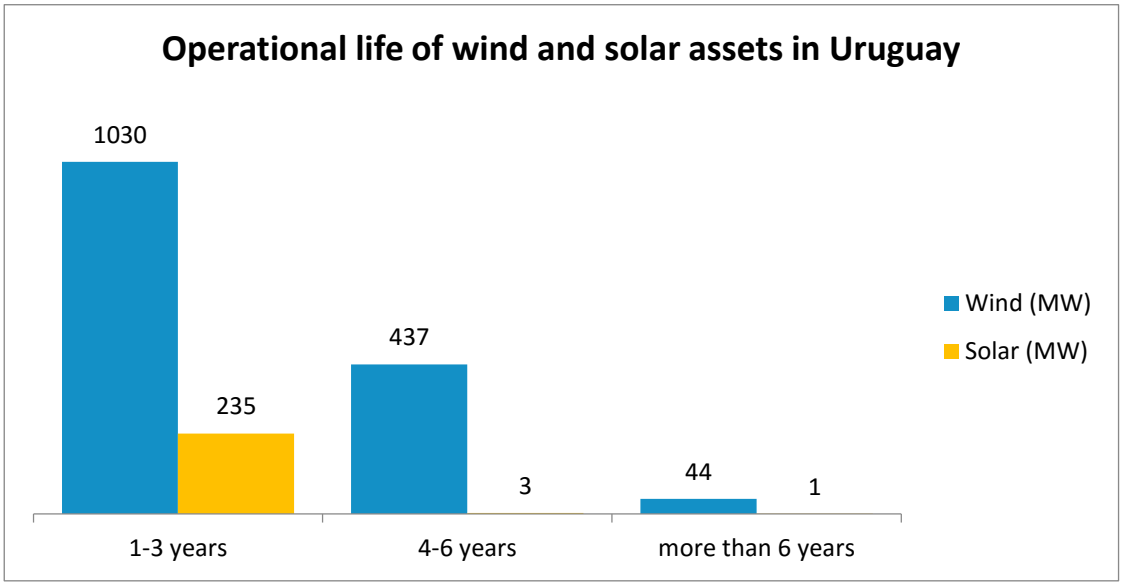
A report by Chile's national energy commission (CNE) in July [17] shows similar figures -- 600 MW of wind and 300 MW of solar capacity under construction. An additional 9,355 MW of wind and 18,276 MW of solar project have an environmental approval resolution (RCA) in place.

Wind and solar capacity in Uruguay

In recent years, Uruguay installed a gigawatt of wind power generation capacity, reaching 1,511 MW at end-2017. Capacity additions were slow up until 2013, when the country had just 59 MW, but then, in 2014, came a 422-MW jump. Annual installations have remained at or above 300 MW in the years that followed.

Uruguay's solar capacity is more modest, at 239 MW, of which roughly 150 MW have been installed last year.

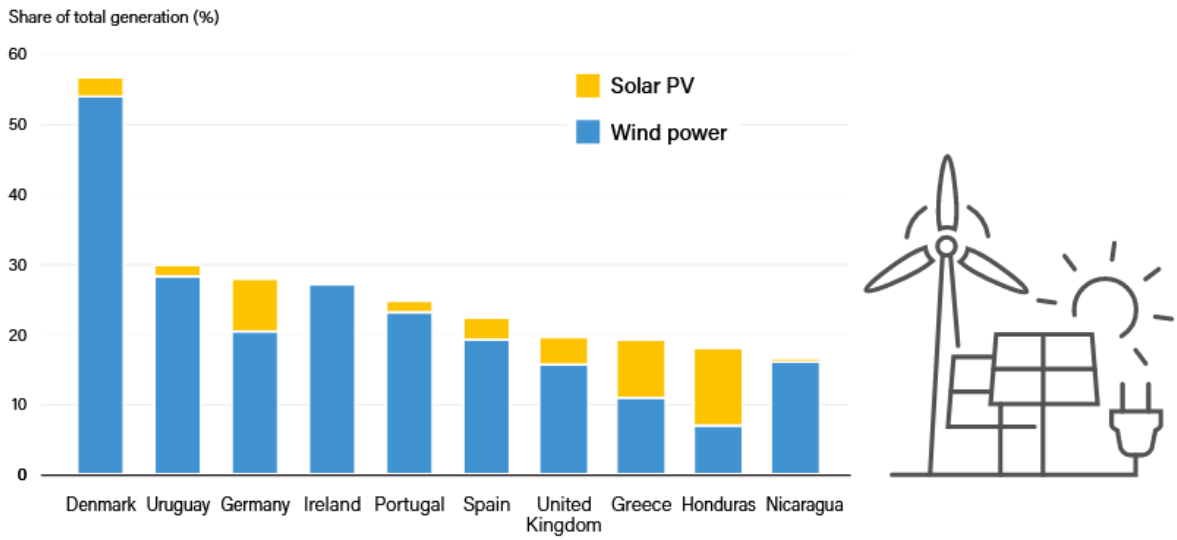
The chart shows for how long wind and solar farms in Uruguay have been operational.



