Policies for Enabling Corporate Sourcing of Renewable Energy Internationally

A 21st Century Power Partnership Report

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Technical Report
NREL/TP-6A50-68149
May 2017

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CLEAN ENERGY MINISTERIAL
Accelerating the Transition to Clean Energy Technologies

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Acronyms and Abbreviations

AWS	Amazon Web Services
BIAL	Bangalore International Airport Limited (India)
CCA	community choice aggregation
CEL	clean energy certificate (Mexico)
CEM	Clean Energy Ministerial
CSP	concentrating solar power
DVP	Dominion Virginia Power (United States)
FIT	feed-in tariff
GHG	greenhouse gas
GO	guarantee of origin
GW	gigawatt
I-REC	International Renewable Energy Certificate Standard
IRENA	International Renewable Energy Agency
KERC	Karnataka Electricity Regulatory Commission (India)
kW	kilowatt
kWh	kilowatt-hour
LCOE	levelized cost of electricity
MBR	market-based rate
MCE	Marin Clean Energy (California, United States)
MW	megawatt
MWh	megawatt-hour
NREL	National Renewable Energy Laboratory
PMA	power management agreement
PPA	power purchase agreement
PV	photovoltaics
REC	renewable energy certificate
TIGRs	Tradable Instruments for Global Renewables
TWh	terawatt-hour
USD	U.S. dollars

Executive Summary

Corporate interest in the use of renewable energy has grown substantially in recent years, with large purchasers having noticeable impact on renewable energy development in some locations. A variety of global companies headquartered in Europe, Asia, and North America have set targets to achieve 100% renewable energy consumption, while many others have established smaller, but substantial goals. Figure ES-1 shows corporate procurement of off-site renewables, based on data from CDP (formerly the Carbon Disclosure Project). Collectively, corporate buyers have the potential to drive a sizable amount of new renewable energy development through private sector investment in both mature and nascent renewables markets. This is because corporates often want to buy renewables near their facilities and their commitment to purchase power from the renewable energy project means the project can obtain financing from banks. The policy enabling environment is a key factor that will determine where and how corporations procure renewables.

Figure ES-1. Location of off-site renewable energy projects purchased by 1,959 companies reporting to CDP

Green > 50, yellow=20–50, orange=5–20, red=1–5 projects.
Data Source: CDP; Map Source: eSpatial

This paper, which explores the policy and regulatory enabling environment for corporate sourcing of renewables, has been developed in support of the Corporate Sourcing of Renewables Campaign, which was launched at the Clean Energy Ministerial (CEM) meeting in June 2016. Through the campaign, a subset of CEM member governments is collaborating with corporate and nongovernmental organization partners to facilitate increased corporate procurement of renewables and pursue supportive policies for corporate procurement.

Policymakers play an important role in the development of robust markets for corporate renewable energy procurement. There are opportunities to facilitate corporate renewable energy use in both liberalized and vertically integrated markets. Table ES-1 summarizes mechanisms that corporations have used to procure renewable energy globally. In general, liberalized markets with direct access for at least some customers typically offer more options and the potential for greater cost savings.

Table ES-1. Summary of Corporate Renewable Energy Procurement Mechanisms

	Capital and Operating Expenditures	Project Size	Contract Length	Level of Risk for Corporation
Corporate Ownership	Yes	Scalable; site limits on-site size	No contract	Production risk
PPAs	No, but significant financial commitment	Scalable; site limits on-site size	Long-term contract	Basis risk if the project is located in a different region
Utility Green Tariff	No	Typically large	Long-term contract	Low to medium risk, little control
Direct Access	No	Scalable, often larger deals	Contract duration varies	Low to medium risk
Community Renewables	Up-front capital required under some programs	Small to medium	Contract duration varies	Low to medium risk
Unbundled Certificates	No	Scalable	Typically 1-3 year terms or longer	No project level risk, but contract duration risk

A variety of options exist for policymakers to expand available procurement options, reduce project development risks, and potentially lower the cost of procurement. Options include:

- Support tracking and certification systems for renewable energy attributes to increase clarity of ownership and the ability of corporate renewable energy purchasers to make claims about the use of renewables
- Eliminate barriers to grid access or grid interconnection and permitting to enable feasible on-site interconnection
- Enable direct access for large purchasers through bilateral contracts or procurement through third-parties where feasible
- Develop open access transmission policies and the ability to "wheel" power from off-site renewable energy generators
- Develop large, transparent wholesale markets that facilitate price transparency and direct participation
- In vertically integrated markets, encourage utility options and tariffs for large buyers
- Ensure policies do not inhibit market development and the ability of corporations to make clear claims about purchases
- Provide other incentives, such as tax exemptions or net metering to enable renewable energy to be more economical, especially in markets where fossil fuel subsidies artificially lower electricity prices.

Policy certainty is also essential to creating vibrant markets for renewable energy. In addition, **policy interaction is important to consider** because buyers seek assurances that their investments in renewables have impact and wish to make clear claims about their renewable energy purchases.

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1 Introduction

Many corporations are increasing their commitments to procuring renewable energy, motivated by a variety of benefits provided by clean energy technologies (e.g., environmental benefits, price stability). Nearly 100 large companies in Europe, India, China, and the United States have set targets to achieve 100% renewable energy consumption in coming years, as evidenced by the participants in the RE100 initiative and the We Mean Business coalition,[1] while a larger number of companies have established smaller, but still substantial, renewable energy purchasing goals. CDP[2] reports that more than 1,100 companies have indicated that they purchase renewable energy for their facilities globally, with collective purchases of more than 1,500 terawatt-hours (TWh) in 2016 (CDP 2017). Sizable purchases and investments by corporations are having noticeable market impact in some locations (e.g., North America, Europe, Asia). Corporate buyers have the potential to drive a substantial amount of new renewable energy development and help advance nascent or mature renewable energy markets. Governments looking to increase renewable energy could enable corporate investment to help build robust markets. However, the policy environment plays a key role in shaping where and how corporations will invest in renewables.

This paper has been developed in support of the Corporate Sourcing of Renewables Campaign, which was launched at the Clean Energy Ministerial (CEM) meeting in June 2016 to spur additional private sector commitments to procuring renewable energy and action by policymakers to enable corporate renewable energy procurement. A subset of CEM member governments is collaborating with corporate and nongovernmental organization partners to facilitate increased corporate procurement of renewable energy and pursue supportive policies. The campaign is led by Germany and Denmark, with support from China, the European Commission, Mexico, Sweden, the United Kingdom, and the United States. As part of the campaign launch, many companies announced new renewable energy purchasing targets and commitments (Apple, Autodesk, Facebook, Google, Microsoft, Wells Fargo), and some made commitments to purchase 100% renewable energy (Dentsu Aegis Network, Equinix, Interface, Inc., Tetra Pak, and TD Bank). This paper is designed to support the campaign by exploring the policy enabling environment for corporate sourcing. This report may help inform dialogues on possible actions governments can take to provide policy and market frameworks that allow corporations to effectively achieve their renewable energy procurement targets.

Interest in renewables procurement in new markets is on the rise. Many large companies have facilities and supply chains in multiple countries, and are interested in procuring renewable energy from the grids where they use energy. For example, many large technology companies have data centers, offices, and manufacturing facilities that span several continents and have made commitments to power their operations, and in some cases the operations of their suppliers, with renewable energy wherever those operations may be located. Other types of companies are also interested in procuring renewables for their manufacturing and office facilities around the globe, but small companies can differ from large companies in their ability to finance or contract for renewable energy projects and in the types of renewable energy products that they can procure. Corporate renewable energy procurement options are influenced by factors such as

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[1] For additional information, see the RE100 Initiative, http://there100.org/re100, and the WeMeanBusiness Coalition, https://www.wemeanbusinesscoalition.org/take-action/commit-100-renewable-power.

[2] Formerly the Carbon Disclosure Project.

internal access to capital; leased versus owned facilities; their investment horizons in a given market; and the size, shape, and reliability requirements of their electricity load.

Internationally, some countries do not yet have robust markets for corporate renewable energy sourcing, but there may be opportunities to develop these markets, particularly in jurisdictions undergoing power sector regulatory reform. For policymakers in jurisdictions that have renewable energy goals, corporate interest in renewables procurement is one way to expand adoption and build markets without the use of direct mandates. Sourcing from renewables can also help address rapid electricity demand growth because renewables can often be developed more quickly than conventional generation sources.

The policy environment and regulations that affect the ability to procure renewable energy are critical for corporations to successfully source their electricity from renewables. Companies are interested in being able to credibly procure renewables at competitive prices, make verifiable claims about purchases, ensure that no other entity is making the same claims from the same resource, and procure renewable energy located near their operations that can also provide positive regional or local impacts.

The contractual mechanisms for procuring renewable energy can be complex, particularly for purchases from off-site renewable projects. Purchasing renewable energy means differentiating electricity based on the attributes of the generation and allocating the renewable attributes to specific customers. These attributes and specified generation are typically not physically delivered to the customer. The renewable energy attributes are separate from the physical electricity, which becomes indistinguishable and untraceable once it is placed on the grid. As a result, the use of specified renewable energy sources can only be determined contractually, which introduces the need for tracking and certification. A variety of procurement mechanisms have been developed and used internationally to address these challenges with renewable energy procurement, but not all jurisdictions have tracking and verification systems in place to accommodate the full suite of procurement options that exist.

The purpose of this paper is to explore policies and regulations that can facilitate corporate renewable energy procurement, whether in fully liberalized or vertically integrated electricity markets. The paper explores global experience and key policy elements that influence the ability of corporations to complete on- and off-site renewable purchases and finance projects. The discussion is informed by interviews conducted with corporate renewable energy purchasers, renewable energy developers, and other stakeholders. In addition, case studies throughout the document highlight examples of policies enabling successful corporate renewable energy sourcing. Finally, the paper concludes with important policy elements that can facilitate corporate renewable energy procurement, based on jurisdictions that have achieved robust renewable energy markets.

2 Background on Corporate Interest in Renewable Energy Sourcing

2.1 Corporate Commitments and Motivations for Renewable Energy Sourcing

Companies are increasingly making commitments to use renewable energy and working with regulators, utilities, and others to facilitate and promote corporate renewable energy sourcing. Some companies have included renewable energy procurement within broader climate change strategies and corporate social responsibility practices, and have also coupled renewable energy procurement commitments with initiatives to reduce energy usage through the installation of energy efficient technologies and through energy management practices.

As of April 2017, 89 companies have pledged to use 100% renewable energy under the RE100 campaign, which is supported by The Climate Group, CDP, and the We Mean Business coalition. Companies making a pledge specify the target year they seek to be 100% renewable. The RE100 commitments alone total over 113 TWh of renewable energy, around the same amount of power consumed by the United Arab Emirates or the Netherlands (RE100 2017). In addition, more than 50 companies reporting to CDP noted that they had a renewable electricity generation target, and more than 1,100 companies, or 56%, (of 1,900 companies) have reported that they have on-site renewable electricity and/or purchase off-site renewable energy. Nearly half of companies in the Fortune 500 have established renewable energy, efficiency, or greenhouse gas reduction targets (WWF et al. 2017).

Companies are setting goals and purchasing renewable energy for a variety of reasons. Top drivers of corporate renewable energy procurement are to meet internal climate change targets, reduce energy expenses, and demonstrate corporate leadership, according to a survey of 37 companies participating in the Corporate Eco Forum or the Buyers' Principles (Figure 1). Figure 1 indicates how companies rank various drivers of renewable energy sourcing, on a scale from zero to five, with five being the strongest driver. Some countries may require companies to comply with renewable energy mandates, as is the case under Mexico's renewable energy target and in parts of South America.

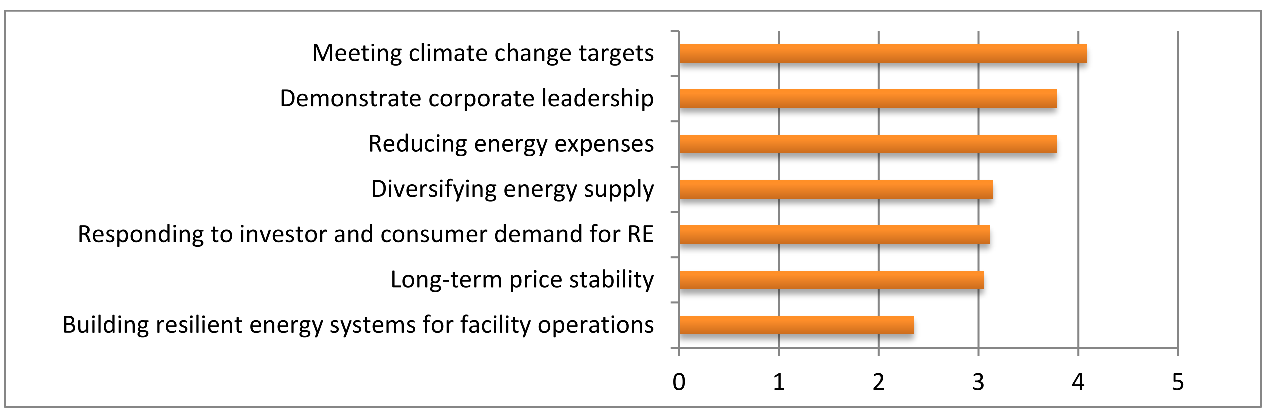

Figure 1. Drivers of corporate renewable energy procurement (scale of 1–5, 5 = strongest driver)

Source: Edwards et al. 2016

Companies are collaborating with utilities and the renewable energy industry to develop new purchasing options around the world as they try to meet their renewable energy goals by procuring renewable energy as close to their load as possible. They are often interested in procuring where they utilize energy to encourage new renewable energy projects in regions where they operate and influence the local electric mix. In addition, some companies have expressed interest in greening their supply chain. For example, companies that buy goods from large manufacturing facilities may want to ensure that those facilities use renewable energy. Ensuring that suppliers use renewable energy can be complicated because the company does not have direct control over what electricity sources are used. Companies can encourage their supply chain to use renewable energy by writing renewable energy use into procurement solicitations and by working directly with suppliers to help them purchase renewable energy. Companies can have a great deal of influence over their supply chain because they may be buying 100% of the output from a particular manufacturer. For example, Apple has committed to working with its suppliers in China to install more than 2 gigawatts (GW) of renewable energy. As part of this program, Apple supplier Foxconn announced that it committed to build 400 megawatts (MW) of solar in China by 2018 (Apple 2015).

2.2 Commercial Sector Opportunities in CEM Countries

Though some companies are already setting renewable energy goals and purchasing renewable energy, there is potential for greater renewable energy procurement. A significant opportunity for increasing renewable energy demand from corporates lies in the commercial sector.[3] Large industrial energy users have the incentive and expertise to manage their energy costs. In the commercial sector, however, energy costs are often a small percentage of costs and typically do not attract the same visibility and managerial attention.

The magnitude of the renewable energy growth opportunity in the commercial sector can be seen in Figure 2, which shows that total commercial sector electricity consumption in CEM countries amounted to 3,530 TWh in 2014 (22% of all CEM consumption that year). The commercial sector ranged from 6.6% of total end-use electricity consumption in China to a high of 36.7% in the United Arab Emirates. It should also be noted that there is significant potential for renewable energy growth in the industrial sector; in India industrial consumption represented 41% of total electricity consumption during 2014, while in China it represented 67%.

[3] The commercial sector is also referred to as the services sector in some parts of the world. This encompasses 14 major sector categories spanning the United Nations International Standard Industrial Classification (ISIC) of economic activities, categories 36-39 and 45-96.

