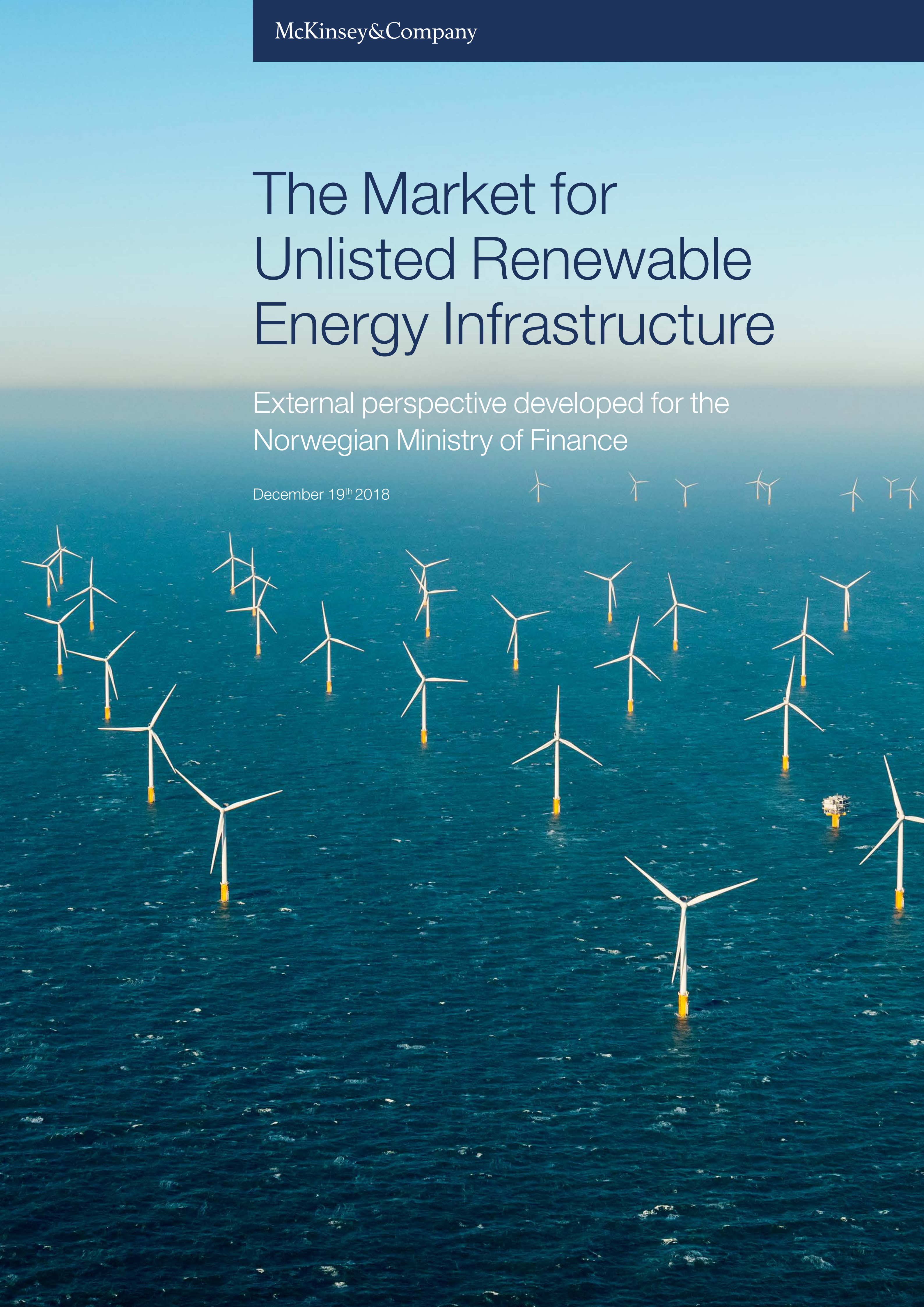
McKinsey&Company

The Market for Unlisted Renewable Energy Infrastructure

External perspective developed for the Norwegian Ministry of Finance

December 19th 2018



Contents

Introduction		3
Executive summary		5
1.	The market for renewable energy infrastructure investments	9
2.	Political, regulatory and reputational risk	19
3.	Investing in the market for renewable energy infrastructure	25
References		30

Introduction

The Ministry of Finance holds the formal responsibility for the management of the Norwegian Government Pension Fund Global (GPFG). The operational management of the Fund is carried out by Norges Bank (the central bank of Norway) in accordance with a management mandate issued by the Ministry. The mandate sets out the general principles and regulations for Norges Bank's management of the Fund. The mandate expresses the Fund's investment strategy, including provisions on the composition of the benchmark index, risk limits, reporting and responsible management. At the end of third quarter 2018, the Fund managed assets worth ~1.0 trillion USD.

The question of allowing the Government Pension Fund Global to be invested in unlisted infrastructure has been discussed in several annual white papers on the Government Pension Fund to the Parliament, and debated in the Parliament.

The Government proposed in the 2018 white paper on the Fund, and got the consent from the Parliament, to assess the regulation of the environment-related investment mandates and the possibilities for investing in unlisted renewable energy infrastructure within these mandates, with the same transparency, risk and return requirements that apply to the other investments in the Fund.

The Norwegian Ministry of Finance has engaged McKinsey & Company to produce a report on the global market for unlisted renewable energy infrastructure. The mandate is to:

1. Provide a practical scope of the global market for unlisted renewable energy infrastructure investments.

2. Specify the size of the collective market and the share available to institutional investors.

3. Describe the collective market and the share available to institutional investors along these specific dimensions:

   a. geography

   b. sub-sectors (solar, wind and hydropower etc.)

   c. projects under establishment and investments in existing infrastructure

   d. investment models (direct investments, co-investments, various fund structures)

   e. historical developments and expectations for future development

4. Provide an update on relevant developmental features of political, regulatory and reputational risk for investments in unlisted renewable energy infrastructure, compared to what is described in the report from McKinsey to the Ministry of Finance, December 1st, 2016.

5. Exemplify how large institutional investors invest in unlisted renewable energy infrastructure. To the extent possible, the examples should describe their strategy towards the dimensions in point 3. a-d, including results and experiences.

The report will be descriptive rather than advisory, in accordance with the mandate. It will be based on public sources of information and interviews with experts on renewable energy technologies and the political and regulatory environments at the regional and national levels.

After the executive summary, chapter 1 describes the market for renewable energy infrastructure assets, the share available to institutional investors, and expected development towards 2030. Chapter 2 describes the political, regulatory and reputational risk associated with renewable energy infrastructure, including examples of risk events. Chapter 3 describes how institutional investors approach this market.

Executive summary

CHAPTER 1: THE MARKET FOR RENEWABLE ENERGY INFRASTRUCTURE INVESTMENTS

The value of the global renewable energy infrastructure market is estimated to grow by almost 50%, from 2.9 trillion USD in 2017 to 4.2 trillion USD in 2030, driven mainly by new solar and wind power capacity additions.

Over the last decade, the market for renewable energy infrastructure has grown rapidly, driven mainly by decreasing installation cost of solar and wind power, resulting in record capacity additions. There is consensus among market-leading energy forecasters that this development is expected to continue going forward. This report uses the McKinsey Global Energy Perspective (GEP) Reference Case 2019 as a reference scenario, which estimates that installed capacity will increase by 150%, from 2,100 GW in 2017 to 4,800 GW in 2030.

The total value of the renewable energy infrastructure market today is estimated to 2.9 trillion USD. Most of the value is in hydropower (~60%), the rest in solar and wind power. For solar and wind power, governmental support regimes currently account for more than half of the value. By 2030, the total value of the market is estimated to reach 4.2 trillion USD. Solar and wind is expected to catch up with hydropower and represent ~50% of the total value. As the costs of installing solar and wind power continue to fall, the share of value accounted for by support regimes is expected to be reduced significantly. The year 2030 is chosen as a relevant time horizon for an investor that considers building a portfolio of unlisted renewable energy infrastructure assets.

Part of the renewable energy infrastructure market is not available to investors due to government ownership and illiquidity. The share of the total market that is available to institutional investors in the period 2018-2030 is estimated to 1.6 trillion USD, and consists largely of unlisted new solar and wind power assets.

Globally, only ~20% of the value of hydropower assets is estimated to be available, due to a high share of government ownership and limited new capacity expected to be added in the period 2018-2030. About ~55% of the value of wind and solar assets is estimated to be available, but there is large geographic variation. Notably, in China, only ~25% of the value of wind and solar assets is estimated to be available, due to a high share of government ownership, while ~70% of the value is available in the rest of the world.

The main characteristics of the estimated investable market for 2018-2030 are:

- ~70% of the investable market is in unlisted assets, of which:
    - ~80% is new capacity built after 2017
    - ~85% is solar and wind power
    - ~55% is in Asia, more than half of it in China and India

CHAPTER 2: POLITICAL, REGULATORY AND REPUTATIONAL RISK

Political, regulatory and reputational risk is particularly interesting to investors in renewable energy infrastructure.

