

Economic Watch

U.S.

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Economic Analysis

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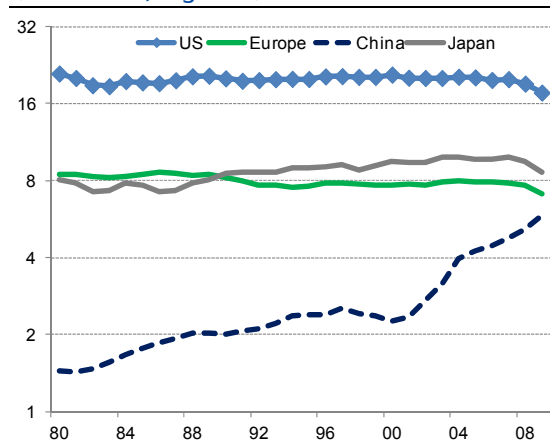
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A Look at Renewable Energy

- Rising greenhouse gas emissions may accelerate global climate change
- Many countries are targeting emission reductions over the next 20 years
- Generous government and development bank support have sparked a recent wave of investment in renewable energy across the globe
- New technological advancements have reduced generation costs, particularly for wind and solar power

Climate change poses a long-term threat to the world, because an unchecked acceleration of current warming trends could have catastrophic consequences for billions of people. For example, warming temperatures impact food production and rising sea levels may flood many currently-inhabited land areas. Scientists have documented increases in global surface temperatures, the melting of snow and ice throughout the world and a rise in the global average sea level, and they attribute these observations to higher concentrations of greenhouse gasses (GHG) in the atmosphere. Industrialization and human activity have been linked to these rising concentrations, because agricultural activity, burning fossil fuels, and deforestation produce a net increase in GHG emissions. By far, the most important contributor to higher GHG concentrations is Carbon Dioxide (CO₂), as its annual emissions grew by about 80% between 1970 and 2004 and it accounted for over 77% of GHG emissions related to human activity in 2004, according to the IPCC.

Chart 1
**Carbon Equivalent Emissions Per Capita
(Metric Tons, Log Scale)**



Source: Bloomberg & BBVA Research

will require an additional \$46 Trillion of investment through 2050 above a baseline scenario. Given the accelerating trend of global carbon emissions, however, some recent studies claim that climate change is occurring faster than previously expected, and that this 50% cut may be inadequate.

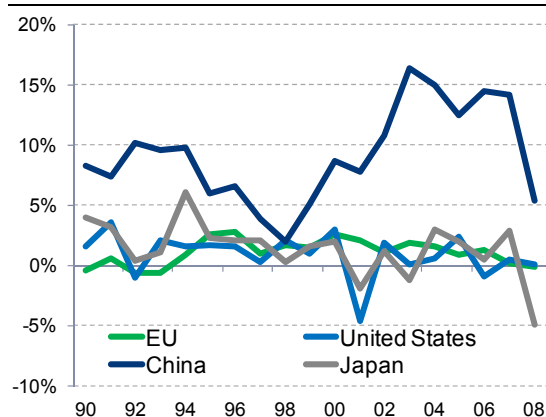
The urgency of action has increased, as the latest report from the United Nations Intergovernmental Panel on Climate Change (IPCC) indicates that although global CO₂ emissions per unit of energy supply exhibited a declining trend since 1970, the trend has turned upward since 2000. This development is due partly to the rise of China, as the country's energy consumption per-capita is rising exponentially and China is now the world's largest emitter of GHG emissions. As a consequence, the IPCC has stated that at least a 50% reduction in global carbon emissions from 2000 levels by 2050 is necessary to maintain the average long-term temperature rise to somewhere between 2 and 2.4 degrees Celsius. The costs will be substantial, as the International Energy Agency calculates that a 50% emissions-reduction scenario

