BBVA | Research

Renewables: The answer is blowin' in the wind

Energy Analysis

Introduction

The prevalence of fossil fuels in the production of electricity is being challenged by the rapid expansion of renewable sources such as wind and solar. Around the world, wind energy capacity has increased fivefold since 2007, reaching 487GW in 2016.[1] Meanwhile, the benchmark levelized cost of electricity (LCOE) of onshore wind keeps declining and, at $67/MWh, it is currently the third lowest among renewables.[2]

This transformation is the result of public policy and technological progress. On the policy side, virtually every country where wind energy has flourished has experienced government support: capacity auctions, long-term contracts, subsidies, tax credits, feed-in tariffs, and renewable portfolio standards. These measures have leveled the playing field between renewables and fossil fuels and continue to attract private investment. Governments justify intervention as a way to: reduce greenhouse gas emissions and pollution, improve energy security, create jobs and boost economic growth, accomplish geostrategic objectives, and increase prestige in the global community.

On the technology front, advances that allow wind turbines to reach stronger, steadier winds, and more sophisticated control systems have significantly increased productivity. Manufacturing is dominated by a few but highly specialized global companies that have been able to make significant advances. For example, since the late 90s, average nameplate capacity has increased almost 200%, average hub height close to 50% and average rotor diameter more than 100%. In fact, latest models of offshore turbines have a rated capacity as high as 8,000kW and rotors up to 155 meters in length.

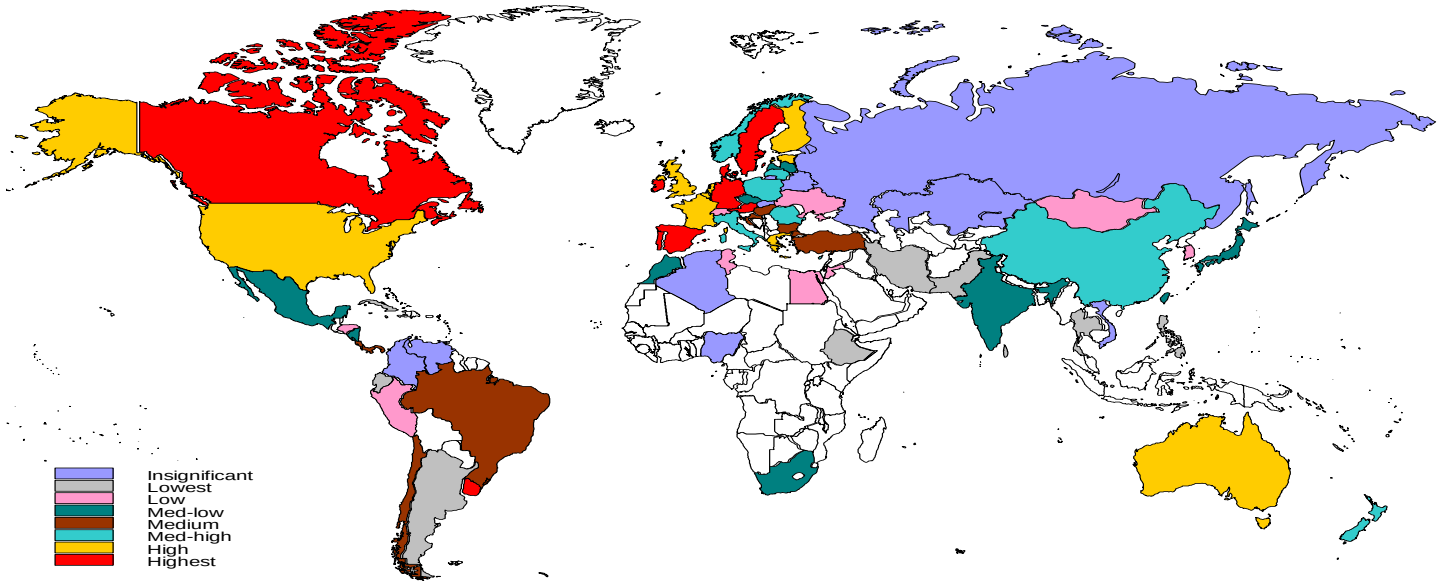
The growth in swept area above nameplate capacity has allowed a decline in specific power and thus an increase in capacity factors, which are already above 40% for existing projects. Since 2009, turbine prices and the cost of wind energy have declined 26% and 66%, respectively.[3] For the best projects, which have LCOEs as low as $33/MWh (in Texas), this means remaining competitive for the next 20 years even against declining LCOEs for solar PV systems.

Although the wind energy industry still accounts for a small fraction of global electricity generation (4%); improving turbine efficiency could take this share up to 20% by 2040. This would require 2,000GW of gross additions onshore and another 200GW offshore, with combined investments in the order of US$4 trillion. This will support further declines in LCOEs.

This report provides an overview of the wind energy markets in key countries including 11 within the BBVA footprint.

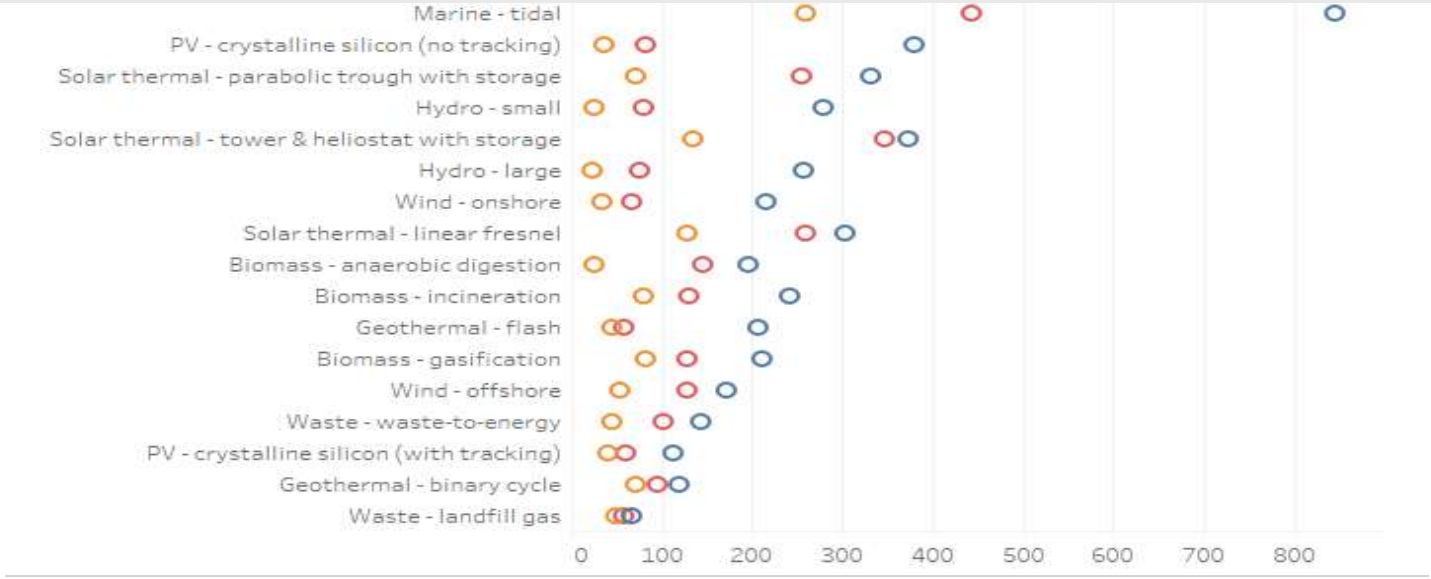
1 Global Wind Energy Council. "Global Wind Report 2016."
2 Bloomberg New Energy Finance. "LCOE Comparison and Visualization."
3 Bloomberg New Energy Finance. "New Energy Outlook 2017-Wind."

Global. Wind installed capacity per 1M people



Source: BBVA Research with data from Global Wind Energy Council and UN

Global. Levelized cost of electricity by sector (nominal $/MW, yellow = lowest, red = mid, blue = highest)



Source: BBVA Research with data from Bloomberg New Energy Finance

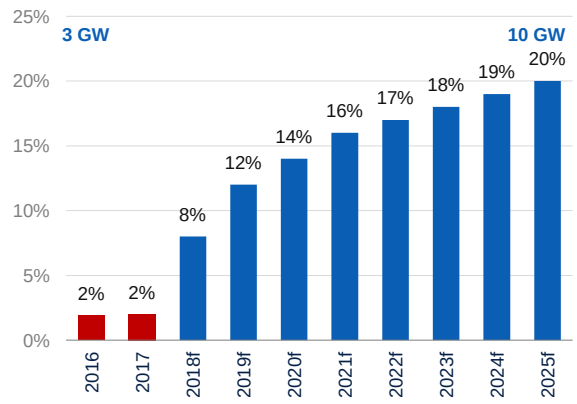
Argentina

Jorge Lamela

Despite Argentina's considerable wind power potential, especially in the Patagonia and the south-east of the Buenos Aires province, the country has barely made use of this resource. The facilities installed only generate 709MW of renewable energy, just 2% of the energy matrix. Excluding hydraulic power, the contribution made by renewable energy falls to 220MW, from which 89% (195MW) corresponds to wind power with investment of around US$350 million. In 2016, there were two public tenders – RenovAR 1.0 and RenovAR 1.5 – in which companies presented their renewable energy projects through a bidding process, setting the long-term energy sales price. The private sector has expressed considerable interest, with the largest share of projects, 1,473MW, going to onshore wind power programs and costing around US$2 billion. Of the 22 successful wind-power bids, 16 were awarded to local sponsors. The majority will be financed through recourse debt. Argentina is reducing consumer subsidies and gradually closing the gap with energy production costs. Generation is dominated by six major groups controlling 53% of the installed capacity – 22% is controlled by international (Enel and AES) and 31% by local companies (Sadesa, Pampa Energía, EPEC and Enarsa). Transmission is dominated by one company, Transener (Pampa Energía, local), while the main distribution companies are Edenor (Pampa Energía) and Edesur (Enel).