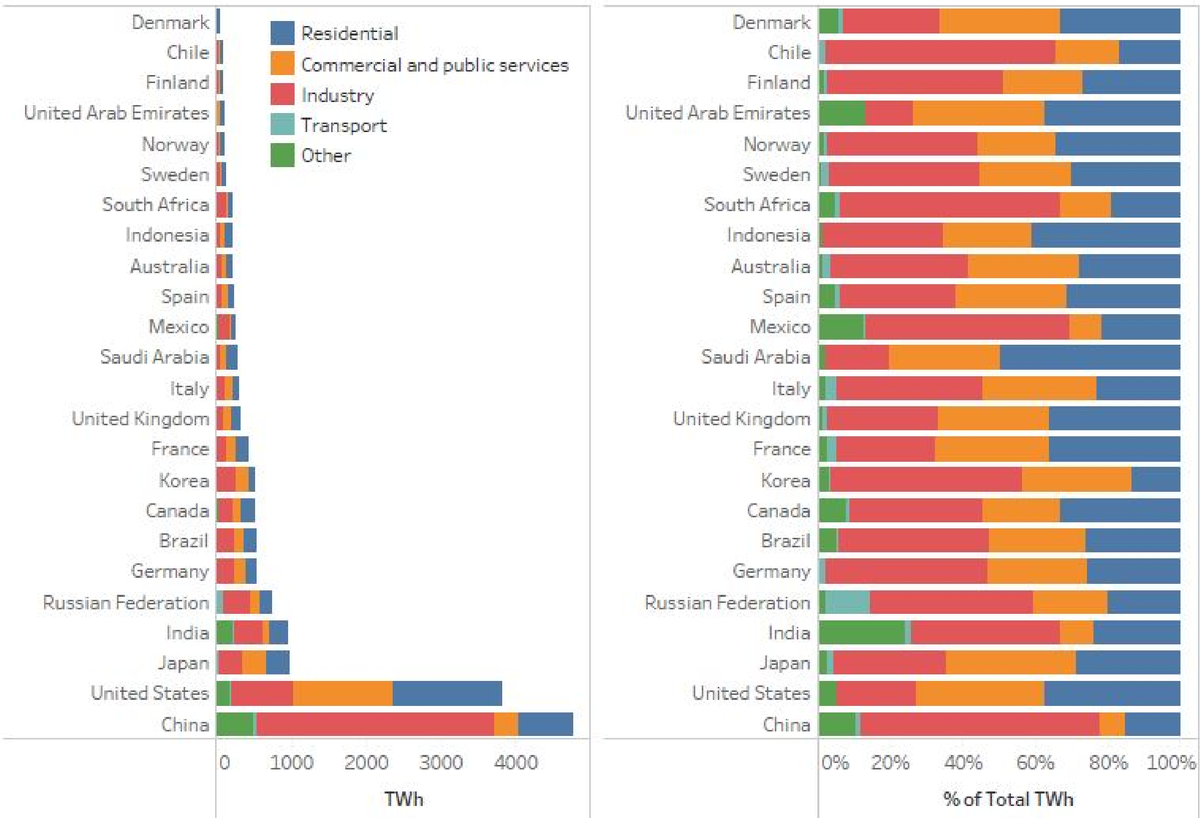

Figure 2. Electricity consumption by segment in CEM countries in 2014

Source: IRENA based on IEA Energy Balances 2016

Enabling policies for corporate renewable energy procurement have the potential to unlock the significant financial resources that companies in the commercial sector spend on electricity. Preliminary estimates for the value of the commercial electricity market in CEM countries indicate an aggregated value of around USD 485 billion/year (Figure 3). In Japan (due to high electricity prices) and the United States (due to high consumption), annual expenditures can exceed USD 100 billion/year.

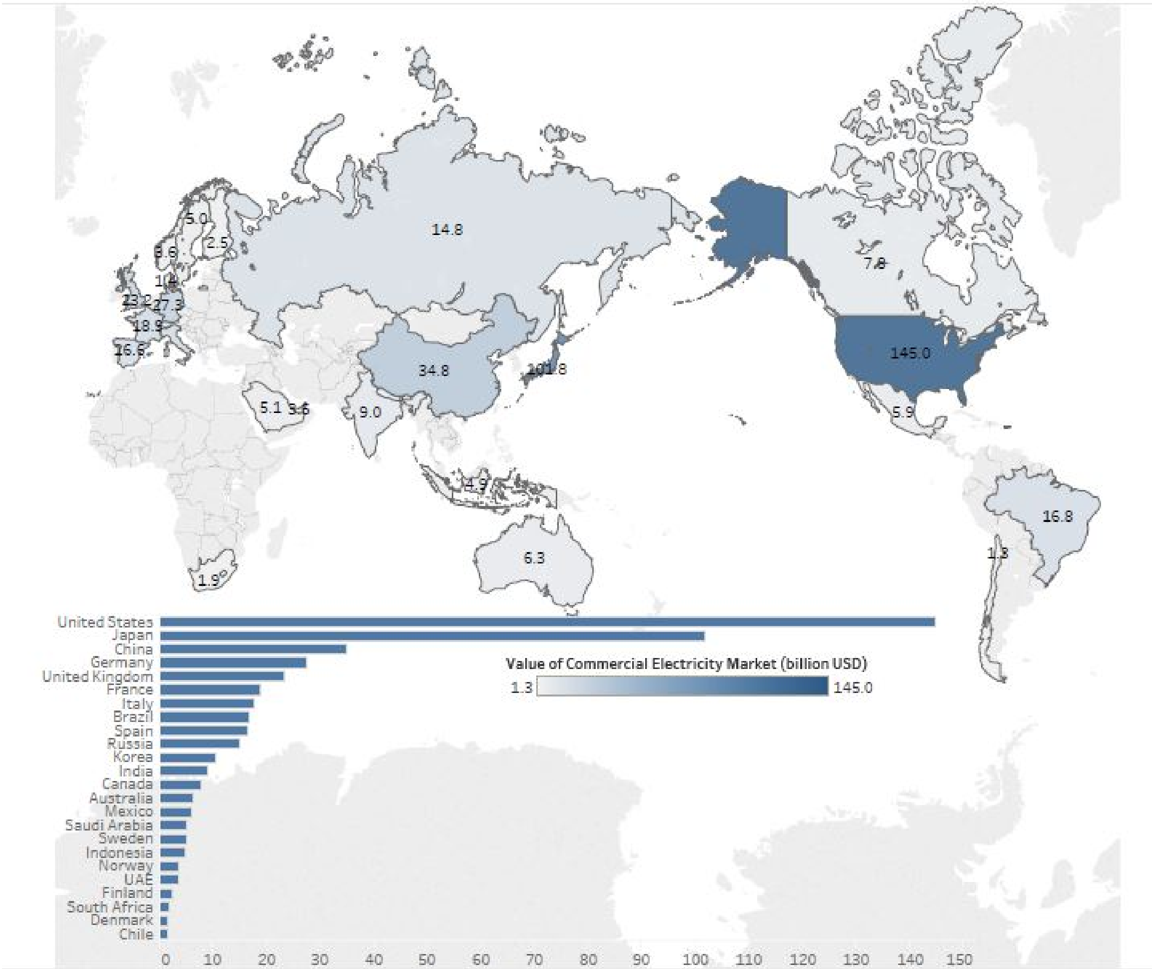

Figure 3. Value of the commercial electricity market of CEM countries (billion USD/year in 2014)

Source: IRENA analysis based on IEA Energy Balances 2016.

3 Overview of Renewable Energy Procurement Mechanisms

Corporations have used a variety of means to buy renewable energy. The degree to which the local market and regulatory context allows corporations to cost-effectively purchase renewable energy from off-site renewable energy generators influences the range of available options. This section summarizes renewable energy procurement options in the context of these factors.

3.1 Electricity Market Structure and Renewable Energy Procurement

The local electricity market structure can have a substantial influence on available renewable energy options, particularly with respect to a company's ability to procure off-site renewables.

In traditionally regulated electricity markets, vertically integrated utilities are granted exclusive rights to provide transmission and distribution services and may also own a substantial share of generation assets. In these vertically integrated markets, corporations interested in sourcing their power from renewable sources must generally procure renewable energy from the utility, install renewable energy on-site, or purchase renewable energy certificates separate from the underlying energy. On-site renewable energy projects are subject to the utility's interconnection requirements, if grid connection is desired (the energy generated may be used exclusively on-site). There may or may not be an organized generation market in these jurisdictions and it may not be a very transparent or liquid market, if it does exist. Often, in these markets, it is difficult or infeasible for a non-utility corporation to procure electricity directly from a third-party renewable energy provider unless specific programs are created or exceptions are granted, although rules vary across jurisdictions.

In liberalized electricity markets, generation services are decoupled from transmission and distribution and non-utility generators bid generation services into a competitive wholesale markets. In fully liberalized markets, suppliers compete at the retail level, providing electricity customers with retail choice, including the ability to procure electricity from renewable sources. In addition, competitive wholesale power markets provide price transparency to corporate buyers and can enable more sophisticated transactions between generators and off-takers.

Table 1 summarizes the types of renewable energy procurement options typically available in vertically integrated or liberalized markets; however, hybrid market structures exist. In reality, many jurisdictions exist somewhere on the spectrum between the two market structures, so available options can vary by market. Each of these procurement options is discussed in more detail below. In vertically integrated markets, corporations generally rely on the utility to provide renewable purchasing options or they can procure energy attribute certificates because they are barred from contracting for energy. In contrast, corporations in liberalized electricity markets may be able to purchase renewables from retail suppliers or contract directly with renewable energy project developers.

Table 1. Renewable Procurement Mechanisms in Vertically Integrated and Liberalized Markets

Vertically Integrated Markets	Liberalized Markets
Viable renewable energy Procurement Options	
Corporate ownership (typically on-site)	Corporate ownership (on-site)
On-site PPAs in some cases	Corporate ownership (off-site)
Utility green pricing	On-site PPAs
Utility green tariffs	Off-site PPAs
Community renewables	Financial PPAs
Unbundled certificate-based transactions	Direct access, procurement through supplier
Financial PPAs if an organized generation market exists	Community Renewables
	Unbundled certificate-based transactions

PPA = power purchase agreement

3.2 Renewable Energy Procurement Mechanisms

Corporations take a variety of approaches to renewable energy procurement. Figure 4 presents the ways in which companies procure renewable energy, based on data reported to CDP in 2016 by 1,959 global companies. Corporate ownership of off-site renewable energy is generating the greatest percentage of MWh of renewable energy followed by corporate ownership of renewable energy consumed on-site (Figure 4).

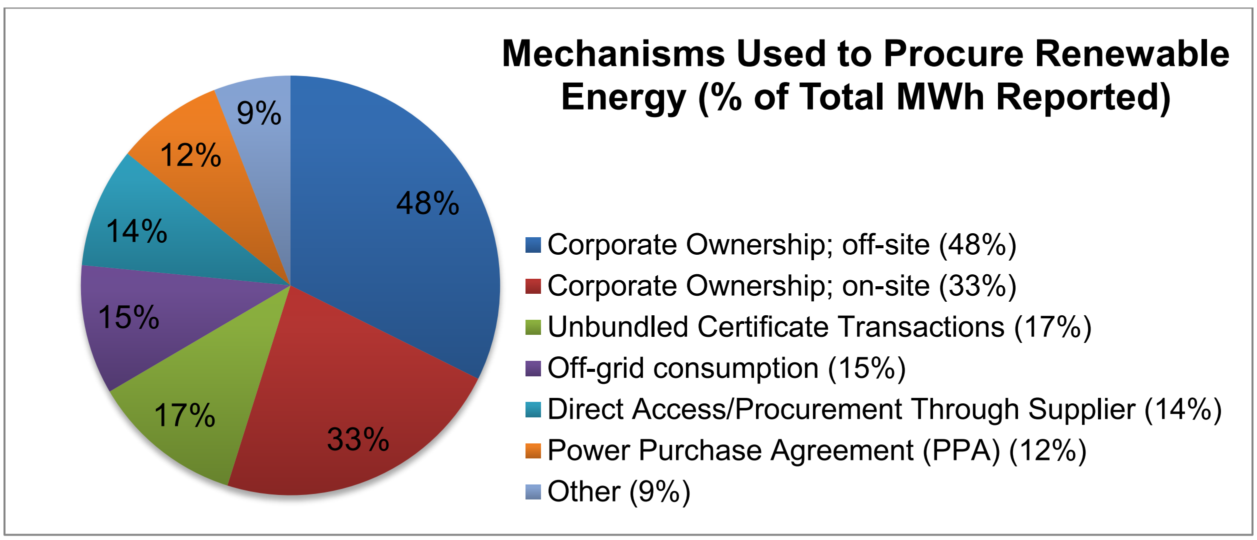

Figure 4. Corporate approaches to renewable energy procurement

Data source: CDP 2017

This section summarizes the primary types of renewable energy procurement mechanisms currently available, though new mechanisms may emerge. Procurement options vary across countries, based on how they are implemented and detailed market rules and regulations. Typically, multiple pathways will be available for corporates to procure renewables. For example, Text Box 1 describes potential procurement pathways that have been utilized or are being developed in China.

Text Box 1. Corporate Renewable Energy Procurement Pathways in China

Corporate renewable energy procurement is nascent in China, but there are five ways in which it can occur today: (1) on-site distributed renewable energy generation; (2) direct investment in renewable energy projects; (3) PPA with the grid company/green power subscription; (4) purchasing energy attribute certificates; or (5) direct purchasing from generation companies. The energy attribute certificate program was announced in early 2016, and the formal launch of the program is expected in July 2017. Direct purchasing models are also still emerging.

Many of the on-site renewable energy systems are implemented with cash sales, such as a 105-kW hybrid wind and solar project for a BMW retailer in Beijing. Some distributed systems use a power management agreement (PMA). Jinko Solar, for example, built a 2.82-MW distributed photovoltaic (PV) system for a TCL Corporation's factory in Huizhou, Guangdong Province and is constructing a new 4.5-MW distributed PV system for TCL in Hefei, Anhui Province. The PMA stipulates that Jinko would sell electricity at the PMA price to TCL, which takes the government PV subsidy into account and is lower than the local electricity price. In return, the rooftop is leased to Jinko for free, and Jinko maintains the system. TCL estimates that the project will result in an annual saving of around RMB 3 million for the factory (NE21 2016).

In addition to the traditional PMA, a unique Chinese model for corporate rooftop solar has emerged from Jiaxing, Zhejiang Province, known as the "Jiaxing Model." The local government led the China Export and Import Bank to establish a 1 billion RMB (approximately USD 156 million) PV Development Fund to provide additional financial incentives for DGPV (Zhejiang DRC 2013). The Jiaxing Xiuzhou PV Industrial Park (a district government entity) actively organized the industrial and commercial and residential customers in the area as well as distributed solar developers to form a three-party PMA that aggregates the rooftop resources for better optimization, control and maintenance, and lower the default risk. By December 2016, Jiaxing had 5,333 solar projects in operation, representing 994 MW of grid-connected capacity (Zhejiang Online 2016).

Larger corporations also have the options of direct investment in renewable energy projects and green power subscription. Apple, for example, bought a 30% stake in a Goldwind subsidiary for four separate wind projects (a total of 285 MW) being developed in China. This is after its 40 MW solar project in Sichuan Province and three solar projects totaling 170 MW in Inner Mongolia Autonomous Region with SunPower. These plants do not provide electricity directly to the Apple factories, and they are subject to curtailment, so Apple takes the production risk. Proctor & Gamble (P&G) and L'Oréal, on the other hand, negotiated green power subscriptions with the local grid company in Jiangsu Province to supply their electricity with wind generation at an incremental cost (a RMB 0.07/kWh increment for P&G starting in 2012; a RMB 0.108/kWh increment for L'Oréal starting in 2014) (Haihe University 2013).

