The answer, my friend, is blowing in Brazil's wind

FRANKLIN TEMPLETON THINKS™ | ALTERNATIVE VIEWS

MARCH 2019

Green infrastructure investment opportunities in Latin America flourish

FRANKLIN TEMPLETON

Executive summary

- **Renewable energy production in Latin America has grown dramatically over the last decade. The use of green technology like wind turbines and solar arrays continues to expand, as countries like Brazil seek to improve energy security and lower carbon emissions.**
- **Given this energy revolution, the opportunity for private investment in renewable energy infrastructure in Latin America is robust.**
- **These private investments are fueled by new public/private partnership frameworks, untapped natural potential, and rising economic demand and stability.**

The winds of change

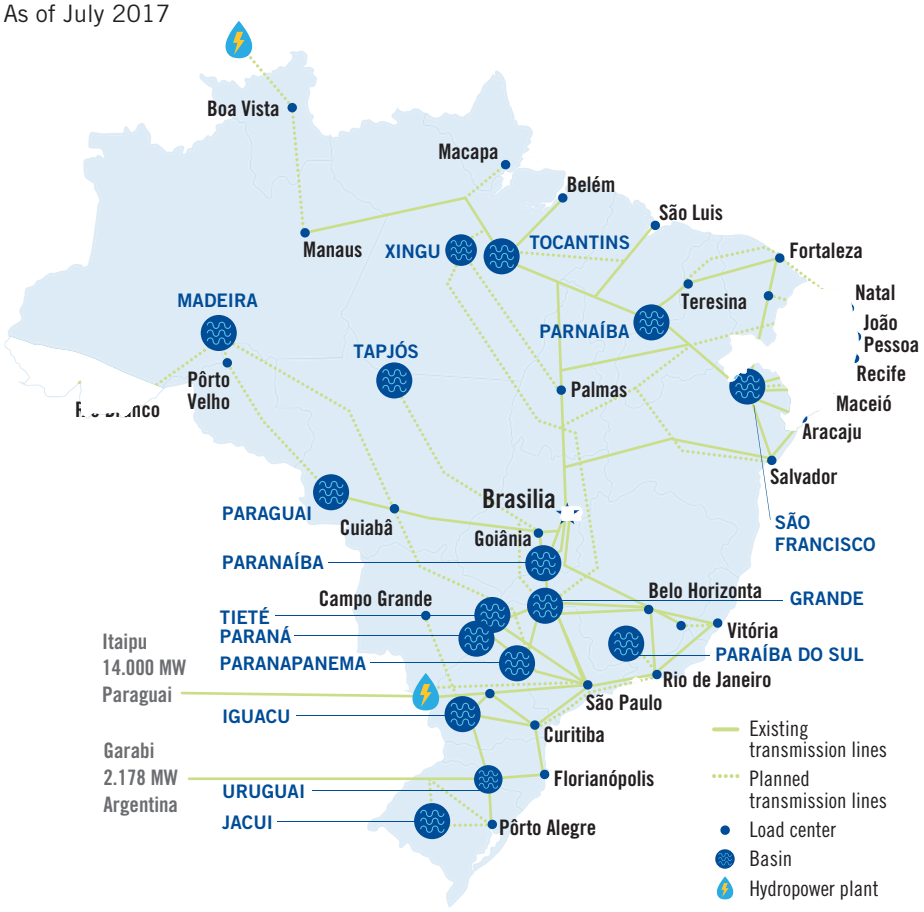
Wind turbine technology thrives in Latin America

Climate concerns are driving change across Latin America, as countries embrace cleaner energy and look for more sustainable ways to increase power generation. Among those more sustainable ways is wind turbine technology—considered one of the cleanest sources of energy on the planet.

