

The Energy Transition

The Creation of a New Infrastructure Asset Class



Executive Summary

Markets throughout the world are seeing development of a new class of infrastructure. This development reflects rapid growth of clean energy, the emergence of new energy and systems, and actions being taken by governments, corporations, and consumers in response to global climate change. Among other trends, profound changes in how we produce, deliver, and consume energy are transforming the global energy industry and creating robust opportunities for investors.

These opportunities constitute a new asset class – *climate infrastructure* – related to investments that reduce greenhouse gas emissions, promote efficient use of natural resources, and/or strengthen climate change resiliency. Examples of climate infrastructure include renewable energy, energy storage, electric transmission, vehicle electrification, energy efficiency, and smart grids.

Climate infrastructure assets comprise a material and growing share of the overall energy infrastructure landscape. As the cost of utility-scale wind and solar power has declined more than 70% over the past decade, renewable energy's share of annual new global power generation has risen to 60%. This has supported investment of over \$1 trillion in clean energy over just the past three years.¹

Expansion of low-cost renewable power is creating ripple effects into other climate infrastructure sectors. For example, the need to manage growing volumes of variable renewable generation is driving demand for energy storage, smart grids, energy efficiency, and new electric transmission. Similarly, declining battery costs and efforts to reduce emissions support the electrification of transport, with more than 280 million electric vehicles expected on the road by 2040 (versus 5.1 million as of 2018).²

Acceleration of technological, economic, and policy drivers is expected to produce more than \$55 trillion of climate infrastructure investment over the next 30 years. Widespread implementation of policies to achieve international climate targets could further increase cumulative investment in climate infrastructure to \$93 trillion.³

Diversified allocations to climate infrastructure (e.g. via investments into assets, companies, and funds) have the potential to generate cash yield, provide diversification, and serve as a hedge against dislocations and stranded assets due to the global energy transition. Despite strong market fundamentals, however, investments in climate infrastructure have seen a wide distribution of returns. This variance underscores the need to prioritize commercially-proven technologies, support management teams with historical and proven experience, and manage regulatory risk.

Separately, in the most well-known sub-sectors of climate infrastructure (e.g. wind and solar power), growing appetite has been compressing asset-level returns (particularly for larger construction-stage or operating assets). Against this backdrop, the potential for attractive risk-adjusted returns in climate infrastructure will increasingly depend on having the flexibility and competence to (1) invest across multiple sub-sectors (e.g. beyond just wind and solar); (2) combine asset-level and corporate-level exposure; and (3) prudently finance pre-construction assets.

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Defining Climate Infrastructure

Countries and companies across the world are seeking to reduce emissions of greenhouse gases and minimize the impacts of global climate change. The motivations for such actions are economic as much as they are environmental. Achieving these goals will likely require fundamental transformations of energy and natural resource systems. Such transformations are already underway and are creating compelling investment opportunities related to climate infrastructure. Climate infrastructure investments support the energy transition and the broader trend of decarbonization of first the power sector and ultimately the economy at large.

Climate infrastructure investments reduce greenhouse gas emissions, promote efficient use of natural resources, and/or strengthen climate change resiliency. The climate infrastructure theme encompasses multiple sectors: renewable energy (including solar, wind, geothermal, hydro, and biomass), energy storage and microgrids, resource and energy efficiency, vehicle electrification, transmission, and smart grids.

Figure 1.
Climate Infrastructure Sectors and Projected Global Power Generation Investment, 2018-2050

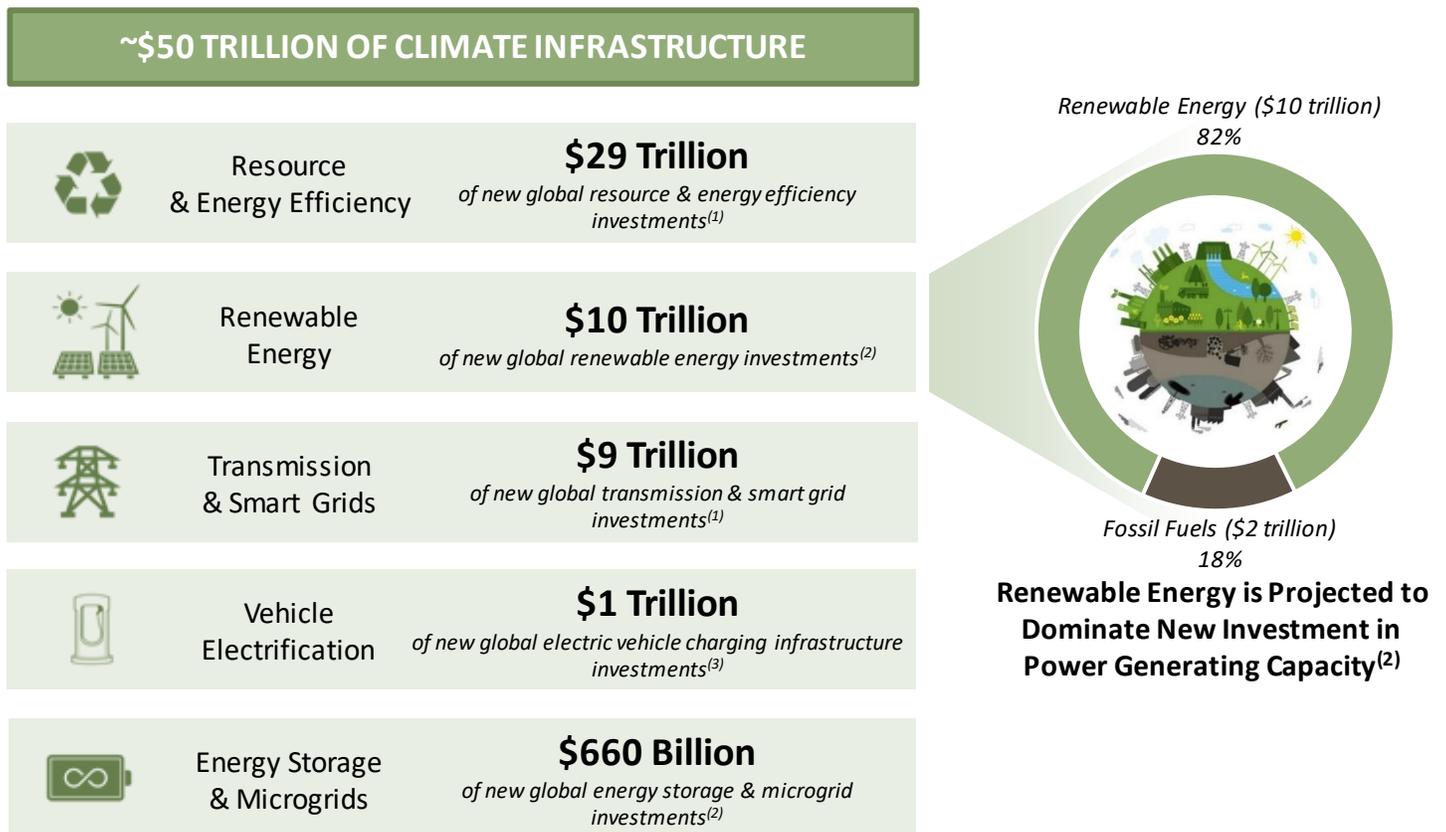


Photo Source: www.emaze.com.