Under most procurement mechanisms, the renewable energy is not physically delivered to corporates (except for energy used on site); rather, the energy flows into the grid and is mixed with conventional power. The contract for the renewable energy is financial in nature, as are all energy contracts. For this reason, energy attribute certificates are a preferred method to track and verify renewable purchases, separate from the actual flow of the electrons on the grid. Energy attributes can be sold together with the underlying electricity or sold separately. Use of renewable certificate tracking systems can enable corporates to ensure that the renewable energy is not double counted by a different end user, to verify renewable purchases in greenhouse gas accounting frameworks, and to substantiate claims about their renewable energy purchases. Most forms of renewable energy procurement involve some level of certificate tracking for verification purposes, while some transactions rely exclusively on energy attribute certificates. Section 6 discusses the details of certification, verification, and tracking systems in greater detail.

3.2.1 Owned Renewable Energy Generation

Corporations can develop, own, and maintain on-site, or potentially off-site, renewable energy systems and use the generated electricity. As noted in Figure 4, CDP data indicate that this is the predominant approach to renewable energy procurement among those companies that report to CDP. Corporate renewable energy project owners take on financing responsibilities and project risks. Corporate owners are also responsible for securing all required permitting. For off-site systems, transmission or wheeling charges may apply if the power needs to access to transmission lines, and these transactions may largely be limited to liberalized markets or jurisdictions where such contracts are allowed.

Table 2 presents the advantages and disadvantages for corporate customers of undertaking ownership of the renewable energy facility. For policymakers, this information can be helpful to understand the relative importance of the various procurement mechanisms and their considerations in selecting approaches. We present the advantages and disadvantages of each of the procurement options discussed below.

Table 2. Advantages and Disadvantages of Corporate Ownership

Advantages	Disadvantages
• Control over the generation asset • Energy savings and potential demand charge savings • Fixed electricity costs for the project lifetime • Visible renewable energy project with potentially local impacts • Greater power reliability if used with storage in areas with weak grids • Drives a new renewable energy project and new renewable energy capacity	• Lack of building ownership can limit or complicate on-site transactions • Requires up-front capital investment or need to obtain financing • Project may need to compete for internal capital and meet internal return rates • Corporate owner responsible for long-term operations and maintenance • Corporate owner bears risk of potential underperformance of assets • On-site projects may only be able to meet a small fraction of load

The primary challenge of corporate ownership is internal competition for capital, where the large up-front investment in a renewable energy system is compared with other viable investment opportunities. Corporations can choose to finance their on-site systems and then use cash flows from reduced on-site electricity consumption to repay the upfront cost (Hassett and Borgerson 2009; Wang 2012). Corporations may also use renewable energy equipment or other capital as collateral to secure loans to finance on-site projects. Less frequently, corporations finance projects by issuing bonds or sourcing bank debt (Hassett and Borgerson 2009). Some nonprofit corporations may be able to reduce capital expenditures for on-site systems through tax-exempt financing options (Wang 2012).

3.2.2 Power Purchase Agreements

A power purchase agreement (PPA) is a contract in which an electricity customer or “off-taker” buys power for a pre-determined number of years and at a pre-determined rate ($/kWh) from a renewable energy generator. The third-party-owned approach shifts project finance responsibilities and several investment risks from the corporation to a third-party owner (Hassett and Borgerson 2009; David Gardiner & Associates 2013; WBCSD 2016). PPAs can take different forms for on-site and off-site renewable energy projects. For on-site projects, the off-taker typically receives the power, but physical delivery of power is not necessary for off-site facilities where a wholesale market exists and certificate tracking and verification systems are in place.[4]

Table 3. Advantages and Disadvantages of On-Site PPA

Advantages	Disadvantages
• No up-front capital investment for the corporate off-taker • Third party is responsible for operations and maintenance and assumes underperformance risk • May have less impact on corporate financials, because may not appear on corporate balance sheet • Can scale project to size needed, depending on site restrictions	• Difficult to implement if building is leased • Some contract durations may be longer than expected building ownership and long for corporations given business strategy timeframes • Need regulatory authority to enable contract with third party

There are two basic types of PPAs: direct and financial. In a "direct" PPA, the off-taker buys all the generated power (or some contractually determined quantity) from the generator at the agreed rate. These rates may either be fixed throughout the duration of the contract or include an escalator that adjusts the rate over time. Another option is that rates can be indexed to a commonly used market index. Typically, but not exclusively, direct PPAs are used for on-site projects where a third party owns and operates the renewable energy system. Local regulatory factors largely determine PPA availability. At a minimum, a PPA requires local policies that allow the off-taker to purchase generation services directly from a third party that owns the renewable energy generator.

[4] On-site, third-party owned systems can also be structured as a lease. A variation is a capital lease, where system ownership transfers to the host after the lease term and the corporation treats the leased system as a capital asset (Hassett and Borgerson 2009).

Text Box 2. Dominion Virginia Power and Amazon Web Services

Amazon Web Services (AWS) procured renewable energy in Virginia using a green tariff that was negotiated with the utility provider Dominion Virginia Power (DVP). The success of this one-on-one green tariff deal has since opened up access for other customers of the same class.

In late 2015, a group of companies (many of them data centers) expressed a desire to the state regulator for more renewable energy options in the state, noting that they were very willing to work with utilities to find mutually beneficial solutions. With support from the Governor of Virginia to better serve data centers in the state, and AWS looking for ways to procure substantial amounts of renewable energy, AWS began negotiating a one-on-one deal with DVP (Virginia Office of the Governor 2016). The one-on-one special contract led DVP to establish a green tariff, called the Schedule Market-Based Rate (Schedule MBR), which was approved in September 2016 by the State Corporation Commission, the regulator.

The green tariff is structured to support financial PPAs in the local organized market, PJM and helps companies align the rates corporations pay with the revenue they could receive by purchasing renewable power from a private developer and having that developer sell that power into the wholesale market. The structure involves two transactions. The first is the Schedule MBR. Schedule MBR charges customers rates that are designed to match the PJM Interconnection wholesale market prices. The second transaction is a financial PPA for renewables, which the renewable developer sells on the corporate's behalf into the electricity market. The price at which the developer sells the energy into the market and the price at which the customer buys the electricity from the market are highly correlated (Guevara-Stone 2016).

The customer pays a rate that reflects the price at which the renewable energy was sold on the market by the developer. This market-based rate effectively hedges the facility's energy costs against market volatility. Therefore, customers like AWS, are able to pay the wholesale price for energy on their electricity bill and sell their renewable energy into the market at nearly the same price (Bonugli 2017).

The deal allows both entities to achieve their renewable energy goals. DVP increases its renewable energy facilities and is approved to sell renewable generation on behalf of customers into PJM Interconnection. DVP is working to achieve 15% renewable power by 2025, in alignment with the state's voluntary renewable goals, as well as a corporate goal of developing 400 MW of utility-scale solar projects by 2020 (Dominion 2017). AWS aims to achieve 50% renewable energy by the end of 2017 (Amazon 2017). AWS has purchased power from six solar farms in Virginia all owned and operated by DVP. The total capacity of these solar farms, in partnership with AWS, will be 260 MW (Dominion 2017).

Other green tariffs enable access to direct PPAs, where the corporate buyer buys and consumes the energy from the renewable energy project, rather than selling it on into the organized wholesale market (Tawney et al. 2017).

A financial PPA, also known as a virtual or synthetic PPA and typically structured as a contract-for-differences, is a contract in which the off-taker provides a price guarantee to a renewable generator but does not directly receive the power output from the facility. The off-taker does retain the energy attribute certificates to verify that the power comes from renewable sources to support any claims about the purchase. The price guarantee enables the developer to build and finance new projects. In a financial PPA, the project owner sells output to the wholesale power market at the applicable wholesale price. If the wholesale price is greater than the agreed upon price, typically called the strike price, then the generator settles the contract-for-differences by paying the overage to the off-taker. If the wholesale price is less than the strike price, then the off-taker settles the difference by paying the deficit to the generator.[5] Financial PPAs can also be structured as options or commodity hedges (Baker and McKenzie 2015).

Table 4. Advantages and Disadvantages of Financial PPAs

Advantages	Disadvantages
• No up-front capital investment for the corporate off-taker • Facilitates transactions with large renewable projects with economies of scale • Developer assumes project risk and handles operations and maintenance • Possibility for price hedging through fixed PPA price or contract-for-differences • PPA contracts may yield net savings in some markets	• Some contract durations (e.g., 15 years) may be long for corporations given business strategy timeframes • Typically requires approval of executives in the corporation • Power price risk and basis risk if the project is located in a region that is different from where energy is consumed • It may be more difficult for corporations to clearly communicate the value of renewable energy procurement via a financial PPA • Other risks include counterparty and accounting risks

3.2.3 Utility Renewable Energy Programs

In traditionally regulated electricity markets with vertically integrated utilities, corporate customers generally have to work through the local utility to procure renewable energy, unless procuring certificates. There are two primary types of utility programs: utility green pricing and utility green tariffs. Utility green pricing options are typically price premium products for residential and small commercial entities, but do not provide long-term potential price savings desired by large commercial customers. Table 5 and Table 6 summarize the advantages and disadvantages of utility green pricing and utility green tariffs, respectively.

Table 5. Advantages and Disadvantages of Utility Green Pricing

Advantages	Disadvantages
• No up-front capital investment for the corporate off-taker • Ability to procure energy directly from utility • Typically no longer term commitment • Corporate purchaser not responsible for operations or maintenance	• Not all utilities offer programs, so not universally available • Corporation has less control over project details by working through utility rather than directly with developer • Pricing is often fixed and can be offered at a substantial premium to electric service (often targeted toward residential/small commercial

Utility green tariffs, which have emerged recently in U.S. markets, are the vertically integrated market analogue to PPAs in liberalized markets. In a utility green tariff, the utility acts as an intermediary between the electricity consumer and the renewable energy generator. The utility

[5] For additional discussion of how PPAs work in the United Kingdom, see DLA Piper (2016).

procures renewable energy on behalf of the off-taker, and the off-taker pays a special utility green tariff rate for the renewable energy service. There are two key differences between utility green pricing programs and green tariffs. First, green tariff customers may be able to work through the utility to support construction of and purchase renewable energy from a specific project, which is often not the case with green pricing programs (although exceptions exist). Second, green tariffs can function similarly to both physical and financial PPAs in that contract terms could result in long-term returns, whereas green pricing programs cannot yield such favorable economics. Text Box 2 describes a green tariff offered by Dominion Virginia Power in which Amazon Web Services participates.

Table 6. Advantages and Disadvantages of Utility Green Tariffs

Advantages	Disadvantages
• No up-front capital investment for the corporate off-taker • Ability to work directly with current service provider (i.e., the vertically integrated utility) • Some programs offer long-term fixed price • More favorable pricing than green pricing programs • Corporate purchaser not responsible for operations or maintenance	• Not all utilities offer programs, so not universally available • Corporation have less control over project details by working through utility rather than directly with developer • Pricing and program structure can require substantial negotiations with the utility • Typically a long term commitment • May not yield cost savings equivalent to PPAs or other structures

3.2.4 Direct Access/Procurement through Competitive Supplier

In liberalized markets with retail competition, customers have "direct access" to competitive suppliers of generation services, sometimes called retail choice. Suppliers compete with each other and with incumbent utilities based on price and product differentiation. Some competitive suppliers offer renewable energy products, either through direct sourcing from independent power producers or by bundling electricity products with energy attribute certificates. Retail competition allows corporations to search for competitive supplier product offerings that satisfy their renewable energy demands at competitive rates, often with overall cost savings.

Most of the world's major electricity markets have at least partially liberalized. Retail competition has been implemented widely in Europe and in parts of the United States as well as in other countries such as Australia, Colombia, Japan, New Zealand, the Philippines, Russia, and Turkey (IEA 2016). Mexico is shifting toward retail competition, and most South American countries have implemented wholesale markets. Text Box 3 discusses emerging renewable energy procurement opportunities for large consumers in Mexico and the requirements for large energy users to procure renewables under the country's clean energy standard.

Text Box 3. Mexican Energy Reform and Corporate Procurement Opportunities

Mexico is currently undergoing electric market reform, which will enable large energy consumers to select the supplier that best suits their needs or directly participate in the market, depending on their demand levels (KPMG 2016). Consumers with at least 5 MW of demand and annual electricity consumption of 20 GWh will be able to participate directly in the wholesale market; those with at least 1 MW of demand in 2017 will be able to purchase through qualified suppliers. Small and medium enterprises that belong to the same economic group as well as other entities (e.g., subnational governments) can aggregate individual loads up to the limit established for qualified users if they meet the requirements published by SENER in March 2017.

As part of the reforms, Mexico established by law, a clean energy standard for electricity suppliers and large energy users with a system of tradable clean energy certificates (certificados de energía límpia, or CELs). Under the rules issued by the Mexican Energy Ministry, SENER, in March 2015, obligated entities, which include consumers participating in the market directly and self-supply customers, must obtain 5% clean energy by 2018, with the levels increasing over time to the ultimate target of 35% clean energy generation by 2024 (with interim targets of 5.8% by 2019, 7.4% by 2020, 10.9% by 2021, and 13.9% by 2022.

Qualified consumers may opt to purchase CELs to meet their requirements through annual auctions, which are organized by the Centro Nacional de Control de Energía (CENACE), or through bilateral transactions. The first auction took place in March 2016, the second in October 2016, and bidding documents were announced in May 2017 for the third auction. The results of CENACE's two power auctions yielded some of the lowest prices for solar globally and will add about 5,000MW of new clean energy capacity (Jiménez 2016). The second auction resulted in an average tender price of $33.5/MWh, with the low prices driven in part by high participation and low equipment prices (BNEF 2016a).

Corporations have also been procuring renewable energy through PPAs in Mexico, but corporate PPA transactions slowed substantially in 2016 because new market reform regulations were emerging. The new electricity market rules requires that large consumers must be wholesale market participants and have the option to procure electricity directly from a generator, through an energy trader/aggregator, or directly purchase renewable energy. Large energy consumers have been waiting to better comprehend the new rules of the energy reform before entering into contracts for renewables. The market reform process has also made projections for the long-term wholesale power price uncertain. As the market becomes fully operational in 2017, the corporate PPA market is expected to rebound and continue its previous upward trend, according to Bloomberg New Energy Finance (BNEF 2016a).

Table 7. Advantages and Disadvantages of Direct Access

Advantages	Disadvantages
• Cost savings possible—competitive supplier may offer lower rates than incumbent utility • No up-front capital investment • Period of commitment may not be long (some suppliers offer near-term fixed rates) • Corporation not responsible for operations and maintenance	• Corporation may have little control over project from which renewable energy is sourced • Pricing can change unless locked in a long-term contract • Markets can have volatility and there can be turnover in suppliers • Renewable energy may be sourced from older or non-preferred renewable energy sources

Community choice aggregation (CCA) is a variant of direct access. Under a CCA program, the local government procures electricity supply on behalf of residential and small commercial customers, often with the objective of procuring renewable energy. Typically, certain classes of electricity customers in the community are automatically enrolled in the aggregation, but can opt out. In some cases, the CCA procures renewable energy through an alternative supplier, and renewable energy may be offered as default or premium products. CCAs have been implemented in the United States in California, Ohio, Illinois, and Massachusetts (O'Shaughnessy et al. 2016). While these programs are typically geared towards residential and small commercial customers, corporations can also play an important role as anchor participants.

3.2.5 Community Renewables

In a community renewables program, a project developer sells portions of a renewable energy generator's output to multiple subscribers. Each subscriber pays for a specified amount of capacity (kW) or output (kWh) from the project and is compensated from their utility or a third-party company according to the corresponding output. In community projects, the corporation may serve as an anchor tenant for the project or could host a renewable energy system with power jointly purchased by multiple electricity customers or "subscribers." In this case, the corporation participates in and benefits from the project but does not finance it or bear substantial project risks.