Globally, from 2000 to 2017, wind capacity increased from 17,000 megawatts to more than 500,000 megawatts, according to the International Renewable Energy Agency (IRENA). Latin America is at the forefront of this revolution. In fact, Brazil is the most advanced country in the region in terms of wind power utilization. As of 2017, the nation has 447 wind farms with an installed capacity of 11 gigawatts (GW)—enough to power more than 10 million homes[1]. In addition, the country has committed to expand non-hydropower renewables, such as wind turbine technology, to at least 20% of total renewables by 2030. The Brazilian

BRAZIL IS AMONG THE WORLD'S LARGEST POWER SYSTEMS, PRESENTING GREAT OPPORTUNITY FOR GROWTH AND EFFICIENCY GAINS

Exhibit 1: Brazilian electricity grid
As of July 2017



Source: National Grid Operator ("Operador Nacional do Sistema"–ONS) 2017–2019 expansion and reinforcement plan as of July 2017.

1. Source: Wind Investors Blow into Latin America. Forbes. July 14, 2017.

Energy Research Company has forecast more than 24 GW of wind power capacity is expected to be added to the energy matrix by 2027[2].

Investing where the wind takes you

The opportunity for infrastructure investment in Latin America is robust

Significant resources in the way of capital will be needed as countries like Brazil look to build out their renewable energy infrastructure. According to Forbes magazine, 226 energy infrastructure-related investments in 2017 were financed by $61.8 billion of foreign capital, and this trend is forecast to continue.

The U.S. Energy Information Administration (EIA) suggests that power generation in the region will have to double by 2030 to support the growing population. The Economic Commission for Latin America and the Caribbean (ECLAC) estimates the population will rise from 625 million today, to 779 million by 2050. This increase will require investments greater than $700 billion[3]. Renewable sources are expected to drive this expansion, particularly in Brazil, as the country reduces its dependence on large hydropower generation. Through 2026, renewable infrastructure in Brazil—like wind power—is expected to grow faster than 8% year-over-year, representing more than half of the total capacity expansion for the period.

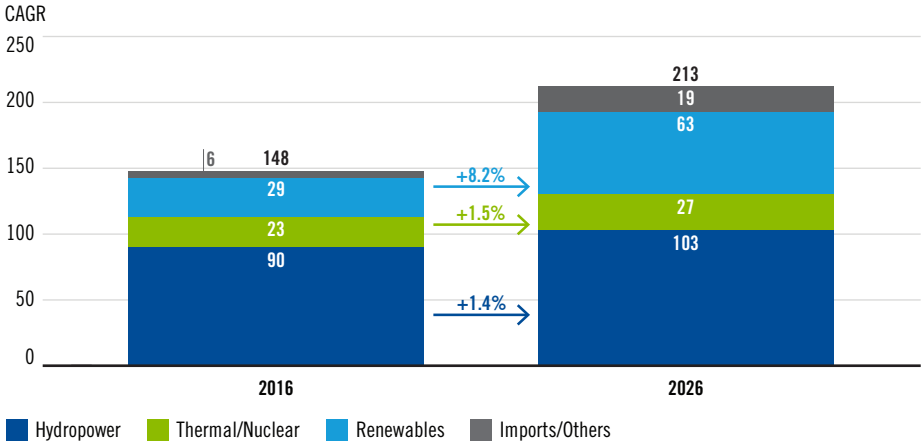
Locally, there are obstacles for this type of fund raising. As such, outside private sector investors are uniquely placed to help fill this gap, but they must be able to recognize and address specific needs by project and country.[4]

Successful investment in the region's infrastructure requires technical, financial and regulatory expertise that are idiosyncratic to the market.

Companies participating in infrastructure projects can encounter a plethora of regulatory, political and financial hurdles that investors might have not experienced in other venues.

RENEWABLE ENERGY SOURCES EXPECTED TO DRIVE INFRASTRUCTURE GROWTH

Exhibit 2: Brazilian electricity matrix—planned expansion (Installed capacity in GW)
As of December 31, 2016



Source: Brazilian Power Research Corporation ("Empresa de Pesquisa Energética"—EPE) 10-year expansion plan as of 2016, most recent plan available. Past performance is not an indicator or guarantee of future performance.

The Brazilian market

- Brazil is one of the world's biggest economies, and has the largest power market in Latin America, serving a population of 200 million.

