



Understanding the U.S. Renewable Energy Market: A Guide for International Investors

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INTRODUCTION

The United States' renewable energy sector, already the second largest in the world, is poised for strong growth. Bolstered by growing demand for clean energy, falling costs, and robust incentives, renewable energy is expected to become the leading source of electricity generation by the mid-2030s. By 2050, renewable energy sources are projected to provide 42 percent of the United States' electricity compared to approximately 20 percent today.¹ Given the pace and scale of the transformation underway, the U.S. renewable market offers a valuable opportunity for investors.

This brief explores the U.S. renewable energy landscape with a focus on the U.S. electricity sector using data from the United States Energy Information Administration (EIA), International Renewable Energy Agency (IRENA), International Energy Agency (IEA), Congressional Research Service (CRS) and *fDi Markets*. Currently, about 60 percent of U.S. renewable energy goes to the electricity sector, while the electricity sector overall consumes about 38 percent of total U.S. primary energy mix which includes energy used directly in transportation, as well as industrial, residential, and commercial heating applications.

Focusing on the five largest sources of renewable electricity generation—hydroelectric, wind, biomass, solar and geothermal—this paper provides information on historical trends in power generation in the United States, forecasted changes in the U.S. electricity market and their key drivers, namely declining construction costs and government incentives, and the implications for foreign direct investment (FDI) in the United States.

Investors interested in the opportunities present in the United States' renewable energy sector are invited to contact SelectUSA, the United States' investment promotion initiative housed in the U.S. Department of Commerce, by emailing selectusa@trade.gov or by visiting the [SelectUSA website](#).

THE U.S. RENEWABLE ENERGY SECTOR HAS ALREADY SEEN STRONG GROWTH

Over the past decade, renewable energy sources (renewables) have become an increasingly important part of the United States' energy mix. Between 2000 and 2020, overall renewable energy generation grew 91.2 percent, from 6.1 quadrillion British thermal units to 11.6. of energy. In 2020, about 12.2 percent of total primary U.S. energy production was generated by renewable sources.²

Renewable energy generation in the electricity sector has also seen impressive growth. Between 2000 and 2020, utility-scale electricity generation by renewables in the United States grew approximately 120 percent, from 356 billion kilowatt-hours (kWh) in 2000 to 783 billion kWh in 2020. In 2020, renewables generated 19.5 percent of the United States' net electricity production.³ In comparison, coal plants

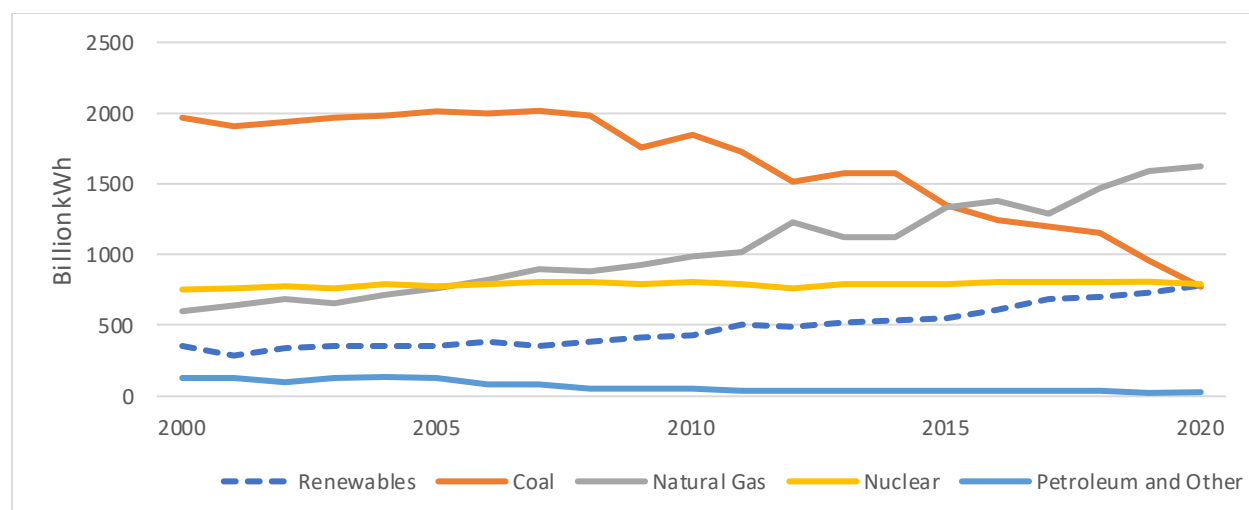
¹ U.S. Energy Information Administration, "Annual Energy Outlook 2021," 2021, <https://www.eia.gov/outlooks/aeo/>.

² U.S. Energy Information Administration, "January 2022 Monthly Energy Review: Primary Energy Overview," <https://www.eia.gov/totalenergy/data/monthly/>.

³ U.S. Energy Information Administration, "January 2022 Monthly Energy Review: Electricity Net Generation," 2022, <https://www.eia.gov/totalenergy/data/monthly/>. These figures exclude small-scale solar photovoltaic generation. In 2020, these sources produced an additional estimated 43 billion kWh in renewable electricity.

generated 19.30 percent and nuclear plants 19.7 percent. Natural gas sources currently still lead the U.S. electricity mix, producing 1624 billion kWh of electricity in 2020 or 40.5 percent of utility-scale electricity production (Figure 1).

Figure 1. U.S. Utility-Scale Electricity Generation by Source, 2000-2020 (billions kWh)



Source: U.S. Energy Information Administration, "January 2022 Monthly Energy Review: Electricity Net Generation," Accessed February 2022.