Community renewables programs could be suitable options for corporations that do not have sufficient demand to merit investment in an entire project but would still like to benefit from the economies of scale achieved by larger project sizes. However, unless a corporation happens to be eligible for an existing community renewables program, initiating a new community renewables project could be complicated by the need to rely on other subscribers to support the project. Some utilities are initiating similar programs to meet corporate demand in their service territory.[6]

Table 8. Advantages and Disadvantages of Community Renewables

Advantages	Disadvantages
• Allows corporations to buy smaller units of output while still benefiting from the favorable economics of a larger project • Generally short-term commitment or subscription can be transferred to another	• Could be difficult to initiate: projects require additional subscribers in order to make economically viable

Companies may also participate in aggregations of on-site systems on rooftops within the community. For example, Apple sourced 32 MW of solar from panels located on more than 800 rooftops across Singapore to meets its renewable energy procurement goals (see Text Box 4).

Local regulations that allow for some mechanism to compensate subscribers for their payments to the community renewables provider can enable these types of community programs. Utilities may provide this service by crediting community renewables output against subscribers' bills, enabling these projects to be developed in vertically integrated markets.

3.2.6 Unbundled Energy Attribute Certificate Transactions

In some regions, corporations can buy unbundled energy attribute certificates (i.e., sold separately from electricity typically in increments of 1 MWh) to match renewable energy

[6] For example, see Tawney (2017).

procurement to their electricity consumption. While other procurement methods described above use certificates for tracking and verification and to enable corporate claims (as discussed earlier in this section), in some regions, renewable energy purchases based solely on unbundled energy attribute certificates are feasible. Certificates may be purchased directly from project owners or through third-party brokers and are typically verified so that the purchaser can claim the sole ownership of generated renewable energy regardless of the ultimate destination of the electrons (Sotos 2015; NREL 2015). Section 6 provides additional discussion of tracking and verification.

Table 9. Advantages and Disadvantages of Unbundled Certificates

Advantages	Disadvantages
• No project-level risk • Simple to align with existing electricity procurement practices • Flexible terms, no long-term requirements	• Less compelling marketing • Generally less control over resource type and project details • There may be no new renewable energy capacity added to the energy system in some cases • May not yield cost savings or long term price certainty equivalent to other structures

Several countries and third parties have developed certificate-based systems for renewable energy transactions and claim substantiation (see Table 10). The development of certification systems has provided flexibility and facilitated increasing corporate renewable energy procurement, as certificate based transactions have been dominate forms of purchasing in some markets (O'Shaughnessy et al. 2016; RE100 2017). Internationally, corporations have struggled to identify credible renewable energy procurement options in markets without certification systems (Powers 2016). Certificates (see Table 10) are sometimes used to match renewable energy generation in one region with electricity consumption in another. Nonetheless, local sourcing is considered best practice for claims and greenhouse gas reporting and companies often seek to procure renewable energy in the region where they operate (Sotos 2015; RE100 2016). The use of certificates from local sources requires the development of new tracking systems in regions where they do not currently exist.

Table 10. Summary of Existing Energy Attribute Certificate Programs

Certificates	Country/Region	Background
International REC Standard (I-REC)	International[a]	I-REC Standard is a nonprofit developing an international framework for the development of attribute tracking (REC) systems
Tradable Instruments for Global Renewables (TIGRs)	International[b]	Developed by APX, an environmental registry service provider
Renewable Energy Certificates (RECs)	Australia	Market established for compliance with national renewable energy targets
Guarantees of Origin (GOs)	Europe	European law requires member states to maintain GOs registries in order to allow for consumer RES claims
RECs	India	Market established for compliance with state-level Renewable Purchase Obligations
Certificados de Energía Limpia (CELs)	Mexico	Market established for compliance with national clean energy requirements
RECs	United States	Market established for compliance with state-level renewable portfolio standards and voluntary markets

[a] As of November 2016, I-REC had authorized issuers to implement tracking systems in Brazil, Chile, China, Colombia, Honduras, India, Israel, Malaysia, Singapore, South Africa, Taiwan, Thailand, Uganda, and Vietnam (I-REC 2016).

[b] TIGRs are currently traded in India, the Philippines, Singapore, and the United States. The product is planned to launch in Brazil, Chile, China, Colombia, Egypt, Honduras, Indonesia, Israel, Japan, Malaysia, Mexico, South Africa, South Korea, Thailand, United Arab Emirates, and Vietnam.

Text Box 4. Apple's Procurement of Rooftop Solar in Singapore

In late 2015, Apple announced that it would power 100% of its Singapore operations with clean energy, making Apple the first company in Singapore to become 100% renewable. Apple partnered with Sunseap, a local renewable energy provider, to acquire 32 MW of solar on more than 800 rooftops across the city (Apple 2016). Singapore is a competitive electricity market for large customers, so the agreement with Sunseap is able to supply power to Apple at a preferential rate compared with retail electricity tariffs (Sunseap 2015).

Under the Off-site Solar PPA, Sunseap retains ownership of the solar PV systems, so Sunseap assumes all capital and operational expenses of the systems and the customer only pays for electricity consumed (Sunseap 2015). The PPA procures solar for Apple's 2,800-person corporate campus, colocation data center facilities, and the future Apple Stores in Singapore (Singapore Economic Development Board 2015). In addition to the rooftop solar in the city, Apple's Ang Mo Kio office will have 1.1 MW of PV capacity installed. Because Singapore's land scarcity presented a challenge for a large solar project, Sunseap installed 50 MW of solar panels on the rooftops of government-owned public housing buildings. A small portion of the PV generation provides electricity to the common areas of the public housing buildings, while the majority is grid-connected and available for offtake through the Off-site Solar PPA. The project aligned the needs of Apple, Sunseap, and the community.

Apple is working with APX, an energy attribute registry provider, to track and verify its renewable energy production. Sunseap piloted APX's Tradable Instruments for Global Renewables (TIGRs) registry, which allows corporations and suppliers in the Singapore renewable energy market to verify and track their participation in the region's renewable energy sector (APX 2016).

3.2.7 Summary of Mechanisms

Table 11 summarizes existing renewable energy procurement mechanisms. The choice of renewable energy procurement depends on a host of country-specific market and regulatory factors that determine which options are available to the corporation. The following sections dive more deeply into the policy and regulatory considerations for on-site and off-site procurement. We address each of these categories separately because the enabling policies largely differ for on-site and off-site projects.

Table 11. Summary of Corporate Renewable Energy Procurement Mechanisms

	Off-Site/On-Site	Capital Expenditures Required	Operations and Maintenance (O&M) Responsibility	Project Size	Contract Length	Level of Risk for Corporate
Corporate Ownership	Available on-site and off-site	Yes	Company is responsible for O&M but can contract functions to others	Scalable; on-site scale depends on site	No contract	Production risk
PPAs (direct and financial)	Available on-site and off-site	No, but significant financial commitment	Not responsible	Scalable; on-site scale depends on site	Long-term contract	Basis risk if the project is located in a region that is different from where energy is consumed
Utility Green Tariff	Off-site	No	Not responsible	Typically large	Long-term contract	Low to medium risk, little control
Direct Access	Off-site	No	Not responsible	Scalable, but more attractive pricing for larger deals	Contract duration varies	Low to medium risk
Community Renewables	Off-site	Depends on program structure	Not responsible	Small to medium	Contract duration varies	Low to medium risk
Unbundled Certificates	Off-site	No	Not responsible	Scalable	Typically 1-3 year terms, but longer options feasible	No project-level risk, risk depends on contract duration

4 Enabling On-Site or Near-Site Renewable Energy Procurement

On-site renewable energy project development faces a number of unique barriers in terms of siting, grid connection, and financing that have important implications for the policy enabling framework. The decision to site systems at a facility is based on the local economics of the facility and utility tariff level and structure, which can differ from how corporations evaluate the economics of off-site renewable energy projects. For these reasons, we address on-site renewables development and the enabling policies in this section and address off-site procurement policy issues in the next section.

We first provide perspective on corporate on-site procurement internationally, based on available data, and summarize on-site renewable energy financing options and risks. We then discuss the unique barriers associated with on-site procurement. Finally, we discuss policies that impact on-site renewable energy development and policy actions that could be taken to develop a supportive policy enabling environment for on-site corporate renewable energy procurement.

4.1 Corporate Experience with On-Site Procurement Globally

Many companies include on-site renewables as part of their overall renewable procurement strategies. On-site electricity generation can be advantageous because it allows corporations to reduce reliance on grid electricity and lower grid-related payments. In addition, on-site generation can demonstrate commitment to corporate sustainability commitments with visible renewables investments. Of 1,959 companies that reported data to CDP, 38% (740 companies) had installed on-site renewable energy projects. Figure 5 indicates the location of the projects reported by the participating companies, indicating clusters of projects in Europe, the United States, and Japan, followed by smaller numbers of installations in India, South Africa, South Korea, Brazil, Australia, Hong Kong, Taiwan, Thailand, China, New Zealand, Philippines, and Singapore.

Figure 5. Number of companies in each country producing on-site renewable energy

Map Source: eSpatial 2017; Data source: CDP (total of 740 companies producing onsite renewable energy out of 1,959 corporate responses). Note: If project location was not provided, the project was associated with where the company is incorporated.

Often renewable energy produced by on-site systems represents a small fraction of the company's electricity load. Solar projects, for instance, are often limited in size by the roof area, unless there is land area available for substantially larger ground-mounted systems. Figure 6 presents data from companies that reported their on-site electricity consumption to CDP. The figure indicates that about half of those companies obtain less than 1% of their electricity from on-site renewable systems. Some companies reported that all of their electricity needs were met with on-site renewables; however, it is possible that some reported data for only a single facility (CDP 2017).

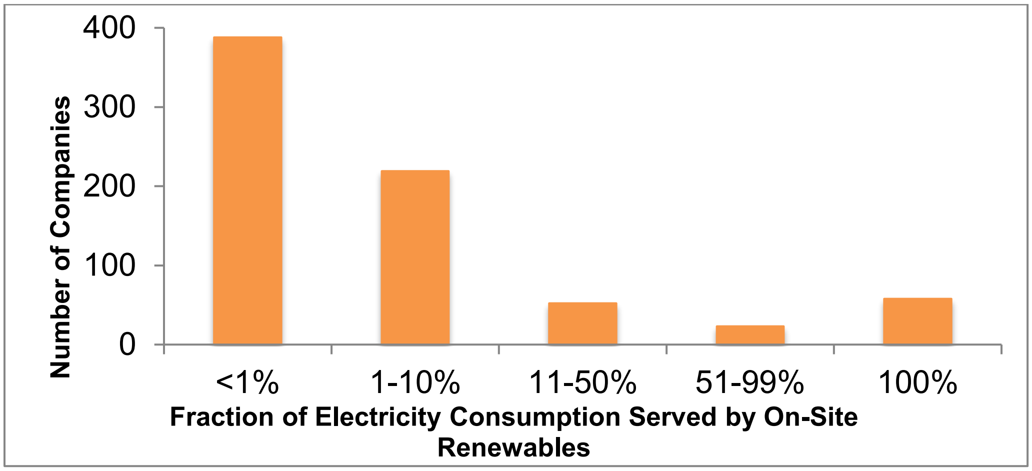

Figure 6. Fraction of load served by on-site renewables for companies reporting to CDP

Data source: CDP

4.2 Cost-Effectiveness of On-Site Systems

For on-site projects, the cost-effectiveness of commercial projects depends on the structure of the electricity tariffs for commercial customers. The potential benefits of on-site projects depend on energy and demand components of the utility tariff as well as the charges related to distribution network access. Energy consumption patterns and the time of consumption of renewable energy can also matter where demand charges are present. In general, areas with higher electricity costs can indicate areas of focus for policy makers to encourage corporate sourcing. Where net metering for solar photovoltaics (PV) is in place (crediting at the retail rate for electricity not used on-site), higher overall electricity prices can make on-site sourcing (where feasible) attractive (IRENA 2015).

The introduction of renewable energy in different commercial subsectors has the potential to provide savings from the energy portion of a utility bill (and sometimes avoid demand charges). However, the diversity of building types, rate structures, and load profiles can make this economic opportunity complex to assess. As one example, Figure 7 shows an analysis by the International Renewable Energy Agency (IRENA) that estimates PV system savings for various building types in California.

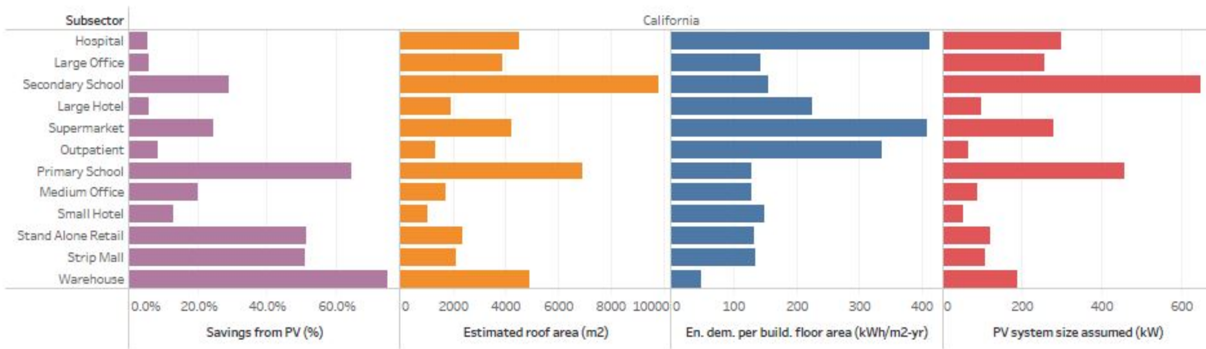

Figure 7. Electricity bill savings from PV in commercial subsectors in California

Source: IRENA analysis based on data from NREL OpenEI/Office of Energy Efficiency & Renewable Energy (EERE) 2017

Savings from PV tend to be greater in the buildings where the available roof area is sufficient to develop solar to meet the building's total energy consumption (e.g., warehouses, primary schools). In contrast, sub-sectors with modest roof availability and large demand requirements may be unable to host enough PV to significantly reduce their bills (e.g., large hotels and offices, and hospitals). One solution for these sub-sectors may be a carefully chosen blend of corporate sourcing methods that allow them to cover all of their electricity needs sustainably.

4.3 Barriers to Corporate Deployment of On-Site Renewable Energy Systems

On-site renewable energy procurement entails a unique set of considerations and challenges, including siting, interconnection, market status, and project economics.

Site challenges refer to those associated with deploying a renewable energy system at a given site. For leased facilities, contracting for on-site renewable energy projects can pose challenges, such as split incentives between tenants and landlords where the tenants reap the electricity savings, but the building owner needs to address on-site installations (Müller et al. 2011; Bird et al. 2016). In addition, on-site renewable energy contract terms or equipment life may exceed the period of leases of some corporate facilities. In some cases, on-site renewable energy systems may require unique permits. For solar PV, which is a common on-site renewable, site buildings may have inadequate roof space to deploy projects or may be located in an area with inadequate renewable resources to justify an on-site investment (Bird et al. 2016). Roofs may need to be rebuilt or reinforced to support a solar PV installation, especially in developing countries.