Harnessing the Four Elements: Earth, Wind, Fire and Air

Policymakers have focused their efforts on multilateral agreements that commit countries to reducing their carbon emissions through long-term planning. The Kyoto protocol, signed in 1997, has been the impetus behind international efforts to reduce carbon emissions; however, this commitment ends in 2012, and more aggressive targets are now being discussed. Although no formal international commitment has been reached, the Copenhagen Accord from the 2009 climate meeting reflected ever-greater consensus on the need for deep cuts to GHG emissions by 2050, limiting the global temperature rise to less than 2.0 degrees Celsius, funding for developing countries, and the role of technology to facilitate reductions. The Cancun Accord from the 2010 meeting reiterated the temperature increase limit, further emphasized the shift to a low-carbon society and called for the establishment of a "Green Climate Fund" that would reach \$100 billion per year by 2020 and a "Climate Technology Center." This accord produced win-win agreements for both developing and developed countries and provided a path to achieve a multilateral GHG-reduction commitment at the 2011 climate meeting in Durban, South Africa that commenced on November 28. This conference will be essential to extend and enhance the commitments and programs that expire in 2012 with the Kyoto protocol.

While debate about the appropriate legally-binding targets continues, governments are already planning for a low-carbon future. The Renewable Energy Policy Network states that "as of early 2011, at least 118 countries had some type of policy target or renewable support policy at the national level, up from 55 countries in early 2005." Europe has set climate targets to achieve by 2020 1) a 20% reduction in CO₂ against 1990 levels, 2) 20% of energy from renewables and 3) a 20% improvement in energy efficiency. China is also exhibiting leadership on setting targets, as China initiated a five year plan during 2010-2015 to cut energy consumption per unit of economic growth by 16%, reduce CO₂ emissions per unit of economic growth by 17%, and increase the use of non-fossil fuels in electricity generation from 8.3% in 2010 to 11.4% by 2015. Furthermore, China has a long-term target to reduce carbon intensity by 40-45% by 2020 from 2005 levels while still achieving high GDP growth.

Chart 2
Per Capita Power Consumption Growth (YoY%)



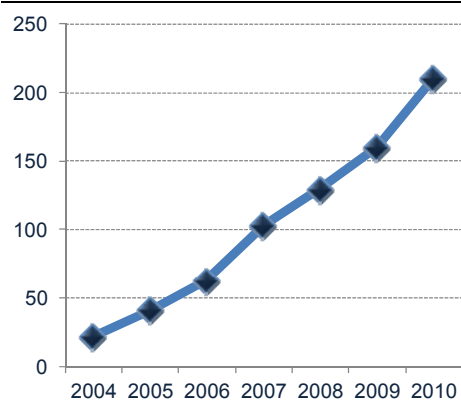
Source: Bloomberg & BBVA Research

The role of governments in providing a strategic plan is essential, because fossil-fuel based energy costs are only projected to rise, as a burgeoning middle class and urbanization trends in emerging markets will demand more energy. Because burning fossil fuels for power generation is the largest source of CO₂ emissions and their future growth, policymakers, entrepreneurs and private companies are focusing their efforts on increasing the share of renewable sources in electricity generation to achieve the drastic reductions in carbon emissions. Transportation-related CO₂ emissions are also growing rapidly, but the current infrastructure for fossil-fuel based vehicles in the developed world means that the conversion to a zero-emissions transportation sector will occur more gradually.

Renewable Energy Investment Surges, Led by Development Banks

The future for renewable energy investment is bright. The 2011 IPCC Special Report on Renewable Energy Sources indicates that renewables have “a large potential mitigate GHG emissions.” Although the U.S. and Europe are struggling to recover from the financial crisis and the pace of growth in emerging markets is softening, global investment in renewable energy has continued to climb as China has entered the stage. Entrepreneurs, energy companies and businesses have not remained on the sidelines as governments have provided generous subsidies and stimulus funds for renewable energy. The U.S. will continue to be a leader in renewable energy research, development and investment. Recently announced initiatives within the U.S. military, for example, will make it a key driver of clean energy investment, as Pike research estimates that annual Department of Defense spending on renewable energy will reach \$10 billion by 2030.