The growth of the renewable power sector in the United States has made it the second largest producer of renewable electricity in the world, following only China. In total, the United States generates more renewable electricity than Germany, Japan, and the United Kingdom combined.⁴

Wind currently dominates the U.S. renewables mix, accounting for 43.2 percent of the United States' utility-scale renewable electricity production, or 337.9 billion kWh. Hydroelectric sources were responsible for an additional 36.43 percent of output or 285.3 billion kWh, while solar sources contributed 11.4 percent and biomass and geothermal sources respectively produced 6.9 percent and 2.03 percent (Figure 2).

Since 2000, electricity generation by wind sources has grown exponentially at 5,941 percent, from 5.6 billion kWh to 337.9 billion kWh, while solar production has grown a staggering 17,979 percent, from just 0.49 billion kWh to 89.1 billion kWh. This growth has transformed renewable sources from a small section of the U.S. electricity mix into an essential element.

Hydroelectric sources like dams have been a mainstay of U.S. electricity production for decades, with the first hydroelectric plant selling electricity opening in 1882.⁵ Most current production facilities were developed in the 1970s with federal dollars. In recent years, few additional facilities have been built in

⁴ International Renewable Energy Agency, "Renewable Energy Statistics 2021," 2021, Accessed February 2022, <https://www.irena.org/Statistics>.

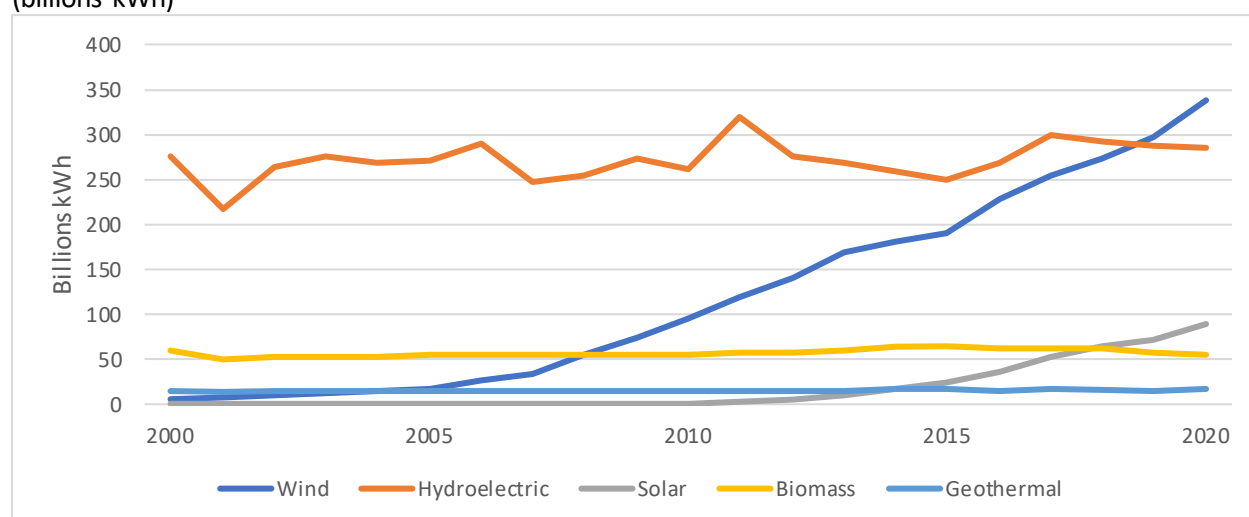
⁵ U.S. Energy Information Administration, "Hydropower explained," 2021, <https://www.eia.gov/energyexplained/hydropower/>.

the United States due to a combination of social and environmental concerns, a limited number of prime locations without a generator, and decreasing cost-competitiveness relative to other generator types.⁶

Electricity generation via biomass is primarily produced via the combustion of waste-wood and wood-derived fuels. In the industrial sector, many lumber and paper producers use their waste products to generate electricity needed to operate their facilities. Other sources of biomass include municipal solid waste and landfill gas. While a small share of utility-scale electricity generation, biomass represented 22 percent of total U.S. renewable energy consumption in 2020, because it is also used in transportation, as well as industrial, residential, and commercial applications.⁷

Geothermal generators use steam from hot water a few miles below the surface of the earth to generate electricity. The use of geothermal production is limited by geologic conditions. As of 2020, just seven states in the United States possessed geothermal powerplants, all located in the western half of the country. While geothermal sources represent a small portion of overall power generation, the United States is the global leader in geothermal electricity generation.⁸

Figure 2. Utility-Scale Electricity Generation from Renewable Energy Sources by Source Type, 2000-2020 (billions kWh)



Source: U.S. Energy Information Administration, "January 2022 Monthly Energy Review: Electricity Net Generation," Accessed February 2022.

SOLAR AND WIND EXPECTED TO DRIVE FUTURE EXPANSION

Growth in the renewables sector is expected to continue in the coming years. According to the EIA, annual electricity generation from renewable sources is expected to exceed contributions from even

⁶ Emilio F. Moran, Maria Claudia Lopez, Nathan Moore, Norbert Müller, and David W. Hyndman, Proceedings of the National Academy of Sciences of the United States of America, "Sustainable hydropower in the 21st century," 2018, <https://www.pnas.org/content/115/47/11891>.