Interconnection and grid export challenges refer to challenges associated with the process of connecting a renewable energy system and exporting excess generation to the local electricity grid. In contrast to site challenges, most corporations may be less familiar with interconnection issues. While some corporations have on-site backup diesel generators, particularly in areas with unreliable grids, these are not grid connected. However, variable renewable generators are often grid tied because they depend on the availability of sunlight or wind, which may not align perfectly with building load profiles. Grid interconnection with compensation for grid exports has been the solution to variability in nearly all countries with growing renewable energy markets (Reid et al. 2010; IEA 2011). By interconnecting on-site renewable energy systems to the grid, corporations are able to export excess output to the grid and be remunerated through various compensation mechanisms. The rules and procedures for interconnecting with the grid can have a substantial impact on project economics and viability.

In addition to siting and interconnection, other challenges to on-site renewable procurement can be a **lack of available suppliers** in the market. Often regulatory policies are required to encourage the development of the industry initially and encourage the development of a supplier base. Further, regulatory uncertainty and complexity can hinder development. WBSCD (2016) found that regulatory uncertainty was the largest non-electricity concern for renewable transactions. Complex regulations can also be a barrier, particularly for companies without energy expertise (WBSCD 2016).

4.4 Key Policies for On-Site Procurement

Robust markets for on-site renewable energy projects have been implemented in both liberalized and vertically integrated markets in a variety of countries. Thus, power market structure typically does not play a large role in influencing the adoption of on-site renewable energy systems, in contrast to off-site renewable energy procurement. The factors driving on-site project deployment are those that influence the relative project economics (utility retail tariffs, compensation for any excess generation exported to the grid, access to financing) and policies and regulations affecting the process of installing and interconnecting the on-site system to the grid.

Policies may need to be adjusted over time based on the state of the market, so that in the early stages of market development the focus may be on incentives and cost reduction, and after markets take off, policies may need to address administrative barriers, such as permitting and interconnection (IEA 2011).

Text Box 5. Bangalore International Airport Solar Procurement

The Bangalore Kempegowda International Airport is located in the Indian state of Karnataka and serves the greater Bangalore region. Sustainability is at the core of Bangalore International Airport Limited's (BIAL's) strategy: the airport has ambitious renewable energy goals, aiming to become the largest solar-producing airport in India. They have a related goal of sourcing 40% of their electricity from solar energy (Krishnan 2016). To move towards these goals, BIAL is implementing on- and off-site solar generation projects.

A major enabler of the project was a groundbreaking order passed in 2014 by the Karnataka Electricity Regulatory Commission (KERC) that provided a waiver of certain charges for solar projects that had shown to be a hindrance to solar development in the state. KERC had previously adopted an open access regulation, allowing certain customers to obtain electricity from independent generators; however, the generation was subject to wheeling, banking, and cross subsidy charges that changed year-to-year. The new order exempted solar projects from these charges for the first 10 years of operation and provided longer term assurance that solar developers and consumers had been previously lacking (Krishnan and Thanikonda 2015). Before this order was passed, the wheeling, banking, and cross-subsidy surcharges were determined on an annual basis and subject to sometimes substantial fluctuations (Krishnan and Thanikonda 2015), which created uncertainty in project costs and impeded the ability to finance renewable energy projects. Developers were hesitant to plan for projects, not knowing what costs they would be locked into for a project's 20–25-year lifetime.

The policy change increased certainty and improved project economics. As a result, the Bangalore airport is in the process of implementing 16 MW of solar, approximately 13 MW to be procured through the grid, 2.5 MW planned to be installed on the runway, and 0.5 MW on the building rooftop, which is already operational. The remaining 15.5 MW are in the final stages of negotiations, as of February 2017.

Companies and stakeholders interviewed for this report have indicated that the policies and regulations summarized in Table 12 and discussed in more detail below are among the most important in influencing their ability to install on-site systems. The policy enabling environment can be important to successful project development, for example, as demonstrated in the case of solar development in Bangalore (see Text Box 5).

Table 12. Summary of On-Site Policy Design Considerations and Best Practices

On-Site Policy	Importance for Purchaser	Policy Design Considerations/Best Practices	Best Practice Examples
Compensation for grid exports (net metering, feed-in tariffs, two-way rates)	Compensation of energy not directly used on site impacts project economics	Policy design balances utility considerations and on-site purchaser; best practices vary by type of compensation mechanism used	California; Europe
Interconnection rules	Interconnection procedures impact the cost and installation time required for grid-connected on-site systems	Expedited interconnection for smaller systems and those with limited grid exports; processes to efficiently manage interconnection queues; cost estimates early in process	Massachusetts; Hawaii
Permitting, inspection, zoning	Permitting and inspection processes affect the time required for installation	Streamlined and coordinated reviews by relevant agencies; viable inspection timeline; simplified application procedures	Austin Energy (Texas); Philippines
Third-party-owned models	Can transfer risk of operations and maintenance to third party; avoid internal financing hurdles	Clarity on whether a third party can own and operate renewable energy systems	United Kingdom
Equipment performance standards and certification	System performance is important for accurately evaluating economics and risk	On-site renewable energy programs provide guidance or requirements for equipment performance when incentives are provided	California Solar Initiative
Ownership of attributes under incentives	Purchasers want to be able to make verified claims about renewable energy purchases	Clear rules regarding ownership of renewable energy attributes and regarding interaction under incentive policies (e.g., FITs) about whether the utility or on-site purchaser can retain attributes for claims and accounting	Australia; India; Mexico; Europe; United States
Near-site renewable energy development options (e.g., community renewable energy, virtual net metering)	Purchasers may have inadequate land area for installing a system on-site (e.g., lack of roof space for PV) but may be able to site a project nearby	Virtual net metering or community renewables policies may enable corporations to develop mid-sized projects near their site, when obstacles prohibit on-site development	Massachusetts
Storage tariffs or policies	Storage may provide improved reliability where grid outages are frequent	Tariffs may need to be adjusted to accommodate on-site storage projects, particularly if peak pricing is used	California; France; United Kingdom;
Contractual and legal requirements	Purchasers need certainty that contracts are enforceable	Contracts are legally enforceable and entities have recourse per the contract terms	United Kingdom; Germany

4.4.1 Compensation for Grid Exports

The economics of on-site renewable energy systems require some mechanism that compensates the system owner for excess output delivered to the local electric grid. This enables on-site users to size their systems to meet their annual electricity use. There are a variety of practices in place internationally to address grid exports from distributed renewable energy systems, including net metering policies, feed-in tariffs (FITs), or tariffs that compensate distributed systems for grid exports at a rate that is different than retail rates (e.g., at the utility's avoided cost) (Couture et al. 2015). System size limits are often in place for more generous compensation rates; for example, net metering is available for systems up to 2 MW in size in some U.S. states (Tian et al. 2016). Some jurisdictions have developed policies offering more generous compensation schemes in the early years of renewable market development and, when certain penetration thresholds of distributed resources are reached, the rates decrease; for example, FIT rates have been designed by policymakers in Europe, North America, and elsewhere to fall over time as installed capacity thresholds are met (Kreycik et al. 2011). Such staging can help grow markets in early years and address grid and utility concerns about financial impacts when higher penetrations are reached. Overall, policies surrounding compensation mechanisms are often the most contentious policies affecting on-site generation, but have a substantial impact on project economics.

4.4.2 Interconnection Policies

Interconnection procedures can affect the cost of on-site projects as well as the time required for grid interconnection. Expedited interconnection processes can be developed for midsized commercial systems, particularly where most of the energy will be used on-site behind the customer's utility meter. In addition, in locations where a large number of projects may be seeking interconnection, queuing processes can create unnecessary delays for new projects if no restrictions are in place to ensure that viable projects are in the queue. Clear and transparent queuing processes that involve provision of public data on queues can help alleviate queuing-related delays. Interconnection costs, and in particular the uncertainty surrounding the magnitude of interconnection costs, can negatively impact project development (Müller et al. 2011; Ardani et al. 2015; Burkhardt et al. 2015). Particularly for larger on-site projects, interconnection costs can be considerable and can change over the course of the interconnection process. To address this issue, California recently instituted requirements that utilities estimate a narrow range of interconnection costs so that project owners can more accurately assess project economics early in the interconnection application process. Overall, greater transparency, cost certainty, and simplicity (where technically feasible) can alleviate barriers to interconnecting on-site systems to the grid.

4.4.3 Permitting, Inspection, and Zoning

On-site renewable energy systems may require permits and inspections to address both site and interconnection challenges. For example, a typical on-site solar PV system may require governmental reviews from multiple agencies (e.g., building, electrical, mechanical, plumbing, fire), permitting fees, various site inspections, and utility interconnection reviews (Burkhardt et al. 2015). Differences in permitting burdens can drive differences in project costs between countries (Seel et al. 2014). Complexity in the permitting and inspection processes can create barriers to project development and unnecessarily slow the speed of installations (IEA 2011). Permitting and inspection best practices include (IREC 2013):[7]

- Provide a clearly defined process and make permitting more transparent, by enabling online permitting and posting documents publicly so applicants can prepare
- Provide expedited permitting for small or low-impact systems
- Require permitting agencies to coordinate processes and to process applications in a timely manner, same day processing is a best practice.

Building zoning policies can, in some cases, interfere with the ability to install on-site renewable energy projects, such as in downtown areas. Building zoning policies can be reviewed to determine whether they should be applied to on-site renewable energy projects. Zoning best practices include: 1) providing specific exemptions or allowances to renewable energy systems from building zoning requirements, and 2) clarifying language for renewable energy system deployment in historic or preservation districts (SolSmart 2017).

4.4.4 Ability to Contract with Third Parties (PPAs)

Owning and operating on-site renewable energy generation is not the core business activity of the vast majority of corporations. As a result, many corporations prefer to contract with third-party providers to alleviate risks associated with an unfamiliar process. In addition, third-party-owned models can be useful in jurisdictions where tax credits are available for renewable energy systems. Some entities (e.g., universities or other non-profits) may be unable to take advantage of tax credits without having a third party to monetize the incentives. Local regulations that allow corporations to contract directly with a non-utility electricity provider can enable on-site renewable energy projects.

4.4.5 Ownership of Renewable Attributes under Incentive Mechanisms

For on-site renewable energy systems whose excess output is compensated by the utility or government, there can be a lack of clarity about ownership of the renewable energy attributes. This can create challenges for corporations seeking to make claims about their renewable energy generation or to account for on-site production in GHG accounting systems. Clarity of attributes can facilitate corporate purchasing and accounting of on-site systems.

4.4.6 Equipment Standards and Certification Requirements

Equipment performance and certification are important for end-users, such as corporations, to be able to accurately evaluate project economics and understand project risks. In cases where financial incentives are provided by the government or a utility, requirements for system performance and longevity can be stipulated as a condition for receiving incentives. For example, the California Solar Initiative developed detailed performance standards for on-site systems to qualify for performance-based incentives. These policies help ensure quality on-site installations, ensure that systems will perform as expected, and reduce purchaser risk.

[7] For additional resources on permitting best practices, see the U.S. Department of Energy Solsmart program http://www.gosparc.org/resources/.

4.4.7 Near-Site Renewable Generation Policies/Community Renewables

Policies that enable near-site projects can help alleviate barriers specific to on-site installation (e.g., roof space) and provide additional procurement options. Virtual net metering policies used in some jurisdictions enable the development of near-site projects with crediting of the generation on the customer's bill (Feldman et al. 2015; Barnes 2013). These policies can also enable multiple entities located in a single utility service territory to jointly participate in a single project. These types of policies can provide options to purchasers and enable them to leverage economies of scale and address siting barriers. Policies that enable customer credits for community renewables can also enable corporate procurement of renewables from larger projects, when on-site development is limited. Corporates can play an anchor tenant role in community projects, in some cases.

4.4.8 Storage Tariffs and Policies

Storage (e.g., batteries) can provide benefits to on-site system owners and allow corporations to store excess output on-site rather than sending it to the grid. On-site storage may, depending on the rate structure, be more economically favorable than exporting excess output to the grid (Simpkins et al. 2016). Further, on-site storage entails additional co-benefits such as improved reliability during grid outages. As storage costs decline, the use of storage may be more popular with on-site renewable energy systems (see Frankfurt School et al. [2016] for storage cost trends). Tariffs may need to be adjusted to account for more frequent utilization of on-site storage systems to equitably compensate customers who may seek to sell electricity back to the grid at peak times from storage devices.

4.4.9 Contractual and Legal Requirements

Contract viability can be a significant issue in some developing countries. Deficient regulatory structures can undermine contract enforcement and hinder project development due to risk of defaults (Müller et al. 2011). Another issue can be the length of contracts required for on-site renewables because of the lifetime (e.g., 20 plus years) of renewable energy systems. Long term contracting can be challenging for corporates who may not have certainty about how long they will own their facilities over the duration of the contract. Furthermore, on-site systems can be particularly challenges for corporates when they lease facilities, because of the added complexity in the contractual arrangement and challenges in allocation of benefits across multiple parties.

4.5 Actions Policymakers and Regulators Can Take to Promote Corporate On-Site Renewable Energy Procurement

A variety of renewable energy policy frameworks have emerged that support corporate on-site renewable energy procurement; however, the effects of different policies on corporate on-site deployment remain an area for further research. Nonetheless, the literature, various case studies, and our interviews allow us to summarize several best practice approaches to promote corporate on-site renewable energy procurement.

Develop clear and stable compensation mechanisms for generation exported to the grid. Policies surrounding the level of compensation for electricity exported to the grid from on-site systems affect project economics. Economic evaluations of on-site projects are conducted based on current compensation levels. Sudden changes to these policies could affect the economic viability of projects mid-stream. Perceptions of policy volatility increase project risk profiles and required returns, undermining potential renewable energy projects. Accurate project economic analyses rely on clear and stable compensation schemes.

Develop interconnection procedures that are transparent, expedient, and equitable to the utility and project owner. Regulations surrounding the interconnection of on-site projects with the grid can be made transparent through the use of public information portals that convey data and information about the process, including publicly available information about interconnection queues. Interconnection processes designed to encourage timely responses by utilities or grid operators can enhance project economics and viability. In addition, interconnection costs can be estimated early in the interconnection process to provide greater certainty for project development.

Create streamlined and coordinated permitting processes. Streamlined permitting and inspection processes can help expedite the process of on-site project development. Coordination across permitting agencies can simplify the process for end-users, reduce unnecessary delays, and increase the viability of on-site projects.

Allow for contracts with third-party financiers and installers. The use of third-party developers for on-site projects can benefit corporations and can leverage the strengths of experts in on-site installation and operation. Regulatory reform or exemptions to existing regulations can allow corporations to purchase electricity from non-utility third parties.

Clarify ownership of renewable energy attributes associated with on-site system generation under incentive policy programs (e.g., FITs). Retention of attributes (e.g., GOs, RECs, I-RECs) from renewable energy projects is important for corporations to make claims about their use of renewable energy or GHG reduction benefits. Under some incentive policies, such as FITs where there is a payment for the generation output of the system, the ownership and retention of attributes can be uncertain. Clarifying attribute ownership under these types of policies can enable purchasers to understand the types of claims they can legitimately make.

Develop zoning ordinances and siting policies that enable on-site renewable energy projects. Zoning ordinances and solar access laws can impact project viability. Local zoning codes that include language that clarifies land use rights for renewable energy systems can provide certainty to enable on-site project development.

Adjust policies according to the state of market maturity. In the early stages of market development, economic barriers are often the primary obstacles to on-site corporate renewable energy deployment. Policies in this "inception" phase should focus on cost reduction. As costs come down, markets move into a "take-off" phase where non-economic barriers become the primary obstacles to renewable energy deployment. During the take-off phase, policies should address administrative hurdles, permitting, interconnection, and other non-economic barriers (IEA 2011).

5 Enabling Corporate Procurement of Off-Site Renewable Energy

On-site renewable options are not always sufficient to meet corporate renewable goals, both because on-site load may be greater than renewable energy generating capacity and because on-site options may not be feasible given site considerations. Corporations may also find better quality renewable energy resources from off-site generators, at lower cost. As such, corporations may look for off-site renewable energy options to meet their renewable energy goals. Corporations can procure off-site renewable energy in either vertically integrated, monopoly electricity systems, or in liberalized markets.