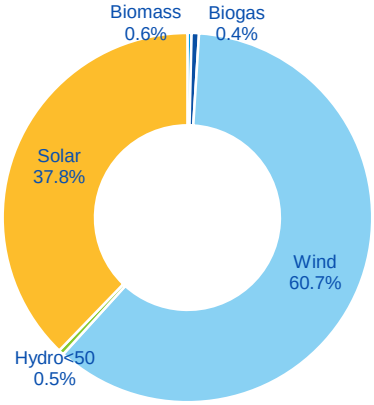
In line with the Paris Accord, the government set the goal of reaching 20% of renewable power generation by 2025. To accelerate the process, it introduced fiscal incentives such as the accelerated amortization of corporate tax, early VAT repayment and exemption from taxation on dividend and profit distributions. A trust fund for renewable energy (FODER) was created with the purpose of issuing guarantees and sureties for the sale and purchase of energy. The future of wind energy is promising due to Argentina's excellent conditions and the government's commitment to achieve its goals. By continuing on this path, targets will most likely be met on time. The main challenge has to do with better credit conditions, which depend on improving the fiscal situation and lowering the inflation rate.

Argentina: Renewable energy as a share of total



Source: BBVA Research with data from the Ministry of Finance

Argentina: Renewable energy rounds 1.0 and 1.5 (MW)



Source: BBVA Research with data from the Ministry of Finance

Brazil

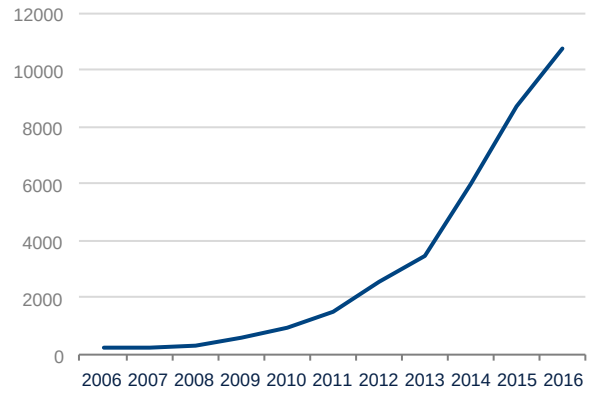
Enestor Do Santos

Wind energy's generation capacity has increased from 235.4MW in 2006 to 10,747MW in 2016, with a remarkable expansion since 2009. That places Brazil as the 8th largest generator of wind energy in the world. The sector represented 7.1% of the total energy produced in 2016, in comparison to 0.2% in 2006. In 2016, investments in wind energy reached US$5.4 billion, and 2,014MW were added to domestic capacity. The wind energy sector is expected to go through some moderation in the next few years mainly due to the slowdown of the economy. Growth in the sector may remain positive in the short-term, and capacity can converge to 16,500MW in 2018, to some extent as a result of previous years' investments. However, in 2019 and 2020 the most likely outcome is that capacity remains broadly stable.

The development of the sector was induced by public policies with the goals of exploring the country's high potential in terms of wind energy, fostering economic development and diversifying the energy mix. The creation in 2002 of a public program to incentivize alternative energy (Proinfa) was a milestone. Particularly important was the funding provided by the government's development bank and the purchase of wind energy through government's regulated auctions. Moreover, the impact of the Lehman Brothers crisis in advanced economies and the positive prospects for the Brazilian economy were key to attract foreign investment. As a result, a relatively dynamic wind power industry emerged, constituted by foreign and domestic companies with a relatively high degree of competition.

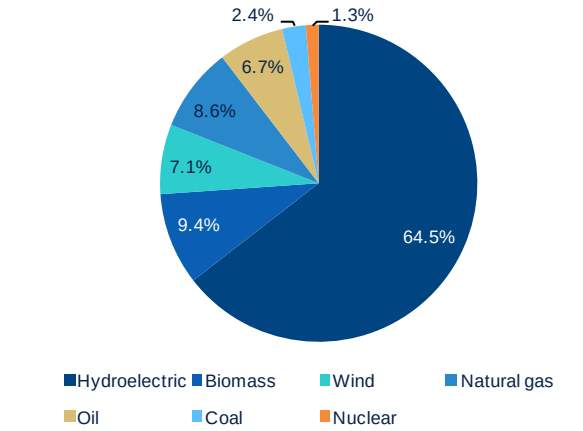
In the Paris Agreement the country committed to cut emissions by 37% until 2025. Related to that, the government's ten-year energy expansion plan outlines a scenario in which wind energy capacity reaches 24,000MW in 2024. That paves the way for supportive public policies for the wind energy sector in the next years. Although economic growth will likely not be as positive as it was in the previous decade, public policies together with the increased competitiveness of the sector support the view that the wind energy sector will play an increasingly important role over the next years.

Brazil: Wind energy capacity (MW)



Source: ABEEólica, the Brazilian Wind Energy Association

Brazil: Energy matrix (%)



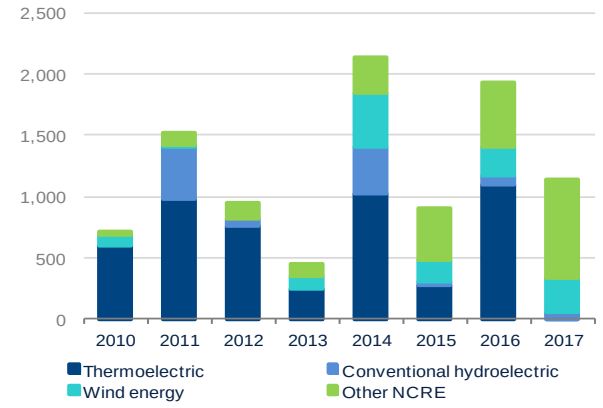
Source: ABEEólica, the Brazilian Wind Energy Association

Chile

Waldo Riveras

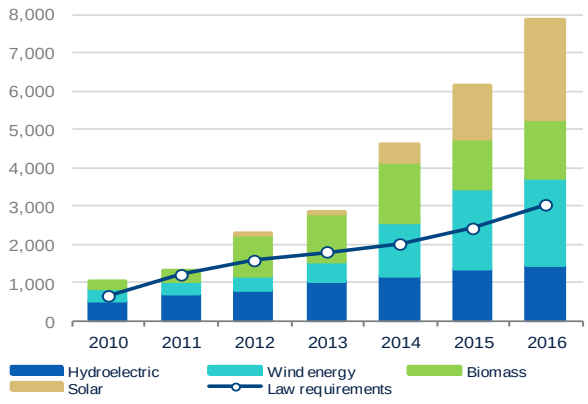
Wind energy has steadily increased its importance within the energy mix, from 0.6% of total electricity generated in 2010 to 3.1% in 2016 (25% of total renewables portfolio or NCRE). Between 2010 and 2016, installed wind power capacity increased by 1,058MW (onshore and from private sector), with investments rounding US$3.4 billion, reaching 12% of total energy added in 2016. It is expected that 300MW of wind capacity will be added in 2017. Currently, there are 23 wind farm projects undergoing environmental assessment, equivalent to 2,100MW, for an investment amount of US$4 billion. Recent studies[4] estimate a potential of 40,452MW for wind energy in the country.

Chile: Power capacity additions (MW)*



* NCRE: Wind, Solar, Biomass, Mini Hydroelectric (<20MW), Biogas, Geothermal and Seawater. It excludes Large Hydroelectric (>20MW).
Source: National Energy Commission (CNE)

Chile: Power production under "Law 20/25" (GWh)*



* In line with both Law No. 20,257 and No. 20,698 which mandate that, by 2025, 20% of the total energy generated must come from NCRE.
Source: National Energy Commission (CNE)

The Chilean electricity market is competitive, although with a few generation firms. The government is in charge of regulation and supervision. New policies have been implemented to allow more players in NCRE and greater diversification of energy sources. In 2017, capacity additions are coming entirely from new players, with 25% coming from wind energy. About two thirds of generation is controlled by foreign multinationals (Endesa/Enel, AES Gener, Engie, etc.), 14% by a large local firm (Colbun) and the remaining by several small producers.

Chile ratified the Paris Agreement in 2017,[5] with the goal of reducing CO2 emissions 30% by 2030.[6] Previously, Chile enacted the "Law NCRE" of 2008 and "Law 20/25" of 2013,[7] which mandate that, by 2035, 20% of total energy generated must come from renewables. In addition, a long-term strategy (Energía 2050) was established in order to reach 70% of the electricity generation from renewables by 2050. Further government support, along with new transmission and interconnection projects, and improvements in energy auctions design, among others, would allow a greater participation of wind in the national energy mix.

4: Source: "Energías Renovables en Chile: El potencial eólico, solar e hidroeléctrico de Arica a Chiloé". Ministry of Energy of Chile, 2014.
5: Chile ratified the Paris Agreement by Decree No. 30 of May 23, 2017.
6: The "Agency for Sustainability and Climate Change" was created for this purpose.
7: This law replaced the "Law NCRE" (No. 20,257 of April 2008) that originally proposed a less demanding convergence of 10% by 2025.