(1) International Renewable Energy Agency, 2018+2019.

(2) BNEF, 2019.

(3) Morgan Stanley, 2019.

Unlike cleantech investments, climate infrastructure is dominated by deployment of commercially-proven technologies that are economic *today* (rather than requiring a demonstration and scale-up of emerging technologies that may become economic in the future).

Quantifying the Climate Infrastructure Market

Clean energy is a key sector within the climate infrastructure market. In 2018, annual global clean energy⁴ investment totaled \$332 billion – three times higher than the amount invested in new coal and gas-fired electric generating capacity.⁵ Since 2011, annual global investment in clean energy has hovered near or above \$300 billion; from 2016-2018, the world has benefitted from over \$1 trillion of new investment into clean energy.⁶

Figure 2.
Global New Investment in Clean Energy, 2004-2018



Source: Bloomberg New Energy Finance, 2019.

Most of the clean energy investment has been at the asset-level. These flows reflect both private-market activity (e.g. investments from pension funds and insurance companies) and balance sheet funding by listed utilities and power producers.⁷

Recently, approximately 80% of annual global clean energy investment has been in wind and solar power. As discussed below, growing appetite from both financial and strategic investors has been compressing returns for de-risked wind and solar projects (particularly for larger construction-stage or operating projects). Against this backdrop of compressed returns for wind and solar, however, the clean energy investment landscape is diversifying to include greater amounts of energy storage, electric vehicles, bioenergy, and other expanding sub-sectors. Beyond electric power generation, there are growing investable opportunities in buildings (e.g. efficiency retrofits, customer-side energy storage), industry (e.g. replacing liquid fuels and natural gas with electricity), and transport (e.g. electric vehicles and related charging infrastructure).

Future Long-Term Projected Investment Needs

The continued proliferation of renewable power provides a solid long-term base for climate infrastructure investment. In a “business-as-usual” scenario through 2050, Bloomberg New Energy Finance (BNEF) expects renewable power to account for 86% of the total \$11.5 trillion of global investment in electric power generation. This represents average annual investment of \$309 billion.⁸

In addition to sustained investment in renewable power, analysts also expect rising investment in energy storage (\$103 billion of cumulative investment by 2030)⁹ and electric vehicle charging infrastructure (\$1 trillion of cumulative investment by 2040 across the U.S. and Europe).¹⁰

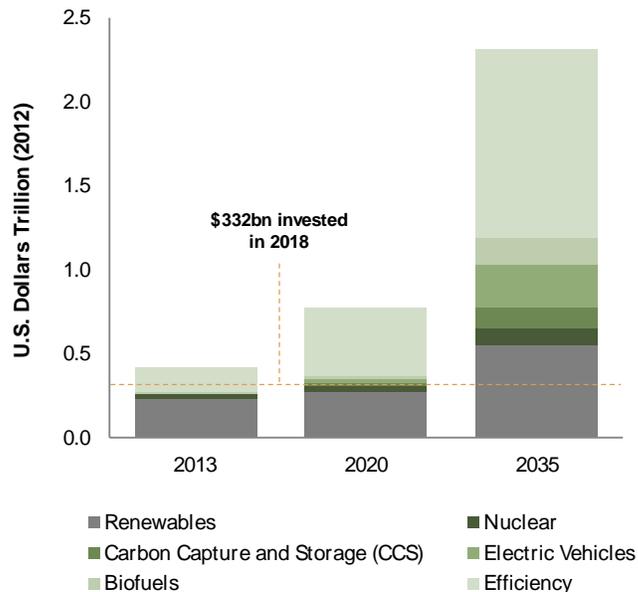
Investment Required to Meet Global Climate Targets

For climate infrastructure investors, there is considerable potential upside above business-as-usual scenarios due to international coordination and increased regulatory action to address climate change. In the December 2015 Paris Agreement, 195 countries formally resolved to:

*...strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.*¹¹

To achieve a 2-degree Celsius (2°C) target by 2040 annual global carbon-dioxide emissions from fossil fuels must decline by at least 43%¹² – with a goal of net zero emissions by or before 2100. This is likely to require increasing the renewable share of global electricity generation to 63% by 2040 (versus 24% in 2016), and transforming energy systems in the building, industrial, and transport sectors. In a 2°C scenario, the International Energy Agency (IEA) estimates that total annual investment into clean energy sources must rise to \$750 billion by 2020 and more than \$2 trillion by 2035.¹³

Figure 3.
Global Investment in Low-Carbon Technologies and Energy Efficiency in the IEA’s 450 Scenario



Note: Nuclear power is excluded from this paper’s definition of “climate infrastructure.” The IEA’s 450 Scenario is modeled to achieve a 50% chance of limiting future climate change to 2 degrees Celsius.

Source: International Energy Agency, World Energy Investment Outlook, 2014.

To achieve a more ambitious 1.5°C target, global emissions must reach net zero by 2050.¹⁴ Among other changes, this is likely to require a near-complete phase-out of coal-fired emissions and an increase to renewables’ share of global electricity generation to 70-85%. In a 1.5°C scenario the International Panel on Climate Change (IPCC) estimates a need for \$2.4 trillion of average annual investment through 2035. This amounts to a sevenfold increase over total 2018 global clean energy investment of \$332 billion; it is also 33% higher than the \$1.8 trillion of total energy investment in 2017.¹⁵