In this section, we discuss corporate experience procuring off-site renewables internationally and the economics of large-scale renewables. We then discuss the unique barriers associated with off-site procurement and policies that impact off-site renewable energy development, in both liberalized and vertically integrated electricity markets. Finally, we list policy actions that could be taken to develop a supportive policy enabling environment for off-site corporate renewable energy procurement.

5.1 Corporate Experience with Off-Site Procurement Globally

Some large corporations with high energy consumption focus exclusively on procurement of renewables from large, off-site projects, while others include off-site projects as one component of their overall renewable procurement strategies. Purchasing from off-site renewable energy projects can be advantageous because corporations can obtain a large amount of renewable energy in a single transaction and leverage the economies of scale of large projects. Of the 1,959 companies that reported data to CDP, 44% (860 companies) had procured energy from off-site renewable energy projects. Figure 8 shows the location of the projects reported by the participating companies, indicating clusters of projects in Europe, the United States, and Japan, followed by smaller numbers of installations in Brazil and South America, China, South Korea, Australia, Africa, Eastern Europe, and Southeast Asia.

Figure 8. Location of off-site renewable energy projects purchased by companies reporting to CDP

Green > 50, yellow=20-50, orange=5-20, red=1-5 projects.
Map source: eSpatial 2017; Data source: CDP (total of 1,959 companies reporting)

Off-site renewable energy purchasing has increased in recent years. While data are limited to the United States, the Europe, Middle East, and Africa (EMEA) region, and Mexico, in 2016, at least 4 GW of PPAs were signed by corporate purchasers in these three regions, with most of the activity occurring in the United States (Figure 9). In these regions, the number of PPA contracts increased rapidly in 2014 and 2015, although total volume decreased in 2016 because of less U.S. activity.

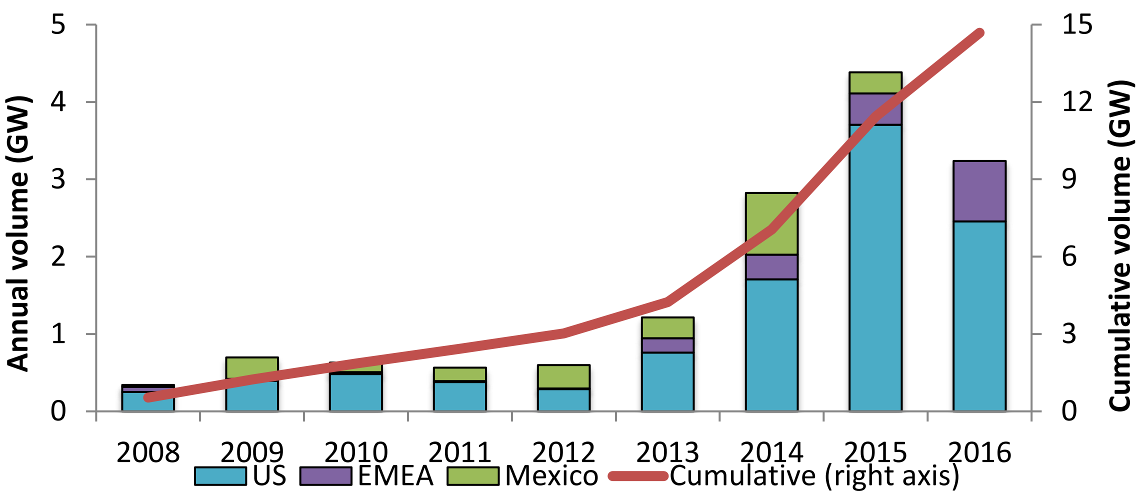

Figure 9. Global corporate PPAs by region and year, 2008–2016 (GW)

Data source: Bloomberg New Energy Finance 2016b. Note: No data available for Mexico in 2016.

5.2 Cost-Effectiveness of Large Scale Renewables

The cost-effectiveness of renewable energy has improved in recent years so that the potential economic benefits of procuring renewable electricity may now be significant in some markets. Corporations that have the ability to purchase energy from large-scale, off-site renewable energy projects can benefit from the cost-competitiveness and economies of scale of these projects relative to on-site projects.

Internationally, biomass, hydropower, geothermal, and onshore wind can all now provide electricity competitively compared to fossil fuel-fired power generation (Figure 10). Solar PV is becoming increasingly competitive with costs falling rapidly, while concentrating solar power (CSP) and offshore wind are in the infancy of their deployment and have significant cost reduction potential (IRENA 2016).

The levelized cost of electricity (LCOE) of utility-scale solar PV fell by 67% between 2010 and 2016, making PV competitive at the utility scale (Figure 10) in some markets. The cost of electricity from solar PV has fallen the most rapidly, driven by not only module declines, but reductions in the balance of system costs. Between 2010 and 2016, module price declines accounted for 59% of the decline in the global weighted average LCOE of utility-scale solar PV, with the balance of system costs accounting for the remainder (see Text Box 6 for additional detail).

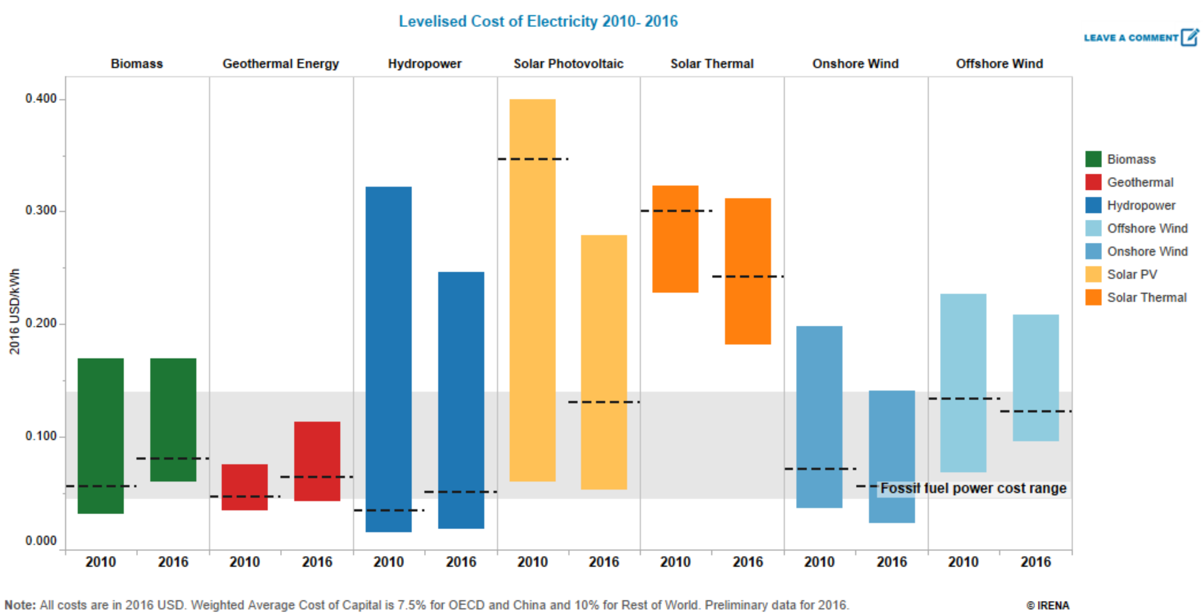

Figure 10. LCOE for utility-scale renewable power generation technologies, 2010–2016

Source: IRENA 2017

Text Box 6. Global Trends in the Cost of Utility-Scale Renewables

In 2016, the global weighted average levelized cost of energy (LCOE) of utility-scale solar PV commissioned in that year had fallen to around USD $0.11/kWh, with a range from $0.05 to $0.45/kWh. In China and India, the weighted average LCOE of solar PV in 2016 was $0.09/kWh in China and India (68% less than in 2010), in Organization for Economic Co-operation and Development (OECD) member countries it was $0.14/kWh (61% less than in 2010), and in the rest of the world it was $0.17/kWh (45% less than in 2010).

Around the world, utilities are receiving bids for solar PV, with results in 2016 highlighting just how competitive solar PV will be, with prices from these auctions consistently below $0.05/kWh for projects to be commissioned between 2018 and 2020, and even results below $ 0.03/kWh where there are excellent solar resources, competitive installed cost structures, and low financing costs. The auction results in the United Arab Emirates, Mexico, Chile, Peru, and South Africa in 2016 represent a turning point for solar PV that has been predominantly deployed in OECD countries with relatively poor solar resources. In locations where projects have been de-risked and the right regulatory and institutional frameworks are in place, as in the 2016 tender result in Zambia ($0.06/kWh), very competitive electricity rates are being contracted for in markets without significant history of solar PV deployment.

Onshore wind has become one of the most competitive sources of electricity for new generation as installed costs have fallen and the technology has improved. The global weighted average LCOE of onshore wind fell by 17% between 2010 and 2016, to around $0.065/kWh for projects commissioned in 2016. There has been a significant convergence in costs between regions as different regional cost structures, resource quality, different market sizes and dynamics, supply chain maturity, and technical skill factors are being evened out in the search for more competitive electricity. The weighted average LCOE of onshore wind in 2016 was $0.066/kWh in China and India (6% less than in 2010), which have some of the lowest total installed cost structures in the world, $0.074/kWh in OECD (26% less than in 2010), and $0.083/kWh in the rest of the world (29% less than in 2010).

CSP and offshore wind are in their infancy in terms of deployment. Total installed offshore wind capacity reached 13 GW at the end of 2016, while CSP installed capacity is around 5 GW. As a result, their costs are higher than solar PV and onshore wind on average, but costs are falling and the technologies have good cost reduction opportunities (IRENA, 2016). The weighted average LCOE of CSP plants that were commissioned in 2016 is estimated to have fallen 18% since 2010, to $0.27/kWh. For offshore wind, the LCOE in China and India for under-construction or commissioned projects is estimated at $0.17/kWh, 4% lower than the value in 2010. Where appropriate de-risking of projects has occurred, PPAs and tenders for future projects have been recently signed at much lower prices, highlighting the likely impact of lower financing costs than the average and technology improvements (notably the large 6–8 MW turbines being proposed for new offshore wind plants).

Sources: IRENA 2016; IRENA 2017

5.3 Barriers to Off-Site Renewables

A variety of barriers to large-scale renewable project development exist. Some of the key barriers identified in interviews and relevant literature are described below (see World Business Council for Sustainable Development [2016], Baker and McKenzie [2015], and Ernst and Young [2016] for additional discussion).

- **Regulatory uncertainty and complexity**. Regulatory uncertainty is one of the largest non-electricity concerns of these types of transactions. Companies in interviews have noted that complex regulations could be a barrier, particularly for companies without energy expertise.
- **Availability of renewable energy projects and quality components**. In order for a market to emerge, sufficient renewable energy needs to be available to corporate

customers. Availability can be limited by lack of transmission, substantial development risks, lack of credible suppliers, lengthy delays in interconnection processes, and other factors. In emerging markets, the ability to source quality components for projects can also impede project development.

- **Factors affecting the relative cost-competitiveness of renewables and contracts**. Across the world, some commercial and industrial customers pay electricity rates that are subsidized in order to promote economic development. With subsidized low electricity rates, procuring renewable energy becomes relatively more expensive. In addition, corporate leaders have concerns about currency fluctuations, which can affect financial transactions for companies operating across international markets, though those can be hedged against at some cost.
- **Curtailment risks**. In some markets, renewable energy is being curtailed, which impacts the economics of projects and available supplies. Uncertainty in the amount of curtailment that will occur increases project and financing risks, which must be typically shared by developers and off-takers, increasing overall project costs and costs to the corporate purchaser.
- **Ability to make renewable claims from purchases**. Similar to on-site systems, if a country or market has instituted a FIT or other compensation mechanism for renewable energy that transfers the renewable attributes to a utility or party other than the off-taker, corporations may be less interested in purchasing in that market. Relatedly, corporate purchasing can be hindered by a lack of a transparent, credible method of tracking renewable attributes (see Section 6).

5.4 Key Enabling Policies for Off-Site Renewable Procurement

When discussing policy priorities with corporations purchasing internationally, perspectives varied, but generally corporate leaders interviewed noted that they found the ability to sign a PPA in a liberalized market to be their preference. Table 13 outlines the key priorities and options for purchasers for a range of off-site procurement mechanisms, including policy design considerations and some best practice examples.

Table 14 provides a summary of policies that are in place in select jurisdictions in parts of Asia as well as South Africa and Mexico to provide a sense of how widely various policies are adopted internationally. The rest of this section describes how liberalized markets and vertically integrated markets can support corporate renewable energy purchasing.

Table 13. Off-Site Renewable Energy Purchasing Options and Supportive Policies in Vertically Integrated or Liberalized Markets

Off-Site Policy	Market Availability	Importance for Purchaser	Policy Design Considerations/Best Practices	Best Practice Examples
PPA	Liberalized markets	Purchaser only pays for kilowatt-hours produced; can provide a fixed or known electricity rate; includes both the energy and the renewable energy attributes	Retail rates that track wholesale rates; ability to sign PPA with third party; polices that expand renewable energy supply	Brazil, Mexico, Netherlands, Sweden, United Kingdom, United States
Purchasing aggregation through a joint PPA	Liberalized markets	Allows smaller companies to participate and receive long-term price stability	Enforceable contracts	Scandinavia
Utility green tariff	Vertically integrated	Enables renewable energy procurement in a vertically integrated market; can provide fixed or known electricity rate; includes both the energy and the renewable energy attributes	renewable energy pricing that is market-based; long-term purchasing option; ability to reduce or eliminate fossil fuel bill charges	United States (at least 10 utilities, e.g., NV Energy in Nevada)
Direct access	Liberalized markets	Purchasers do not need significant energy expertise; can make short-term commitment	Real market access; policies which expand renewable energy supply; clear and transparent tracking of energy attributes	Chile, Japan
Unbundled certificates	Vertically integrated and liberalized markets	Allows smaller companies, and large companies with small loads in multiple jurisdictions, to purchase renewable energy	Clear and transparent tracking of energy attributes	Guarantees of Origin (Europe), Renewable Energy Certificates (India, United States)

Table 14. Availability of Key Policies to Support Corporate Procurement in Select Markets

	Direct access to retail/ wholesale markets	Utility green tariff	Direct PPAs	Unbundled certificates	Wheeling	FIT and/or tendering	Tax incentives
China	◑Some ongoing attempts at wholesale markets in select provinces	○Previous pilots in Shanghai Municipality and Jiangsu Province	◑Available in most provinces; very limited use for RE so far	●Voluntary RECs; National REC system launches July '17	●Available for DPPA; scheduled for DG projects in July 2017	◑FITs being phased out	●VAT exemption for RE power generation
India	●	○	◑	●Voluntary RECs	◑Wheeling regulations set at state level; vary in support of renewables	◑	◑
Indonesia	○	○	◑Electricity businesses ≤ 50 MW in areas unserved by PNL operate as mini-utility	◑Planned launch of voluntary RECs	◑Wheeling agreements negotiated on an ad hoc basis	◑RE tariffs capped at PLN production costs	◑
Mexico	●	○		●Planned voluntary RECs; RPS for large consumers beginning in 2018	●	●	●
Philippines	●	○	◑Available for on site	●Voluntary RECs available; RPS in consideration	◑At distribution level, available to Retail Electricity Suppliers (RES)	●	●
South Africa	○	○	●	◑Planned launch of voluntary RECs	●	●	◑Carbon tax under consideration
Vietnam	○	○	◑Discussion of a possible pilot direct PPA	◑Planned launch of voluntary RECs	○	◑Is revised solar PV FIT rate is sufficient to drive investment?	●

○No Policy | ◑Limited Policy | ●Supporting Policy

5.4.1 Off-Site Renewable Energy Corporate Procurement in Liberalized Power Markets

In fully liberalized markets, customers are able to choose the source of their electricity supply. Thus, no explicit policy is needed to enable corporate procurement of renewable energy. Customers can choose a supplier that offers a renewable energy option or engage in a PPA for renewable energy. For example, Chile's liberalized power market enabled Google to purchase 80 MW of solar (Text Box 7). Although no explicit polices are needed, several related policies can enable corporate procurement of renewable energy in a more cost-effective manner. Companies have expressed interest in governments taking the following actions to enable their purchasing in liberalized markets:

- Larger, more integrated grids (within or across countries)
- Open access transmission policies and ability to "wheel" power by paying a fee
- Retail tariffs that are transparent and set by the market.