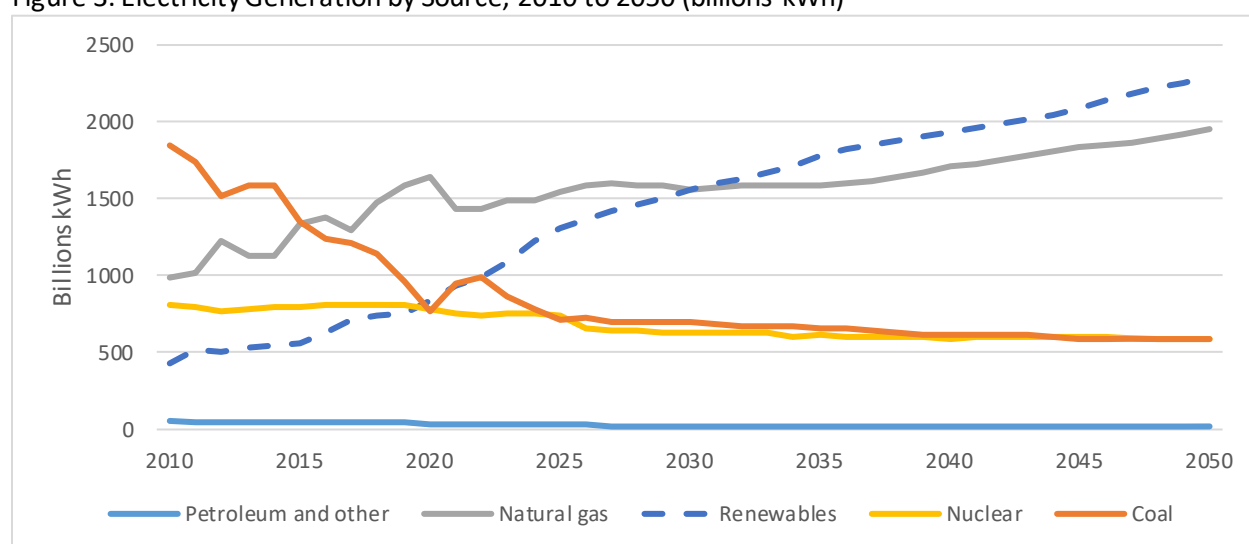
⁷ U.S. Energy Information Administration, "The United States consumed a record amount of renewable energy in 2020," 2021, <https://www.eia.gov/todayinenergy/detail.php?id=48396>.

⁸ U.S. Energy Information Administration, "Geothermal explained," 2021, <https://www.eia.gov/energyexplained/geothermal/use-of-geothermal-energy.php>

natural gas by 2050 (Figure 2).⁹ This shift will be primarily driven by the addition of new renewable sources and the retirement of older fossil fuel plants. Coal plants, most of which were built in the 1970s and 1980s, will be steadily retired due in large part to state-level clean energy standards that mandate reductions in carbon emissions and a changing economic landscape that has left them increasingly uncompetitive. As of December 2021, plant owners anticipate that they will retire 28 percent of existing coal capacity by 2035, though EIA expects that figure to grow.¹⁰ Renewables, along with natural gas, are positioned to replace them due to their cost-effectiveness and limited emissions.

By 2050, renewable sources are expected to supply 42 percent of the United States' electricity, or 2,258 kWh, while natural gas will supply 36 percent and nuclear and coal will provide 11 percent each. Moreover, the EIA expects approximately 60 percent of new electrical capacity added during this period to come from renewables while roughly 40 percent will come from natural gas.¹¹

Figure 3. Electricity Generation by Source, 2010 to 2050 (billions kWh)



Source: U.S. Energy Information Administration, Annual Energy Outlook 2021, Accessed September 15, 2021, <https://www.eia.gov/outlooks/aeo/>.

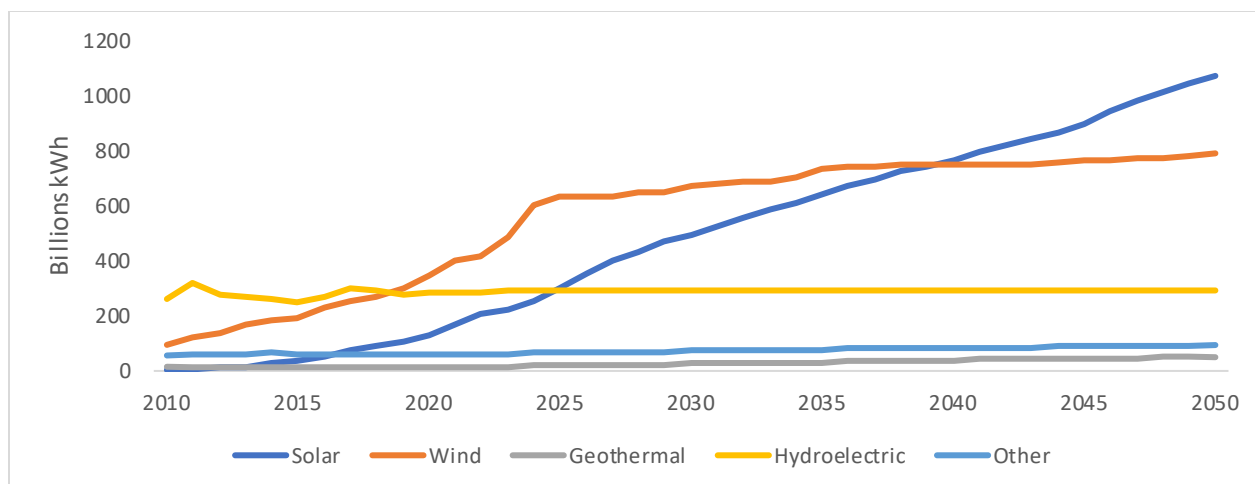
While wind and hydroelectric sources are leading sources as of 2022, solar is projected to lead 2050's renewable mix. By 2050, solar is expected to produce 47 percent of electricity generated from renewable energy or 1,070 kWh. Wind is expected to come next at 34 percent of renewable output, followed by hydropower at 13 percent, and geothermal at 2 percent (Figure 2).

Figure 4. Renewable Electricity Generation by Source, 2010 to 2050 (billions kWh)

⁹ U.S. Energy Information Administration, "Annual Energy Outlook 2021," 2021, <https://www.eia.gov/outlooks/aeo/>.