Chart 3
Global New Investment in Renewables (\$bn)



Source: REN21 / Bloomberg Energy Finance

Total global annual investment in renewable energy sources excluding large hydropower surged 32% to a record \$211 billion in 2010 (large hydropower adds \$40-45 billion). For the second year in a row, China topped the investment list, as it attracted nearly \$50 billion in 2010, and for the first time, renewable energy investment flows to emerging markets topped those of developed economies. Nevertheless, the growth rates of investment in some developed economies exceeded those of developing economies, which underscores that renewable investment is maintaining traction in the developed world. In the United States, new investment jumped 58% in 2010 to surpass \$25 billion and put the U.S. in second place behind China.

The majority of global renewable investment in 2010 involves the asset-finance of “new utility-scale renewable energy projects such as wind farms, solar parks, biofuel and other thermal plants.” Of this \$128 billion total, China (\$43.8 billion) and the United States (\$19.6 billion) together accounted for more than half, and Germany, Italy and Spain led the investment charge in Europe. By type of investment, wind power attracted more than \$90 billion, an increase of 33% over 2009. The second largest asset-finance sector was large-scale solar power plants that attracted \$19 billion; this sum represents a surge in real investment as the price of photovoltaic panels fell during this period. Asset-financing for biomass and biofuels declined in excess of 10% in 2010 due largely to lower oil prices and feedstock price and supply uncertainty.

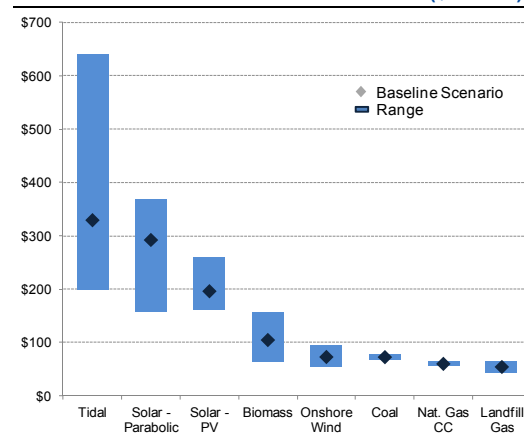
An additional \$60 billion, or 75% of new solar market investment, went to small-scale distributed generation projects that are primarily based on solar power. Government support programs and a decline in photovoltaic panel prices pushed Europe to the forefront in this sector, as Germany took the lead with the majority share of investment. In Europe, these small-scale distributed generation projects will likely continue to dominate investment in solar technology; however, lower panel prices are enabling the design of large-scale solar arrays across the world.

Venture capital and private equity are still significant sources of funding for renewable investment, although private equity has fallen slightly due to funding constraints in developed economies. Multilateral, bilateral and state-owned development banks continue to be a driving force for renewable investment: in 2010, more money flowed from these institutions than from government stimulus packages. Renewable asset finance has slowed in the developed economies in 2011 as some fiscal support programs expired; however, 1Q11 growth in wind financing is up 25% and 100% in China and Brazil, respectively on a year-over-year basis.

A Costly Proposition

In the developed economies, aging coal plants provide an opportunity for renewable investment, because many plants are being retired rather than being retrofitted with expensive carbon-capture technology. The principal factor that is holding back a rapid shift to renewable technologies for large-scale power generation is their relatively higher cost per unit of output versus coal, nuclear or natural gas powered plants. Thus, government subsidy programs have been instrumental in stimulating renewable demand, as we have observed in the case of Spain and solar energy. In 2008, developers installed nearly 2,800 MW of solar power (up from 99 in 2006 and 546 in 2007) due to high feed-in tariffs. When these tariffs were reduced, however, installations fell to 69MW in 2009 and 392MW in 2010. Only onshore wind, geothermal and large-scale hydropower are currently competitive with fossil-fuel based generation. According to Bloomberg New Energy Finance, as of 2Q11, the levelized costs of energy per megawatt-hour of renewable sources versus coal range from 1.1x for onshore wind to 2.7x for solar photovoltaic and upward to 5.3x for ocean wave generation.