Renewable energy infrastructure has many characteristics that are attractive to long-term institutional investors. However, the asset class has low liquidity and high transaction costs, which implies that investors tend to take higher ownership shares in fewer assets. With a high ownership share, the owner is typically more closely associated with the investment, and can thus be more vulnerable to political, regulatory and reputational risk.

Political, regulatory and reputational risk has been a topic in previous debates regarding the potential to extend the mandate of the GPFG to allow for investments in unlisted infrastructure. It is therefore a part of the mandate of this report to build on McKinsey's 2016 report to the Ministry of Finance on political, regulatory and reputational risks in unlisted infrastructure investments, with a specific assessment of these risks in unlisted renewable energy infrastructure.

For renewable energy infrastructure, political, regulatory and reputational risk levels are often lower in developed markets, and can be higher for hydropower than for solar and wind power.

As renewable energy infrastructure assets are highly diverse, the exposure to political, regulatory and reputational risk varies from project to project. However, three main asset characteristics can explain many of these differences: geography, technology and lifecycle stage.

Developed markets often, but not necessarily, have more robust political and regulatory frameworks, and hence imply lower political and regulatory risk for investors, than developing markets.

All renewable energy technologies are associated with political, regulatory and reputational risk, but at varying levels. Hydropower projects are in many regions associated with higher reputational risk, primarily due to environmental impacts and safety risk during construction. Solar and wind power projects are also exposed to reputational risk, but typically at a lower level than hydropower. Solar and wind power projects are often exposed to the regulatory risk of retroactive changes in governmental support regimes, as agreed energy price levels for older assets often exceed typical power market price levels.

The political, regulatory and reputational risk types differ across the lifecycle of a renewable energy infrastructure asset. In particular, reputational risk related to safety and environmental impact is typically higher during the construction phase.

Towards 2030, shifts in the technological and geographic composition of the renewable energy infrastructure market will change the overall risk landscape. However, a large investment opportunity is expected in lower risk segments of the investable market.

On the one hand, the growth in the renewable energy market towards 2030 is expected to be highest in the lower risk technologies, which includes solar and wind power. On the other hand, growth is expected to be highest in countries with higher political, regulatory and reputational risk, such as emerging markets in Asia.

Ultimately, there is a large investment opportunity in segments of the investable market with lower political, regulatory and reputational risk. In the period 2018 - 2030, ~45% of the investable market for unlisted renewable energy infrastructure is within OECD countries, which corresponds to ~500 billion USD. Almost all of this, ~430 billion USD, is within solar or wind power.

CHAPTER 3: INVESTING IN THE MARKET FOR RENEWABLE ENERGY INFRASTRUCTURE

Institutional investors are increasingly active in the market for unlisted renewable energy, driven by the attractive characteristics of the infrastructure market and the increased maturity of renewable energy technologies.

A study of large transactions made by a selection of institutional investors that are active in the renewable energy infrastructure market indicate that investors focus on the lower end of the risk spectrum by investing in operating solar and wind power assets in OECD countries.

Investors access unlisted renewable energy infrastructure through three investment models typical for equity investments: direct investment in renewable energy assets, indirect investment in renewable energy assets (e.g. through investment in a renewable energy company), and investment in renewable energy funds. They can also access renewable energy infrastructure debt, e.g. through green bonds. The selection of large transactions studied suggests that indirect investment in renewable energy companies is the most common investment model. Often investors co-invest with one or several other investors. For very large projects, e.g. offshore wind farms, investors typically make direct investments, often by co-investing with experienced industrial owners.

A case study of a large institutional investor that is active in renewable energy infrastructure provides an example of an operating model and an organizational set up that enables such investments.

This investor started investing in the renewable energy infrastructure market early, compared to other sovereign wealth funds and state pension funds. Organizational and operational changes have been made to support these investments.

Most of the investments have been made in the investor’s home region within the OECD. However, it has recently taken steps to enter emerging markets. To mitigate risk, it leverages its internal capabilities and knowledge of local markets, and partners with local companies. Recent organizational development and continued investments indicate that the investor maintains a positive outlook for renewable energy infrastructure investments.

1. The market for renewable energy infrastructure investments

This chapter presents a description of the market for renewable energy in terms of installed capacity and value. First, the chapter describes current installed capacity and estimated growth towards 2030. Second, the chapter describes the current estimated value and growth towards 2030 and analyze the share of this market that is investable for an institutional investor.

Market definition

The market is defined as the monetary value of the stock of renewable energy capacity at a given time. This report will provide both a view of the current[1] capacity and monetary value as well as an estimate for 2030. The year 2030 is chosen as a relevant time horizon for an investor considering to build a portfolio of unlisted renewable energy infrastructure assets.

Renewable energy infrastructure is in this report defined as the renewable electricity production sector. This excludes non-renewable zero carbon electricity production (e.g. nuclear) as well as other sectors (e.g. renewable heat and biogas). Power transmission and distribution beyond direct grid connection of renewable energy assets is also excluded. Although it is highly relevant for the future power system and for the broader energy infrastructure investment opportunity, the grid will continue to carry large quantities of non-renewable power for decades to come and can thus over the period 2018-2030 not be classified as renewable energy investments.

This report focuses on main power production technologies, including onshore and offshore wind power, solar power[2] and hydropower. This implies that niche technologies (e.g. biomass and geothermal[3]) and emerging technologies (e.g. wave and tidal) are out of the scope.

For the valuation, the projects are valued on a total project basis and do not discriminate between equity and debt[4]. The debt portion will not impact the economics of the projects. Using the total project value approach will give a higher USD value of the market, compared to analyses describing only the equity part. The total project value approach is in line with how debt in unlisted real estate investments by GPFG is treated.

The valuation is pre-tax. This will mostly impact valuation of hydropower, where some countries have a resource tax in addition to the regular corporate tax.

1 2017

2 Including solar photovoltaic (solar panels) technology only.

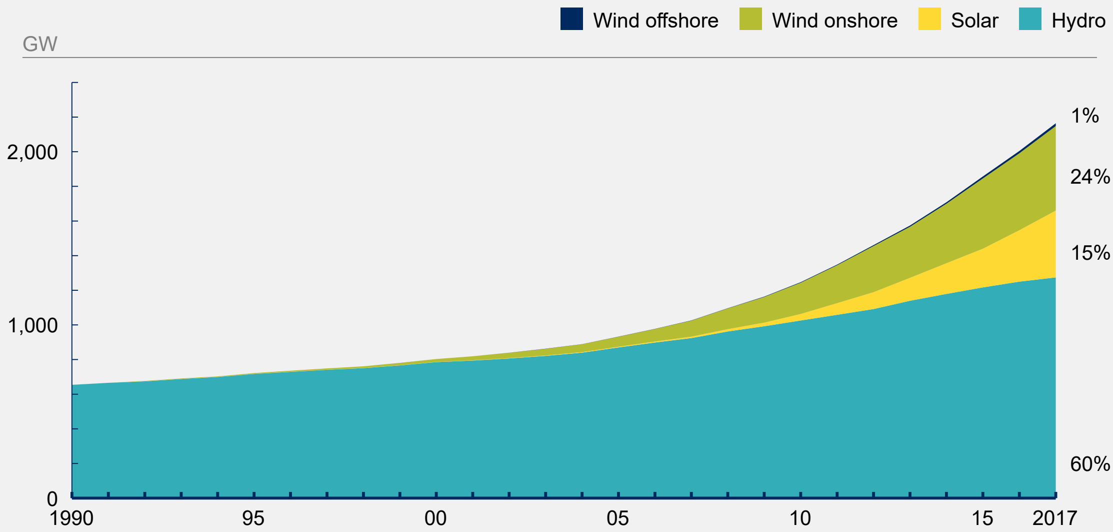
3 In addition to the total annual production of 6 000 TWh of renewable energy within this scope, the current annual geothermal energy production is 75 TWh and biomass electrical energy production is 555 TWh. Not all biomass energy production could be considered sustainable.

4 The valuation is based on region-specific, yearly average technology cost and profitability, both historically and projected into the future. The asset values are assumed to be depreciated linearly based on technology-specific lifetime estimates.

Current market for renewable energy infrastructure

Over the last decade renewable energy capacity has grown rapidly, driven mainly by solar and wind power additions (Exhibit 1). Currently, the total installed renewable energy capacity is 2,100 GW and produces 6,000 TWh of renewable electricity per year. Renewable energy thus account for 25% of the world's total electricity production of 25,000 TWh[5].