Country snapshot (2017)	
Population[5]	208M
2017 GDP[6]	USD $2.1T
GDP rank[6]	8th globally
Inflation (IPCA)[5]	3.5%

- Manufacturing, services and agriculture sectors underpin a diverse economy. For example, Brazil is both an agricultural powerhouse and home country to one of the leading aircraft design and manufacturing companies globally.
- In terms of wind power, the market is under expansion, with good opportunities in both brownfield* and greenfield**. Capacity grew from 0.2 GW to 12.8 GW in the last 10 years. Over 24 GW is expected to be implemented by 2027.
- For solar power the market is still under-exploited, with high quality greenfield opportunities. Capacity grew from 0 MW to ~1 GW in the last 10 years, and is expected to grow more than 40% per annum over the next 5 years.

*Brownfield projects are infrastructure already in use.

**Greenfield projects are built from scratch, lacking constraints of prior work. In these there is no existing building or infrastructure.

Source: Brazilian Power Research Corporation ("Empresa de Pesquisa Energética"—EPE) 10-year expansion plan as of 2007 and 2017. Past performance is not an indicator or guarantee of future performance.

2. Source: Brazilian government presents 10-year energy plan (PDE 2026). Medium.com. July 19, 2017.
3. Source: "Latin America population will reach 625,000,000 inhabitants by 2016. According to ECLAC estimates". February 2, 2016.
4. Source: Renewables 2018 Global Status Report.
5. Source: Historical data from The Brazilian Institute of Geography and Statistics (IBGE); World Bank, October 2018.
6. Source: International Energy Agency.

Catalyst for energy change

The Brazilian government's Alternative Energy Sources Incentives Program, although dormant for several years, served as a catalyst for the shift toward renewable energy in the region. The program offered independent power producers attractively priced and flexible 20-year power purchase agreements (PPAs) with the government majority-controlled entity Eletrobras. In addition, the largest development bank of Brazil, BNDES (Banco Nacional de Desenvolvimento Economico e Social), provided financing at low costs[7].

As such, the segment has grown rapidly in the last 10 years, from 400 MW in 2008 to 13,667 MW in 2018, or 45% per annum. This can be attributed primarily to: (i) strong growth and diversification of the energy matrix; (ii) a reduction in the capital expenditures given technology improvements, and an increase in supply given the lower economic growth of developed countries; and (iii), high capacity factors, significantly above global averages (i.e. 50% vs 20%)[8].

A national emergency

In addition to government incentives, climate change has also served as a catalyst for wind technology. Between 2014 and 2017, Brazil faced some of the worst drought conditions in the country's history. More than four million people were affected, and cities across the country were forced to impose water rationing. In São Paulo—the most populous city in South America and the worst hit by the crisis—water use was temporarily cut by as much as 40%.[9]