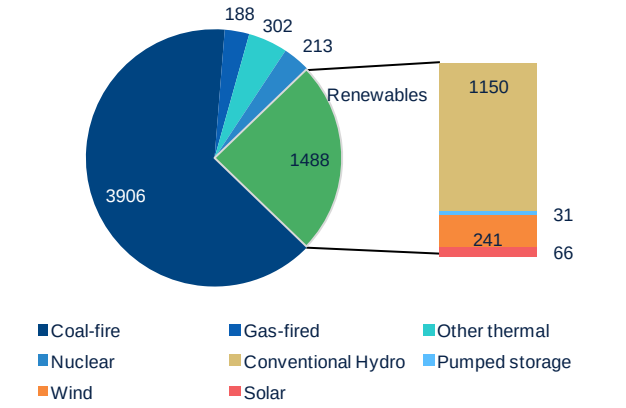
China

Betty Huang

China dominates the world in wind power installed capacity. In 2016 241TWh of electricity was produced, representing 4% of the total energy mix and 16.2% of the total renewables portfolio. In the same year, 17.3GW wind power capacity was added. Capacity additions and investments increased significantly between 2007 and 2016 (see chart).Onshore and public enterprises dominate the market, with offshore wind capacity only accounting for 1.3% of the market share. Private companies represent 3.8% of the market and foreign players 2%. To finance the projects, a renewable Energy Development Fund was established. Wind power capacity is anticipated to keep an AAGR of 14% during 2017-2020.

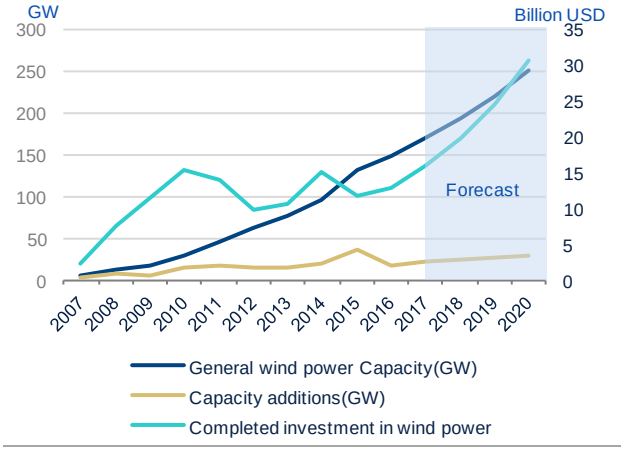
Chinese wind industry is composed by wind farm developers (74%), wind turbine manufacturers (15%) and third-party O&M companies (11%). Hydro and solar are the major substitutes. To provide certainty to the market, the government establishes the target capacity as well as prices. A land-based feed-in tariff system was implemented so that grid companies pay an average coal price for wind power, with the gap funded by a surcharge on consumers. Tax exceptions and subsidies are provided for newly established firms and wind power products are eligible for a 50% VAT refund. In terms of private investment, foreign companies are allowed to establish Wholly Foreign-Owned Enterprises. The top 5 domestic manufacturers control 61% of the market (Goldwind, Envision, Mingyang, United Power and CSIC Haizhuang) while four foreign companies (Vestas, Gamesa, GE and Suzlon) have 5% market share.

China: Electricity mix (TWh)



Source: China Electricity Council and BBVA Research

China: Capacity additions and investments



Source: China Electricity Council and BBVA Research

China has promised to uphold the Paris Agreement and the 13th Five-Year-Plan targeted an increase in domestic wind capacity to 250GW by 2020. Wind power curtailment is the biggest challenge as grid transmission can't match with capacity expansion, while wind farm management and O&M would be the main opportunities. Policy support is targeting smart grids development and power infrastructure investment. China has started to exempt import VAT on wind power manufacturing equipment and to provide subsidies for wind power distribution for several years.

Colombia

Fabián García

Colombia has 16.6GW of total installed capacity. The share of wind in the total energy mix is only 0.1% and it has decreased over the last years as there has not been any investment since 2004. Total installed capacity is expected to reach 23.5GW by 2030, with wind energy being the main focus of growth. Wind is expected to contribute with 1.5GW, gaining more than 6 percentage points in share of the energy mix. Although the country has only one 20MW wind farm in operation (Jepírachi), there are 3 more projects under evaluation that would enable it to reach the goals set for 2030. In the Colombian electricity market, generation is open to competition and the market determines prices within a regulatory framework. However, the three top operators, Emgesa, Isagén and EPM concentrate around 60% of total generation. For transmission and distribution, public-private companies are responsible to provide Colombia with a reliable electricity grid; however, Interconexión Eléctrica (ISA) owns 81% of the network's assets. Meanwhile in the distribution segment, the four leading companies (EPM; Codensa, Electricaribe and Celsia) control 60% of the market.

Given the country's vulnerability to droughts and exceptional amount of non-conventional energy resources like wind,[8] solar and biomass, the government enacted the Law 715 of 2014 to make non-hydro renewable projects economically feasible. As such, developers can benefit from (1) 50% income tax exemption for up to 50% of the initial investment, (2) accelerated depreciation of assets, (3) VAT exemption on goods and services related to the investment, and (4) import duty exemptions on raw materials and components needed for each project. Following this change, the Colombian government submitted its Intended Nationally Determined Contribution (INDC) to the United Nations, pledging to reduce by 20% its greenhouse gas emissions below the business-as-usual scenario by 2030. Despite this progress, further investments in transmission infrastructure and the speed up of environmental licenses must be undertaken if wind energy is to become an important contributor to the Colombian energy mix.

Colombia: Installed capacity by energy resource (MW)[1]

	Capacity	Share
Hydro	**10,963.0**	**66.1**
Thermal	**4,728.0**	**28.5**
Gas	1,528.0	9.2
Coal	1,328.0	8.0
Fuel oil	187.0	1.1
Jet[1]	46.0	0.3
Gas-jet[1]	**246.0**	**1.5**
Small generators	**771.5**	**4.6**
Hydro	648.1	3.9
Thermal	105.0	0.6
Eolic	18.8	0.1
Cogeneration	**99.6**	**0.6**
Self-generation	**32.4**	**0.2**
Total	**16,595**	**100.0**

1: As of December 2016
Source: XM

Colombia: Change in installed capacity (MW)

	Capacity in 2016 (base scenario)	Share in 2016	Capacity in 2030	Share in 2030
Hydro	10,890.1	65.6	10,963.0	53.6
Gas	3,509.0	21.1	4,728.0	23.1
Coal	1,344.0	8.1	1,528.0	7.5
Small generators	745.4	4.5	1,328.0	6.5
Cogeneration	117.1	0.7	187.0	0.9
Eolic	--	0.0	46.0	0.2
Solar	--	0.0	246.0	1.2
Geothermal	--	0.0	771.5	3.8
Others	--	0.0	648.1	3.2
Total	**16,606**	**100.0**	**20,446**	**100.0**

Source: Unidad de Planeación Minero Energética (UPME, 2016)

8: Wind regime in northern Colombia is rated among the best in South America, comparable only to the Patagonia region. Peredes and Ramirez (2017) found that wind and solar farms might be able to back up hydropower plants during seasonal and inter-annual periods of low-flow hydrological periods. Source: Parades, Juan and Ramírez, John (2017). "Variable Renewable Energies and Their Contribution to Energy Security: Complementarity in Colombia." IADB.

Mexico

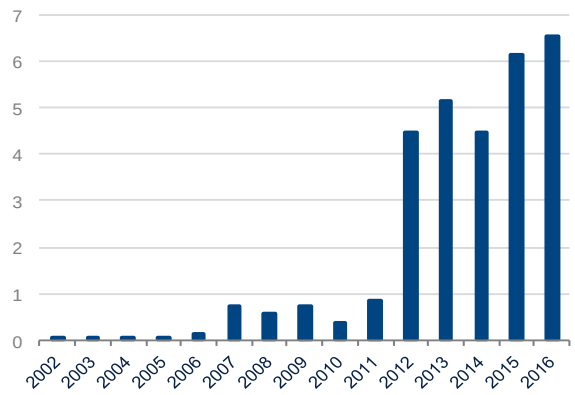
Arnulfo Rodríguez

In Mexico, wind energy has led the use of renewable sources for electricity generation. Although electricity generated by wind energy represented only 0.9% of total generation in 2016, wind has increased its share in the renewable energy mix from 0.4% in 2010 to 6.5% in 2016. The higher participation was the result of strong additions to installed capacity as private independent power producers added 2.6GW between 2010 and 2016. In this period, private investment boosted total wind capacity by almost six-fold to 3.0GW. Going forward, investments in wind energy will remain strong in 2018 and 2019 as new facilities will come online from projects still in construction and from winning bidders from the first- and second-long term auctions. Wind energy projects have usually required syndicated loans for their financing.

The power market in Mexico has been restructured by the Law of the Electric Power Industry of 2015, which provides the mechanisms to transit from a vertically integrated state-owned monopoly to a competitive market in generation and retail. Transmission and distribution remain under the control of the state, although private participation is now allowed for network expansion projects. The National Center for Energy Control, an independent system operator, is now in charge of the transmission network. The aforementioned law mandated both a vertical separation of CFE — the state electricity company — and its horizontal restructuring in the generation segment. The new CFE generation subsidiaries will help to improve market competition at the regional level. As a consequence, more wind energy projects could be developed than in the absence of such conditions.