Text Box 7. Google's Solar Energy Purchase in Chile

In late 2015, Google entered into an 80-MW solar PPA with Acciona, a Spanish renewable energy developer, to supply Google's datacenter in Chile with solar energy produced at the El Romero solar farm in the Atacama desert, which is one of the sunniest places on earth.

Under the agreement, Acciona serves as Google's Chilean electricity supplier. Acciona supplies all the electricity that Google consumes at its data center near Santiago for an agreed price, including the solar power and the power from the grid. Although the solar farm only produces electricity during the day, Acciona supplies 24/7 power to Google's data center by withdrawing power from the electricity grid as needed. When the solar farm is producing, however, it is actually *over*-producing compared to the data center's consumption, such that over the course of the year, the amount of electricity produced by the solar farm equals or exceeds the amount of electricity consumed by the data center. This solar production is tracked by non-conventional renewable energy credits, which Google purchases bundled with the electricity.

This contractual structure is possible because of the liberalized power market structure in Chile. Under Chilean market rules, any electricity customer over a certain size can choose their supplier from a competitive pool of approved firms, which differentiate themselves in various ways (price, renewable energy, etc.). Thus, Google was able to shop for the supplier that could best meet its need for renewable energy, among other factors.

Despite this structural advantage, the Chilean electricity market still has room for improvement. Currently only electricity suppliers like Acciona can hold the non-conventional renewable energy credits, whereas end customers like Google cannot. Also, there is no mechanism to retire the credits (in Google's case, Acciona will hold the credits until they expire, but this is not ideal). The ability to retire the credits is important for making greenhouse gas or other claims associated with the purchase. Still, Google found the advantageous structure of the Chilean electricity market conducive to corporate purchasing of renewable energy.

First, creating larger, more integrated grids can provide a greater supply of renewable energy that corporations could source from, enabling more options and potentially lower-cost renewable energy procurement. In addition, some corporations are interested in sourcing renewable energy from the same region where their loads are located to have more localized impacts. If load is located in an isolated region with limited renewable energy project options, sourcing can be more difficult. For example, in Asia, West Africa, Mexico, Ireland and the western United

States, regulators and policymakers have expanded regional grids, which can also be beneficial for renewables integration.[8]

Second, opening access to transmission lines to all generators (renewable and not) can allow renewable energy deployment in areas where the resources are of greater quality. In addition, some counties have chosen to discount transmission fees for renewable energy projects. For example, in Mexico, before the energy reform, renewable generators paid a postage stamp rate for transmission access, for the entire life of the project (Heeter et al. 2016). Postage stamp rates are a per-unit fee (e.g., per kilowatt) to use the transmission system. Because a generator will pay the same rate whether it is located far or close to the load it is serving, postage stamp rates tend to favor large wind or solar generators located far from load.

Third, for financial PPA transactions, it is important that retail tariffs are transparent and are tied to wholesale market prices. This enables corporate leaders to decide whether they can potentially reduce electricity cost expenditures and create an effective hedge for their future retail electricity costs by buying power through a financial PPA (otherwise known as a synthetic PPA or contract-for-differences). Under a financial PPA, the corporate purchaser continues to pay their existing retail energy bill. Therefore, to provide an effective hedge, the increases or decreases in generation costs at the wholesale level must be passed on to the purchaser in their retail rates. When that happens, if the corporation is paying higher prices for renewable generation, it will also be paying lower prices for conventional generation on their electricity bill.[9]

5.4.2 Off-Site Corporate Procurement in Vertically Integrated Markets

In vertically integrated markets, where customers do not choose the source of their grid-supplied electricity, utilities and regulators can create new policies and programs to enable corporate renewable energy procurement. These policies and programs can either be mandated by regulators or offered voluntarily by utilities. Emerging policies and programs include creating a utility green tariff and/or providing wholesale access and/or retail choice to large customers.

Utility green tariffs or "riders" are purchasing mechanisms by which a utility contracts for generation from a renewable generator, then provides an option for commercial and industrial customers to purchase that renewable generation, typically on a long-term basis. These programs are emerging in the United States as corporate renewable energy purchasers have been discussing their renewable energy needs in states with vertically integrated markets (Tawney et al. 2017). Utility green tariffs enable utilities to play a leadership role in developing renewable energy while meeting the requirements of corporations that are requesting the option to purchase renewable energy and allowing the utility to recover costs associated with purchasing power from a renewable energy generator.

Utility green tariffs can have many different structures. To formulate an effective tariff (i.e., have corporate customers subscribe and new renewable generation built), regulators, corporate purchasers, and utilities work together. Each stakeholder has a unique perspective on how utility green tariffs should be structured.

[8] For example, see http://www.asean.org/storage/images/2015/October/outreach-document/Edited%20APG-3.pdf and the West African Power Pool http://www.ecowapp.org.

[9] For additional discussion, see Chadbourne (2013).

- Regulators want the tariff structured so that program, project costs, and other related regulatory costs are not transferred to non-participating customers. This is especially important in countries that are concerned about the political implications of increasing electricity costs.
- Most corporations are interested in having utilities play the role of renewable energy purchaser, but corporations also want to ensure that options created do not come with a large price mark-up. Corporate purchasers may want products that pass the economics of renewables on to them, for example, on an hourly basis.
- Utilities want to ensure that they will not be left with a renewable asset that is unsubscribed. They also want to ensure that their administrative costs are recouped from the corporate purchaser. Some utilities may also be hesitant to manage the variability of the renewable resource.

Text Box 8. Autodesk Serves as the Anchor Tenant of the Marin Clean Energy CCA

Marin Clean Energy (MCE) was California's first CCA, launched in 2010. MCE approached Autodesk, a global company providing 3D design, engineering, and entertainment software headquartered in Marin County, about serving as their anchor tenant. At that time, Autodesk already had a science-based GHG emissions reduction goal (created in 2008) and had an internal goal to build all new facilities to a Leadership in Engineering and Environmental Design (LEED) Gold standard. Because renewable energy procurement could be applied to Autodesk's existing facilities sustainability goal, they made the case internally to support MCE. For their campus buildings in the City of San Rafael, Autodesk agreed to purchase 100% of their energy demand through MCE, with a product mix that was 50% renewable.

Autodesk was able to switch their electricity supply to MCE through a California provision passed in 2002 that allows development of CCAs. CCAs can then procure energy directly from independent power producers. Although CCAs are not required to include renewable energy, in practice they have been designed in California to focus on procuring more renewables than would otherwise be included in the utility generation mix (O'Shaughnessy et al. 2016). Without the ability to procure directly from independent power producers and without the 2002 provision, Autodesk would not have had this local option for renewable energy. Autodesk simply signed a contract with MCE with no capital investment or physical infrastructure upgrades.

The primary challenge of the CCA option was for Autodesk to estimate the long-term price impact of MCE's renewable option. Autodesk found that the flexibility in size of off-take and the ability to opt out at any time made supporting the newer renewable energy mechanism less daunting.

As Autodesk looks for purchasing options internationally, they are looking for a credible third-party or government entity that has jurisdiction over certification and verification of voluntary renewable energy offerings. Autodesk considers the integrity of the renewable project they are supporting in terms of chain-of-custody to avoid double accounting, verifiability of the renewables generation, and environmental benefits of the project.

Aside from transitioning a vertically integrated market to a fully liberalized market, regulators may allow some subset of customers (typically large commercial and industrial customers) to have retail choice and/or direct access to wholesale energy markets.

In Japan, electricity market reforms began in 2000, enabling large-scale factories, department stores, and office buildings to choose their power supply. In addition, these customers were allowed to buy electricity from new producer and supplier companies. Since then, Japan has begun to liberalize its market further, with full liberalization of the market starting in April 2016 (Japan Agency for Natural Resources and Energy 2017).

In the United States, seven states have passed legislation allowing certain jurisdictions to form CCAs. CCAs allow a government entity to purchase electricity on behalf of an aggregation of customers (typically residential and smaller non-residential). In Marin County, California, the Marin Clean Energy CCA allows customers to purchase a renewable energy option (see Text Box 8.)

5.5 Actions Regulators Can Take to Promote Corporate Off-Site Renewable Energy Procurement

In both liberalized and vertically integrated markets, regulators can support corporate off-site renewable procurement. A summary of potential actions are the following.

Allow corporations to purchase renewable energy directly. Efforts to restructure markets are underway in China, Japan, Mexico, Vietnam, and other countries. Regulators and policymakers may consider allowing large electricity users to procure their own electricity supply. This option gives large users more control over what can be one of their largest business expenses. Many developing countries face challenges in meeting rapidly increasing electricity demand growth. Allowing corporations to procure energy directly can help ensure that energy needs are met and to take some of the onus off of the utilities; however, utilities may be reluctant to have large customers leave, in particular industrial customers, who may be the best paying customers. Enabling large customers to procure their own supply can be done in many ways, from fully liberalizing the electricity market to allowing only certain customers or customer classes to purchase their own electricity supply.

Design tariffs for large electricity users in vertically integrated markets to price electricity based on wholesale market rates (that reflect actual costs of production). Electricity costs are one of the largest operating expenses for some corporations. As such, they would like to have control over those expenses. By exposing large users to market prices, these users can more effectively hedge against high prices by purchasing renewable energy.

Create utility green tariffs in vertically integrated markets. In vertically integrated markets, regulators can work with utilities and large customers to craft a green tariff that allows customers to purchase renewable energy from the utility through a long-term contract. Regulators can ensure that renewable energy purchasing by large customers does not impact rates of those not participating in the utility green tariff. The utility green tariff allows utilities to maintain their role as a single buyer and in its leadership role supporting development of renewable energy projects.

Create liquid wholesale markets with price transparency. In some countries, a wholesale market may exist but have few buyers and sellers. In that case, it can be difficult for a renewable generator with a PPA to sell into the wholesale market. Regulators can encourage more liquid wholesale markets by creating more energy buyers and sellers. Price transparency in a market enables full understanding of renewable energy project economics; in that way, corporate purchasers can understand the costs of their renewable energy PPA compared to traditional electricity supply.

Support energy rates that reflect the actual cost to serve customers. In some markets, corporate customers pay electricity rates that do not reflect the cost to serve them. These rates are either subsidized by residential or other customer classes and/or by the government through another source, such as taxes. These discounted electricity rates may be implemented as part of a national policy to encourage economic development. However, paying artificially low rates makes the cost to procure renewables seem relatively more expensive and may be a disincentive to reduce energy usage through efficient technologies and practices.

Develop open access transmission policies that enable project developers to wheel power, if needed. Opening access to transmission lines to all generators (renewable and not) can allow renewable energy deployment in areas where the resources are of greater quality.

Address curtailment risks. The risk of curtailment of project output can translate to significant financial risks to the project off-taker and developer. Policies that encourage sufficient transmission grid infrastructure and clarity surrounding dispatch order and priority can help reduce risks.

6 Enabling Renewable Energy Product Quality and Credible Transactions: Verification and Standards

6.1 Importance of Market Infrastructure for Renewable Energy Sourcing

A certain level of market support infrastructure can ensure the credibility of transactions and facilitate the development of robust markets for corporate renewable energy procurement. Without it, individual projects and transactions are more difficult to execute and verify, and they are less likely to enable legally enforceable and exclusive claims and benefits to corporate customers. This infrastructure includes (but is not limited to) contractual instruments, tracking and verification systems, and standards and certification programs.

This infrastructure is important to purchasers who want to ensure that they can make exclusive claims about their renewable energy use and account for the associated GHG benefits. In addition, it enables a greater variety of product options and the potential expansion of the market beyond corporations to other customer classes, including residential consumers. Finally, voluntary market infrastructure can be used to support future compliance markets, such as quota systems or renewable portfolio standards.

6.2 Conditions for Effective Voluntary Markets

Effective voluntary markets and corporate renewable energy procurement depend on the exclusive and verified delivery of generation attributes from specified renewable energy generators in the context of existing local electricity sector laws and practices and surplus to what is required by law or regulation. The conditions for effective markets for corporate renewables sourcing include the following:

1. Transactions that provide legally enforceable property rights to renewable energy (i.e., generation attributes).

   The transaction or electricity product includes environmental attributes, price, and electricity benefits of use of that generation, which may vary by product, resource, location and market.

2. No double counting or double claiming of the attributes by other electricity customers or regulated entities.

   Avoiding double counting can help ensure consumer confidence and demand by allowing for the delivery of real benefits.

3. Voluntary renewable energy purchases are not used to meet governmental targets, laws, or legal mandates.

   Corporate purchasers expect their investments to support renewable energy in excess of what is required by law, not to reduce the costs of compliance for regulated entities. This enables the voluntary market to make an incremental difference or demand-side impact often referred to as “regulatory surplus.” Where the law does not require consumption or delivery of renewable energy, regulatory surplus may not be required for a customer to make an exclusive claim or purchase. But, moving the needle in terms of renewable energy generation and its emissions benefits drives voluntary demand.

Maintaining these conditions requires continual monitoring of the policy and regulatory landscape as it changes.

These conditions are different but related to the criteria for credible renewable electricity usage claims, articulated in a RE100 white paper, *Making Credible Renewable Electricity Usage Claims* (Braslawsky, Jones, and Sotos 2016). These criteria do not necessarily apply to voluntary claims specifically, though many of the things needed to make a credible renewable electricity usage claim are the same things needed for a vibrant, credible voluntary market, and vice versa.

6.3 Market Infrastructure

The following tools support credible and transparent markets for renewable energy sourcing. This section explores considerations for the design and implementation of these tools, though the specific features and functionality of each along with how they are created and used will depend on the circumstances of each market.

6.3.1 A Mechanism for Documenting Ownership and Claims: Energy Attribute Certificates

Purchasing renewable energy means differentiating electricity based on the attributes of the generation and allocating the renewable attributes of generation to specific customers. These attributes and specified generation are not physically delivered to the customer. The attributes are separate from physical electricity, which is indistinguishable and untraceable on the grid regardless of how it was produced. As a result, the use of specified generation sources on the grid and their attributes can only be determined contractually.

Contractual instruments are used to demonstrate delivery and consumption of renewable energy on the grid. One such instrument is the energy attribute certificate (or simply "certificate"), which is created (either by a generator in a contract or by a designated issuing body on behalf of a generator) when electricity is generated and deployed to the local electricity grid. Certificates are trackable and verifiable. They also represent a standardized currency for renewable energy. Certificates can help facilitate transactions, lower transaction costs, increase market participation, and increase available product options. They can also be helpful for implementing other policies, such as quota policies, and ensuring that policies with overlapping objectives in the power sector are incremental.

Certificates are just one way to trade renewable energy. Attributes can be defined and traded without certificates, such as in legally enforceable contracts. However, uniform instruments defined in law may produce a much more vigorous market. Certificates can be created through designated issuance bodies on the basis of verified renewable energy generation data. Text Box 9 describes common characteristics of successful certificate programs.