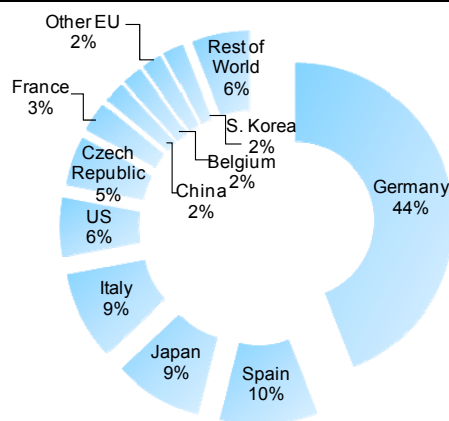
Chart 4
Levelized Cost of Power Generation (\$ / MWh)



Source: Bloomberg Energy Finance / BBVA Research

As Solar Power Prices Plunge, Demand Grows

Chart 5
Global Solar Photo Voltaic Capacity in 2010



Source: RENZI / EPIA, BMU, IDAE, GSE, KOPIA, CREIA

Technological advancements in generation, transmission and distribution, the increasing scale of installations, further research and development, and the rising price of fossil fuels will certainly bring relative costs down in the future. For example, the global solar market has seen a dramatic collapse in panel prices as new manufacturing techniques, expanded production capacity, and government subsidies have caused prices to fall since March. Despite the industry shake-out that is occurring, highly productive manufacturers are expanding and new solar investment in asset finance skyrocketed in the second and third quarters according to Bloomberg New Energy Finance. The total global capacity of solar energy now exceeds 40 Gigawatts (GW), which is more than 7 times higher than in 2005. Solar energy has been the fastest growing segment of renewable energy with an annual average growth rate in excess of 50% during 2005-2010. Price declines will accelerate additional expansion, particularly for large-scale solar photovoltaic plants. Additionally, the March 2011 earthquake in Japan highlighted the risks of nuclear energy, and some countries opted to take plants offline or postpone nuclear energy expansion until the governments could perform additional reviews. Most notably, China opted to cut its 2020 target for nuclear energy and build more solar farms as a substitute. With 10 of the top 15 solar cell manufacturers located in Asia, the economics will prove favorable for solar expansion in China.

Harnessing the sun's power, however, is not only limited to the photovoltaic market. In 2010, the concentrating solar power (CSP) market (or parabolic trough technology) exploded in capacity due primarily to investments by Spanish and U.S. companies. Spain leads this market, as it has over 60% of the total global capacity due to substantial additions in 2010. The U.S. has the remainder, and added hybrid capacity to a combined cycle natural gas power plant in Florida last year. CSP growth is occurring rapidly, as Spain added an additional 50MW in early 2011 and has more than 900MW under construction that will bring the country's total installed capacity to nearly 1800MW by 2013. The Spanish CSP industry has over 80 active firms, and will lead the world in project design and implementation. The dramatic fall in panel prices, however, poses a challenge to additional expansion of CSP because some projects, particularly in the United States, have been redesigned to use photovoltaic panels. Nevertheless, CSP has technical properties that enable thermal storage and allow dispatch-on-demand which is attractive for utility companies. Global interest is growing: in 2011, hybrid capacity was added in both Morocco and Egypt and nearly 2.6GW of global capacity were under construction as of late 2010 and expected to be operational by 2014.