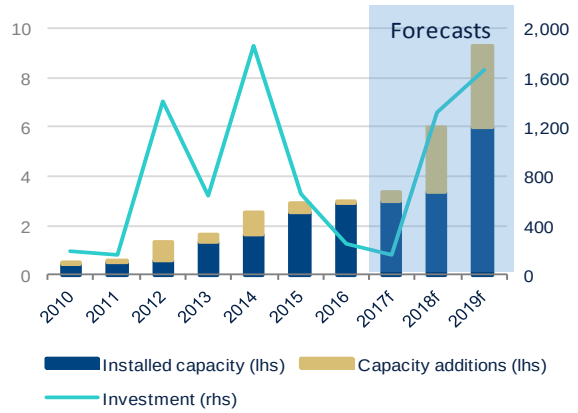
Mexico ratified the Paris Agreement in September 2016. One of the main commitments is to increase the share of clean energy sources to 35% by 2024. There are three public policies that will support the expansion of clean energy: 1) mid- and long-term auctions of electricity; 2) renewable energy certificates; and 3) the national inventory of clean energy along with a map of the zones with the highest potential for clean energy production. The main challenge to wind energy projects is related to the provision of efficient mechanisms to expand the transmission network to zones with potential for the development of such projects.

Mexico: Wind energy for electricity generation (% of renewable)



Source: BBVA Research with SENER data

Mexico: Capacity additions and investment in wind energy for electricity generation (GW & US$ million)



Source: BBVA Research with SENER and CRE data

Peru

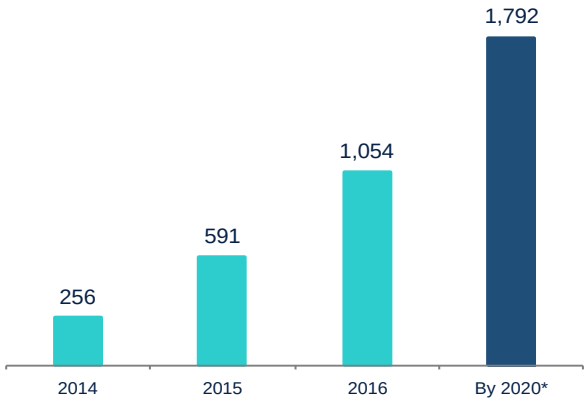
Yalina Crispin

Wind energy production in Peru is small, but has increased in recent years. It currently amounts to 1,000GWh, equivalent to 2% of total electricity production and 4% of production from renewables.[9] All wind energy projects are onshore and owned by foreign private companies, whose investments were financed by multilateral organizations and the Peruvian Development Bank. Currently, Italian and Spanish companies are building three projects in which they have invested US$200 million. These projects will add 738GWh of capacity or 1.5% of the electricity produced in 2016.

Under current legislation, the state auctions the power that it wants to be generated by renewables and the winner is the one who offers to charge the lowest price. Four auctions have been held since 2010.[10] Winners are granted with twenty-year contracts. Depending on the offered prices, the state guarantees a certain amount of revenues, which is eventually financed by the electricity rate. It is noteworthy that these guarantees have had an upward impact on domestic electricity rates,[11] but this is changing as generation costs fall and competition increases.[12]

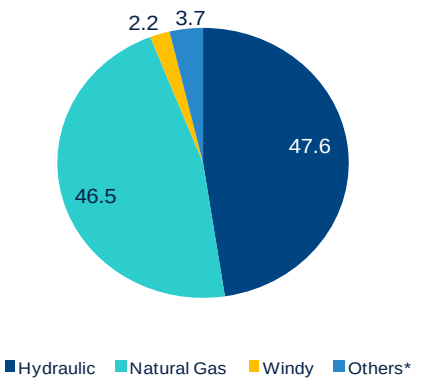
Peru ratified the Paris Agreement in 2016. Previously, the government designed a strategic plan for the period 2014/25 and set the goal for renewables to reach 5% of electricity demand. This goal could be achieved by 2020 as the 2016 RER auction awarded thirteen projects with a combined power of more than 1,700GWh. However, the Peruvian electricity market is currently oversupplied, and the Executive seems to have no intention to expand the participation of the RERs. Nevertheless, there is a proposal in Congress to set a target of 20% for unconventional RERs participation by 2030.

Peru: Wind energy production (GWh)



* Expected when the three current projects under construction begin production (+738 GWh).
Source: COES

Peru: Electricity production share by source (%)



*Coal, solar, and others.
Source: COES

9: It is also equivalent to 73% of electricity production that comes from non-conventional renewable energies, i.e. excluding hydroelectric source.
10: The Minister of Energy and Mines announced that in 2017 there will be no auctions.
11: Between 2011 and 2015, there was a 6% upward impact on residential customer rates due to (i) higher RER costs compared to those of conventional energy and (ii) the reduction of marginal costs in the generation system.
12: At the last wind energy auction, offered supply exceeded by 16x the demand. The average price of wind energy has gone down by 50% since 2009 and is now around US$38/MWh

Portugal

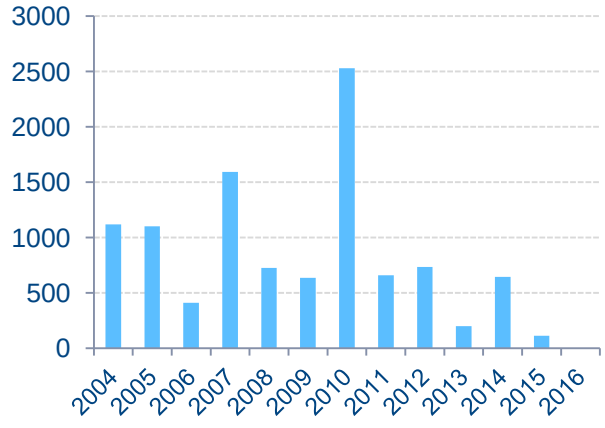
Nathaniel Karp

Portugal ranks among the top five countries in the world in terms of renewable power capacity per capita (excluding hydro). Total wind energy capacity is 4.8GW, which represents 24% of the total electricity mix. By 2020, the country aims to increase 5.3GW of onshore wind power and 27MW of offshore. It also expects to reduce 17% its fossil fuels imports, and cut its import energy balance by 25%. This could imply total savings for US$2.6 billion or 1.3% of GDP. By 2030, Portugal aims to reach 40% of energy consumption from renewable sources, with wind energy as the cornerstone. In addition, Portugal aims to phase out coal use. Electricity generation is highly concentrated as EDP accounts for more than 50% market share and Trust Energy accounts for 19%. Other players include Endesa, Iberwind, and Galp Energia.

Before 2000, transmission infrastructure was owned by private power companies, with little interest in investing in renewables. In response, the government took bold actions and bought the transmission lines in order to adapt them to renewables requirements. This included flexibility and improvements to the grid in order to allow production from remote areas. Between 2001 and 2005, the government played a major role in financing renewable energy capacity installation. In addition, it developed a sophisticated feed-in tariff system first introduced in 1988. Although the strategy seemed to work for some time, the tariff deficit that exploded after the financial crisis turned into a major burden on the sustainability of the electricity sector and the economy.

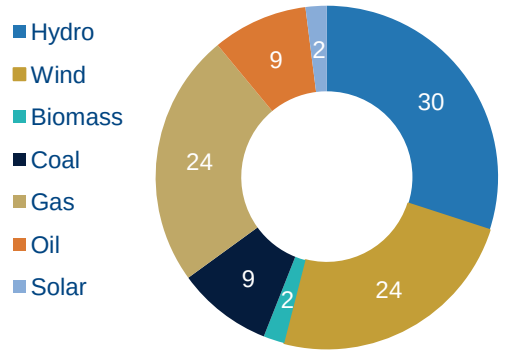
Since 2012, Portugal has been introducing different measures to reduce outstanding debt and increase savings. This included suspending support for new renewable energy projects and a shift toward market-based mechanisms. During the last three years investments in wind energy have averaged US$250 million, with debt finance becoming more relevant than equity. In 2016, Portugal became a net power exporter. In the same year, the country ran for four straight days on renewable energy alone. The country remains committed to become a major player in the application of wind power. In fact, Portugal has successfully created a wind turbine industry that has now become an exporting sector.

Portugal: New build wind energy asset finance (US$ million)



Source: BBVA Research with data from Bloomberg New Energy Finance

Portugal: Share of installed capacity by source, %



Source: BBVA Research with data from Bloomberg New Energy Finance

Spain

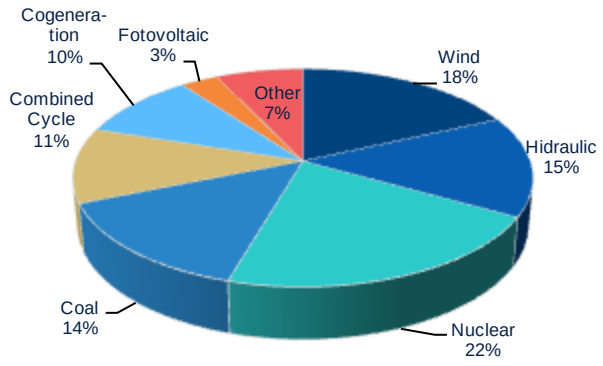
Joseba Barandiarán

Spain is the fifth eolic power in the world (share of 4.7%), with installed capacity of 23,074MW in 2016. Wind energy averaged 18.7% of total production in the Spanish market between 2014 and 2016. Almost half of renewable power in Spain comes from onshore wind. Six companies concentrate two thirds of the wind farms in the country with Iberdrola, Acciona Energia and EDPR controlling 50%. In contrast, the supply of wind turbines is led by Siemens Gamesa, while Red Eléctrica de España handles the country's transmission network.