The energy industry felt the most pain

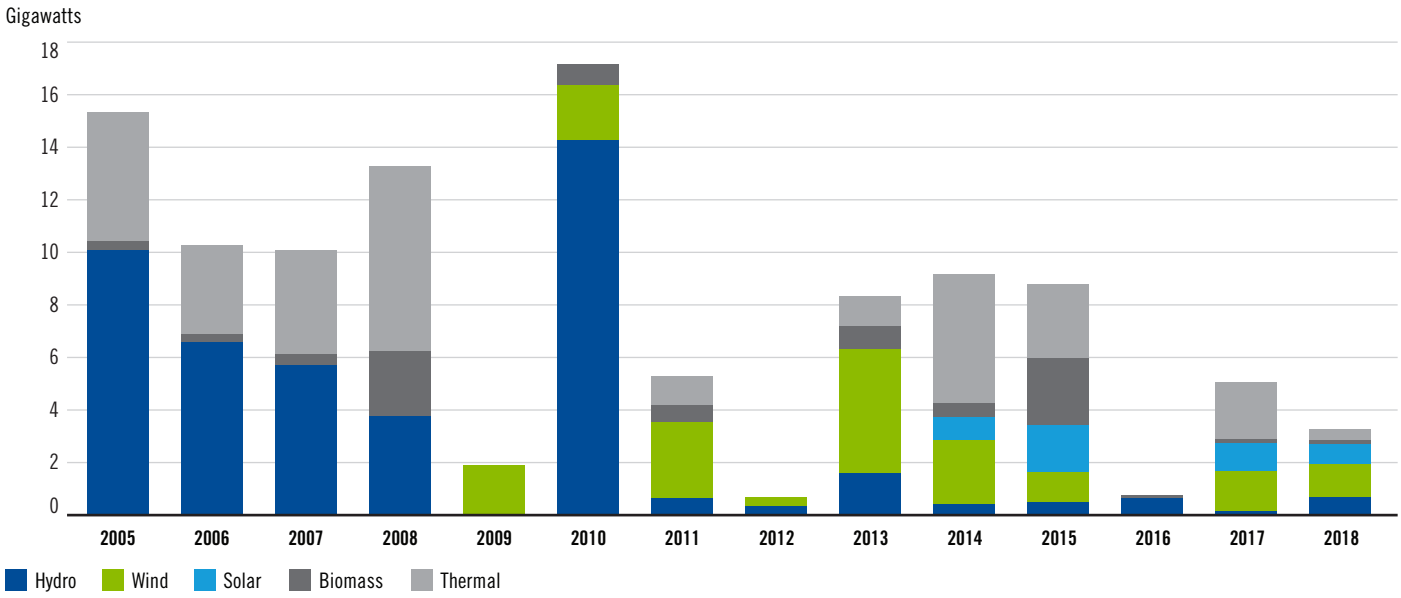
Obviously, the droughts significantly impacted the Brazilian economy and quality of life. Perhaps the most profound shock, however, was felt by the energy sector. This is because a significant source of power for Brazil—roughly 68%—has long been hydroelectricity.

Given the water shortages energy production was of course, severely hampered. Blackouts and brownouts rolled across the country for weeks. High temperatures and increased air conditioning demand overwhelmed grids.

WIND, BIOMASS AND SOLAR POWER REPRESENT MORE THAN 40% OF TOTAL ADDITIONAL ENERGY CAPACITY AUCTIONED IN BRAZIL SINCE 2008

Exhibit 3: Additional capacity publicly auctioned

As of October 2018

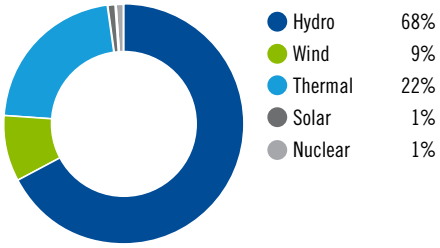


Source: Electricity Commercialization and Clearing Chamber (CCEE).

7. Source: International Energy Agency.
8. Source: BTG Research as of February 14, 2019.
9. Source: Brazil's worst drought in history prompts protests and blackouts. The Guardian. January 23, 2015.

BRAZIL'S HEAVY RELIANCE ON HYDROPOWER

Exhibit 4: Energy generation by type in Brazil
As of 2018



Source: ONS, Brazilian Government Energy Operator, as of 2018.

Climate change a national security threat

Clearly, the droughts caused substantial distress. It should come as no surprise then: a 2017 Pew Research Center survey of 38 countries, Brazil, along with five other Latin American nations, ranked global climate change as the topmost threat to national security. A full 77% of the population identified climate change as an area of immediate concern.

According to a World Bank study, it seems their worry is well placed. Despite accounting for only 12.5% of global greenhouse gas emissions, if the earth's temperatures rise more than 2°C, Latin America will be one of the most affected regions.

For example, the melting of glaciers in the Peruvian and Bolivian Andes will likely accelerate. Most ice-flows below 5,000 meters will possibly disappear, disrupting water supplies, and affecting agriculture and hydroelectricity for millions.

In addition, as storms intensify, flash flooding will likely increase as well. In 2017, Peru and Columbia were pummeled by rains that led to catastrophic floods and mudslides, killing hundreds. In Peru alone, more than 240 bridges and thousands of miles of roads were destroyed. The reconstruction bill was estimated to be around $6 billion, more than 3% of the country's GDP.