EXHIBIT 1 – TOTAL INSTALLED CAPACITY DEVELOPMENT, 1990-2017

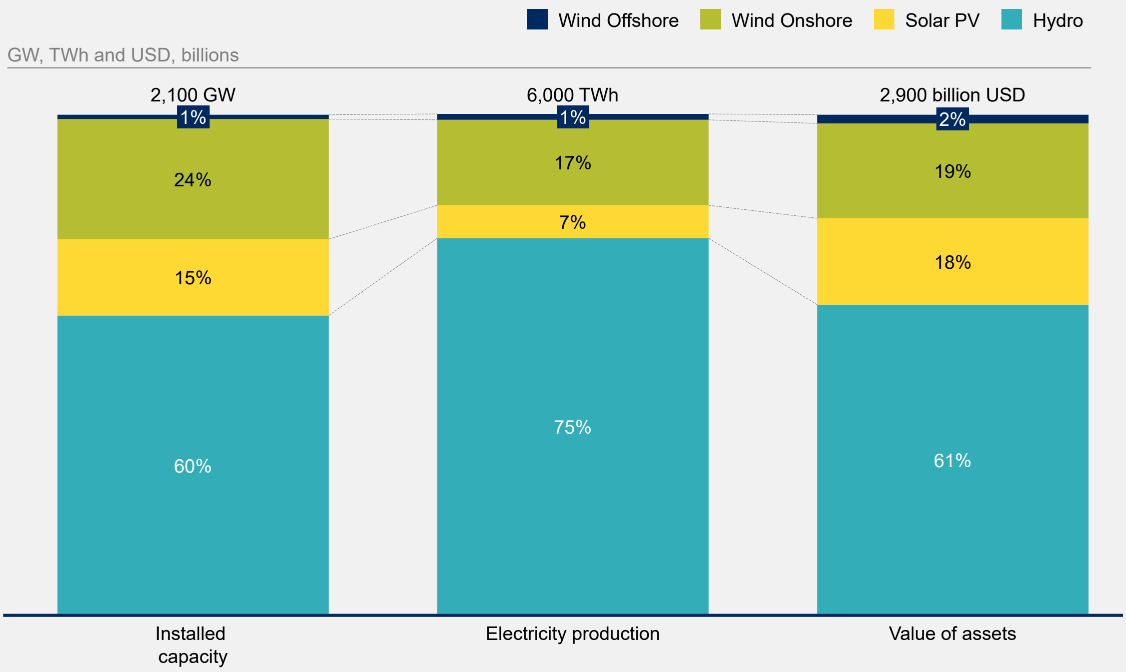


SOURCE: Enerdata

The total value of the renewable energy infrastructure market today is estimated to 2.9 trillion USD (Exhibit 2). While solar and wind power account for ~39% of the total value it accounts for only 25% of total energy production. This can be explained by the governmental support regimes still in effect, which account for almost half the value of current solar and wind energy production.

5 Source: IEA: World Energy Outlook 2018 (2018)

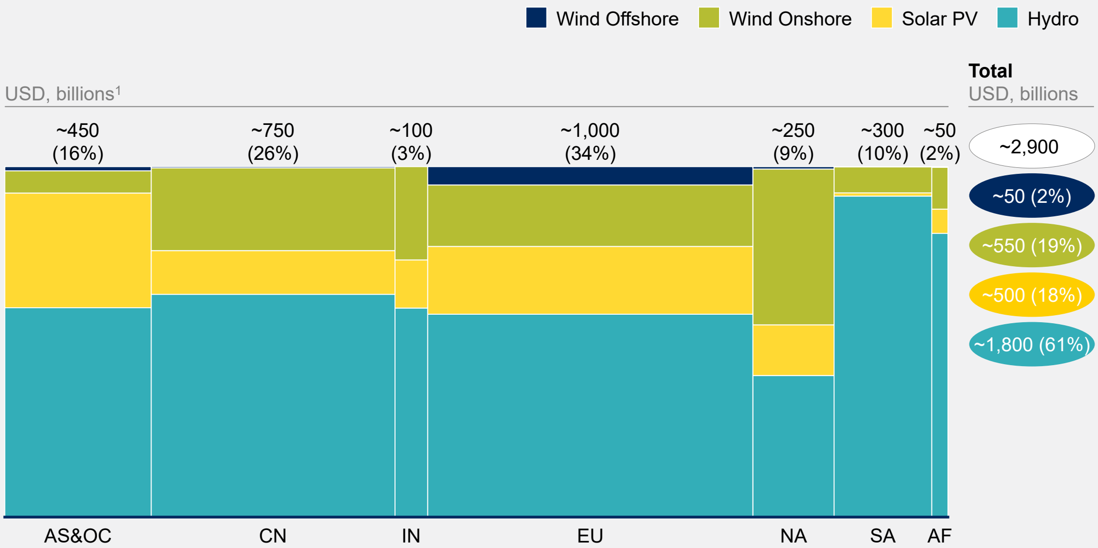
EXHIBIT 2 – INSTALLED CAPACITY, ELECTRICITY PRODUCTION AND VALUE OF ASSETS, 2017



SOURCE: McKinsey Global Energy Perspective (reference case 2019), McKinsey estimates

There are regional differences in the renewable energy mix (Exhibit 3). For example, South America is dominated by hydropower, while North America has the highest share of onshore wind power. Europe is the only region with significant offshore wind power capacity. 45% of the value of the current stock of renewable energy is concentrated in Asia and Oceania, of which most is in China.

EXHIBIT 3 – VALUE OF RENEWABLE ENERGY ASSETS, BY REGION AND TECHNOLOGY, 2017



1 AF: Africa, AS&OC: Asia and Oceania (excl. China and India), CN: China, EU: Europe, IN: India, NA: North America, SA: South America.

SOURCE: McKinsey Global Energy Perspective (reference case 2019), McKinsey estimates

Current annual investments in renewable energy infrastructure

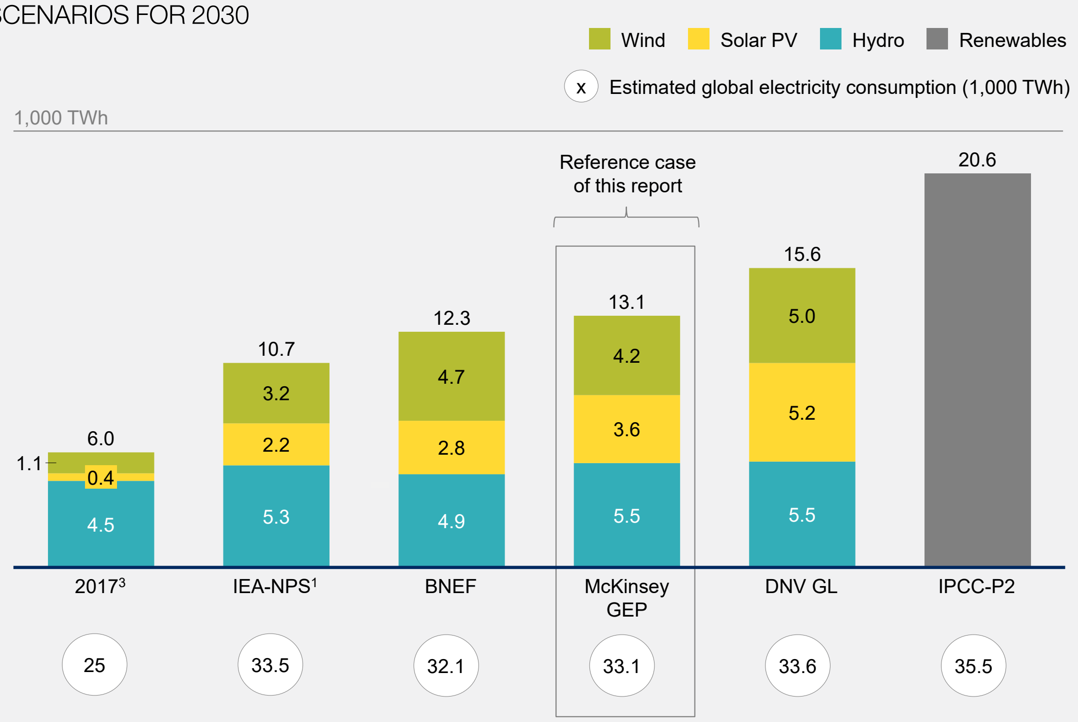
The annual investment in new renewable energy has in recent years been ~200-250 billion USD per year[6], which corresponds to ~7-9% of the value of the current renewable energy asset stock. Growth has been driven by solar and wind power which have accounted for ~75% of annual investments. Brownfield investments[7] account for ~10% and greenfield investments[8] ~90% of total investments[9].

Trends and forecasts towards 2030

Going forward, renewable energy is expected to continue to grow rapidly towards 2030, driven by both supply and demand side factors.