¹⁰ U.S. Energy Information Administration, "Of the operating U.S. coal-fired power plants, 28% plan to retire by 2035," 2021 <https://www.eia.gov/todayinenergy/detail.php?id=50658>.

¹¹ U.S. Energy Information Administration, "Annual Energy Outlook 2021," 2021, <https://www.eia.gov/outlooks/aeo/>.



Source: U.S. Energy Information Administration, Annual Energy Outlook 2021, Accessed September 15, 2021, <https://www.eia.gov/outlooks/aeo/>

SIGNIFICANT DECLINE IN COSTS

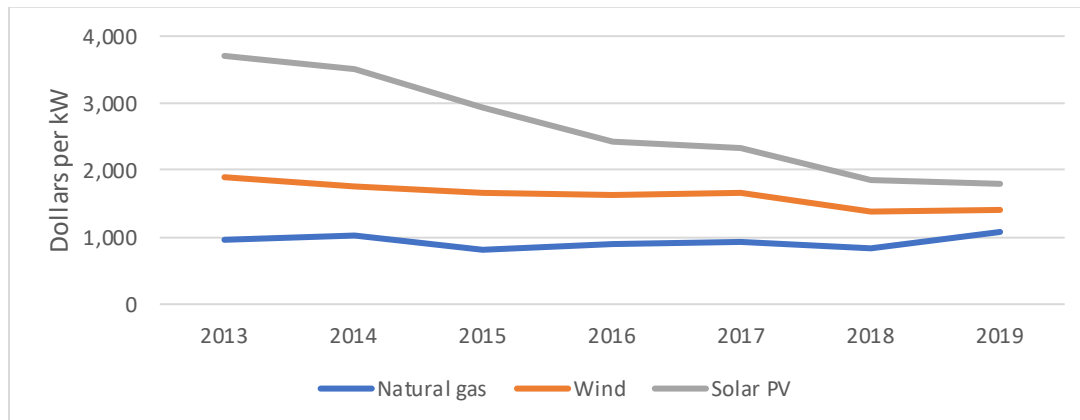
One of the fundamental drivers behind the growth of renewable electricity generation has been the sharp decline of construction costs associated with solar and wind projects.

While construction costs can vary significantly based on region and on the specific technology deployed, installation costs for utility-scale energy projects have declined sharply in recent years. At the end of 2019, the average construction cost for onshore wind turbines was \$1,391 per kilowatt, down 26.6 percent since 2013. Similarly, the average construction cost for solar generators in 2019 was \$1,796 per kilowatt, 51.5 percent less than in 2013.¹²

Currently, natural gas remains the most competitive power source in terms of construction cost. As of 2019, average construction costs associated with natural gas plants rested at \$1,078 per kilowatt (Figure 3).

¹² U.S. Energy Information Administration, "Construction Cost Data for Electric Generators Installed," 2021, <https://www.eia.gov/electricity/generatorcosts/>.

Figure 5. Average Construction Costs for Electric Generators by Source, 2013 – 2019, (Dollars per kW)



Source: U.S. Energy Information Administration, Construction Cost Data for Electric Generators Installed, Accessed February 7, 2022, <https://www.eia.gov/electricity/generatorcosts/>

The EIA, however, expects that average national overnight construction costs for solar to be lower than those of natural gas by 2050, with wind also seeing significant declines as well.¹³ By 2050, the EIA's standard reference case expects overnight construction costs for wind to reach \$918.36 dollars per kilowatt, \$655.97 for combined cycle multi shaft natural gas plants, and \$640 for solar photovoltaic plants with axis tracking.¹⁴

Initial construction costs, however, are only one element of the costs associated with running a power plant. Over its lifetime, a plant incurs a variety of operating costs while generating revenue. The levelized cost of electricity (LCOE) represents the installed capital and operating costs associated with a power plant over its lifetime. The levelized avoided cost of electricity (LACE) represents the revenues available to that power plant over the same period and their relative value to the power grid. A project is more economically viable when it has a higher ratio of LACE to LCOE.¹⁵

In their 2021 Outlook, the EIA forecasts that solar sources will, on average, begin outperforming natural gas and other sources in these terms by 2026 (Figure 6). By that point, wind is also expected to outperform nuclear and coal, delivering more value over its lifetime relative to the cost of investment and maintenance. While natural gas is expected to remain a significant part of the United States'

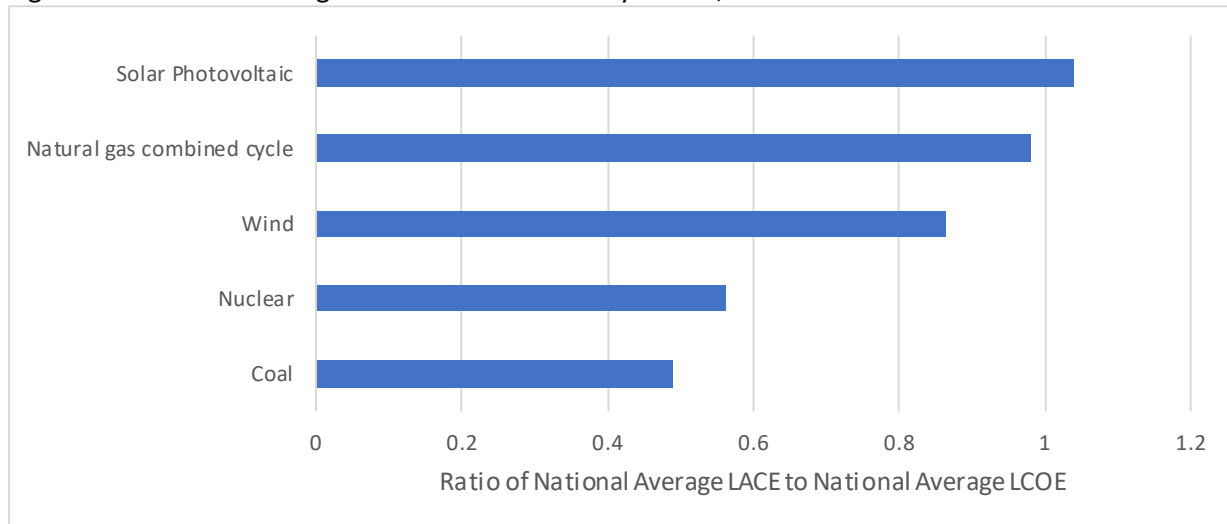
¹³ U.S. Energy Information Administration, "Annual Energy Outlook 2021," 2021, <https://www.eia.gov/outlooks/aeo/>.