Key Drivers of Climate Infrastructure Sector Growth

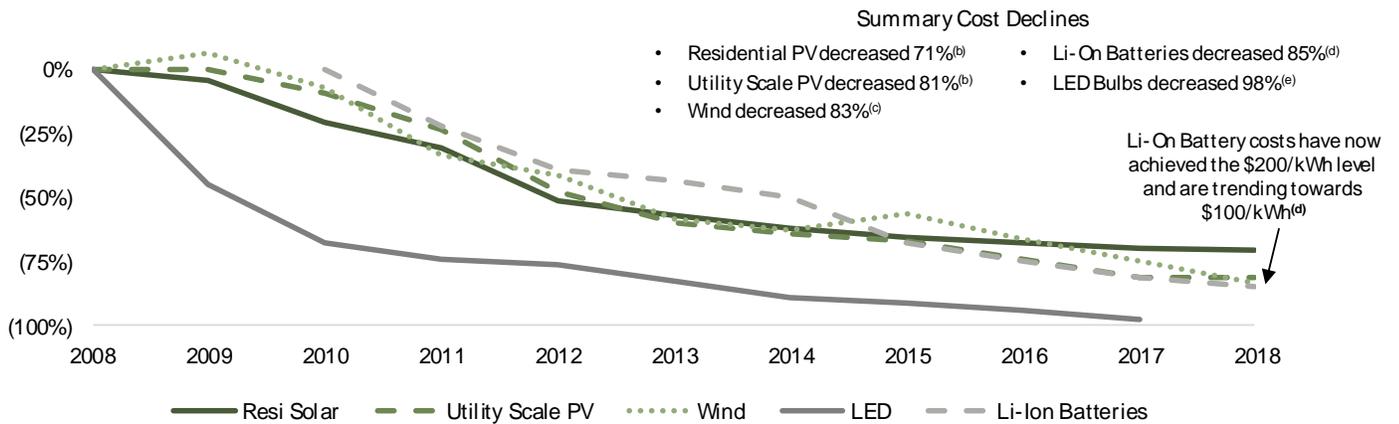
The climate infrastructure sector’s growth reflects a combination of economic, technological, and policy drivers that are poised to accelerate in coming years.

Declining Costs and Rising Competitiveness of Clean Energy Technologies

The cost of clean energy systems has been declining rapidly. For systems deployed in the U.S., the magnitude of cost declines since 2008 ranges from 55% for residential solar photovoltaic (PV) systems to 94% for light-emitting diode (LED) bulbs. ¹⁶ Contributors to these cost declines include economies of scale in production, higher conversion efficiencies, and streamlined installation procedures, not to mention broader adoption and a lower cost of capital.

Figure 4.
Cost Declines of Clean Energy Technologies, 2008–2017

Solar panel cost per Watt has fallen 99% since 1977. If battery costs follow the same trajectory, costs could fall below \$100/kWh by 2025^(a)



Notes:

- BNEF.
- NREL, “Costs Continue to Decline for Residential and Commercial Photovoltaics in 2018,” December 2018.
- LBNL, “2018 Wind Technologies Market Report,” August 2019. Reflects median PPA prices to capture emphasis on capacity factor improvement driven by PTC policy.
- BNEF, “A Behind the Scenes Take on Lithium-ion Battery Prices,” March 2019.
- Office of Energy Efficiency & Renewable Energy, “Adoption of Light-Emitting Diodes in Common Lighting Applications,” July 2017.

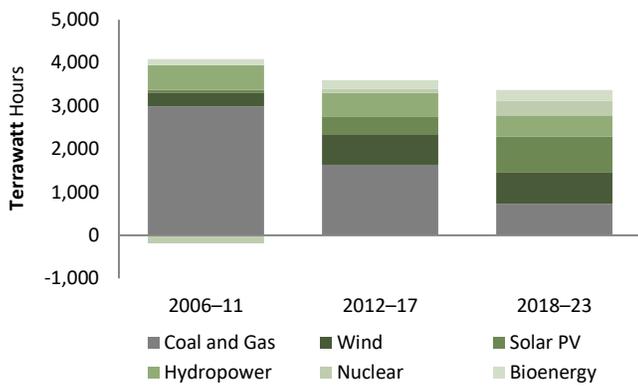
Cost declines are supporting a boom in deployment of clean energy systems (which will likely enable further cost reductions). In 2013, the global power generation sector witnessed a critical inflection point as new installations of renewable generating capacity of 143 Gigawatts (GW)¹⁷ surpassed new installations of fossil-fuel generating capacity of 141 GW for the first time. This trend has continued and Bloomberg New Energy Finance (BNEF) projects that by 2030 global renewable generating capacity will be ~4X its current level. ¹⁸

In the US and elsewhere, solar power is expected to account for 60% of medium-term global renewable capacity additions owing to continued cost declines (e.g. on the order of 25% for utility-scale solar).¹⁹ Increasing deployment of renewable generating capacity is dramatically altering the composition of new global power supply. Whereas from 2006-2011 renewables (wind, solar, hydropower, and bioenergy) accounted for roughly 25% of new electricity supplies, from 2018-2023 this share will increase to over 66%.

Over the next five years, the IEA expects the world to install more than 1,200 GW of renewable power (which exceeds the entire current generation capacity of the European Union), including 116 GW of new renewable power in the US. Behind China, the US is expected over the next five years to account for more additions of new renewable generation capacity than any other

Figure 5.

Global Power Generation Growth by Technology, 2006–2023



Source: International Energy Agency, Bloomberg.

Electrification of Buildings, Industry, and Transport

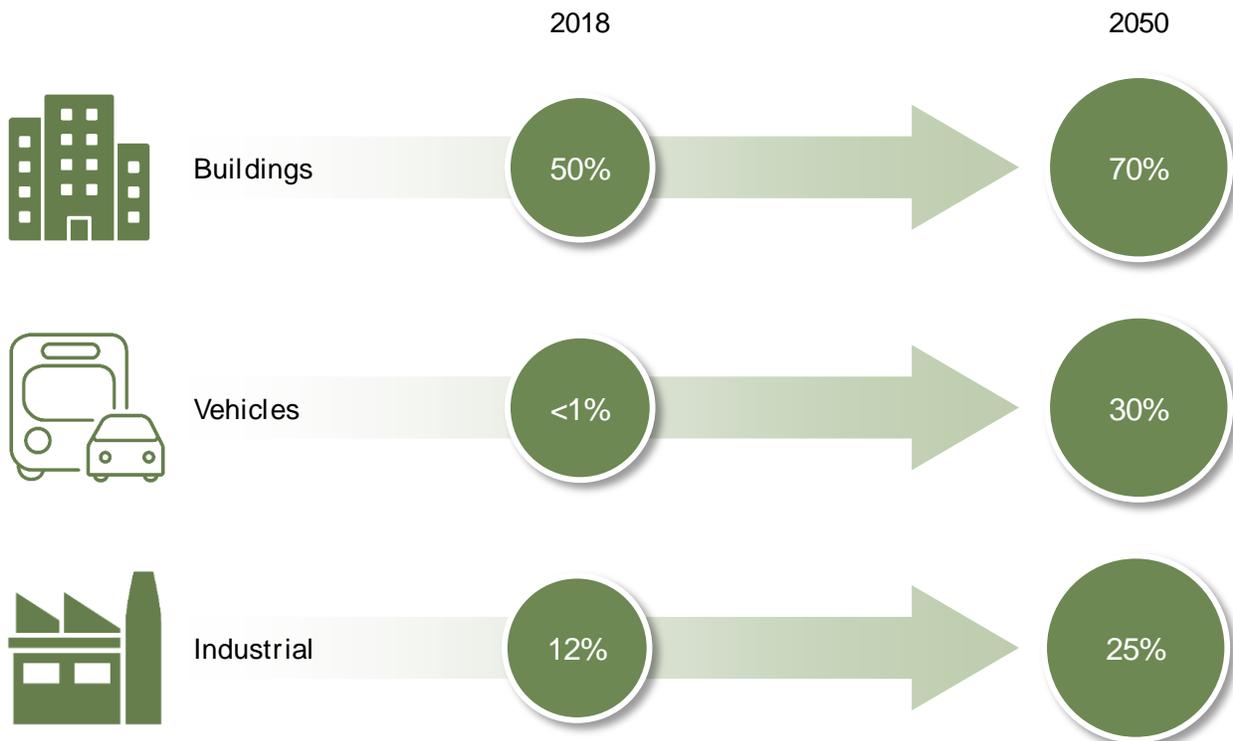
The cost-competitiveness of renewable energy technologies is supporting another key driver of climate infrastructure