On the supply-side, solar and wind power have experienced rapid cost decline over the past decade. Solar power capex has declined from ~4,400 USD/kW in 2010 to less than 1,000 USD/kW today[10]. Wind power has also seen a strong cost reduction. In some regions that have carbon emission pricing and/or good resources, solar and wind power have reached or exceeded cost

EXHIBIT 4 – CURRENT GLOBAL RENEWABLE ELECTRICITY PRODUCTION AND DIFFERENT SCENARIOS FOR 2030



1 IEA's New Policies Scenario

SOURCE: IEA World Energy Outlook (2018), Bloomberg NEF New Energy Outlook (2018), McKinsey Global Energy Perspective (reference case 2019), DNV GL Energy Transition Outlook (2018), IPCC Special Report (2018)

6 Various other sources describing annual investment in new renewable energy infrastructure typically include biomass, energy efficiency and different governmental funding as well as the investors' own investments in renewable energy infrastructure, and can therefore report higher numbers.

7 Upgrades, rehabilitation or repowering of existing power plants

8 New projects

9 Source: Preqin: Preqin Renewable Energy Infrastructure (May 2018)

10 Source: IRENA: Renewable Power Generation Costs in 2017 (2018a)

parity with new coal and gas assets and are approaching cost parity with existing coal and gas assets. Cost improvements are expected to continue going forward and play an important role in accelerating renewable energy capacity build.

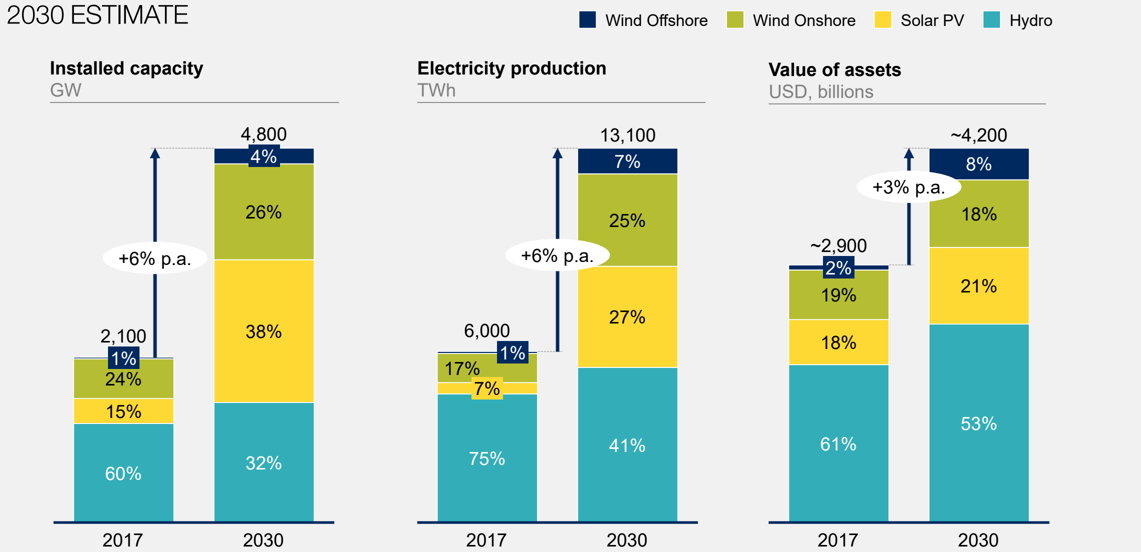
On the demand-side, the overall growth in energy demand and increasing share of electricity required in the energy mix to meet global and national emissions targets, are important drivers for renewable energy capacity build. There is increasing awareness in the public that the consequences of not meeting the 1.5°C target will pose a major threat to human health.

There are many different forecasts for renewable energy production in 2030. A comparison of scenarios from recognized sources illustrate the spectrum of views (Exhibit 4). All market leading energy perspectives predict that the total renewable electricity production will increase towards 2030, although the estimated growth varies across sources. While there are significant differences among forecasts related to the development of solar and wind power, there is consensus that hydropower will see moderate growth. The IPCC does not present forecasts but describes alternative pathways to meet the 1.5°C target in 2050. The growth in renewable energy forecasted in the scenarios from the other sources will likely not be sufficient to avoid global warming above the 1.5°C target. This report uses the McKinsey Global Energy Perspective (GEP) Reference Case 2019[11] as a reference scenario, which represents a mid-point along the different scenarios.

Estimated market for renewable energy infrastructure in 2030

The installed capacity is estimated to increase by 150% from 2,100 GW in 2017 to 4,800 GW in 2030 (Exhibit 5).

EXHIBIT 5 – INSTALLED CAPACITY, ELECTRICITY PRODUCTION AND VALUE OF ASSETS, 2017 VS 2030 ESTIMATE



SOURCE: McKinsey Global Energy Perspective (reference case 2019), McKinsey estimates

11 McKinsey Global Energy Perspective (GEP) is based on a bottom-up energy demand model, projecting the evolution of energy systems by country (for 145 countries), by sector (for 28 sectors), and by fuel (for 55 energy types). This includes a granular perspective on power markets, based on optimization models that address capacity expansions as well as dispatching. In GEP's projections, the views of McKinsey experts worldwide are brought together, with expertise across the broad range of sectors and geographies that are included in the perspective. Moreover, the outlook is part of an integrated perspective that also includes supply side views, closely aligned with specialist teams in McKinsey Energy Insights. McKinsey GEP data and methodology to be published in Q1 2019.

65% of the capacity growth is expected to come in Asia and Oceania, including India and China[12].

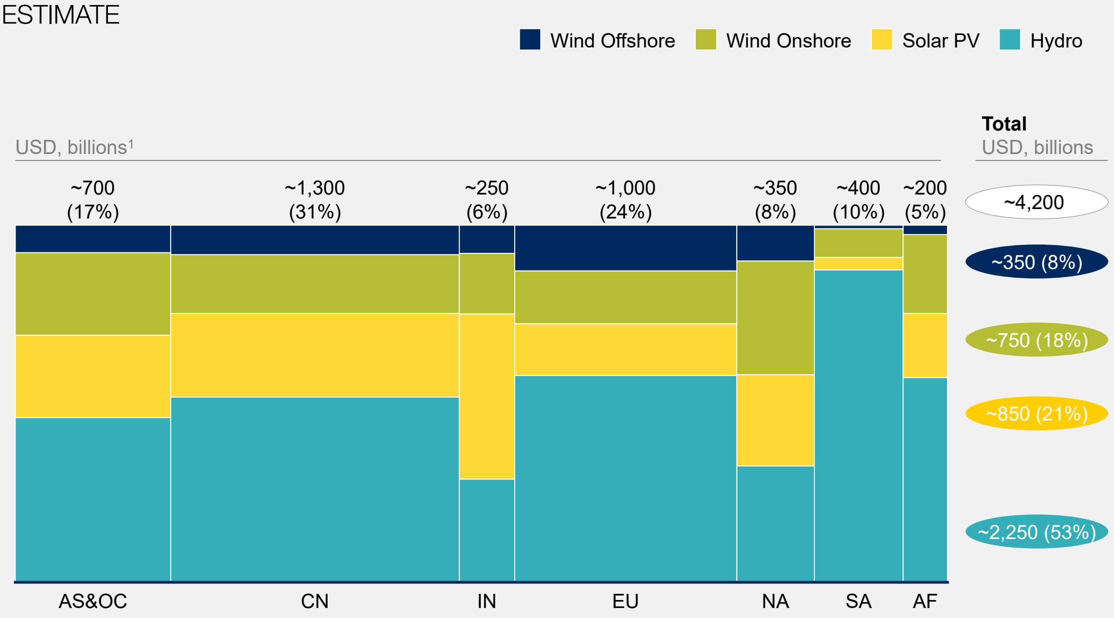
The renewable energy production is estimated to increase by 120% from 6,000 TWh in 2017 to 13,100 TWh in 2030. The production moves from being dominated by hydropower in 2017 to more equal shares of hydropower, solar power and wind power in 2030.

The value of the global renewable energy infrastructure market is estimated to grow by almost 50% from 2.9 trillion USD in 2017 to 4.2 trillion USD in 2030.

From a regional perspective, comparing 2030 (Exhibit 6) to 2017 (Exhibit 3), ~80% of the global growth in value is expected to occur in Asia and Oceania, including ~45% in China. The growth in value in Europe is estimated to be near zero. North America is estimated to have a renewable energy growth of ~2% per year, which is well below world average.

The value of the solar and wind power assets in 2017 is to a large part driven by the governmental support regimes, which account for more than half the value of these assets. The installation cost for these technologies is expected to continue to decrease from 2018-2030. As the costs of installing solar and wind power continues to fall, the value of support regimes is also expected to decline significantly.

EXHIBIT 6 – VALUE OF RENEWABLE ENERGY ASSETS BY REGION AND TECHNOLOGY, 2030 ESTIMATE



1 AF: Africa, AS&OC: Asia and Oceania (excl. China and India), CN: China, EU: Europe, IN: India, NA: North America, SA: South America.