Source of data: International Renewable Energy Agency (IRENA).

According to REN21's Global Status Report, the share of wind and solar power in Uruguay's total generation for 2017 was very close to 30%. Only Denmark had a higher share, while no other South American country made it to the top 10 list.

FIGURE 8. Share of Electricity Generation from Variable Renewable Energy, Top 10 Countries, 2017



Source: REN21 Global Status Report. [17]

Industry Experience

Enel testing different O&M tools and strategies

Enel has 842 MW of wind capacity in Brazil, 642 MW in Chile, 50 MW in Uruguay and has also been awarded a 100-MW wind project in Argentina. The company also has 820 MW of solar farms in Brazil and 492 MW more in Chile. Antonio Scala, the company's Head of Renewable Energies South America, explains that the range of different and extreme climates on the continent allow the company to test different O&M tools and strategies for further developments in the management of daily challenges.

"One example is a model we developed to optimise the cleaning of photovoltaic modules. The dust and dirt that settles on the surface of the photovoltaic modules can cause a decrease of up to 50% of production. The model makes a balance between expected production and cleaning costs, using as input data % of soiling, marginal energy cost, cost of each cleaning, probability of rain, etc. which results in the optimum date for the next cleaning, an annual cleaning plan per plant, types of recommended cleanings, etc."

In other parts of the continent, such as Uruguay, power plant operators face high humidity resulting in failures in the pad mount transformers (PMT), Scala said. "We installed space heaters inside the PMT panels and we created a new sealing system inside and outside the transformers, resulting in a considerable drop in the rate of failure."

In some regions of Brazil, Scala explains, the extreme heat can cause batteries to overheat and increase the risk of premature failure in some wind farms. To address this, Enel worked with the battery supplier to develop batteries that can bear the high temperatures and guarantee a normal lifecycle.

Asked about the O&M considerations that Enel integrates into the plant design stage, Scala described the whole process, which involves Best Practice and Lesson Learned in previous projects.

"Once a Project Team is established, the design and construction process of our plants involves several areas, with particular importance given to Engineering and Construction (E&C) as well as Operation and Maintenance (O&M).

"During the development phase, we apply a PDCA (Plan, Do, Control, Act) approach and management of Best Practice and Lesson Learned for the drafting of the technical specifications of the plants. This editing process, managed by E&C, uses the reports on Best Practice and Lesson Learned of previous plants, continuously improving the strategy and management structure thanks to the experience of our people in the field in the construction phase, but above all during the Operation & Maintenance phase.

"E&C and O&M also strongly collaborate in South America to find efficient solutions for panel cleaning and wind turbine maintenance."

Lessons learned by Eurus Energy in Latin America

In an exclusive interview ahead of the Green Assets congress, Leonardo Valencia of Eurus Energy America summarised the main lessons the company has learned operating in Latin America. Japan's largest wind power developer has two wind farms in Uruguay, with a combined capacity of 91.5 MW, which have been fully operational since 2015 and 2016, and it has two 9-MW solar farms in Chile, operational for a bit more than a year.

"We're facing very new problems in Chile which can't be experienced in other countries in the same way," Valencia said. He gave as an example the soiling problem "unique in its intensity". Eurus initially anticipated production losses of about 4% due to soiling, but in reality this level sometimes reached up to 20%-30%.

One of most important lessons the company learned was that it is crucial for O&M professionals to be involved in the construction phase. "**O&M totally disconnected from construction doesn't work.** So you can forget about receiving a project without having total knowledge about how it was constructed. The O&M guy must be involved in construction, from the very beginning," Valencia says.

Another point taken is that proactive maintenance is crucial. "It would be great to see more O&M service companies offering something more than just repairs; companies more focused on root cause analysis," said Valencia.