Recently, the government auctioned new onshore renewable plant permits: 500MW in Jan 2016 and 3,000MW in May 2017. All the permits were granted to wind projects. Privately owned domestic companies got over 60% of the total, all of them at zero incentive bonuses. Only the May's auction guaranteed a minimum €42/MW price. The average investment is US$1.25 million per MW, and will be funded through project finance (about 60%), equity, and funds from the European Investment Bank. The official goals in the 2011-2020 Plan were 35,000MW onshore wind plus 3,000MW offshore by 2020; however, they will not be reached. The government estimates that the additional 3,000MW that will be auctioned in 2017 (this time solar energy could take part of it) together with efficiency measures will be enough to meet the European Commission goal of 20% renewables by 2020 from Spain's actual 16% (2015).

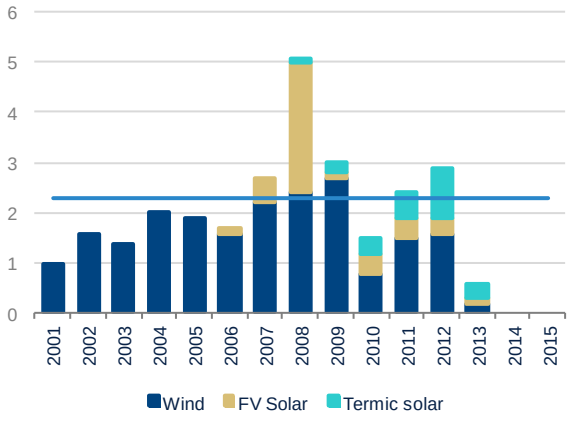
The prospects for wind energy are positive. Following the Renewable Energy Plan 2011-2020, Spain and the rest of the EU members must submit, by Jan 2019, their 2030 national energy plans. The goal is to meet the at least 27% RES target in final energy demand. There is a fair political consensus around these goals, however, the challenge is how to handle the transition given that nuclear and coal still account for over a third of the Spanish electricity mix with strong local economic impacts. In any case, we could expect coal's share (14%) to become either solar or wind energy by 2030, taking the renewables' share to or beyond 55% of electricity production.

Spain: Electricity sources (%)



Source: BBVA Research

Spain: Solar and wind additions vs. needs (GW)



Source: BBVA Research

Turkey

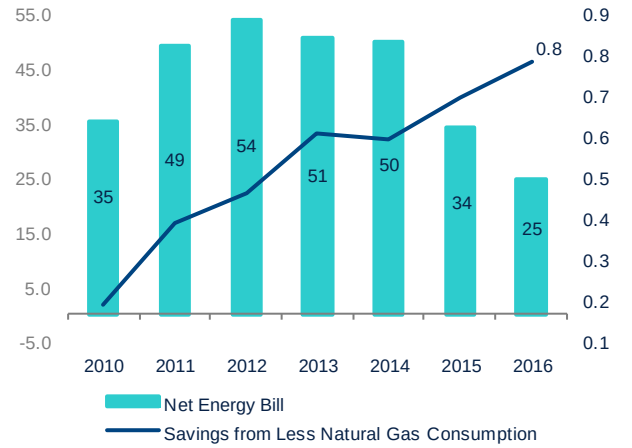
Seda Guler / Gizem Onen

In 2016, Turkey's total installed power capacity climbed to 3rd place in Europe and 7th place in the world. Around 43.4% (including 34% of hydraulic) of total capacity comes from renewables. Wind energy increased its share to 5.0% from 2.6% in 2010 and continues to gain importance in Turkey's total energy mix. During 2010-2016, total installed wind power capacity converged to 6.5GW from 1.3GW and it is expected to reach 9.2GW* by 2020. Investments in wind energy have been solely undertaken by private companies and done onshore. They reached US$11 billion in 2016. Out of the US$9 billion that has been financed so far, 95% has been via project finance and the rest via corporate loans. Going forward, new financing options such as bond issuance may facilitate the financing of more wind energy projects.

Wind energy projects have helped reduce supply security problems. In fact, the share of natural gas in electricity production has retreated to 33% from 50%. This is important considering that Turkey imports almost all the natural gas it consumes. Since 2010, the country has saved nearly US$4 billion from its energy bill, which was US$25 billion at the end of 2016. In Turkey, electricity is generated in a competitive market. In 2011, the Government began to subsidize wind energy projects by guaranteeing a minimum price per kWh for 10 years. By 2016, tenders started to suggest negative price caps in order to reduce the burden on the government. A new regulation on Renewable Energy Designated Areas (RERA) has come into force in 2017. It encourages the domestic manufacturing of high-tech equipment in order to reduce the current account deficit while creating regional wind power generation areas in a more competitive and efficient way.

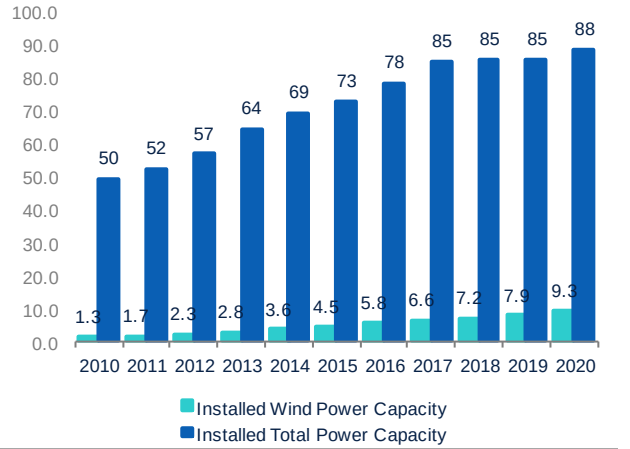
Turkey's wind energy potential was estimated at 48GW in 2016. In the Paris Agreement, Turkey committed to reach 20GW installed power by 2030. To meet this goal, the government is seeking to attract US$12 billion in new investments. Looking ahead, unstable regulatory environment, lasting bureaucratic issues and unpredictable market pricing may create challenges for the sector. However, high potential capacity, government incentives, and the availability of financing options will continue to expand opportunities.

Turkey: Savings from less natural gas consumption (USD bn)



Source: Garanti Bank, TURKSTAT

Turkey: Installed power capacity (GW)



Source: Garanti Bank, TURKSTAT

United States

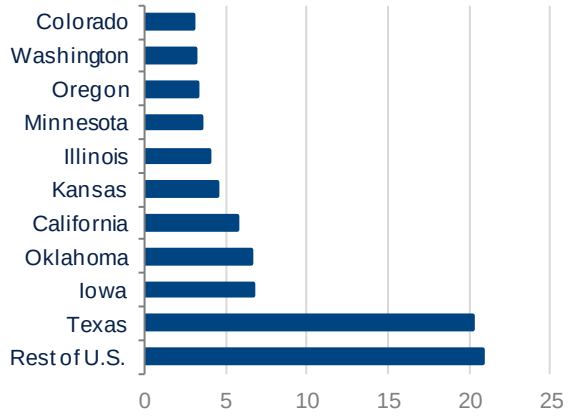
Marcial Nava

At the end of 2016, wind generating capacity was 81GW or 8% of total capacity, the highest share of any renewable source including hydroelectric, supported by improving turbine technology, state renewable portfolio standards (RPS), federal production tax credits, and expanded access to transmission infrastructure. Since 2004, investments in wind energy amount to $156 billion, funded mainly by tax equity and to a lesser extent by debt. Ten states concentrate 75% of total onshore capacity, with 25% in Texas. The first offshore wind project in Rhode Island (29.3MW) started operations in December 2016. Offshore wind could experience momentum beyond 2020 as Massachusetts auctions 1.6GW.

The market for wind power generation is comprised by several domestic and foreign private entities. Five players (Nextera Energy, Southern Co, Berkshire Hathaway, Tri Global and Iberdrola) concentrated 43.4% of the projects commissioned or in advanced development in 1H17.[13] Competition is based on prices but varies depending on base load, intermediate or peak load capacity. Wind power developers also compete with solar, hydroelectric and natural gas; however, an increasing number of them are opting for diversified sources. Transmission is controlled by independent regional organizations while GE, Vestas and Siemens dominate the manufacturing space. This level of concentration reflects the amount of capital and expertise needed to build turbines.

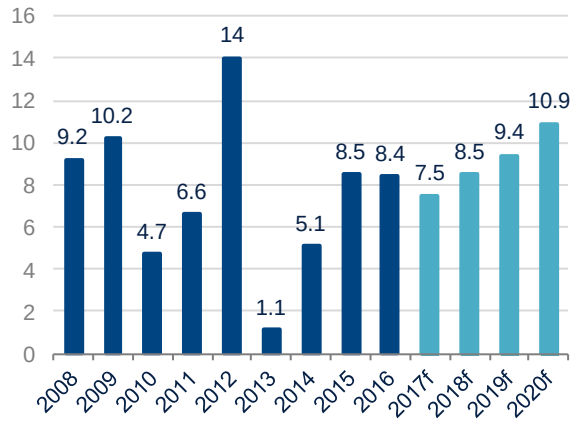
Although the U.S. has abandoned the Paris Agreement and rescinded the Clean Power Plan (measures aimed at a 32% reduction in emissions by 2030), wind capacity will continue to grow as producers reap the benefits from: production tax credits, existing and new RPS, increasing competitiveness and demand growth. Around 40GW could be added between 2017 and 2020, with potential investments in the order of $65 billion. In the short-term, the main source of uncertainty is tax policy. Given that the majority of wind projects are financed using tax equity schemes, a potential corporate tax cut or a major overhaul of the tax code could alter investment decisions.