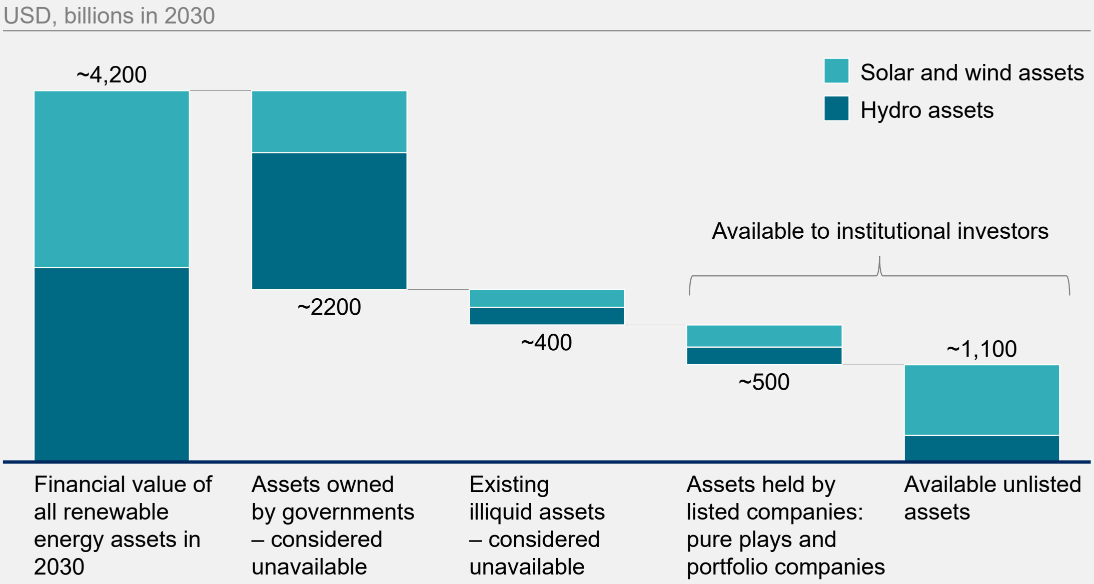
SOURCE: McKinsey Global Energy Perspective (reference case 2019), McKinsey estimates

12 India and China are in this report considered as separate regions because they have the largest estimated growth of renewable energy capacity throughout the world.

Estimated value of the investable share of the market from 2018-2030

In this report, the investable share of the market is defined by supply-side limitations[13] (Exhibit 7). Specifically, part of the renewable energy infrastructure market is not available due to illiquidity and government ownership. This approach thus describes whether it is practically possible to buy the assets, not whether it is attractive for an individual investor.

EXHIBIT 7 – VALUE OF MARKET AVAILABLE TO INSTITUTIONAL INVESTORS, 2018-2030 ESTIMATE



SOURCE: McKinsey Global Energy Perspective (reference case 2019), UDI, Capital IQ, Investment Journal, Web search, McKinsey estimates

The investable share of the market for renewable energy infrastructure over the period 2018-2030 is estimated to 1.6 trillion USD and consists of both listed and unlisted assets.

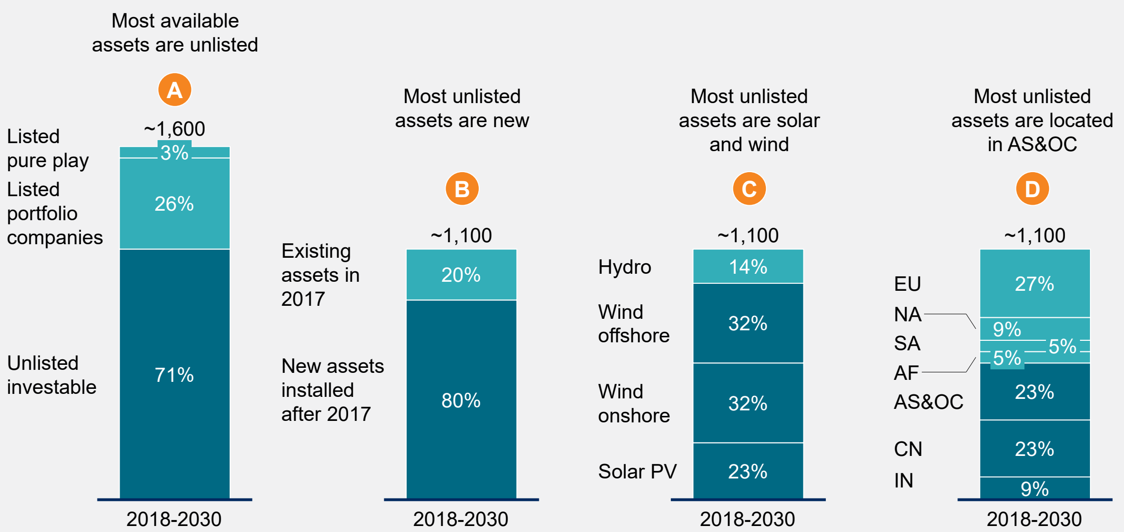
The investable share of the market available to institutional investors in the period 2018-2030 differs between solar/wind power and hydropower. Out of the total estimated value of assets in 2030, ~70% of the solar and wind power assets in the world outside China are estimated to be available to institutional investors in the period 2018-2030. Only ~25% of the solar and wind power assets in China are estimated to be available, due to high government ownership. Similarly, only ~20% of the hydropower assets globally are estimated to be available over the same period, due to high share of government ownership across markets as well as low share of new capacity build.

13 The market available for institutional investors is limited by government ownership and illiquid assets. This analysis of the current ownership split is based on data from UDI SNL Power plant. For this report, the ownership split between government, listed companies and unlisted companies is assumed to remain unchanged within each combination of region and technology between 2017 and 2030. Our analysis of illiquid assets is based on transaction data from Infrastructure Journal, and such constraints are also assumed to remain constant over the period. Residential rooftop solar power and half of the commercial/industry rooftop solar power are assumed to be unavailable to institutional investors.

There are four main characteristics of the estimated investable market (Exhibit 8).

EXHIBIT 8 – BREAKDOWN OF ESTIMATED INVESTABLE MARKET BY OWNERSHIP, INSTALLATION YEAR, TECHNOLOGY AND REGION, 2018-2030 ESTIMATE

USD, billions[1]



1 AF: Africa, AS&OC: Asia and Oceania (excl. China and India), CN: China, EU: Europe, IN: India, NA: North America, SA: South America.

SOURCE: McKinsey Global Energy Perspective (reference case 2019), UDI, Capital IQ, Investment Journal, Web search, McKinsey estimates

A. *71% of the investable market is unlisted.* 29% is in listed companies, and most of this is held by portfolio companies[14] that don't have renewable energy as their primary focus. Only ~3% of the assets are estimated to be held by listed pure-play renewable energy companies[15]. Thus, there is limited opportunity to increase the exposure to renewable energy infrastructure within the current investment mandate of the GPFG[16]. However, as the market matures, it is not unlikely that entry of large listed energy companies and a broader offering of listed investment products will increase this share[17].

14 Examples of portfolio companies investing in renewable energy infrastructure are Berkshire Hathaway, Enel, E.ON, Iberdrola, AES.

15 Pure-play renewable energy companies are in this report defined as companies that have more than 50% of their income from renewable energy infrastructure (e.g. NHPC, Ørsted).

16 Current investment mandate covers listed equity, fixed income and real estate

17 There is a trend that more of the large listed energy companies are entering the renewable energy space. This will likely increase the listed share of the renewable energy infrastructure over time. However, most of the large listed companies entering the renewable energy space will still have most of their investments in non-renewable energy assets. A more mature market for renewable energy infrastructure assets will likely lead to a broader offering of listed investment products with exposure to this sector, e.g. by revival of YieldCo stocks or similar products that will provide liquidity to the renewable energy infrastructure market by increasing market access for investors.

B. *80% of the unlisted investable market is new capacity* installed after 2017, only 20% of the investable value comes from existing assets. Most of the value of existing assets from 2017 is either depreciated (solar and wind power[18]), government-owned (mainly hydropower) or illiquid.

C. *86% of the unlisted investable market is solar and wind power.* Only 14% is in hydropower, since most of the hydropower is government-owned and assumed not to be privatized, and there is low expected growth in the investable share of the total hydropower market.

D. 55% of the unlisted investable market is in Asia and Oceania, more than half of it in China and India.

18 About half of the value of solar and wind power in 2017 is from governmental support regimes with an assumed lifetime of 15 years from construction

2. Political, regulatory and reputational risk

This chapter will cover political, regulatory and reputational risk for renewable energy infrastructure investments along the dimensions of geography, technology, and stage of project lifecycle.

Renewable energy infrastructure has many attractive characteristics to long-term institutional investors. Since it is unlisted, has low liquidity and transaction costs are high (e.g. due to complex due diligence processes), investors tend to take higher ownership shares in a limited number of assets. With higher ownership shares, the owner is more closely associated with the investments, and thus more vulnerable to political, regulatory and reputational risk.