¹⁴ Prices in USD as of year-end 2020. The standard reference case assumes the continuation of current laws and regulations. The low renewables cost case developed by the EIA, however, which assumes higher learning rates for renewable installation, anticipates both wind and solar plants will have significantly lower capital costs than natural gas by 2050. U.S. Energy Information Administration, "Annual Energy Outlook 2021," 2021, <https://www.eia.gov/outlooks/aeo/>.

¹⁵ U.S. Energy Information Administration, "Levelized Costs of New Generation Resources in the Annual Energy Outlook 2021," 2021, https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf.

electrical grid, renewable electricity production will become increasingly economically attractive going forward.

Figure 6. Estimated Average LACE-to-LCOE Ratios by Source, 2026



Source: U.S. Energy Information Administration, U.S. Energy Information Administration, Levelized Costs of New Generation Resources in the Annual Energy Outlook 2021, Accessed February 3, 2022, https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf.

These dynamics have already helped shape planned power projects. For instance, of the 46.1 new gigawatts of production expected to come online in 2022, 46 percent or 21.5 gigawatts are expected to come from solar sources while an additional 17 percent or 7.6 gigawatts will come from wind. New natural gas projects represented 21 percent or 9.6 gigawatts.¹⁶

STRONG GOVERNMENT SUPPORT FOR RENEWABLE ENERGY

Another key factor driving the growth of renewable energy in the United States, both in the electricity sector and elsewhere, has been the variety of support and incentives offered by federal, state, and local governments.

While the EIA expects that some of the largest benefits will soon be wound down, federal tax credits for production and investment have helped bolster the cost-competitiveness of wind and solar projects and will continue to support investment in the near term.¹⁷ In total, tax-related support for renewable energy reached an estimated \$11.7 billion in 2017 and \$8.4 billion in 2018.¹⁸ Companies without existing

¹⁶ U.S. Energy Information Administration, “Solar power will account for nearly half of new U.S. electric generating capacity in 2022,” 2022, <https://www.eia.gov/todayinenergy/detail.php?id=50818>.

¹⁷ Ibid.

¹⁸ Congressional Research Service, “The Value of Energy Tax Incentives for Different Types of Energy Resources,” 2019, <https://sgp.fas.org/crs/misc/R44852.pdf>.

U.S. tax liabilities can still take advantage of these benefits via “tax equity” financing, where firms trade federal tax credits for various forms of capital financing.

Grant and loan programs have also been provided by several federal agencies, including the U.S. Department of Agriculture, the U.S. Department of Energy, and the U.S. Department of the Interior. According to the International Energy Agency (IEA), the United States dedicated roughly \$8.8 billion dollars towards energy research, development, and demonstration in 2020—the single largest amount spent by an IEA member state and more the combined national expenditures of Japan, France, Germany, and the United Kingdom.¹⁹

New efforts by the federal government are likely to further expand the market for renewables. The recently passed Infrastructure Investment and Jobs Act, for instance, commits \$65 billion towards modernizing the U.S. energy grid to enable greater uptake of renewable electricity nationwide.²⁰ The Biden-Harris Administration has also set out ambitious goals for the federal government and its partners, mandating that the federal government achieve 100 percent carbon pollution-free electricity use by 2030 and net-zero emissions from federal procurement by 2050.²¹ These goals have been accompanied by efforts by the Administration to improve permitting and regulatory processes for renewable energy projects and investments in U.S. supply chains and manufacturing.²²

Many state and local governments also offer incentives and other forms of support for renewable energy projects. These range from traditional tax credits to state and local “green banks” that can help provide financing support for renewable energy projects. More than thirty states also possess renewable portfolio standards or similar legislation that mandates a certain percentage of electricity come from renewable sources, further bolstering demand for renewable power.²³

¹⁹ International Energy Agency, “Energy Technology RD&D Budgets: Overview,” 2021, <https://www.iea.org/reports/energy-technology-rdd-budgets-overview>.

²⁰ The White House, Office of the Press Secretary, “FACT SHEET: The Bipartisan Infrastructure Deal Boosts Clean Energy Jobs, Strengthens Resilience, and Advances Environmental Justice,” 2021, <https://www.whitehouse.gov/briefing-room/statements-releases/2021/11/08/fact-sheet-the-bipartisan-infrastructure-deal-boosts-clean-energy-jobs-strengthens-resilience-and-advances-environmental-justice/>.

²¹ The White House, Office of the Press Secretary, “FACT SHEET: President Biden Signs Executive Order Catalyzing America’s Clean Energy Economy Through Federal Sustainability,” 2021, <https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability/>.

²² The White House, Office of the Press Secretary, “FACT SHEET: Biden-Harris Administration Races to Deploy Clean Energy that Creates Jobs and Lowers Costs,” 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/12/fact-sheet-biden-harris-administration-races-to-deploy-clean-energy-that-creates-jobs-and-lowers-costs/?utm_source=link.

²³ Congressional Research Service, “A Brief History of U.S. Electricity Portfolio Standard Proposals,” 2021, <https://crsreports.congress.gov/product/pdf/IF/IF11316>.