In short, climate risk is real risk, especially for Latin America. The region anticipates extreme weather events to become more frequent and intense due to global warming.

Wind is an ideal solution to hydropower disruption

Wind energy is an ideal solution to supplement hydroelectric plants in the Latin American region. This is because even if there are no droughts, dry seasons still occur, and this still limits the generation of hydroelectric power. Renewables, like wind, round out hydro generation. It is during the dry season when wind energy production is usually the strongest.

The challenge with hydropower is sustainability

Many Latin American countries, like Brazil and Paraguay, have long been global leaders in renewable energy. In 2016, the region produced 53%[10] of its electricity from renewable resources, compared with the global average of just 22%.

It is important to note, however, the vast majority of this renewable energy is in the form of hydropower. In fact, according to the International Renewable Energy Agency (IRENA), hydropower accounts for 50% of the region's electricity demand.

So the emphasis on renewables in the region has historically been a function of cost competitiveness versus a deliberate move towards greener energy production. With the many rivers and tributaries that intersect countries like Brazil and Paraguay, the use of hydroelectric power was a practical choice.

The problem with hydropower is sustainability. For example, as the frequency and severity of droughts in the region increase, capturing energy from flowing water is increasingly difficult.

Historically the country's hydropower plants were built with considerable reservoirs, where large inventories of water could be converted to power during dry periods. For environmental reasons many of these reservoirs in recent decades were converted to "run of river" systems, which hold less water by channeling a portion of the river through a canal.

With more "run of river" reservoirs, the country's energy storage capacity as a percentage of total capacity has decreased. During severe dry spells, such as those that occurred in 2001, 2002, 2014, and most recently in 2017, supply cannot support demand. As such, thermoelectric energy is often required to compensate[11]. Finally, while hydropower is technically renewable, large hydro plants, dams and lock systems may create environmental complications.

10. Source: World Bank.
11. Source: Recent transformations of Brazilian matrix of generation electrical energy-causes and main impacts. March 2010.

The answer, my friend, is blowing in Brazil's wind

Why is Brazil so suitable for wind power?

The website Go-kite.com, the self-professed "preeminent kitesurf travel guide in the world", proclaims the northeast coast of Brazil to be among the world's best locations for kitesurfing. They describe it as a "kite paradise," where adventurous kite surfers will find the "gnarliest of gnarly" winds.

It is not just the adrenaline junkies that have discovered the Brazilian coastline for its superior breeze. Brazil is also recognized by the energy industry as one of the best locations for wind farm development. Because of the steady winds that blow up and down its eastern seaboard, the region is ideally suited for capturing wind power. For example, in the state of Ceara in northeast Brazil, in-season winds average 22 knots. Moving further up the coast towards the northwest, the winds get slightly stronger, averaging 30 knots in Prea and Jericoacoara. It is not just the wind speed that is significant, it is the direction and the consistency as well. The vast majority of the year the winds blow onshore from the east, and generally the gusts are sustained but not excessive. These conditions are ideal for wind turbines seeking to wring power from the air.

There are likely a host of meteorological, environmental, and geographic factors contributing to this dynamic. Perhaps the most obvious are the country possesses an immense coastline, is near the equator, and is relatively undeveloped along the shore. This contributes to the region's proclivity for steady wind. Consider wind is essentially the movement of air from a high pressure area to a low pressure area. This movement is triggered by the sun heating the earth's surface unevenly. As hot air rises, cooler air moves in to fill the void. In essence, as long as the sun is shining the wind will eventually blow—and there is certainly a lot of sun in equatorial Brazil.

Conclusion

The opportunity for renewable infrastructure investment in Latin America, specifically in Brazil, appears significant. Demographic changes, government incentive plans, and geographic factors have all dovetailed in recent years to create a sort of perfect storm for green energy development. Wind farms in particular are especially vital, as countries like Brazil look to mitigate their heavy reliance on hydropower with other sources of energy. Wind energy is an ideal solution to supplement hydroelectric plants. It is during the dry season when wind production is typically the strongest.