Biomass for the Masses

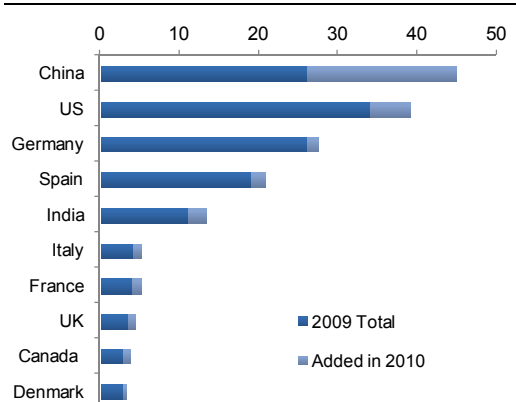
Superseding solar energy as a power-generation source, biomass is responsible for 62GW global capacity, and new installations are coming online. The U.S. leads the world with biomass installations totaling over 10GW of capacity, and there is rising desire to harness landfill gas in the U.S. as a cheap source of power. In developed economies, the primary source of biomass growth will come from an expansion of co-generation capacity. Power plants are being converted to fire biomass with coal and natural gas. In Africa, there is growing interest in landfill gas as a power source. Already, in addition to an important role in electricity generation, the IPCC estimates that biomass is the leading contributor of renewable energy to the primary energy supply, and biomass fuelled 25% of the total global demand for heat.

Wind and Hydropower Are Vital Renewable Generation Sources

The second-largest source of global renewable energy capacity, wind power, has also been growing steadily over the previous five years at an average annual rate in excess of 25%. Total global capacity now exceeds 200GW, and while the U.S. topped the ranking of installed capacity in 2009, in 2010, China surged ahead and now has more than 45GW of generating capacity. Germany takes the ranking for 3rd place, but Spain led Europe in new installations in 2010 and is now the world's 4th largest market in wind. Interestingly, Spain actually generated more electricity with wind than Germany due to more advanced turbine technology and high winds. Investment is starting to surge in the rest of the world, but many of these areas remain a small share.

Latin America, Africa and the Middle East will all see expansions of capacity over the coming years. Attention is also turning to offshore wind power generation, particularly in Europe and China. In 2011 and 2012, China will lead the world by adding a projected 30GW of capacity over these two years, while projects under construction in the U.S. are on pace to add substantial capacity in 2011. The market for wind appears to be stable and able to continue growing throughout the world, as manufacturers are continuing to improve turbine designs that can generate more power with greater efficiency. On a cost-per-megawatt hour basis, wind is the second-most competitive renewable energy source with fossil fuels, but low and stable natural gas prices are holding back sales growth, particularly in the United States. The challenge, however, remains the potential for declines in wind speed, and the inability to store wind-generated power.

Chart 6
Wind Generation as of 2010 (Gigawatts)



Source: REN21 & BBVA Research

Chart 7
Ranking of Installed Renewable Electric Power Generation Capacity, 2010 (Gigawatts)

Rank	Total Renewable Capacity	Wind Power	Biomass Power	Solar (PV)	New Renewable Capacity Investment
1	China	China	US	Germany	China
2	US	US	Brazil	Spain	Germany
3	Canada	Germany	Germany	Japan	US
4	Brazil	Spain	China	Italy	Italy
5	Germany	India	Sweden	US	Brazil

Source: REN 21 / F.O. Licht & BBVA Research

By a five-fold multiple over installed wind capacity, the largest source of renewable electricity generation is hydropower. Due to the fact that it already provides over 1000 GW of total global electric power capacity, the annual growth rate of additional capacity has remained in the single digits for the past five years between 3 to 5%. Large hydropower installations are the most cost-competitive with traditional fossil-fuel based generation, and they are in use in over 150 countries. Hydropower generates the vast majority of total electricity demand in Brazil and Canada, and China's hydropower generation capacity is likely to have doubled since 2005 by the end of 2011 to more than 230 GW. Canada is adding double-digit capacity through 2012. Hydropower is particularly well-suited for base-load electricity generation, and indeed, some countries in Africa along with Norway and New Zealand generate nearly 100% of their distributed electricity with hydropower. New technological advancements are enabling small-scale hydropower projects to become viable in many parts of the world. Asia (China) and Latin America (Brazil) are planning fervent investment in hydropower technology during the next five years.