Several no-cost online tools exist to help investors navigate government incentives and programs that may be available in the U.S., including [the Federal Programs and Incentives Database](#) and SelectUSA's dataset of [publicly listed U.S. state business incentives](#).

For public programs specifically related to renewable energy, the [Database of State Incentives for Renewables & Efficiency \(DSIRE\)](#) is a comprehensive source of information on existing government and utility requirements and incentives for renewable energy projects.

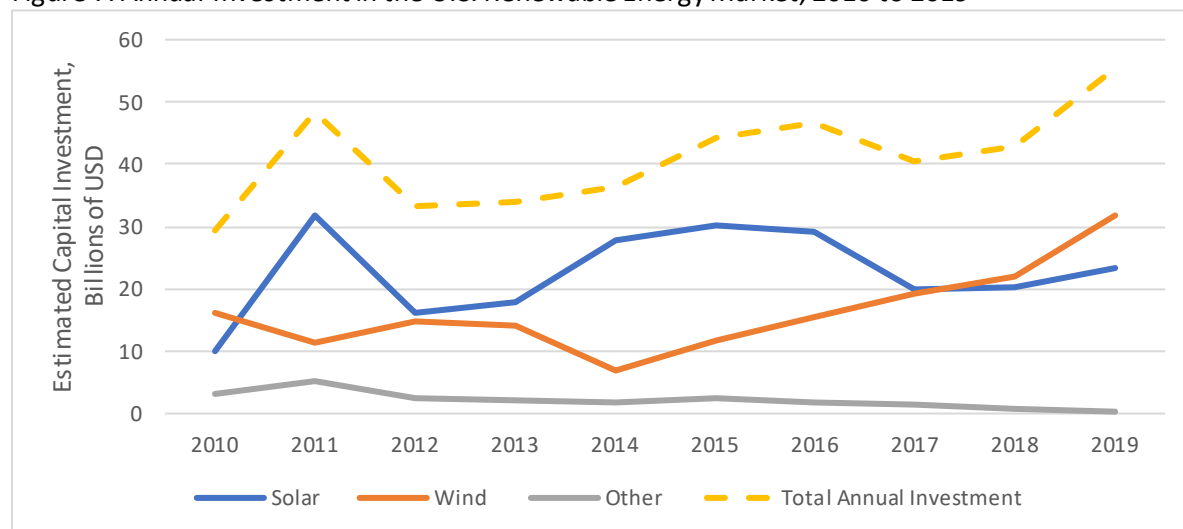
Many other non-public incentives, however, exist at the state and sub-state level. These incentives are best investigated through direct conversations with U.S. state economic development organizations.

INVESTMENT IN RENEWABLES GROWS, SUPPORTED BY SUBSTANTIAL GREENFIELD FDI

The potential of the renewable energy sector in the United States, combined with traditional U.S. strengths like a flexible workforce, robust intellectual property protections, and deep capital markets, has helped draw investors' interest. Between 2010 and 2019, annual investment in renewable energy in the United States grew from \$29.4 billion to more than \$55.4 billion (Figure 8).

This inflow is justified in part by the strong performance of U.S. renewables firms relative to traditional firms in the energy sector. An analysis by the IEA and Imperial College London's Centre for Climate Finance & Investment found that, over the past decade, large publicly listed renewable energy firms in the United States have consistently delivered higher total returns than firms with a portfolio dominated by fossil fuels.²⁴

Figure 7. Annual Investment in the U.S. Renewable Energy Market, 2010 to 2019



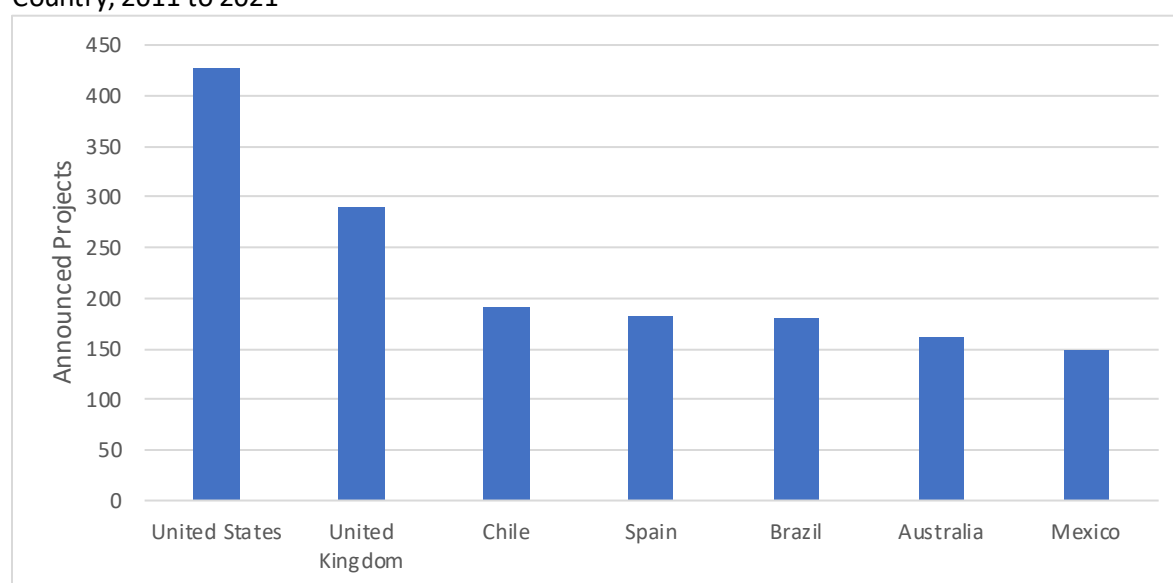
Source: Bloomberg NEF, UN Environment.