deployment: electrification. As of 2018, the share of U.S. total *final* energy consumption served by electricity (as opposed to gas, coal, or liquid fuels) ranged from 50% in the buildings sector to less than 1% in the transport sector.²⁰ By 2050, however, the overall share of electricity in U.S. total final energy consumption is projected to double. Particularly rapid growth is expected in the transport sector, as electric vehicles begin heavily penetrating the light-duty vehicle market. Europe, China, and other major economies are expected to experience similar dynamics.

Rising electrification is significant on two fronts. First, greater demand for electricity increases the total addressable market for renewable electricity sources such as wind and solar, etc. Second, electrification will require deployment of new forms of infrastructure, e.g. electric vehicle charging stations, that over the next several decades will themselves require trillions of dollars of new investment.

Figure 6.

Percentage of U.S. Final Energy Consumption by Sector that is Served by Electricity, 2018–2050



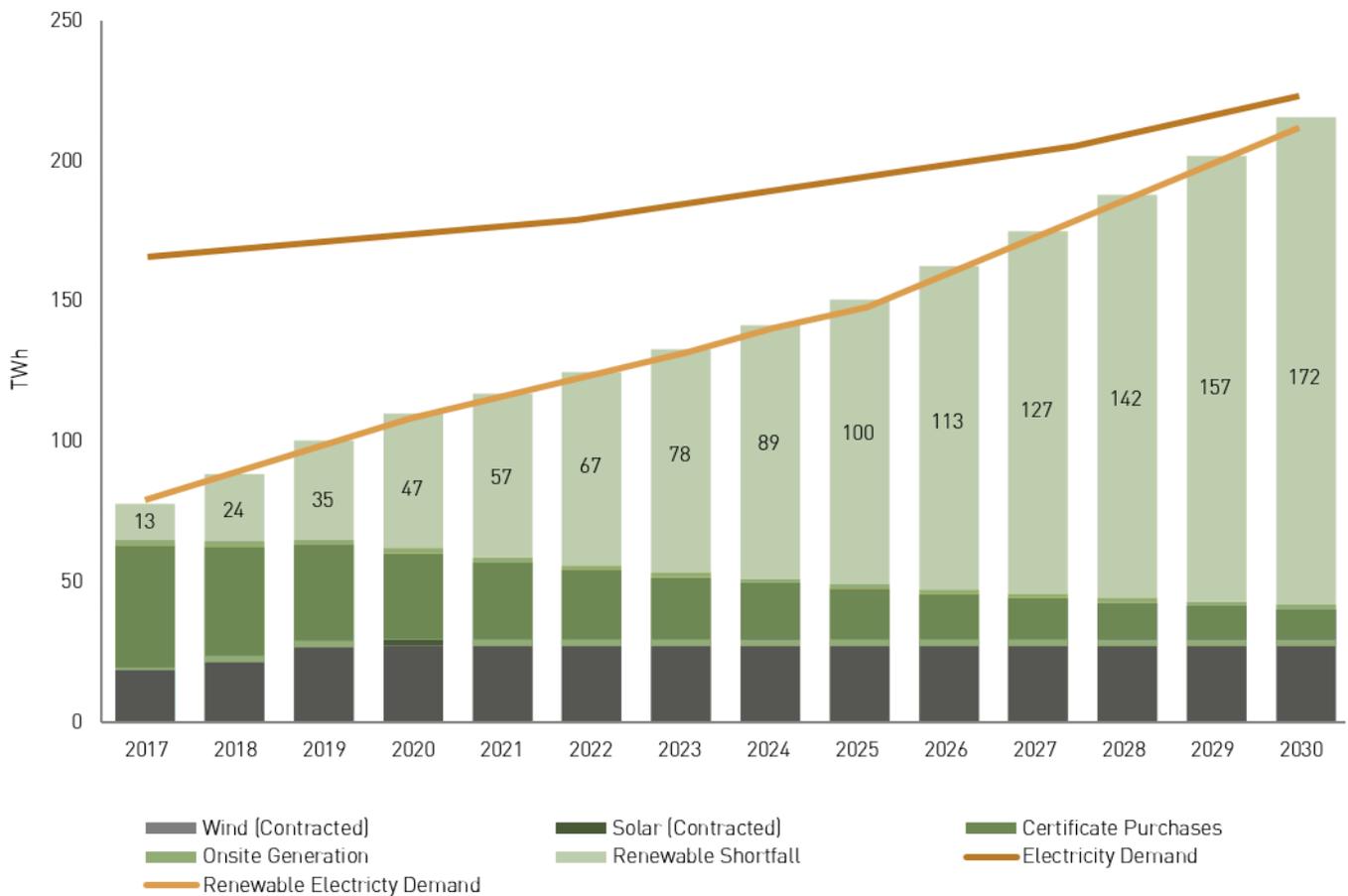
Note: ‘Electric Vehicles’ include autonomous electric vehicles (AEVs), battery electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs).
EIA, “Monthly Energy Review,” September 2019

Market Demand —
Corporate Procurement of Renewable Energy

We believe the investment case for climate infrastructure is buttressed by surging corporate demand for renewable energy. In 2018, U.S. corporations directly procured a record 8.5 GW of renewable energy (and 2019 data suggesting a similar volume, with 6 GW of capacity having been procured through August); since 2008, more than 60 U.S. corporations have procured a total of 13.5 GW of renewable energy.²¹ Corporations procure renewable energy for a variety of reasons including reducing electricity bills, hedging against fuel price risk, increasing operational resilience, and meeting corporate sustainability

goals. In terms of sustainability goals, more than 130 corporations have committed to procuring 100% of their electricity from renewable energy.²² Fulfillment of these pledges will require an estimated 172TWh of additional renewable energy generation by 2030 and represents a \$94 billion investment opportunity.²³ The continuing growth of corporate demand is providing opportunities for contracted revenue (that have otherwise narrowed) while diversifying the market for renewable energy away from excessive reliance on government subsidy programs and utility mandates and creating attractive opportunities for investors.

Figure 7.
Projected Global Renewable Electricity Shortfall for RE100 Member Companies



Source: Bloomberg New Energy Finance, Bloomberg Terminal, The Climate Group, company sustainability reports.