The lesson is simple "your data is essential".

In Valencia's experience companies working in South America need to get access to the very best data available, ideally raw data. **"**Avoid receiving just a calculation that was done for the plant, try to obtain all the data at the lowest possible level, that's the key to understanding and solving the problems rapidly and in the very best way."

The full interview is available for download here.

NEXTracker : designing with serviceability, resiliency in mind

NEXTracker has delivered close to 3 GW of smart solar trackers to the Latin American region. Mexico is the strongest market for the company at this point, followed by Argentina, Brazil and Chile.

The company's NX Horizon single-axis horizontal tracker has been designed with unlinked rows per array and built with connectivity in mind to support the lowest LCOE. NEXTracker explains that its mechanical design mitigates issues resulting from undulating terrain, allowing for ease of access for cleaning and maintenance, making it easier to maneuver between rows with ease and much faster speed. Cleaning trucks can not only move freely between each row, but they can face arrays into "cleaning mode". In regions where dust and soiling can limit productivity significantly, such as Chile's Atacama Desert, the ease of cleaning is very important.

Image by NEXTracker. [19]

NEXTracker has also invested in the pioneering wind tunnel R&D work done by David Banks and his team, which investigated torsional instability, vortex lock-in and other factors in single-axis trackers and demonstrated the critical importance of analyzing not just the static but the dynamic impact of wind on PV structures. Thus, its current NX Horizon system has experienced zero wind-related failures in the field, the company tells Renewables Now.

"We have also conducted in-depth, site-specific wind engineering studies in Australia, India, Latin America and other regions where our systems have been or will be deployed in ever-greater numbers."

Connectivity is key: With NEXTracker's connectivity capability, the firm has created a suite of software-as-a-service products allowing for the enhancement of energy yield post installation, as well as on greenfield sites. "Our ability to employ row-to-row tracking using machine learning at sites with high preponderance of particulates in the air (such as what occurs with slash and burn agriculture or pollution) and undulating sites become advantageous in these conditions."

The smart control system TrueCapture, designed to optimize the tracking algorithm of each individual row in a solar farm in response to site features and changing weather conditions, is now being deployed in Brazil.

"Connectivity for the Latin American region will be interesting to watch, especially with so many remote site locations under consideration. With connectivity, NEXTracker can assess and monitor

performance and components with a secure data pipeline and predictive analytics."

Below you can see some recommendations from the asset management team of Marty Rogers, Vice President of Global Asset Management and Support at NEXTracker.

1. Proper selection of the technology involved taking into account supplier bankability and historical data; equipment features and potential future upgrades; warranties provided according to the project's needs; potential service contract to enhance the plant performance during operations -- component monitoring, secure data pipeline, predictive analytics/signal processing.
2. Optimized design of the plant, LCOE rather than CAPEX only analysis.
3. Adequate selection of the EPC contractor: entering into solar has a low entry barrier and not all are suitable to perform a reliable work. Experience in the region and tooling availability must be analyzed.
4. Alignment among all the stakeholders: long-terms owners need to be involved in equipment selection.

Chile's newest wind farm - preparing for life near the ocean

Australian renewable energy company Pacific Hydro inaugurated at the end of August the 82-MW Punta Sierra wind farm in Chile's Coquimbo Region. The facility has a total of 32 Goldwind turbines of 2.55 MW each.

Brett Dutton, executive manager for the Punta Sierra project at Pacific Hydro, told Renewables Now that the turbines have been installed at a semi-arid location where thunderstorms and heavy rains are an uncommon occurrence, but because the wind farm sits at an altitude of 100-300m above the ocean, the company had to procure marinised high-grade surface finishes capable of resisting a sea-side location.

Asked about the O&M strategies and practices that can limit the impact of specific conditions on wind assets in Chile, Dutton said:

"Condition based monitoring is critical in these environments. Planned maintenance may have durations that permit degradation before it is detected during a planned maintenance. Or a combination can be used; a condition based inspection regime laid on top of a base planned maintenance regime. Blade inspections are also of high importance. A baseline study should be conducted after construction and then early-intervention practices used to rectify any blade issues before they become major issues."

Source: Pacific Hydro. [20]

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Many thanks to Antonio Scala at Enel, Marty Rogers at NEXTracker, Leonardo Valencia at Eurus and Brett Dutton at Pacific Hydro for providing professional insight for this report!

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