The political, regulatory and reputational risk has been a topic in previous debates on potentially opening for GPFG investments in unlisted infrastructure. It is therefore a part of this report's mandate to build

EXHIBIT 9 – POLITICAL, REGULATORY AND REPUTATIONAL RISKS

Risk category	Risk sub-category	Examples of issues
Political risks	Security and instability	▪ Social unrest ▪ Terrorism ▪ War
	Legal	▪ Expropriation ▪ Deletion or revision of existing agreements ▪ Change in political direction of infrastructure asset management
	Leadership and regime	▪ Election (e.g., democratic, quasi-democratic) ▪ Coup
	Politics and policies	▪ Tax legislation ▪ Labor laws ▪ Environmental standards ▪ Foreign direct investments and trade openness
Regulatory risks	Regulatory certainty	▪ Renegotiations of existing agreements ▪ Modification of public-private partnership framework ▪ Unexpected cut in subsidy schemes ▪ Change in regulatory price point, e.g., stipulated prices, interest rates, asset base ▪ Change in electricity market design, e.g., market resolution ▪ Limitations in price point changes ▪ Limitations to trade (e.g., of critical spare parts), e.g., trade tariffs, local content requirements, import/export quotas, bottlenecking inspections ▪ Inconsistent definitions and enforcement
	Regulatory efficiency	▪ Unclear requirements ▪ Delays to decision making and timelines
Reputat-ional risks	Environmental, social, and governance	▪ Environmental damage, e.g., air and noise pollution, chemical spills ▪ Re-settlements ▪ Lack of local content or diversity ▪ Corruption ▪ Executive remuneration and perks
	Health, safety, and (work) environment	▪ Injuries ▪ Long-term disabilities or chronic conditions ▪ Fatalities
	Stakeholder disagreements	▪ Energy supply vs. amenity disruptions ▪ Local industries and minority interests vs. foreign technology
	Litigation	▪ Defendant (e.g., related to ESG or HSE) ▪ Involuntary co-plaintiff (i.e., end-investor could be implicit co-plaintiff)
	Other negative publicity	▪ Allegations, e.g., adverse press campaigns, profiteering, corruption, embezzling ▪ Subject in political debate, i.e., false accusations of adverse events, e.g., blackouts, community issues ▪ Picketing by special interest groups, e.g., labor unions, community leaders, environmental activists ▪ Association with second-party, e.g., partner accused of corruption ▪ Association with third-party, e.g., partner with close ties to administration accused of corruption

SOURCE : Expert interviews, interviews with large institutional investors, McKinsey & Company (2016) on McKinsey's 2016 report to the Ministry of Finance on political, regulatory and reputational risk in unlisted infrastructure investments with a specific assessment of this risk in unlisted renewable energy infrastructure.

There are multiple examples of relevant political, regulatory and reputational risk categories for infrastructure investments (Exhibit 9). In general, these risks are of similar character in unlisted renewable energy infrastructure as for other unlisted infrastructure. Overall, regulatory risk is particularly important for renewable energy infrastructure as the electricity markets globally are highly regulated. Important regulations include the tariff system, access to the grid, grid charges, price zone resolution, capacity markets and CO2 markets where applicable. Also, conditions in concession agreements and tax regimes represent regulatory risk to all types of renewable energy.

As renewable energy infrastructure assets are highly diverse, the exposure to political, regulatory and reputational risk varies from project to project. Three main asset characteristics explain many of these differences: geography, technology and lifecycle stage.

Risk across geographies

There are large differences in political and regulatory stability and potential for reputational risk between countries. Developed markets often, but not necessarily, have more robust political and regulatory frameworks and hence lower risk. Regulatory quality indicates how regulatory risk varies across the regions. The high-income OECD countries have the highest ranking, followed by the rest of Europe and Central Asia, East Asia and Pacific, Latin America and Caribbean, Middle East and North Africa, South Asia and Sub-Saharan Africa[1]. There are several established frameworks and quantitative indices that can be used to assess the level of political risk for a specific region. For example, EIU's Political Instability Index shows that the OECD countries also have the lowest political instability on average[2]. Reputational risk, e.g. the risk of business conduct, also varies along the geographical dimension.

Risk across technologies

All renewable energy technologies are associated with political, regulatory and reputational risk, but the risk level varies across technologies.

Hydropower projects are often associated with higher reputational risk in many regions, primarily due to environmental impacts and safety risk during construction. Solar and wind power projects are also exposed to reputational risk, but typically at a lower level than hydropower. Solar and wind power projects are also often exposed to regulatory risk of retroactive changes in governmental support regimes.

Hydropower

Large-scale hydropower projects often have social and environmental risk directly related to the construction of the plant, such as ecosystem and marine life impacts, the displacement of ethnic

1 Source: The World Bank: Doing Business 2019 (2018)

2 Source: Economist Intelligence Unit Political Instability Index

groups, and methane release from biomass degradation of flooded areas[3,4]. Hydropower projects also entail risks related to the technical integrity, e.g. the risk of dam breaches[5]. These events are rare but can have large consequences. All these risks increase reputational risk for an owner – especially for projects in regions that lack robust regulatory frameworks and standards or that fail to enforce existing standards.

Hydropower is also exposed to political risk, for example the risk of nationalization following political regime changes. Furthermore, public debate and opposition can cause delays or cancellations of planned and approved projects. For example, in 2014 a 3GW hydroelectric power plant project in Chile was cancelled by the incoming government after several years of public debate and 320 million USD of investments[6].

Hydropower projects are typically heavily regulated to balance the interests of profit creation, the impact on nature and the security of supply to the population and are thus exposed to regulatory risk. For example, many countries impose a resource tax on hydropower to ensure a share of the profit is transferred to the government. Unexpected changes to existing tax schemes or introduction of new tax schemes represent a regulatory risk for these projects.

It is important to note that construction of hydropower also has significant positive effects on the local communities. Beyond providing clean energy and typically reducing greenhouse gas emissions, hydropower projects often provide many water-related benefits, such as flood and drought control, improved navigation and water supply for agriculture, industry and urban consumers[7].

Onshore wind

Onshore wind power installations are located on land, often clustered and are at times located close to populated areas, which has implications for reputational and political risk. However, overall the risk is lower than for hydropower.

Sound and visual impact are the main public health and community concerns associated with operating wind turbines[8]. Furthermore, wind energy can represent a risk of adverse impacts to wildlife, particularly birds[9]. The above factors can represent reputational risk.

Finally, onshore wind power relies on government support regimes in many markets and is thus exposed to the risk of retroactive changes to these, as remuneration levels for older assets are often far above typical power market price levels.

---

3 Hydroelectric reservoirs emit greenhouse gases equaling about a billion tons CO2 every year, caused by degradation of biomass in the water. This represents 1.3% of total annual anthropogenic (human-caused) global emissions. Source: BioScience, Volume 66, Issue 11: Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis (2016)

4 Source: United Nations Framework Convention on Climate Change: How Hydropower can help Climate Action (2018)

5 Source: Chinese Academy of Engineering (CAE) Engineering, Volume 3, Issue 1: Dams and Floods (2017)

6 Source: Nature Conservancy: Improving Hydropower Outcomes Through System-Scale Planning (2016)

7 Source: International Hydropower Association: Do the benefits of sustainable hydropower outweigh the costs? (2014)

8 Source: Union of Concerned Scientists: Environmental Impacts of Wind Power (2013)

9 Source: American Wind Wildlife Institute: Wind Turbine Interactions with Wildlife and Their Habitats (2018)

Offshore wind

Offshore wind power installations are located far from land, which on the one hand reduces reputational and regulatory risk, but on the other hand increases health, safety and environmental (HSE) risk.

The reputational risk related to offshore wind is considered to be lower than for onshore wind. Especially, as offshore wind projects are increasingly being built far from shore, visual impact is a significantly smaller concern for these projects. On the other hands, offshore wind projects entail a significantly higher health and safety risk compared to onshore wind –related mainly to many working hours in an offshore environment during construction (and to a lesser degree during maintenance). Furthermore, additional environmental risks need to be considered, e.g. the impact of "piling noise" on sea mammals[10] or the impact on seabirds, due to collisions, avoidance of area, habitat loss and barrier effects[11].

With respect to political risk, offshore wind power projects have long lead time until completion. Like hydropower, they are therefore exposed to the risk of delays or cancellations of planned and approved projects.

Finally, like onshore wind, offshore wind projects are exposed to regulatory risk related to changes in government support regimes and regulatory risk related to the electricity markets in general.

Solar power

Solar power projects are near ground constructions that generally require significant land areas[12]. They are typically exposed to lower reputational and political risk than other renewable energy technologies, as they have less negative impact on landscape and environment.

Solar power typically has the lowest associated health, safety and environmental risk of the major renewable energy technologies due to the relative simplicity of installing and operating this technology. However, there is some perceived risk related to the decommissioning of solar panels made of cadmium telluride (~5% of worldwide solar panel production[13]) due to toxicity of cadmium[14]. Still, the typical solar projects expose its owners to lower reputational risk than typical projects in other technologies.