USA: Operating wind generating capacity by state (GW)



Source: BBVA Research with data from the Energy Information Administration

USA: Wind energy capacity additions (GW)



Source: BBVA Research with data from Bloomberg New Energy Finance

13: Source: Bloomberg New Energy Finance

Uruguay

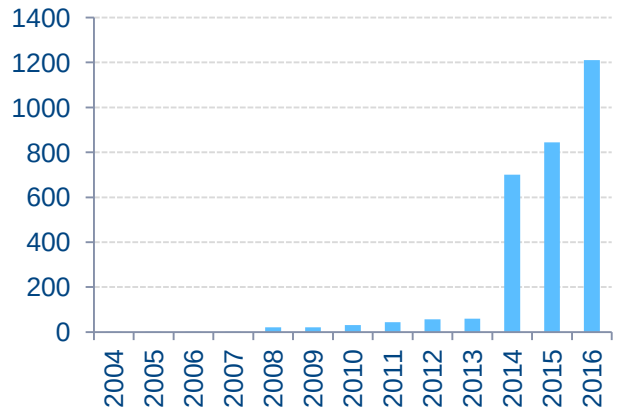
Nathaniel Karp / Marcial Nava

As of 2016, wind energy capacity reached 1,210MW, almost 30 times more than in 2011. The state-owned power company known as UTE controls 100% of power transmission, distribution and sales, and 50% of power generation. The key market players in the wind segment are Vestas, Gamesa, Nordex, Enercon and Suzlon. Wind energy supplies almost 30% of total electricity demand. UTE expects US$1 billion investment over the next 3 years as part of a US$3.4 billion five-year plan; US$600 million from UTE and US$400 million from the private sector.

Uruguay is ranked among the top 10 countries in the world in terms of wind energy capacity per capita with wind energy needs covered until 2020. Therefore, it is unlikely that more competitive auctions will be awarded in the next couple of years. However, energy exchange agreements with Argentina and Brazil, smart grids and balancing demand variability could help attract investment and boost efficiency. Moreover, there are ample available attractive sites remaining. In fact, it is common to reach capacity factors over 40% in wind-rich regions.

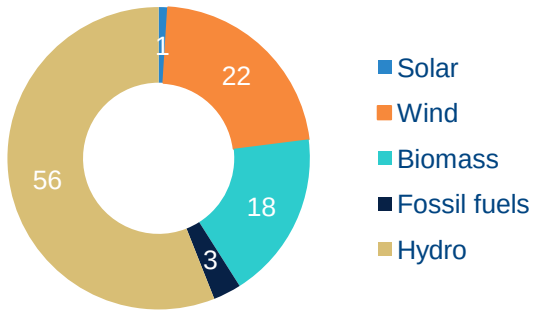
This remarkable achievement started in 2010 after a new energy policy added wind power and other renewables as key policy priorities, followed by competitive tenders and extensions of existing wind farms. Ample support from the public and politicians reflects the severe and costly droughts suffered between 1997 and 2007, which made dependency on hydropower a liability rather than an advantage, and increased the country's dependency on fossil fuels, which generated significant vulnerabilities to businesses and public finances. The desire for energy security is likely to continue. According to UTE, installed wind capacity is expected to reach 1.4GW by year-end 2017. Financing has come mostly from development banks such as the Inter-American Development Bank, Development Bank of Latin America – Corporación Andina de Fomento (CAF), KfW Development Bank and the state owned Banco de la República Oriental del Uruguay. Options include public tenders for power purchase agreements with UTE, competitive bidding made directly by UTE, and investments by companies sponsored by UTE, including trust funds and corporations.

Uruguay: Installed wind power capacity (MW)



Source: BBVA Research with data from Ministerio de Industria, Energía y Minería

Uruguay: Share of electricity generation by source, %



Source: BBVA Research with data from Ministerio de Industria, Energía y Minería

Venezuela

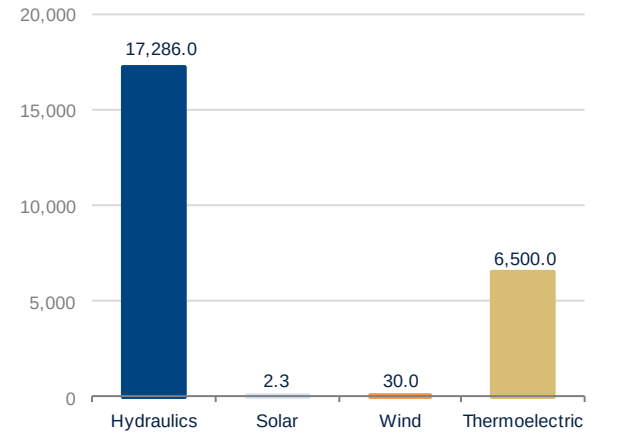
María Fernanda Medina

More than 60% of total energy in Venezuela is generated by renewable sources, from which 99.8% is hydroelectric, 0.17% wind energy and less than 0.01% is solar energy. In 2012, the first phase of an onshore wind power project proposed by the late president Hugo Chavez in 2006 was completed. This involved the construction of two farms (Los Taques and La Guajira), which both have the capacity to produce 30MW and required the investment of approximately US$170 million. The complete project included additional turbines needed to generate 10GW, for which a budget of US$2.8 billion was approved but the project was abandoned after the completion of the first phase.

Venezuela's energy sources became public in 2007, when Chavez decided to nationalize the country's electrical system, starting with the complete control of the country's power generators in order to establish a “fair price” over the tariffs charged for the service, and break with the “capitalist scheme” executed by the previous owners. There are currently no official figures available on the effective power generation capacity of any source as well as on the state of any of the facilities. However, after El Niño phenomenon of 2016, the deterioration of the main hydroelectric and thermoelectric plants was evident, leading to emergency rationing and a severe disruption of economic activity. As a result, potential GDP might have decreased.

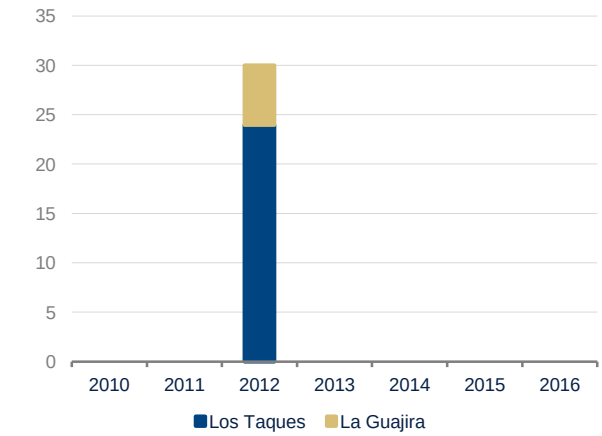
Due to the economic crisis, the alarming external debt, as well as the social and political problems that Venezuela is experiencing (the worst since 2014), the possibility of financing a restructuring of the energy system and finishing the old renewable energy projects has turned very unlikely in the medium term. In 2016, GDP is estimated to have dropped by 15.5% and in 2017 it is expected to decline 7.5% further, which is why, despite the country's participation in international agreements that seek the development of renewable energy, Venezuela has a very limited capacity and a non-priority interest in developing green energy projects.

Venezuela: Energy mix by source (MW)



Source: Corpoelec, thewindpower.com, MPPEE

Venezuela: Wind energy capacity additions (MW)



Source: Corpoelec, thewindpower.com, MPPEE

Bottom Line

Our country analysis confirms that the prospects for wind energy are reasonably positive. However, there is a significant degree of variability. Although the majority of countries have established ambitious goals for the expansion of wind and other non-conventional renewables, reaching these targets will not be smooth given economic and political realities. In the long-run, the biggest challenge for wind energy comes not from hydrocarbons but from other renewables that will also experience a significant cost decline.

Brazil, China, Spain and the United States are among the top ten producers of wind energy and together with Portugal and Uruguay will remain at the forefront of the wind revolution. China, in particular, will continue to be the undisputable leader in capacity additions, investments and manufacturing. In less mature markets such as Argentina, Chile, Mexico and Turkey, wind energy is likely to experience momentum due to upgraded legal frameworks and other policy measures aimed at diversifying the energy mix and make electricity markets more efficient.

In China, for example, coal will remain the cheapest source of energy for several more years despite substantial investments in renewables and thus, transition depends more on the government's commitment to develop a renewable energy sector rather than just economic conditions. Meanwhile, the U.S. withdrawal from the Paris Agreement has made the expansion of renewables entirely dependent on state and local policies. In Peru, Colombia and Venezuela, abundance of hydropower and fossil fuels ultimately makes the transition to wind and solar less of a priority than in countries with a stronger dependency on imports of fossil fuels, like Uruguay, Portugal and Spain. Economic and political adversity in Venezuela limits the possibility of wind energy investments in the short-run, although the need to upgrade existing infrastructure could open a window of opportunity in the future.

For countries with comparative advantages, elevated fossil fuel dependency or strong environmental goals, the importance of wind energy will remain strong, either with new additions or upgrades to existing infrastructure in mature markets. Moreover, although government support will continue to play an important role in the expansion of wind energy, ongoing productivity gains are expected to make subsidies and tax breaks less relevant over time as the cost of wind projects falls below other alternatives. In other words, investment will increasingly come mostly from private sources and allocated based on market conditions.