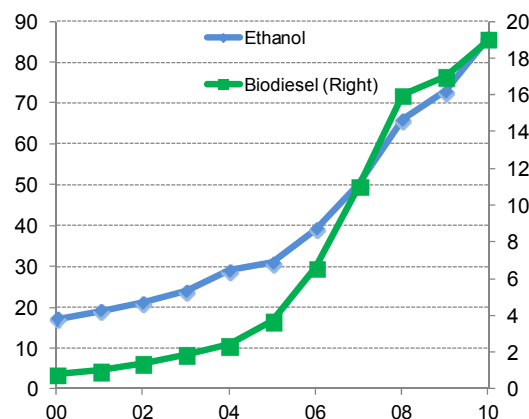
Currently, ocean energy (wave and tidal) is cost prohibitive for most applications, and it provides a fringe source of the global generation capacity. However, research and development is progressing in this area, and most commercially viable applications are yet to come. The Renewable Energy Policy Network notes that although ocean energy is 15-25 years behind wind technology, it is projected to follow a similar path of rapid commercialization in the near future. Scaled-down versions of hydro, wind, solar and biomass electricity generating sources are finally becoming cost effective and will potentially provide power sources for the world's rural population. This segment has traditionally been underserved due to the prohibitive costs of extending a city electricity grid.

The Transportation Sector is a Secondary Target

While replacement, upgrade and capacity expansion of power plants with renewable sources will attract the majority of investment in the electricity generation sector, government emissions reduction plans are also considering targets for the transportation fleet. Aside from electric vehicles, ethanol and biodiesel are the two most promising liquid fuels. Most of the biodiesel production is concentrated in Europe, where Germany, France and Spain are important contributors. But, while the growth of biodiesel production has slowed since 2008, ethanol

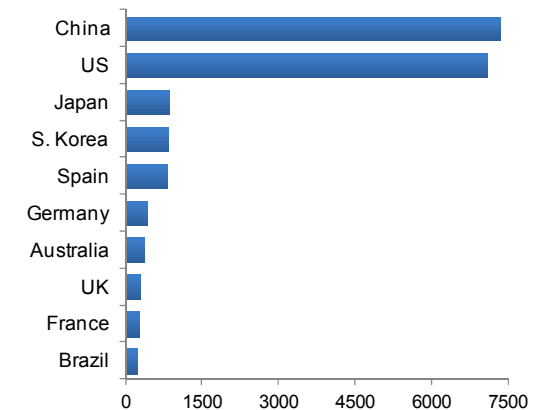
production continues to surge. The U.S. produces almost 60% of the world's total, and it became a net exporter in 2010 as sugar prices rose and corn-based ethanol became more cost-competitive. Second to the U.S., Brazil produces nearly 33% of the global total, and production is rising in Asia, Africa and throughout Europe. In the U.S., the surge of ethanol has been supported by generous subsidies and gasoline blending mandates that make it profitable. The rise in corn prices, however, increased global tensions as the rising costs of food drew international protests and provided ammunition for ethanol critics. Thus, some policymakers and international organizations have called production subsidies into question as mounting evidence demonstrates that they are bidding up the prices of food staples. Along with fiscal austerity measures in developed economies, these pressures may halt momentum for additional blending mandates in until further studies can confirm the sustainability and long-term benefits of these fuels.

Chart 8
Ethanol and Biodiesel Production (billions liters)



Source: REN 21 / F.O. Licht

Chart 9
Government Investments In Smart Grid Technology, Millions of USD (2010)