Note: Certificate purchases includes green tariff programs and are assumed to step down 10% each year. Onsite generation and contracted wind and solar purchases are assumed to remain flat through 2030.

Policy Commitments to Reduce Emissions and Promote Clean Energy Systems

Alongside declining technology costs, rising electrification, and corporate demand, the climate infrastructure opportunity benefits from further implementation of policy commitments to reduce greenhouse gas (GHG) emissions and promote clean energy systems.

Regional and National Policy

Regions and countries are supporting the deployment of climate infrastructure with concrete regulations and commitments. In addition to reducing greenhouse gas (GHG) emissions, benefits of such policies often include improved public health and local job-creation. Examples of such policies include:

- The European Union’s 2030 targets for (1) 32% of its energy (across electricity, heat, and transport) to come from renewable sources, versus roughly 15% as of 2016; and (2) a 32.5% improvement in energy efficiency relative to a business-as-usual scenario, with a potential upward revision in the target by 2023.²⁴

Targets and policies from fifteen countries to phase-out sales of internal combustion engines and/or promote sales of electric

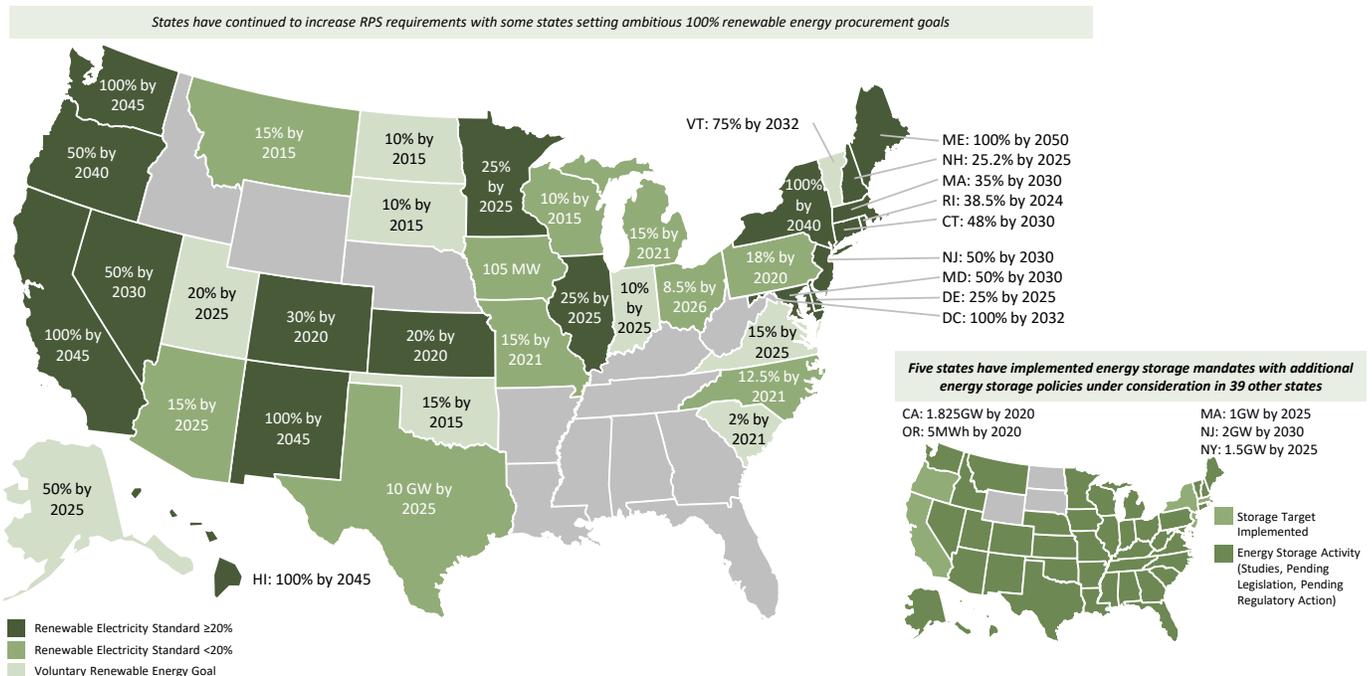
vehicles, with the timeline for such phase-outs varying from 2020 (Austria) to 2040 (France and the United Kingdom).²⁵

State and Local Policy

State and local governments are also supporting investment into renewables and energy storage. More than half of all U.S. states have a Renewable Portfolio Standard (RPS), and six states and the District of Columbia now include RPS targets of 100%, up from only one state in 2016. This includes binding, ambitious programs such as California’s targets of 60% renewable electricity by 2030 and 100% zero-carbon electricity^(a) in California by 2045, and New York’s target of 70% renewable electricity by 2030 and 100% zero-carbon electricity^(a) by 2045. Moreover, mandates for deployment of energy storage now exist in five states (and are under consideration in 37 others).²⁶ Adoption of energy storage mandates resembles the previous proliferation of RPS adoption and reflects the key role of energy storage in enabling states to realize higher levels of renewable power penetration.

- (a) The definition of “zero-carbon” electricity – which applies to long-term 100% targets in California, Washington, and New York - usually includes non-emitting sources such as nuclear power and, if built, gas-fired generation with carbon capture and sequestration.

Figure 8. Renewable Portfolio Standards^(a) and Energy Storage Procurement Targets^(b) by State