To the extent that technological advancements increase productivity in otherwise less attractive regions, new capacity will be added in untapped markets. As a result, the battle to become the leading technology developer and manufacturer will intensify. Although newcomers are unlikely, M&A activity and vertical integration will intensify. These trends are likely to disrupt the geopolitics of energy.

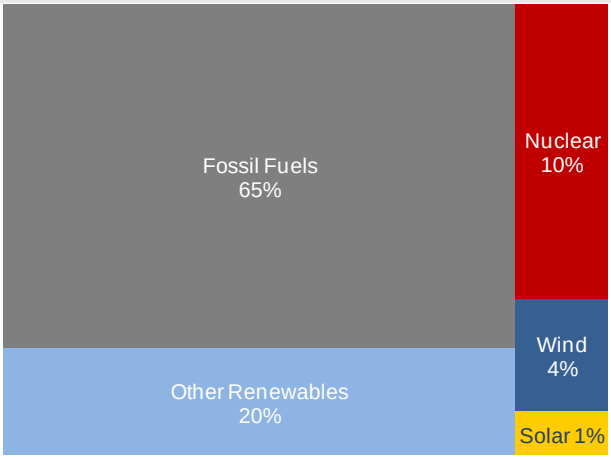
Appendix

Global. New wind investment (US$ million)

	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
Total by type	**112,478.4**	**124,233.9**	**108,455.0**	**89,003.2**	**84,411.8**	**84,176.7**	**101,617.3**	**79,701.3**	**74,846.0**	**61,069.6**	**39,655.9**	**28,517.4**
Asset finance	107,902.3	122,496.9	101,139.9	84,802.3	82,417.0	79,119.3	94,923.2	73,835.8	69,692.1	49,012.0	37,093.1	26,514.7
Africa (exc N. Africa)	253.0	1,978.6	984.0	1,980.1	1,936.6	242.1	5.0	0.0	316.4	14.8	11.5	0.0
Asia	41,265.8	55,252.8	45,681.2	35,020.9	33,395.8	30,587.5	34,553.8	29,737.3	20,419.5	10,466.6	6,392.8	3,970.9
Central & South America	6,084.7	8,633.7	5,891.0	4,484.2	5,519.7	5,429.8	2,112.1	1,816.9	1,638.8	600.5	156.9	292.2
EU Europe	37,418.2	34,726.9	31,075.9	22,130.8	19,408.0	26,275.9	30,375.2	27,890.0	25,756.3	21,515.6	18,849.2	16,114.7
Middle East & N. Africa	1,933.1	420.9	455.3	320.3	566.6	327.9	1,036.1	294.8	229.5	169.2	290.9	195.7
Non-EU Europe	3,231.1	2,189.3	1,488.1	2,186.1	2,087.9	1,104.0	1,549.9	1,458.9	935.0	1,018.4	478.3	140.0
N.America & Caribbean	16,139.1	18,654.8	15,555.7	17,180.8	18,509.7	14,456.2	23,103.4	11,691.0	19,774.8	14,246.5	10,143.3	5,198.0
Oceania	1,577.4	640.0	8.6	1,499.1	992.7	695.8	2,187.8	947.0	621.9	980.4	770.2	603.1
Corporate R&D	381.0	797.5	677.5	751.7	752.3	752.5	646.6	695.6	671.1	558.0	435.6	382.6
Government R&D	828.8	586.6	636.8	609.2	619.6	639.1	698.6	587.9	327.9	324.5	300.2	284.8
Public markets	4,278.7	2,579.1	6,563.8	2,159.0	875.2	4,205.5	4,785.9	4,313.6	3,943.5	11,196.4	1,466.5	1,193.9
Reinvested equity	-1,451.6	-2,609.5	-899.8	-351.5	-950.7	-1,032.2	-996.2	-1,198.3	-1,812.2	-648.6	-531.3	-53.7
Venture cap./Priv. equity	539.1	383.4	336.9	1,032.4	698.4	492.5	1,559.2	1,466.7	2,023.7	627.4	891.8	195.2
Total by region	**112,478.4**	**124,233.9**	**108,455.0**	**89,003.2**	**84,411.8**	**84,176.7**	**101,617.3**	**79,701.3**	**74,846.0**	**61,069.6**	**39,655.9**	**28,517.4**
Africa (exc N. Africa)	253.0	1,977.6	1,109.0	2,133.9	1,936.6	334.3	25.4	16.8	316.4	14.8	11.5	0.0
Asia	41,713.3	56,515.1	47,639.2	35,883.6	34,105.6	33,857.7	37,390.3	33,124.7	21,127.2	12,590.0	6,796.4	4,456.4
Central & South America	6,513.8	8,179.8	8,036.9	4,749.1	5,479.6	5,637.5	2,431.1	1,996.7	1,644.4	592.9	160.1	294.2
EU Europe	40,488.1	35,441.4	33,229.6	24,024.2	20,181.3	27,507.7	31,906.6	29,245.9	29,314.9	30,366.9	20,791.9	16,865.4
Middle East & N. Africa	1,933.6	421.5	457.8	354.9	575.2	329.0	1,047.4	297.6	172.1	170.8	290.9	195.7
Non-EU Europe	3,284.9	2,278.7	1,579.3	2,263.9	2,198.6	1,173.0	1,654.5	1,493.2	954.4	1,061.3	486.7	148.8
N. America & Caribbean	16,741.6	18,779.8	16,394.5	18,095.1	18,933.6	14,691.4	24,915.1	12,565.2	20,685.6	15,086.5	10,243.4	5,644.0
Oceania	1,550.0	640.0	8.7	1,498.5	1,001.3	646.0	2,247.1	961.3	631.0	1,186.5	875.0	912.9

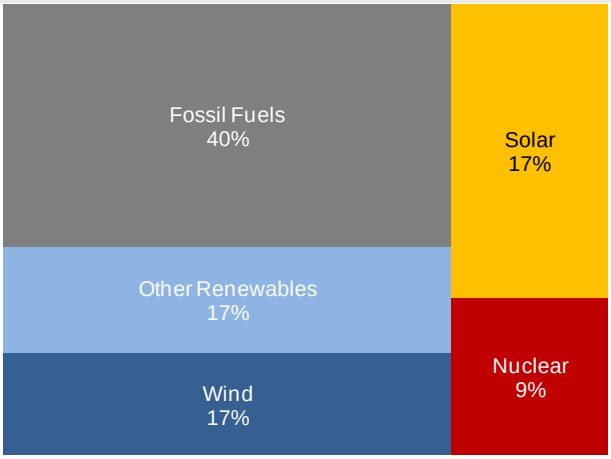
Source: Bloomberg New Energy Finance. Quarterly data excludes Corporate and Gov't

Global. Electricity mix by source, 2016 (%)



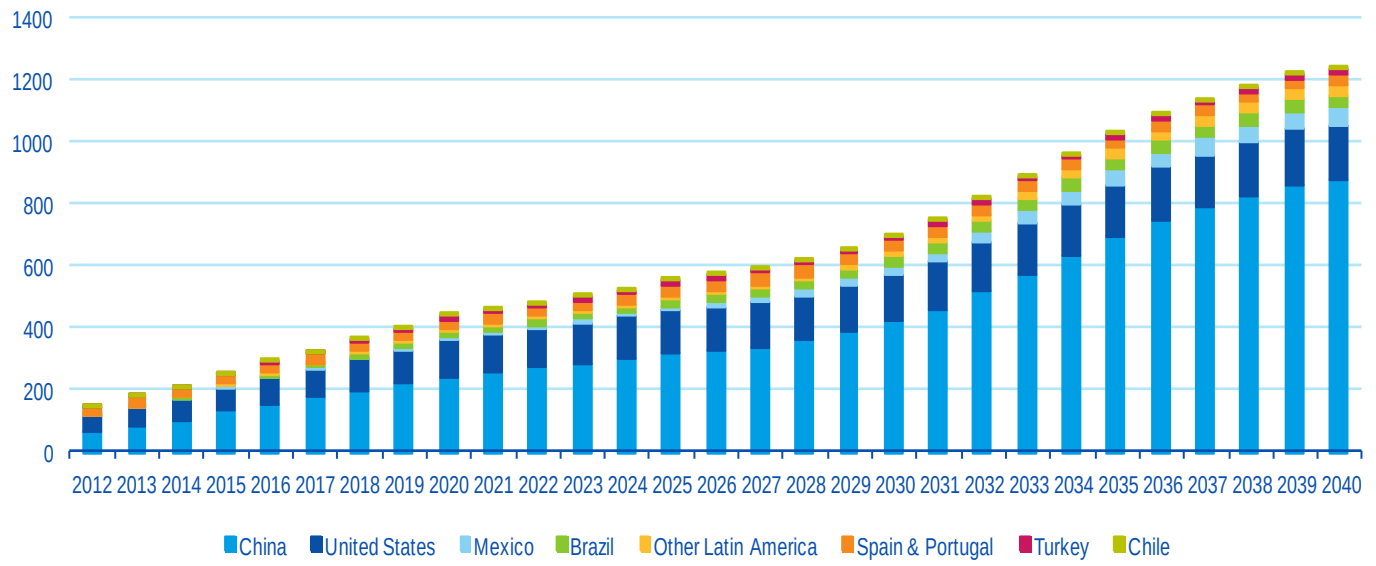
Source: Bloomberg Energy Finance

Global. Electricity mix by source, 2040 (%)