Finally, as for other renewable energy technologies, solar power is exposed to general power price risk drivers, most of which are regulatory in nature. Also, like onshore and offshore wind, solar power is particularly exposed to regulatory risk related to changes in government support regimes and to other regulatory risks specific for the highly regulated electricity markets.

Risk across the project lifecycle stages

The political, regulatory and reputational risk types differ across the lifecycle of a renewable energy infrastructure asset.

10 Source: The Norwegian Water Resources and Energy Directorate: Havvind – Forslag til utredningsområder (2010)

11 Source: Norwegian Institute for Nature Research: NINA Report 616, Offshore vindanlegg og sjøfugl (2011)

12 There is also a significant portion of rooftop solar power, but this section focuses on utility scale, ground mounted solar power that are the most available assets for institutional investors.

13 Source: Fraunhofer ISE: Photovoltaics Report (2014)

14 Source: The Norwegian Geotechnical Institute: Environmental risks regarding the use and end-of-life disposal of CdTe PV modules (2010)

The project lifecycle can be divided into pre-operating stage and operating stage, and an investor can invest in both stages. Overall, investing in an operative asset entails less political, regulatory and reputational risk than investing in assets in the pre-operating stage. However, reputational risks, especially those related to safety, are more pronounced during the construction phase.

Political risk is mainly region-specific and will be present at both stages. The total risk exposure will be higher for the operating stage as it is longer.

Regulatory risk is present at both stages, but in different forms. At the pre-operating stage there will be negotiations on the terms for the future lifecycle of the project. If the terms are unfavorable, the investor may have the option to abandon the project with limited sunk cost.

Reputational risk is highest at the pre-operating stage, but also present at the operating stage. Any special interest group that wants to change or stop the project will direct most of their effort into the pre-operating stage. HSE risk is particularly higher in the labor-intensive construction phase of the pre-operating stage than at operating stage, entailing reputational risk exposure.

Expected development towards 2030

Going forward, the regulatory, political and reputational risk exposure for renewable energy infrastructure will gradually shift as the technologies develop and the mix of asset types changes:

- As installation costs of solar and wind power continues to decrease and the economic attractiveness increases, the regulatory risk of support schemes is expected to decrease. Exposure to the general regulatory risk inherent to all power sector investments will remain.
- Growth in renewable energy infrastructure will be highest in solar and wind power, which are associated with lower political, regulatory and reputational risk than hydropower.
- Growth will be concentrated in the emerging markets, which could increase exposure to overall political, regulatory and reputational risk.

Finally, as the effects of climate change are more widely recognized, it is possible that the public support for renewable energy will increase due to its important role in limiting global warming. This may over time balance the political, regulatory and reputational risk of renewable energy infrastructure versus other investment options.

There is a large investment opportunity in segments of the investable market with lower political, regulatory and reputational risk. Towards 2030, an estimated ~45% of the unlisted investment opportunities (~500 billion USD) are within OECD countries. Almost all of this, ~430 billion USD, is within the combination of OECD countries and solar or wind power.

Mitigation of political, regulatory and reputational risk will be important for investors entering this space. Mitigation mechanisms include, but are not limited to, partnering with local actors, internal capabilities, presence in target markets, board representation, and adequate choice of investment models[15].

15 Source: McKinsey & Company: Unoterte infrastruktur-investeringer (2016)

3. Investing in the market for renewable energy infrastructure

This chapter describes how large institutional investors invest in unlisted renewable energy infrastructure, in terms of the level of activity, types of assets targeted, and investment models deployed.

The information in this chapter is based on publicly available information in annual reports, sustainability/responsible investor reports, company press releases, available transaction databases[1], and expert interviews. As the publicly available information on investors' positions in unlisted renewable energy infrastructure is fragmented, the description of the market and individual players may not be complete or fully representative of the total investor landscape.

Activity of institutional investors in unlisted renewable energy infrastructure

Over the last decade, institutional investors have been increasingly active in the unlisted investable renewable energy market[2]. This can be explained by the increased allocation of capital to infrastructure in general due to the attractive characteristics of this asset class and the increased maturity of renewable energy technologies.

EXHIBIT 10 – SELECTED INSTITUTIONAL INVESTORS THAT ARE INVESTING IN UNLISTED RENEWABLE ENERGY

Region	Investor[1]	Country	AUM 2017[2] USD, billions	Year of first reported UREI deal[3]	Examples of recent statements on renewable energy strategy
North America	CPP Investment Board		277	2008	Created Power & Renewables group with a mandate to build a global portfolio in renewable energy in 2017
	CDPQ		238	2014	Committed to ~6 billion USD in low carbon investments by 2020, including expanding its large renewable energy portfolio
	OMERS		76	2018	N/A
Europe	ABP		490	2016	Committed to a target of ~5.7 billion USD investments in renewable energy by 2020. Reached ~4.7 billion USD already in 2017
	PGGM		263	2010	Targets a ~20 billion USD impact investment portfolio including investments in renewable energy. Has currently invested ~7.3 billion USD in sustainable energy and clean technology.
	atp		128	2009	N/A
	PFA		91	2016	Aims to extend their portfolio of alternative investments, including renewable energy, by 6 billion USD within 2020
	AP2		40	N/A	N/A
	PensionDanmark		40	2012	Committed to invest 600 million USD in Copenhagen Infrastructure Partners' 3rd renewable energy fund in addition to its current investment of ~3 billion USD
Asia	ADIA		769[4]	2015	N/A
	GIC		398[4]	2015	N/A
	TEMASEK		235	2017	N/A

1 These investors represent a sample of large pension funds and sovereign wealth funds from North America, Asia and Europe (including two Scandinavian funds) | 2 AUM: Assets under management | 3 UREI: Unlisted Renewable Energy Infrastructure | 4 GIC and ADIA AUM based on estimates from SWC

SOURCE: Preqin, SWFI, SWC, Company reports, Company websites, Press search

DISCLAIMER: The data is based on publicly available information and may not be complete of fully representative

1 Source: Preqin: Preqin Renewable Energy Infrastructure (May 2018) and Sovereign Wealth Fund Institute (SWFI) databases

2 Source: Preqin: Preqin Renewable Energy Infrastructure (May 2018)

Development and commercialization of solar and wind power technologies has brought down technical risk to an acceptable level for institutional investors. In addition, some institutional investors face requirements from their owners to invest responsibly e.g. by improving the climate profile of their portfolios. This is often the case for state-owned pension funds.

This report looks more closely at a sub-set of large institutional investors comprised of large pension funds and sovereign wealth funds that have unlisted renewable energy in their portfolios (Exhibit 10)[3].

Type of investments made by large institutional investors in renewable energy infrastructure

Looking at a selection of large transactions made by large institutional investors between 2015 and 2018 gives an indication of which renewable energy infrastructure assets institutional investors are investing in, in terms of technology, geography and lifecycle stage (Exhibit 11).

EXHIBIT 11 – RENEWABLE ENERGY INVESTMENTS BY INSTITUTIONAL INVESTORS

Offshore wind | Onshore wind | Solar | Hydro

Buyer	Seller	Acquisition target	Project phase[1]	Total capacity of acquired asset GW	Deal value USD, billions	Investment model	Ownership structure
CPP Investment Board	Enbridge	Renewable energy portfolio (2018)	Non-operating Operating	1.8	1.3	Indirect investment	▪ CPPIB (49%) ▪ Enbridge (51%)
	NextEra Energy Resources	Renewable energy portfolio (2018)	Operating	0.4	0.7	Direct investment	▪ CPPIB (100%)
	ADB	ReNew Power Ventures (2018)	Operating	4.9	0.4	Indirect investment	▪ CPPIB (16,2%) ▪ GS (48,6%) ▪ ADIA, Jera, GEF
CDPQ	enel	Renewable energy portfolio (2018)	Operating	1.8	1.4	Indirect investment	▪ CDPQ and CKD IM (80%) ▪ Enel (20%)
	DONG energy	London Array (2017)	Operating	0.7	1.1	Direct investment	▪ CDPQ (25%) ▪ E-on (30%) ▪ Ørsted (25%) ▪ Masdar (20%)
OMERS	ARCLIGHT	Leeward Renewable Energy (2018)	Non-operating Operating	1.7	Undisclosed	Indirect investment	▪ Omers (100%)
ABP	CapitalDynamics	Renewable energy portfolio (2018)	N/A	1.2	0.4	Fund investment	▪ ABP, CalSTRS and ADIA
	Primary investment	Åskalen (2017)	Non-operating	0.3	1.2	Direct investment	▪ ABP (100%)
PFA	Ørsted	Walney Extension (2017)	Non-operating	0.7	1.3	Direct investment	▪ PFA (25%) ▪ PKA (25%) ▪ Orsted (50%)
PGGM	EDF renewables	Renewable energy portfolio (2018)	Operating	0.9	Undisclosed	Direct investment	▪ PGGM (50%) ▪ EDF (50%)
TEMASEK	CYPRESS CREEK	CypressCreek Renewable Energy (2018)	Non-operating Operating	0.3	0.7	Indirect investment	▪ N/A
GIC	Greenko	Greenko (2015-2018)	Non-operating Operating	4.5	1.0	Indirect investment	▪ GIC (60%) ▪ ADIA (15%) ▪ Founders (25%)
ADIA	CapitalDynamics	Renewable energy portfolio (2018)	N/A	1.2	1.2	Fund investment	▪ ABP, CalSTRS and ADIA
	Greenko	Greenko (2015-2018)	Non-operating Operating	4.5	0.3	Indirect investment	▪ GIC (60%) ▪ ADIA (15%) ▪ Founders (25%)

1 Project phase at time of investment

SOURCE: Preqin; SWFI; Company reports; Company websites; Press search

DISCLAIMER: The data is based on publicly available information and may not be complete of fully representative

3 Other institutional investors are also active in the market for unlisted renewable energy infrastructure, e.g. insurance companies and fund managers. These investor categories are not described in this report.