²⁴ International Energy Agency & Imperial College Business School Centre for Climate Finance & Investment, "Energy Investing: Exploring Risk and Return in the Capital Markets," 2020. <https://www.iea.org/reports/energy-investing-exploring-risk-and-return-in-the-capital-markets>

Foreign investors have also recognized the United States' potential and have helped contribute to the growth in renewable sectors. According to data collected by *fDi Markets*, the United States was the number one global destination in terms of number of announced renewable energy projects between 2011 and 2021, attracting 428 new greenfield FDI projects during this period (Figure 8).

In terms of capital commitment during this period, the United States was the second biggest market for renewable energy, attracting an estimated capital commitment of \$83.1 billion. It was only surpassed by the United Kingdom, which received an estimated \$108.8 billion in investment across 291 projects. In comparison, China was the 18th largest market in terms of announced projects, receiving just 56 between 2011 and 2021. These announced projects represented an estimated \$7.5 billion in investment, placing China 23rd in the global rankings behind Romania, Pakistan, and Nigeria.

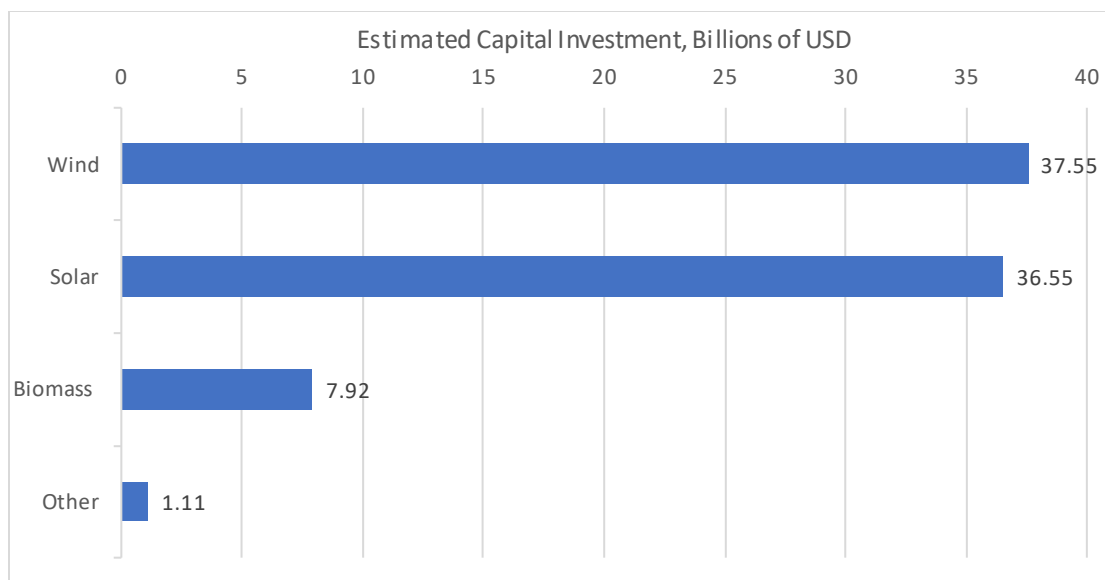
Figure 8. Number of Announced Renewable Investment Projects Generated by Greenfield FDI, by Country, 2011 to 2021



Source: Financial Times, Renewable Energy Investments in Destination Markets, Accessed February 7, 2022, www.fdimarkets.com.

Solar and wind projects together captured 89 percent of the investment in renewables in the United States, with wind projects receiving an estimated \$37.6 billion and solar projects an estimated \$36.6 billion. Biomass projects received the third most investment, collecting \$7.9 billion over this period (Figure 10).

Figure 9. Capital Expenditure from FDI into U.S. Renewable Energy Market, 2011 to 2021

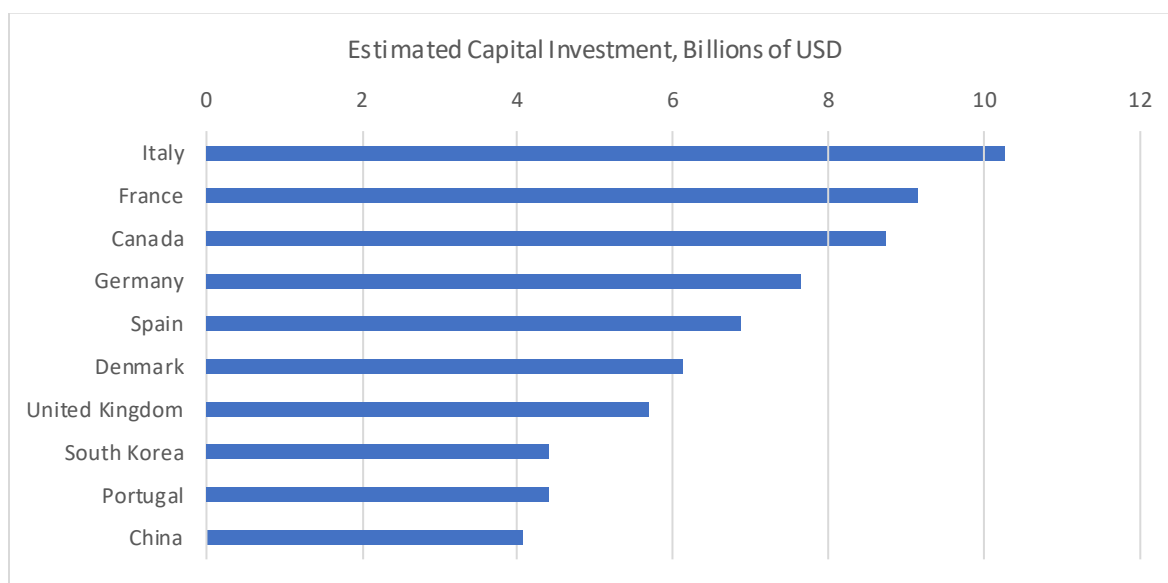


Source: Financial Times, Renewable Energy Investments in Destination Markets, Accessed February 7, 2022, www.fdimarkets.com.