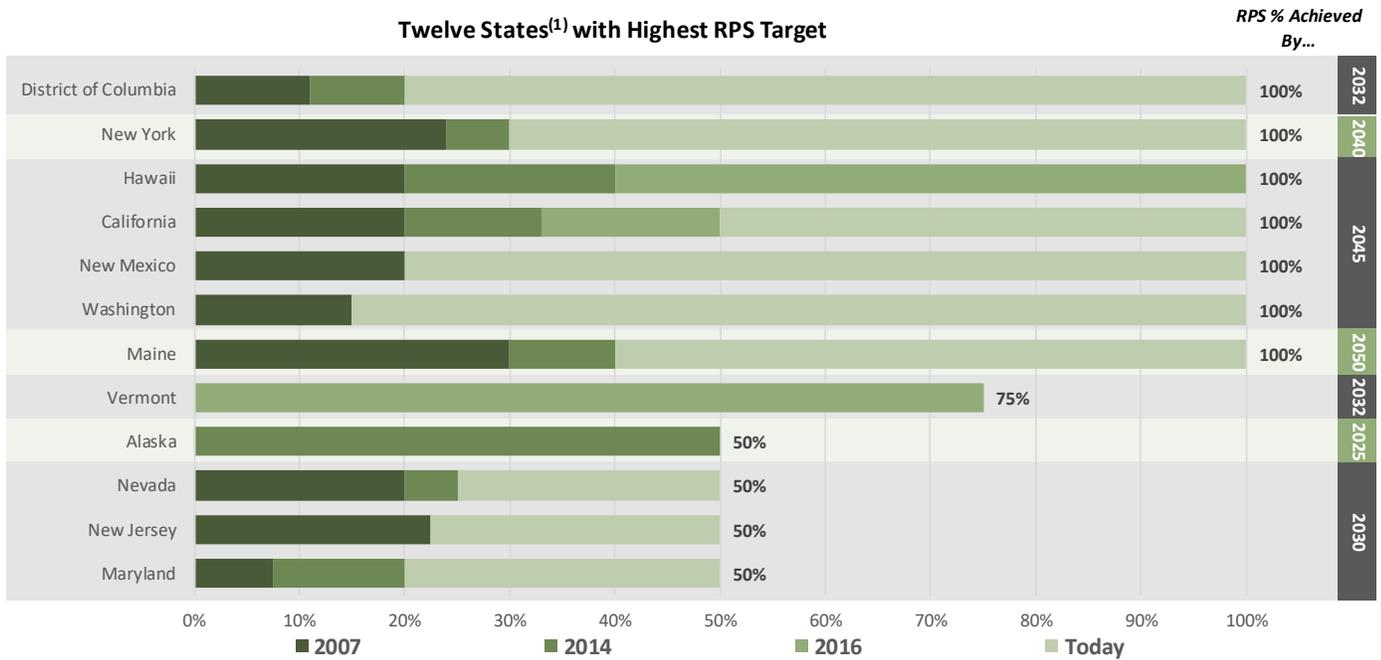


Projections and forward looking statements are not reliable indicators of future events and there is no guarantee that such activities will occur as expected or at all.

(a) NC Clean Energy Technology Center. “Renewable Portfolio Standard Program Overview,” 2019.

(b) NC Clean Energy Technology Center. “50 States of Grid Modernization: Q1 2019 Quarterly Report & 2018 Annual Report,” October 2019.

Figure 9.
Increasing Renewable Portfolio Standards by State



Note: The above chart highlights states with clean energy standards (RPS targets) at or above 50%.

1. Includes the District of Columbia.

Sources:

- Utility Dive, “Senators Target 50% National Renewable Energy Standard by 2025, Zero-Carbon by 2050,” June 2019.
- DSIRE NC Clean Technology Center, Renewables Portfolio Standards, 2019.
- State Policy Opportunity Tracker for Clean Energy, 2018.

Role of Climate Infrastructure in Institutional Portfolios

Allocations to climate infrastructure can enhance investor portfolios by generating cash yield, providing diversification, and serving as a hedge against dislocations amid the transition to a lower-carbon economy.

Infrastructure assets in sectors such as renewable energy and transmission have historically offered multi-year, inflation-linked, contracted cashflows with creditworthy counterparties. Such assets can generate low volatility cash yield with limited correlation with public markets – thereby providing a potential diversification benefit to investor portfolios. In OECD markets, the cash yields available on clean energy and other climate infrastructure assets can be three to five times the approximately 1.92% yields available on 10-year U.S. Treasury notes.²⁷

For investors willing to accept additional risk (e.g. exposure to corporate-level entities or pre-construction development risk), growth of the climate infrastructure market offers selective opportunities to potentially earn double-digit returns.²⁸ Indeed, given compression of asset-level returns for operating and

construction-stage wind and solar projects, the potential for attractive risk-adjusted returns in climate infrastructure will increasingly depend on having the flexibility and expertise to (1) invest across multiple sub-sectors, rather than just the dominant segments of clean energy (e.g. wind and solar); (2) combine asset-level and corporate-level exposure; and (3) prudently finance pre-construction assets.

Finally, given that 81% of the world’s energy still comes from fossil fuels,²⁹ investing in climate infrastructure provides a hedge to make portfolios more resilient amid the transition to a lower-carbon economy. As Mercer has observed:

The potential impact of climate change on infrastructure, as an asset class level, needs to be considered in the wider context of the drivers for additional investment in infrastructure globally, including: Replacement of ageing assets; Provision of additional capacity to reflect socio-economic growth; Replacement of assets or construction of new assets as part of adapting to climate change; Increasing efficiencies to support economic growth.³⁰

Simulating the long-term performance of 14 different asset classes under a variety of climate change scenarios (that varied future trends related to technology, resource availability, physical climate impacts, and policy), Mercer found infrastructure to have the second-highest potential for positive variability in returns (particularly in a low-carbon scenario) with minimal potential for negative variability in returns. This finding underscores the hedge value from allocations to climate infrastructure.

Pathways for Institutional Investment into Climate Infrastructure

Multiple avenues exist to provide investors with exposure to climate infrastructure. Within fixed income, the investable universe of “climate-aligned” bonds is nearly \$400 billion and growing strongly.³¹ Public equity markets also offer straightforward exposure to aspects of the climate infrastructure theme via indices such as WilderHill New Energy Global Innovation Index.³²

Despite the scale and liquidity of public markets, we believe the private markets will be the most attractive climate infrastructure investments to help maximize both portfolio risk-adjusted returns and positive environmental impact for many asset owners.

On the direct side, several large pension funds and insurers (chiefly in Canada and Europe) have led the way in allocating capital to clean energy projects and companies.³³ For many institutional asset owners, however, lack of internal resources negates or diminishes the possibility for direct investment. Moreover, even for asset owners with internal infrastructure teams, lack of specific expertise related to clean energy, energy storage, and other climate infrastructure sub-sectors can hamper efforts to allocate capital into these areas.³⁴

Existing institutional investor exposure to climate infrastructure often occurs via ownership of wind and solar power assets. Intense competition for such assets, however, has caused returns on these assets to compress considerably over the past few years.³⁵ As a result, current and future opportunities to earn attractive risk-adjusted returns are likely to be most robust in other sub-sectors of climate infrastructure such as energy storage and microgrids, as well as resource and energy efficiency (or in less competitive segments of renewable energy such as biopower). Investors devoted to mastering these sub-sectors stand to reap substantial benefits in the form of higher-returning, less competitive transactions.

Deep Understanding of Energy and Power Markets

Deployment of clean energy assets manifests a fundamental shift in electric power markets – from centralized systems to systems that are decentralized, decarbonized, and digitized. Capitalizing on new opportunities requires a keen appreciation of evolving power market fundamentals and how these changes will impact existing markets while creating new opportunities and revenues profiles.

Policy Expertise

Newer incentive regimes in support of climate infrastructure (e.g. New York’s “Value of Distributed Energy Tariff”)³⁶ are often far more complex than simple feed-in tariffs. Moreover, in the U.S., key policy drivers (e.g. Renewable Portfolio Standards, energy storage procurement mandates, community solar programs) are often at the state level, requiring an ability to navigate policies across dozens of separate jurisdictions. Investing around these incentives requires an ability to thoroughly assess public policies and the credibility behind such policies. Moreover, as the policy landscape is continually evolving, investors must devote substantial resources to tracking and analyzing how potential policy changes will affect capital-allocation decisions.