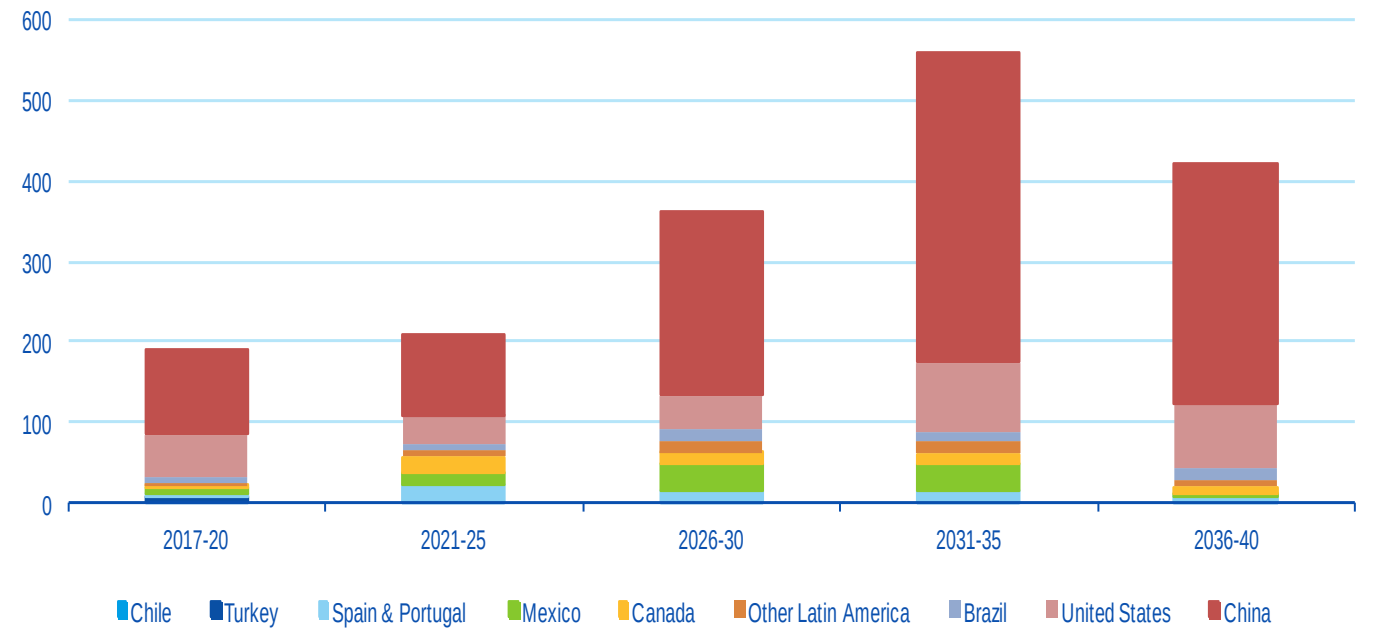
Source: Bloomberg Energy Finance

Global. Projected cumulative installed capacity (GW)



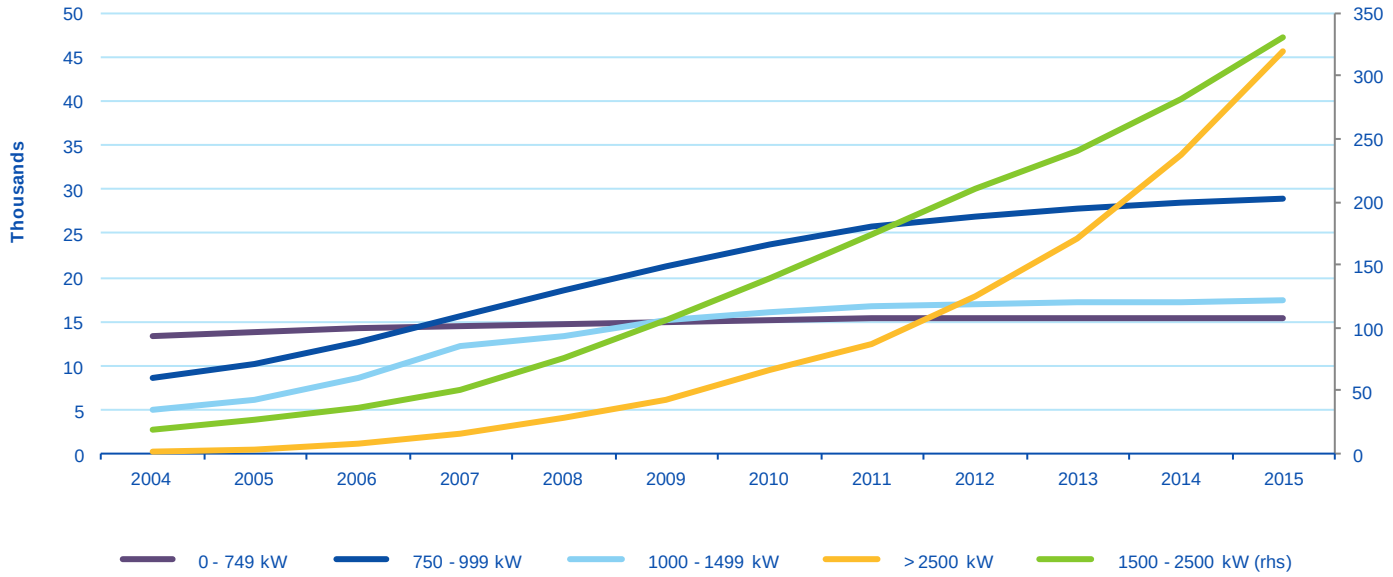
Source: Bloomberg New Energy Finance

Global. Cumulative new investments (US$ billion 2016)



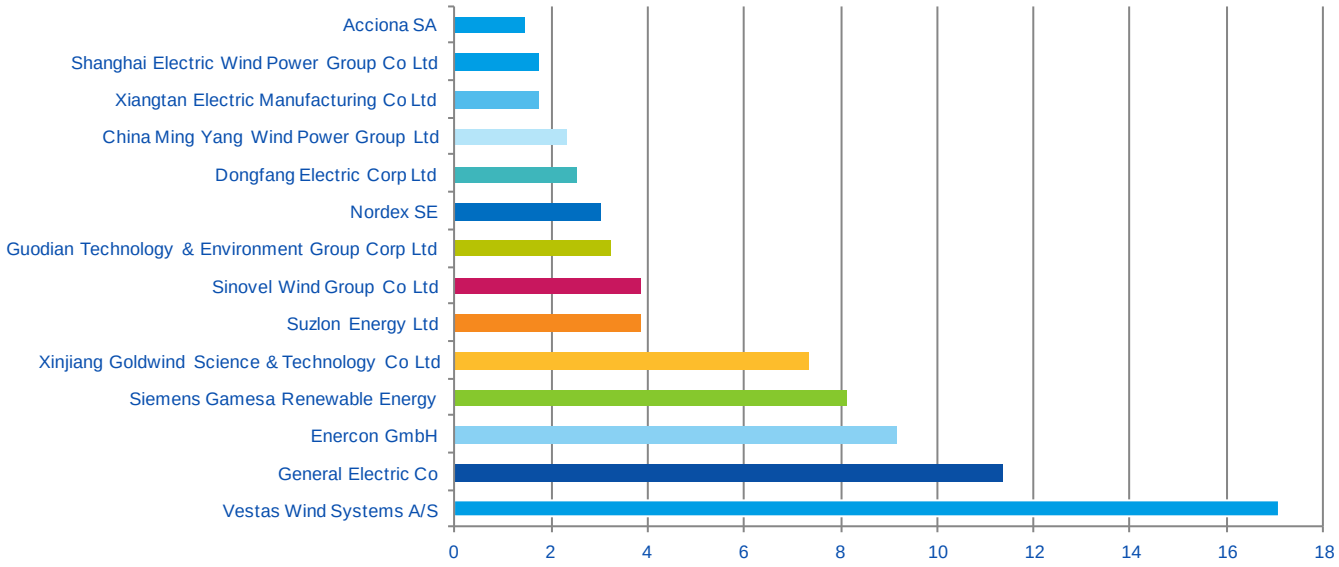
Source: Bloomberg New Energy Finance

Global. Cumulative market share by turbine size



Source: Bloomberg using data from Navigant

Global. Cumulative market share by MW supplied (%, 2015)



Source: Bloomberg using Navigant data

DISCLAIMER

This document has been prepared by BBVA Research Department, it is provided for information purposes only and expresses data, opinions or estimations regarding the date of issue of the report, prepared by BBVA or obtained from or based on sources we consider to be reliable, and have not been independently verified by BBVA. Therefore, BBVA offers no warranty, either express or implicit, regarding its accuracy, integrity or correctness.

Estimations this document may contain have been undertaken according to generally accepted methodologies and should be considered as forecasts or projections. Results obtained in the past, either positive or negative, are no guarantee of future performance.

This document and its contents are subject to changes without prior notice depending on variables such as the economic context or market fluctuations. BBVA is not responsible for updating these contents or for giving notice of such changes.

BBVA accepts no liability for any loss, direct or indirect, that may result from the use of this document or its contents.

This document and its contents do not constitute an offer, invitation or solicitation to purchase, divest or enter into any interest in financial assets or instruments. Neither shall this document nor its contents form the basis of any contract, commitment or decision of any kind.

In regard to investment in financial assets related to economic variables this document may cover, readers should be aware that under no circumstances should they base their investment decisions in the information contained in this document. Those persons or entities offering investment products to these potential investors are legally required to provide the information needed for them to take an appropriate investment decision.