These 428 announced investments came from firms based in 26 different countries. The largest number of announcements came from Canadian-based firms, which made 57 announcements or 13.3 percent of the total. Other top investor countries included France and Germany, whose firms each announced 44 and 43 respectively, and Italy, whose firms announced 40 projects.

In terms of capital expenditure, Italian firms led the pack with an estimated \$10.3 billion in announced investments, followed by French and Canadian firms with \$9.1 billion and \$8.7 billion respectively.

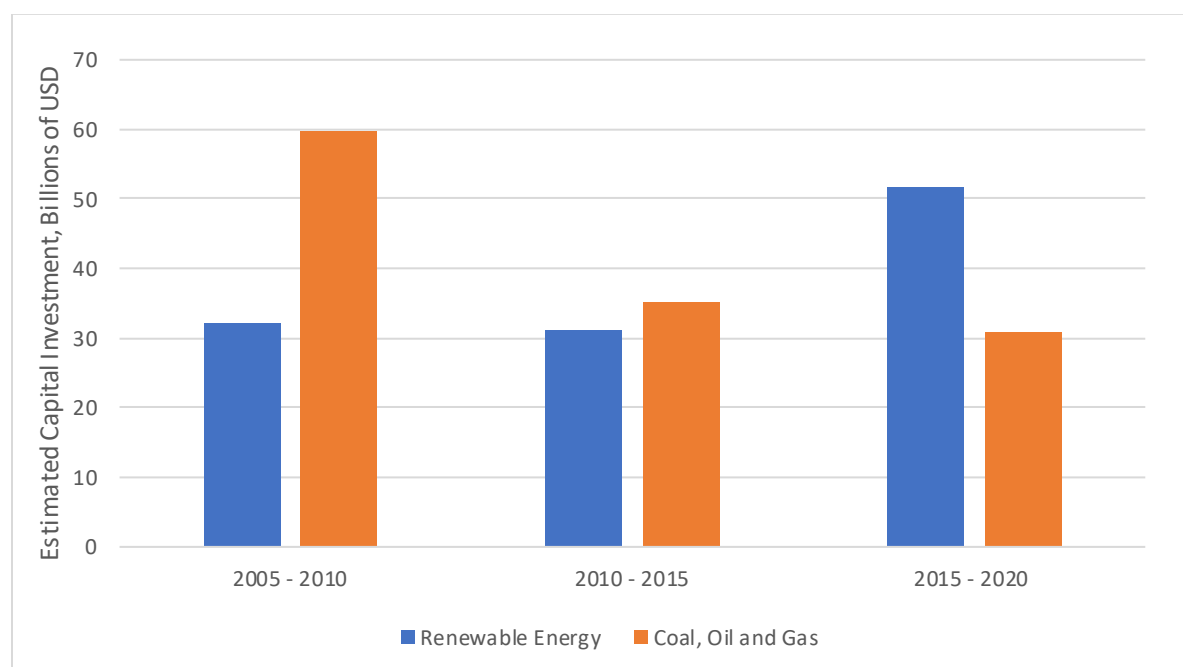
Figure 10. Top Ten Sources of FDI into U.S. Renewable Energy Market, 2011 – 2021



Source: Financial Times, Renewable Energy Investments in Destination Markets, Accessed February 7, 2022, www.fdimarkets.com.

Greenfield FDI in renewable energy has begun to outpace FDI in coal, oil, and gas production and their related support activities. Beginning in 2013, announced investments in renewables consistently exceeded those in the fossil fuel sector, only falling behind in 2019. Between 2015 and 2020, renewable energy projects attracted an estimated \$51.2 billion in greenfield investment while fossil fuel projects attracted \$30.8 billion (Figure 11).

Figure 11. Total Estimated Capital Expenditure for Energy FDI Projects in United States, 2010 – 2020



Source: Financial Times, Renewable Energy Investments in Destination Markets, Accessed February 7, 2022, www.fdimarkets.com.

These inflows have also proved resilient. In 2020, substantial new FDI investments in renewable energy continued to be announced despite the start of the COVID-19 pandemic which waylaid investments in fossil fuels and other sectors. 2020 and 2021 together saw international investors announce an estimated \$22.1 billion in U.S. renewable energy projects compared to \$327.9 million in coal, oil, and gas projects.

These FDI commitments highlight the substantial opportunities currently present in the U.S. renewables market for overseas investors. As the pace of the green energy transition in the United States accelerates, these opportunities are likely to grow.

CONCLUSION

As this brief illustrates, the U.S. renewable energy market presents a valuable opportunity to investors. This sector is expected to grow by leaps and bounds in the coming years. Electricity generation from renewable sources as a percentage of utility-scale production is expected to double by 2050, primarily thanks to investments in increasingly cost-effective wind and solar plants. By that point, renewables are expected to be the single largest contributor to the U.S. power grid, overtaking natural gas.

Due to its rapid growth—and traditional American strengths like strong intellectual property protections, deep capital markets, and a well-trained workforce—the renewable energy sector has already drawn in billions of dollars in foreign direct investment. As the United States continues its transition towards a green economy, new investment opportunities will emerge. Investors interested in positioning themselves to take advantage of these opportunities should contact SelectUSA.

The SelectUSA program conducts one-on-one client counselling and provides data and research to help investors understand and navigate U.S. market. To access these resources, investors are invited to contact SelectUSA by emailing selectusa@trade.gov or visiting the SelectUSA [website](#).

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