Operational, Technical, and Financial Capabilities

In the growing segments of the clean energy market that are not wind and solar PV, investors must know how to distinguish projects that are bankable from those that are not. Just as importantly, investors must have proven expertise in adding operational value to assets (e.g. by improving uptime, reducing O&M costs, etc.). Many attractive areas of climate infrastructure (e.g. energy storage assets) are more operationally-complex than wind turbines and solar panels; transacting successfully in these segments thereby requires more sophisticated operating capabilities. Moreover, even in the wind power space, seizing attractive opportunities to retool or repower older assets requires vendor-specific knowledge and engineering competence.

Flexible Capital and Capital Markets Expertise

From distributed solar PV to diversion of waste from landfills to water efficiency, most climate infrastructure sectors are both growing and evolving quickly. Companies that succeed in these sectors often must be able to serve a variety of customers (e.g. residential, corporate, utility) across multiple jurisdictions.

Successful companies typically seek out capital partners who can provide solutions tailored to specific applications.

Ability to invest across the capital structure can help investors to differentiate themselves in the climate infrastructure space. More flexible mandates (with respect to capital structure) will generally help investors to achieve better risk-adjusted returns particularly as (1) competition for assets has compressed the spread between the cost of equity and the cost of debt; and (2) developers seek to grow their platforms without diluting their equity ownership stakes.

Given the capital intensity of climate infrastructure assets, cost of capital is key to making projects economic. Equity investors or sponsors can add significant value to portfolio companies and assets by helping to secure competitive terms from construction and/or term lenders, as well as (in the U.S.) third-party tax equity providers.

Ability to Efficiently Source and Aggregate Smaller Opportunities

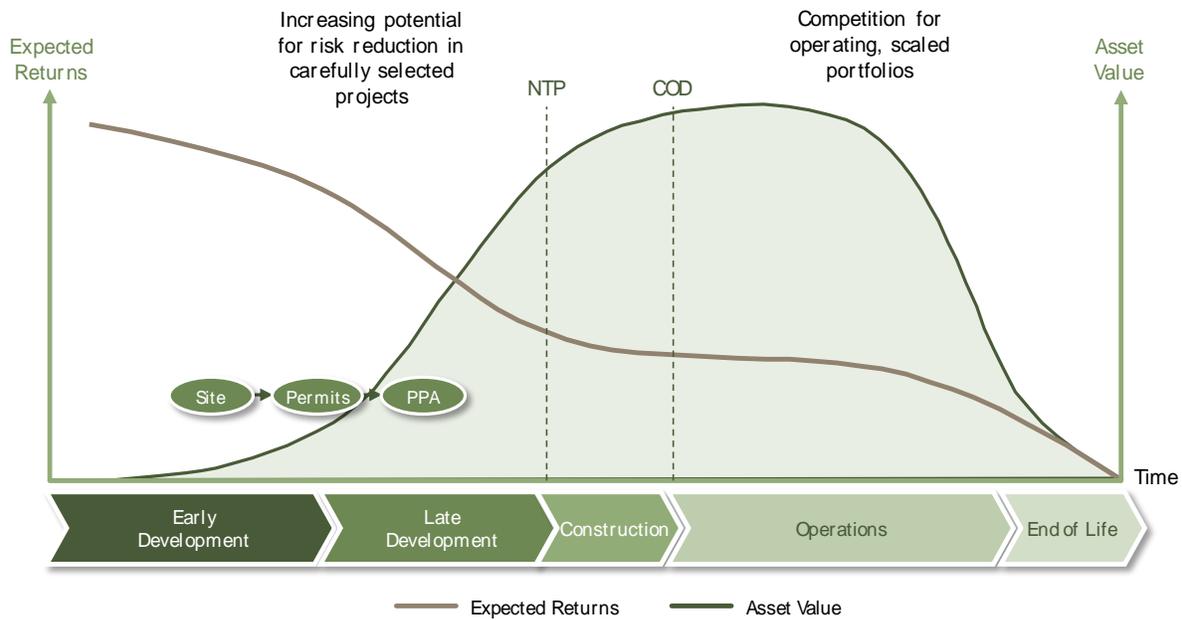
It has been observed that solving climate change will require “many thousands of million-dollar projects, not hundreds of billion-dollar projects.” Indeed, a move from larger centralized systems to smaller distributed systems is a defining trend of climate infrastructure. To benefit from this trend, investors must be able to transact efficiently in smaller assets such as distributed solar PV, batteries, and anaerobic digesters (or be able to back quality management teams transacting in this areas).

Competence in Taking Prudent Exposure to Pre-Construction Risk

Relative to fossil fuel assets, many clean energy assets (especially onshore wind and solar) have short construction timelines (e.g. 9-12 months) and relatively simple construction processes. As a result, by the time assets reach the start of construction, they have often been de-risked to the point where competition from “commodity capital” begins to erode returns.³⁷

In these sub-sectors, it is the *pre-construction activities, including late-stage development activities* – such as locking down and optimizing agreements with equipment suppliers and construction firms, and arranging bank debt and tax equity financing – that we believe create the bulk of project value. Investors who can support “best-in-class” developers in these pre-construction stages stand a much better chance of securing a robust pipeline and achieving attractive project-level returns. To diversify away the idiosyncratic, “binary” risks associated with greenfield development (e.g. inability to secure an essential permit), intelligent exposure to pre-construction risk will usually target a portfolio of assets rather than a single asset.

Figure 10.
Illustrative Asset Value Evolution Across the Asset Life-Cycle



Note: NTP refers to Notice to Proceed (i.e., the start of construction). COD refers to Commercial Operation Date (i.e., the start of operations).
Source: Ceres, “In Sight of the Clean Trillion: Update on an Expanding Landscape of Investors Opportunities”, May 2018.

Ability to Combine Asset-Level with Corporate-Level Investment

We believe that a reasonable climate infrastructure strategy should deploy the bulk of its capital into hard assets to be deserving of a categorization as “infrastructure.” That said, investors can sometimes improve expected risk-adjusted returns by also funding companies associated with developing and/or selling such assets. Moreover, as with the provision of pre-construction project capital, providing more bespoke corporate capital can be highly useful for securing a direct or indirect control over a company’s asset pipeline.

Ability to Source Deals from Non-Traditional Channels

Due to the societal implications of climate change, the climate infrastructure marketplace has attracted the efforts of a wide cross-section of entities – not just private companies and investors, but also policymakers, universities, non-governmental organizations, and philanthropists. Many of these “non-traditional” market participants are working to create investable opportunities for private capital. Successful investors must be able

to navigate multiple arenas and forge partnerships across domains.