The U.S. Energy Information Administration (EIA) suggests that power generation in Latin America will have to double by 2030 to support the population. Renewable sources are expected to underpin this expansion.

To develop these green infrastructure facilities capital will be needed. Locally there are obstacles for this type of fund raising. As such outside private sector investors are uniquely placed to help fill this gap.

Did you know?[12,13]

- Germany and Spain lead the world in terms of power generated by wind.
- Windmills have been in use since 2000 BC. They were first used in Persia and China to pump water for crop irrigation.
- The first modern wind turbine was built in 1940 in Vermont. It operated for 1100 hours before one of the fan blades failed. Engineers were aware of the structural deficiency, but had to make do because of material shortages from war-time rationing. This would be the largest wind turbine built until 1979.
- Today the largest wind turbines are operated off the coast of Belgium. The fan blades are 80-meters long, the length of an American football field, and have a sweep area of 21,124 meters-squared. The turbines are bigger than the London Eye and a single fan can power an average of 8,300 households.

12. Source: 14 little-known facts about wind energy. May, 2016.
13. Source: Wind Power, National Geographic.

Franklin Templeton Thinks: Alternative Views highlights our alternative investment teams' insights about the opportunities and risks in the current market environment. Each issue spotlights our experts' thinking on different macro forces, and particular sector views that drive our investment process.

Darby Private Equity

Darby specializes in emerging markets infrastructure and private debt within the Franklin Templeton global integrated platform. Darby is headquartered in Washington, D.C., United States and has been physically present since 1997 in Brazil.

Primary contributors to this issue

Paulo de Meira Lins
Managing Director
Darby Brazil

Valentina Cumo
Senior Vice President
Darby Brazil

IMPORTANT LEGAL INFORMATION

This material is intended to be of general interest only and should not be construed as individual investment advice or a recommendation or solicitation to buy, sell or hold any security or to adopt any investment strategy. It does not constitute legal or tax advice.

The views expressed are those of the investment manager and the comments, opinions and analyses are rendered as at publication date and may change without notice. The information provided in this material is not intended as a complete analysis of every material fact regarding any country, region or market. **All investments involve risks, including possible loss of principal.**

Data from third party sources may have been used in the preparation of this material and Franklin Templeton Investments ("FTI") has not independently verified, validated or audited such data. FTI accepts no liability whatsoever for any loss arising from use of this information and reliance upon the comments opinions and analyses in the material is at the sole discretion of the user.

Products, services and information may not be available in all jurisdictions and are offered outside the U.S. by other FTI affiliates and/or their distributors as local laws and regulation permits. Please consult your own professional adviser or Franklin Templeton institutional contact for further information on availability of products and services in your jurisdiction.

Issued in the U.S. by Franklin Templeton Financial Services Corp. which offers Franklin Templeton private placements (non-public offerings) and U.S.-registered institutional mutual funds to U.S. corporations, pension plans, trusts, and fiduciary clients.