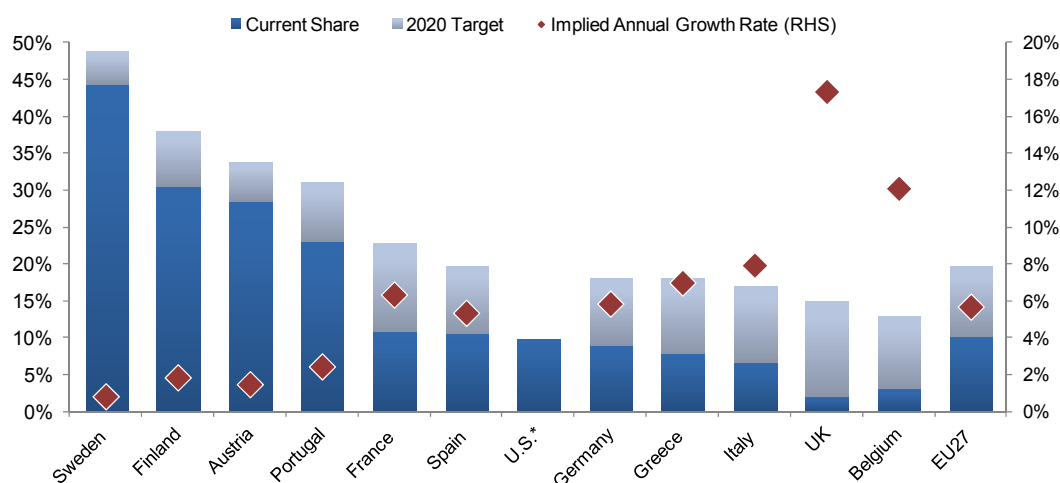
Source: GE Reports

Complementary Investments in Carbon Management and Smart Grids Are Vital for Success

Reaching the aggressive carbon-reduction targets that governments have set will not be easy. For example, as Europe prepares to enter the third phase of its cap-and-trade program in 2013, energy costs for industrial producers and other large consumers of energy will skyrocket as emission caps are reduced to meet the 20% by 2020 target. Kevin Houston, founder of the UK consultancy CarbonMasters explains that a company's first step should be to comprehensively measure its carbon footprint across all activities. These assessments reveal the potential for companies to enhance productivity by producing more with less energy. CarbonMasters has developed innovative software and carbon measurement tools for companies, and it has just launched a three-tier certification program in which businesses can publicly demonstrate their commitment to emissions reductions. As more companies voluntarily participate in international consortiums such as the Carbon Disclosure Project, firm-level carbon measurement and energy use reduction will be essential to achieving cost savings and national emissions reduction targets. Pike research predicts that North America will become the largest market for carbon management services and software by 2013 with annual spending in excess of \$1.1 billion and swelling to \$2.5 billion by 2017.

Chart 10

2008 Share of Renewables in Electric Power Generation and 2020 Targets



*U.S. current share is listed for comparison – no target exists
Source: Bloomberg & BBVA Research

In addition to carbon footprinting, new smart-grid technology is also a thriving complementary area for investment. The idea behind smart grids is simple, but the engineering is quite complex. A smart grid actively manages power delivery to consumers, and it can also respond to the availability of renewable energy sources. This technology allows multiple sources of power generation to seamlessly co-exist on the same grid. For example, if a wind farm suddenly starts producing more electricity due to high winds, a smart-grid can direct that electricity to nearby homes and businesses and re-direct electricity from other sources to different consumers. This dynamic response could prevent a natural-gas fired plant from needing to be started to satisfy additional demand, and it could provide a real-time price signal to consumers. The Asia-Pacific region is a hotbed of smart grid investment, because these countries are installing new electricity generation equipment to meet rapidly growing demand. Pike research estimates that revenue through 2017 from smart-grid investment in the Asia-Pacific region alone will surpass \$170 billion. This region is particularly well-suited for this new investment, as it is not saddled with a legacy electricity distribution grid that must be upgraded over time.

Bottom Line

The discussion surrounding climate change and its mitigation take center stage this week as the UN IPCC holds its third annual summit in Durban, South Africa from November 28 to December 9. Participants intend to finalize multilateral emission reduction agreements ahead of the expiration of the Kyoto protocol's agreements. Stringent carbon emission reduction targets and the implementation of phase III of the European Union's carbon trading market in 2013 will further the deployment of renewable energy technology for electricity generation. Government subsidies and global development bank support in the form of grants, tax credits, feed-in tariffs and loan guarantees remain essential to make renewable electricity generation cost competitive with traditional fossil-fuel based sources. Furthermore, technological advancements have also reduced the costs of wind, solar photovoltaic and biomass power which are leading candidates for investment today. Complementary investments in carbon measurement and smart grid technology will also surge during the next decade, because renewable generation will certainly co-exist with fossil fuel based generation from natural gas and coal.

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