Conclusion — Seizing the Climate Infrastructure Opportunity

Investment into climate infrastructure represents a long-term, multi-trillion-dollar opportunity supported by accelerating trends related to technology, economics, and public policy. In our view, the most attractive entry points related to climate infrastructure will often involve private market investments that provide a mix of income and capital appreciation. Transacting successfully in climate infrastructure, however, requires deep industry, structuring, and regulatory experience and a thoughtfully-constructed investment strategy. For investors seeking a diverse portfolio of asset types, the energy transition presents a myriad of investments, including and beyond traditional wind and solar, that are fundamentally changing our energy landscape for decades to come.

Co-authored by Aligned Climate Capital, an advisor focused on low carbon and sustainable real assets.

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REF: PE-01074

Endnotes

- ¹ Source: Bloomberg New Energy Finance. *New Energy Outlook 2018*. 2018
- ² Source: International Energy Agency. *Global EV Outlook*. 2019.
- ³ Source: International Renewable Energy Agency. *Global Energy Transformation: A Roadmap to 2050*. 2018.
- ⁴ This paper's definition of "climate infrastructure" overlaps with the Bloomberg New Energy Finance (BNEF) definition of "clean energy" via shared coverage of energy storage and microgrids, resource and energy efficiency, renewable energy, vehicle electrification, and smart grids. The BNEF "clean energy" universe, however, excludes traditional power transmission assets, in addition to having potentially incomplete coverage of smaller-scale resource and energy efficiency investments). Though not identical, BNEF data on new clean energy investment are a very useful proxy for overall climate infrastructure investment.
- ⁵ Source: Bloomberg New Energy Finance, Clean Energy Investment Trends, 2018. January 16, 2019. REN21, Renewables 2019 Global Status Report, June 16 2019.
- ⁶ Source: Bloomberg New Energy Finance, Clean Energy Investment Trends, 2018. January 16, 2019.
- ⁷ The balance of total clean energy investment reflects a mixture of private equity, venture capital, public equity, and government/corporate R&D.
- ⁸ Source: Bloomberg New Energy Finance, *New Energy Outlook 2018*, June 19, 2018.
- ⁹ Source: Bloomberg New Energy Finance, *Global Storage Market to Double Six Times by 2030*, November 20, 2017.
- ¹⁰ Source: Morgan Stanley, *EV Infrastructure: Tesla's Footprint Maps a \$2.7Tr Industry Problem*, October 2017.
- ¹¹ Source: United Nations Framework Convention on Climate Change, *The Paris Agreement*, December 2015.
- ¹² Source: International Energy Agency, *World Energy Outlook 2017*, November 14, 2017.
- ¹³ Sources: International Energy Agency, *World Energy Investment Outlook*, 2014. Mark Fulton and Reid Capalino, *Investing in the Clean Trillion: Closing the Clean Energy Investment Gap*, Ceres, January 15, 2014. Ceres, *In Sight of the Clean Trillion: Update on an Expanding Landscape of Investors Opportunities*, May 2018.
- ¹⁴ Source: Chris Mooney and Brady Dennis, *The world has just over a decade to get climate change under control, U.N. scientists say*, Washington Post, October 7 2018.
- ¹⁵ Source: Reed Landberg, Chisaki Watanabe and Heesu Lee, *Climate Crisis Spurs UN Call for \$2.4 Trillion Fossil Fuel Shift*, Bloomberg News, October 8, 2018.
- ¹⁶ Sources: U.S. Department of Energy, *U.S. Energy and Employment Report*, January 2017. U.S. DOE.
- ¹⁷ One Gigawatt is one billion watts, which is roughly the power output of one nuclear power reactor.
- ¹⁸ Source: Source: Bloomberg New Energy Finance, *New Energy Outlook 2018*, June 19, 2018.
- ¹⁹ Source: International Energy Agency, *Renewable 2019*, 21 October 2019. Jeremy Hodges, *Climate Changed: World to Install Over One Trillion Watts of Clean Energy by 2023*, Bloomberg News, October 7, 2018.
- ²⁰ Source: National Renewable Energy Laboratory, *The Electrification Futures Study*, December 2017.
- ²¹ Source: Business Renewables Center, *BRC Deal Tracker*, August 8, 2018.
- ²² Source: RE100, March 2018.
- ²³ Bloomberg New Energy Finance, *RE100 Signatories to Spur \$94B Investment Opportunity*, 2018.
- ²⁴ Sources: European Commission, *Energy efficiency first: Commission welcomes agreement on energy efficiency*, June 19, 2018. Robert-Jan Bartunek, *EU agrees 32 percent renewables target for 2030*, Reuters, June 14, 2018.
- ²⁵ Source: Center for Climate Protection, *Actions by countries to phase out internal combustion engines*, 2018.
- ²⁶ Sources: Database of State Incentives for Renewables & Efficiency, 2018. National Conference of State Legislatures, "State Renewable Portfolio Standards and Goals," August 2017. NC Clean Energy Technology Center. "50 States of Grid Modernization: Q2 Q2018 Quarterly Reports," August 2018.
- ²⁷ Sources: Mercatus Energy Investment Management (EIM) Platform Data, 2016. City of London Green Finance Initiative, *The Renewable Energy Infrastructure Investment Opportunity for UK Pension Funds*, 2017. Bloomberg New Energy Finance, *Portfolio Hunters 2016: Solar*, October 26, 2016. Bloomberg, *Rates and Bonds, 10-Year Government Bond Yields, United States*, December 31, 2019.
- ²⁸ Sources: Cambridge Associates, *Clean Tech Company Performance Statistics*, March 31, 2018. Pattern Energy Group, Inc., *Investing in Development - Understanding the Risk-Reward Profile*, 2017.
- ²⁹ Source: International Energy Agency, *World Energy Outlook 2017*, November 14, 2017.
- ³⁰ Source: Mercer, *Investing in a Time of Climate Change*, April 2015.
- ³¹ Source: Climate Bonds Initiative and HSBC, *Bonds and Climate Change: The State of the Market 2018*, 2018. This includes bonds issued to raise finance for climate change solutions or issued by entities that earn 75% or more of their revenues from climate-aligned assets and business lines. Further, the \$389 billion of bonds deemed to be "investable" have met minimum criteria related to size, liquidity, and currency denomination.
- ³² Source: Institutional Investing in Infrastructure, Q&A: A conversation with Reid Capalino, August 20, 2018.

- ³³ Source: Christopher Kaminker and Robert Youngman, Sustainable Energy Infrastructure, Finance and Institutional Investors, OECD Observer, OECD, November 2015.
- ³⁴ Source: Ceres, In Sight of the Clean Trillion: Update on an Expanding Landscape of Investors Opportunities, May 2018.
- ³⁵ Sources: Mercatus Energy Investment Management (EIM) Platform Data, 2016. City of London Green Finance Initiative, The Renewable Energy Infrastructure Investment Opportunity for UK Pension Funds, 2017.
- ³⁶ Source: New York State Energy Research and Development Authority, Value of Distributed Energy Resources (VDER), 2018.
- ³⁷ Source: Ceres, In Sight of the Clean Trillion: Update on an Expanding Landscape of Investors Opportunities, May 2018.