Australia: Issued by Franklin Templeton Investments Australia Limited (ABN 87 006 972 247) (Australian Financial Services License Holder No. 225328), Level 19, 101 Collins Street, Melbourne, Victoria, 3000. **Austria/Germany:** Franklin Templeton Investment Services GmbH Mainzer Landstr. 16, 60325 Frankfurt/Main, Germany. Tel +49 (0) 69/27223-557, Fax +49 (0) 69/27223-622, institutional@franklintempleton.de. **Canada:** Issued by Franklin Templeton Investments Corp., 5000 Yonge Street, Suite 900 Toronto, ON, M2N 0A7, Fax: (416) 364-1163, (800) 387-0830, www.franklintempleton.ca. **Netherlands:** FTIS Branch Amsterdam, World Trade Center Amsterdam, H-Toren, 5e verdieping, Zuidplein 36, 1077 XV Amsterdam, Netherlands. Tel +31 (0) 20 575 2890 **Dubai:** Issued by Franklin Templeton Investments (ME) Limited, authorized and regulated by the Dubai Financial Services Authority. Dubai office: Franklin Templeton Investments, The Gate, East Wing, Level 2, Dubai International Financial Centre, P.O. Box 506613, Dubai, U.A.E., Tel.: +9714-4284100 Fax:+9714-4284140. **France:** Issued by Franklin Templeton France S.A., 20 rue de la Paix, 75002 Paris France. **Hong Kong:** Issued by Franklin Templeton Investments (Asia) Limited, 17/F, Chater House, 8 Connaught Road Central, Hong Kong. **Italy:** Issued by Franklin Templeton International Services S.à.r.l. – Italian Branch, Corso Italia, 1 – Milan, 20122, Italy. **Japan:** Issued by Franklin Templeton Investments Japan Limited. **Korea:** Issued by Franklin Templeton Investment Trust Management Co., Ltd., 3rd fl., CCMM Building, 12 Youido-Dong, Youngdungpo-Gu, Seoul, Korea 150-968. **Luxembourg/Benelux:** Issued by Franklin Templeton International Services S.à r.l. – Supervised by the Commission de Surveillance du Secteur Financier - 8A, rue Albert Borschette, L-1246 Luxembourg - Tel: +352-46 66 67-1 - Fax: +352-46 66 76. **Malaysia:** Issued by Franklin Templeton Asset Management (Malaysia) Sdn. Bhd. & Franklin Templeton GSC Asset Management Sdn. Bhd. **Poland:** Issued by Templeton Asset Management (Poland) TFI S.A.; Rondo ONZ 1; 00-124 Warsaw. **Romania:** Issued by Bucharest branch of Franklin Templeton Investment Management Limited ("FTIML") registered with the Romania Financial Supervisory Authority under no. PJM01SFIM/400005/14.09.2009,, and authorized and regulated in the UK by the Financial Conduct Authority. **Singapore:** Issued by Templeton Asset Management Ltd. Registration No. (UEN) 199205211E. 7 Temasek Boulevard, #38-03 Suntec Tower One, 038987, Singapore. **Spain:** FTIS Branch Madrid, Professional of the Financial Sector under the Supervision of CNMV, José Ortega y Gasset 29, Madrid, Spain. Tel +34 91 426 3600, Fax +34 91 577 1857. **South Africa**: Issued by Franklin Templeton Investments SA (PTY) Ltd which is an authorised Financial Services Provider. Tel: +27 (21) 831 7400 ,Fax: +27 (21) 831 7422. **Switzerland:** Issued by Franklin Templeton Switzerland Ltd, Stockerstrasse 38, CH-8002 Zurich. **UK:** Issued by Franklin Templeton Investment Management Limited (FTIML), registered office: Cannon Place, 78 Cannon Street, London EC4N 6HL Tel +44 (0)20 7073 8500. Authorized and regulated in the United Kingdom by the Financial Conduct Authority. **Nordic regions:** Issued by FTIS Stockholm Branch, Blasieholmsgatan 5, SE-111 48, Stockholm, Sweden. Tel +46 (0)8 545 012 30, nordicinfo@franklintempleton.com FTIS is authorised and regulated in the Luxemburg by the Commission de Surveillance du Secteur Financier and is authorized to conduct certain financial services in Denmark, in Sweden, in Norway and in Finland. **Offshore Americas:** In the U.S., this publication is made available only to financial intermediaries by Templeton/Franklin Investment Services, 100 Fountain Parkway, St. Petersburg, Florida 33716. Tel: (800) 239-3894 (USA Toll-Free), (877) 389-0076 (Canada Toll-Free), and Fax: (727) 299-8736. Investments are not FDIC insured; may lose value; and are not bank guaranteed. Distribution outside the U.S. may be made by Templeton Global Advisors Limited or other sub-distributors, intermediaries, dealers or professional investors that have been engaged by Templeton Global Advisors Limited to distribute shares of Franklin Templeton funds in certain jurisdictions. This is not an offer to sell or a solicitation of an offer to purchase securities in any jurisdiction where it would be illegal to do so.

Please visit www.franklinresources.com to be directed to your local Franklin Templeton website.

FRANKLIN TEMPLETON

For Financial Professional Use Only. Not For Public Distribution.