In the deals studied, we see that investors are investing across a wide range of renewable energy technologies. Most investments have been in solar, onshore and offshore wind power.

On the geographic dimension, the selection of deals studied suggest that investors focus their investments in OECD countries, mainly in Western Europe and North America. The exception is Singapore and Abu Dhabi-based sovereign wealth funds GIC and ADIA and Canadian pension fund CPPIB that have acquired equity positions in Indian renewable energy companies.

As described in chapter 1, most of the market for renewable energy infrastructure available to institutional investors from 2018 to 2030 is estimated to be in Asia and Oceania (55%). Going forward, an investor preference for Western Europe and North America where there is relatively fewer investment opportunities, could drive up asset prices in these markets, while the investment opportunities in Asia and Oceania could become relatively more favorable.

In terms of lifecycle, the deals studied suggest that investors take positions in both operating assets and greenfield investments.

Approach to renewable energy infrastructure investments

Institutional investors can access renewable energy infrastructure through different investment models. The investment model has implications for the investor's need for internal organization and capabilities, as well as the exposure to, and the mitigation of, political, regulatory and reputational risk.

- *Direct investment* is when the institutional investor invests directly (not via an external manager or operating renewable energy company) into specific infrastructure assets such as wind farms and solar power plants, either in development or operating phase. This typically involves taking a significant ownership share in large projects, e.g. offshore wind farms.

  For example, ABP invested directly in the primary market by taking a 100% stake in the Åskalen wind farm project in Sweden, which will be the largest onshore wind farm in Sweden. PFA has invested directly in Walney, the world's largest offshore wind farm, along with pension fund PKA and wind farm operator Ørsted.

- *Indirect investment* is when the institutional investor invests in companies that either develop, acquire, own and/or divest a portfolio of renewable energy infrastructure assets. Often, these are co-investments with one or several other investors. The ownership share taken can range from minority stake to full ownership. The sample of deals studied indicate that indirect investment in renewable energy companies is the most commonly used investment model (Exhibit 11).

  For example, both ADIA and GIC have invested in Greenko, an Indian renewable energy company. Similarly, CPPIB has invested ~16% in ReNew Power in which also Goldman Sachs and ADIA have a significant equity stake.

  Some investors create joint venture companies with a strategic partner, which in turn invest directly or indirectly in renewable energy infrastructure. For example, CDPQ and CKD IM, a consortium of Mexican pension fund managers, have created a JV investment platform that combines CDPQ's infrastructure expertise with CKD IM's local knowledge. Through this co-investment vehicle, they invest in different infrastructure assets in Mexico. Similarly, CPPIB has created a JV with Enbridge as an operating partner to explore investments in renewable energy.

- *Fund investment* is when the institutional investor invests in funds managed by an asset manager, that in turn invest in a portfolio of renewable energy assets or companies. For example, Pension Denmark invests in fund management company Copenhagen Infrastructure Partners that focuses on investments renewable energy.

  For example, Pension Denmark invests in fund management company Copenhagen Infrastructure Partners that focuses on investments in renewable energy.

In addition to these three investment models that are typical, but not restricted to, equity investments, the investors can access debt in unlisted renewable energy infrastructure projects. Green bond investment is when the institutional investor invests in bonds issued to raise capital for renewable energy infrastructure specifically.

Case example: A large institutional investor's approach to renewable energy infrastructure investments

To provide a more detailed understanding on how a large institutional investor can approach the market for renewable energy infrastructure, this section describes a case example on a professional investment management company managing one of the top 10 largest public pension funds in the world, with a significant share of assets under management in infrastructure. This investor entered the market for renewable energy infrastructure relatively early compared to other sovereign wealth funds and state pension fund investors, and is continuing to pursue investment opportunities.

The mandate for this investor distinguishes it from a typical sovereign wealth fund, in that it operates at arm's length from national and state/regional governments, guided by an independent professional Board of Directors. The mandate is investment only and insulated from political interference in investment decision-making. The investor is addressing climate change as part of their overall strategy and has an explicit mandate to invest in renewable energy.

Organizational and operational changes have been made to support the strategic focus of investments in renewable energy. First, the investor has established a dedicated Steering Committee on climate change to "accelerate understanding and take action on both the risks and opportunities stemming from climate change". Second, it recently established a dedicated corporate level renewable energy investment group, with a mandate to build a global portfolio and take advantage of growing market opportunities as the energy sector transitions and global power demand grows, especially for low-carbon energy alternatives. This group is focusing on the transition towards renewable energy, which requires specific capabilities. The group consists of more than 15 people, including generalists and domain specialists. The renewable energy investment organization of the investor has a matrix structure, comprised of the central renewable energy investment group, local investment teams, and functional expertise on infrastructure. The renewable energy investment organization has presence in the investor's offices in Europe, North America, South America and Asia. The central group develops the investment strategy and priorities, while local teams follow up on investments.

Looking at investments over the past decade, the investor has reported transactions in unlisted renewable energy infrastructure comprising more than 1% of total value of assets under management. In terms of geographic focus, most of the investments in renewable energy infrastructure assets have been made in their home region within the OECD. However, it has recently taken steps to enter emerging markets such as Latin America and Asia. Most investments have been in onshore wind power. However, it recently invested in offshore wind projects in Europe and has entered a joint venture (JV) with a major utility company to pursue further offshore wind power opportunities in this region. Recently, the investor issued green bonds to finance further investments in renewable energy infrastructure.

The investor has deployed both indirect and direct investment models. Most of the deals are indirect investments in companies that in turn own assets. It invests in different parts of the value chain, e.g. in both developers of assets and operators. It also considers partnerships with developers to get exposure to greenfield projects.

When assessing the risks of investment opportunities, it puts more emphasis on geographic risks than technology-specific risks. To mitigate risks, multiple preventive actions are taken. An important part of risk-mitigation is leveraging the internal capabilities and knowledge of local markets. It also partners with external companies to complement internal organization and capabilities. For example, it has invested in building long-term partnerships with high performing investment managers and locally specialized investment expertise in regions of interest. It has entered into a JV agreement with a local partner focused on investments in a specific power generation market. Risk is also managed on the company level. The typical governance mechanism is appointment of board members in the target's Board of Directors. This typically applies for investments where the investor has a significant or majority ownership share.

Although investment results are not publicly available, both organizational development changes and continued investments indicate that the investor maintains a positive outlook for renewable energy infrastructure investments.

References

External publications

- DNV GL: Energy Transition Outlook 2018 – A global and regional forecast to 2050 (2018)
- IEA: World Energy Outlook 2018 (2018)
- IPCC: Intergovernmental Panel on Climate Change, Special Report: Global warming at 1.5°C (2018)
- IRENA: Renewable Power Generation Costs in 2017 (2018a)
- REN21: Renewable Energy Policy Network for the 21st Century: Renewables 2018 – Global Status Report (2018)
- The World Bank: Doing Business 2019 (2018)
- McKinsey & Company: Unoterte infrastruktur-investeringer (2016)
- McKinsey & Company: Equity investments in unlisted companies (2017)
- McKinsey & Company: McKinsey Global Energy Perspective (2018)

Databases

- Dealogic, Dealogic (2018)
- Enerdata: Enerdata (2018)
- IRENA: Global Renewable Energy Policies and Measures Database (2018b)
- Infrastructure Journal
- McKinsey & Company: McKinsey Global Energy Perspective (2018)
- Preqin: Preqin Renewable Energy Infrastructure (May 2018)
- UDI: UDI SNL – Power plant list (2018)

Company websites

CPPIB, CDPQ, OMERS, ABP, PGGM, Temasek, GIC, ADIA, ATP, AP2

December 2018

www.mckinsey.com