Text Box 9. Characteristics of Successful Certificate Programs

Certificates convey clearly defined property rights.

Defined legal rights to certificates and the attributes included can limit uncertainty. A strong legal basis for how the certificate system is used to meet policy goals helps mitigate legal uncertainty, which can lead to lawsuits and conflicts with other programs, dampen the certificate market, and slow clean energy development. Proper definition of the essential qualities of certificate attributes and the property rights that certificates transfer can help programs avoid double counting attributes.

There is full aggregation of attributes.

Clearly defining what attributes are included in the certificate can prevent double counting (both within the market and potentially by other related programs, such as a carbon trading programs) and can signal to potential users the eligibility of the certificate for different types of programs.

***Certificates are the exclusive means of conveying attributes and use*.**

Multiple attribute allocation or verification paths, or purchasing options where certificate surrender is not required, can weaken the certificate system as a mechanism to deliver value and incent project development. Having two alternative systems for tracking clean energy (e.g., certificates and electricity) can increase verification costs.

There are clear geographic boundaries for certificates.

Well-designed constraints on geographic eligibility of projects that are eligible to generate certificates can help provide a strong incentive for new development within a certain region. But, overly constraining supply can decrease the efficiency of the market and drive certificate prices up.

Eligibility limitations are carefully considered.

There are several different options for setting limitations on generation eligible to create certificates. Creating certificates for all types of generation (beyond that which has voluntary demand now) can create a system with most data that can be used for power source disclosure, GHG accounting, and other purposes.

Certificate systems are designed for multiple uses.

Allowing different voluntary programs and standards to set eligibility requirements in terms of things like vintage, banking, price banding, and bundling and unbundling of certificates provides flexibility and can increase program usage and total transactions.

6.3.2 A Mechanism for Tracking and Verification: Tracking Systems

Verification of delivery and use of renewable energy is necessary because renewable attributes are not physically delivered. Delivery and receipt of renewable generation can only be verified if the generation is properly tracked. Proper verification and tracking prevents double counting, including double issuance, transfer, and ownership of attributes and instruments.

Tracking can be done using contracts. In this case, the transfer of attributes is articulated in a legally enforceable contract or series of contracts that link the generator to the end user. Claims are based on the permanent end-use ownership or final use of those attributes, which is specified in a contract.

In electronic energy attribute certificate tracking systems (or simply "tracking systems"), certificates are electronically serialized and issued to generators with accounts in the system. Certificates are tracked between account holders where they are traded until the certificate is permanently retired or cancelled electronically by or on behalf of an end user making a claim. Where tracking systems exist, transactions outside of the tracking system are usually limited to special cases (e.g., when participation in the tracking system is too costly for very small generation units).

Where renewable energy generation facilities only have access to one designated system, tracking systems provide exclusive issuance, trading, and retirement of attributes to support credible claims. Many of these systems also provide verification of generation data and ensure full aggregation of attributes. While many tracking systems are initially built to serve voluntary market participants, they can, like the certificates themselves, also be used or adapted for other government policies, including compliance purposes (e.g., quotas). Key elements of tracking systems are listed in Text Box 10.

Markets without certificates, or without sufficient tracking or certification systems, may have difficulty verifying that there has been no double counting or double claiming. In these markets, renewable energy usage claims may be more difficult to substantiate.

6.4 Third-Party Standards and Certification Programs

Even in markets where instruments or tracking systems are well established, verification that attributes are not being claimed or counted elsewhere, or altered by changes in policy, adds credibility and increases consumer confidence. These are functions that can be provided by independent certification programs.

To enhance market assurances and reduce transaction risks, corporate purchasers can look to third-party standards and certification. Standards and certifications can serve different purposes and cover different areas. Typically, however, standards are developed through public stakeholder consultation processes and act as governing documents for certification

Text Box 10. Elements of Certificate Tracking Systems

1. **Governance**. The governance structure ensures that tracking systems are independent, transparent, and policy neutral.
2. **Design parameters**. An up-front, inclusive system design may avoid difficulties and costs later as needs from the system change.
3. **Data reporting and issuance**. Issuance is limited to generation for which there is verified generation data from qualified independent entities. There is issuance for all production by registered generator. All certificates are traded within the system and all deposits are made into generator accounts. There is proper safeguarding of confidential information. There are different options for other items, such as the timing of certificate issuance, and the aggregation of small and distributed generation systems.
4. **Certificate information**. Megawatt-hour is the most common certificate unit. Basic certificate information includes the location, resource type, capacity, commercial operation date of the generation facility, as well as the date of generation, date of issuance, and the unique serial identification number.
5. **Transfers and retirement**. Tracking systems can allow free transfer between account holders and include a mechanism to retire or cancel certificates so they can be “used” and no longer traded.
6. **Verification of static and dynamic data**. Reviewing static data for accuracy and verifying data upon generator registration helps to prevent double registration. Dynamic generation data can come directly from an electricity market operator based on metered data. Special rules can address issues such as multi-fuel generation, imported and exported generation, distributed generation, and generation with multiple owners.
7. **Verification of transfers and retirement**. In addition to checks built in to the system software, the system may include procedures to contact account holders to verify that transfers and retirements are correct.
8. **Monitoring**. Internal and external monitoring and evaluation of system operations and account activity ensures proper functionality and helps identify potential fraud and misuse.
9. **Reporting**. The systems include reporting processes that allow users to document transfers and retirements, as well as provide aggregate data for the public while protecting confidentiality of individual account holders.

programs. In the renewable energy market, there are three main areas of certification: facility, transaction, and usage.

Facility Certification. In many countries, certification is available to assess and set a standard for renewable electricity generation facilities, providing assurances around the type of technology used, the commission date of the facility, repowering activities, capacity of the facility, and production quantities. Some standards assess facilities against a set of sustainability, market driver (e.g., date of commercial operation), and/or cultural protection criteria.

Transaction Certification. Transaction certification benefits the corporate procurement process by helping to reduce risk, allowing for simplification of procurement, and facilitating transactions. Transaction certification can increase consumer confidence in transactions and encourage more participation in the market. Transaction-level certifications can:

- Verify the sale of renewable energy to ensure exclusive retail ownership of the environmental attributes and prevent double selling.
- Protect against double claiming by verifying that all renewable energy instruments or other instruments (e.g., carbon offsets issued for renewable energy generation) have been retired by or on behalf of the same entity and that there are no other usage claims being made on the generation or attributes.
- Verify regulatory surplus—that the generation or attributes of generation were not used to meet a government or legal mandate.
- Enforce market-specific requirements that ensure full attribute aggregation and exclusive ownership and claims on account of existing and changing practices, policies, and legal frameworks that determine how electricity and renewable energy is transacted in different markets.
- Enforce product-specific requirements like sourcing and supply requirements for certain types of products to protect consumer expectations and meet policy objectives.
- Protect consumers by requiring minimum disclosures to customers and truthful marketing of products.

Usage Certification. In addition to purchasing certified renewable energy, corporate users may elect to have their own usage and public claims verified through a third party. This type of certification allows companies to publicly communicate their renewable electricity purchase with the backing of a third party, often using the certification logo and claim language when available. Renewable electricity usage certification can bridge trust gaps with stakeholders and enhance public perception.

6.5 Policy Interaction

The market and policy environment in which transactions occur may dictate available product options and their attributes. Voluntary renewable energy markets can aim to support the ability to legally trade or purchase renewable energy and associated attributes and ensure that voluntary procurement by corporations or others are accounted for separately from other renewable energy activities, mandates, support schemes, or markets. Satisfying this basic market infrastructure can help enable corporate purchasers to feel confident that they are using renewable energy that no other user can claim.

The voluntary market may interact with the following markets and policies:

Compliance markets (quotas, renewable portfolio standards). Renewable electricity purchases may or may not help another entity meet a legislative or legal obligation, such as a quota requirement. Voluntary procurement of renewable electricity that follows best practices will ensure, for example, that none of the underlying attributes or commodities are used towards renewable energy mandates or claimed as a part of related climate change policies. Though corporate buyers may meet their goals with a blend of regulatory compliance by their suppliers and voluntary procurement that goes beyond that compliance.

Financial incentives: Many governments provide incentives such as grants, tax incentives, and preferential pricing (e.g., FITs) to renewable electricity generators. While receiving government incentives may prohibit certain renewable electricity projects from generating carbon offsets under specific carbon offset project protocols, most incentives used to assist the development of new renewable energy projects do not preclude usage claims or exclusive ownership of generation attributes. The claim to be using renewable electricity does not depend on whether the facility is existing or new, or what caused the facility to be built. In some cases, however, the generation facility must surrender the attributes in order to receive the government incentive. In these cases, any public claims of renewable electricity usage made on the same certificates would constitute double counting.

Carbon offset products and regulation: Carbon offsets and renewable energy certificates are both tradable environmental commodities. Carbon offsets do not convey usage of renewable electricity to grid consumers. Conversely, renewable electricity instruments (e.g. certificates) are not tradable GHG emissions reductions even if they come from projects that meet offset-quality additionality criteria. However, use of renewable electricity can include certain carbon benefits and claims (namely, carbon footprint claims related to the emissions associated with electricity usage) and avoided grid emissions claims related to the effect that purchased renewable energy generation has on the grid). Though the claims associated with each instrument are different, the avoided grid emissions attribute of renewable energy is the basis of an offset claim and also a secondary attribute often conveyed in energy attribute certificates. So, depending on how attributes and certificates are defined, offsets and energy attribute certificates may not be able to be issued for the same MWh without double counting. Also, in the presence of carbon regulations and programs such as cap-and-trade systems, renewable energy may not retain avoided carbon emissions benefits and cannot be considered surplus to GHG regulation unless specific mechanisms, such as a voluntary renewable energy set-aside, are in place

7 Summary and Conclusions

Corporations have the potential to play a significant role in driving demand for renewable energy in coming years, particularly in countries with nascent renewable energy markets today. For policymakers who have goals for growing renewable energy deployment, private sector investment by corporations is one way to build markets and expand adoption, without the use of direct mandates. Sourcing from renewables can also be a method of addressing challenges in meeting rapidly increasing electricity demand growth because renewables can often be developed more rapidly than conventional generation sources.

The policy environment for enabling corporate procurement is a key factor that will determine how and where corporations procure renewables. Such decisions have implications for energy markets because corporations often have substantial energy loads and bring significant resources to bear in facilitating transactions.

Policymakers can help facilitate corporate renewables sourcing, whether in traditionally regulated energy markets, liberalized markets, or in areas where the power sector is undergoing transformation. A number of potential actions by policymakers are not specific to market structure, but can be applied in all types of markets:

- **Develop adequate infrastructure to verify and track renewable energy purchases and enable corporations to have confidence in their procurement through strong contractual arrangements.**
- **Develop clear and stable compensation mechanisms for generation from on-site renewable energy systems** exported to the grid to enable off-takers to accurately evaluate project economics over the project lifetime.
- **Develop interconnection procedures that are transparent, expedient, and equitable to the utility and project owner** by providing publicly available information about interconnection queues, guidelines on the speed of interconnection, and cost certainty.
- **Create streamlined and coordinated permitting processes** to simplify the process for end-users, reduce unnecessary delays, and increase the viability of on-site projects.
- **Clarify ownership of renewable energy attributes associated with renewable generation** under incentive policy programs (e.g., FITs) to enable corporations to make clear claims about their use of renewable energy or GHG reduction benefits.
- **Create tariffs for large electricity users that price electricity on wholesale market rates that reflect actual costs of production**. By allowing large users to be exposed to market prices, they can more effectively hedge against them by purchasing renewable energy.

In general, enabling corporations to purchase renewables directly, either through fully liberalized markets or enabling certain customer classes to have direct access, can help lower the cost of renewables procurement and drive wide-scale adoption of renewables. In regions that have partially or fully liberalized electricity markets, or are undergoing market restructuring, the following can aid in the development of more robust markets for corporate renewables sourcing.

- **Create liquid wholesale markets with price transparency**, which can enable corporations to evaluate the economics of PPA and other wholesale transactions.

- **Develop larger, more integrated grids (within or across countries)**, which can increase supply of renewable energy that corporations could source from, enable more procurement options, potentially lower the cost renewable energy procurement, and enable sourcing of renewable energy locally from the same region where their loads are located.
- **Develop open access transmission policies and the ability to "wheel" power by paying a fee.** Opening access to transmission lines to all generators (renewable and not) can allow renewable energy deployment in areas with greater quality renewable resources. Alternatively, some counties have chosen to discount transmission fees paid by renewable energy or structure fees so that they are more favorable toward renewable energy generators.

In regions with vertically integrated markets, policymakers can take other steps to encourage the development of robust markets for corporate sourcing of renewables, such as:

- **Allow for contracts with third-party financiers and installers** for on-site projects to leverage the strengths of entities expert in on-site installation and operation.
- **Create utility green tariffs that allow customers to purchase renewable energy from the utility on a long-term basis** from a newly developed renewable energy project. Policymakers can ensure that the costs of the renewable purchase are paid by the participant, not passed on to non-participating customers.
- **Support energy rates that reflect the actual cost to serve customers** to avoid customers paying artificially low rates, which makes the cost to procure renewable energy seem relatively expensive and discourages energy efficient technologies and practices.

Policy certainty is also essential to creating vibrant markets for renewable energy. While policymakers may need to adjust policy mechanisms over time as markets go through different stages of maturity, they can also consider the economic decisions that end-users make in evaluating projects and the implications of policy shifts on market uptake. While early policies may need to encourage adoption, after markets grow, policymakers can focus on non-cost-related barriers, such as administrative hurdles. **Policy interaction is also important to consider** because buyers seek assurances that their investments in renewables have impact and wish to make clear claims about their renewable energy purchases.

References and Further Reading

Amazon. 2017. “AWS & Sustainability.” Accessed April. https://aws.amazon.com/about-aws/sustainability/.

Apple. 2015. “Apple Launches New Clean Energy Programs in China To Promote Low-Carbon Manufacturing and Green Growth.” News release, October 22. http://www.apple.com/pr/library/2015/10/22Apple-Launches-New-Clean-Energy-Programs-in-China-To-Promote-Low-Carbon-Manufacturing-and-Green-Growth.html.

APX. 2016. “APX Opens Renewable Energy Registry in Singapore and Issues First TIGRs for Apple.” News release, September 6. http://tigrs.apx.com/2016/09/06/apx-opens-renewable-energy-registry-in-singapore-and-issues-first-tigrs-for-apple/.

Ardani, Kirsten, Carolyn Davidson, Robert Margolis, and Erin Nobler. 2015. *A State-Level Comparison of Processes and Timelines for Distributed Photovoltaic Interconnection in the United States*. NREL/TP-7A40-63556. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy15osti/63556.pdf.

Baker and McKenzie (2015) The Rise of Corporate PPAs: A New Driver for Renewables http://www.bakermckenzie.com/en/insight/publications/2015/12/the-rise-of-corporate-ppas/

Barnes, Chelsea. 2013. *Aggregate Net Metering: Opportunities for Local Governments*. Raleigh: North Carolina Solar Center. http://icleiusa.org/wp-content/uploads/2015/11/Aggregate-Net-Metering-Opportunities-for-Local-Governments.pdf.

Barua, Priya. 2017. Discussion with authors, February.

Bird, Lori, Jaquelin Cochran, and Xi Wang. 2014. *Wind and Solar Energy Curtailment: Experience and Practices in the United States*. NREL/TP-6A20-60983. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy14osti/60983.pdf.

Bird, Lori, Pieter Gagnon, and Jenny Heeter. 2016. *Expanding Midscale Solar: Examining the Economic Potential, Barriers, and Opportunities at Offices, Hotels, Warehouses, and Universities*. NREL/TP-6A20-65938. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy16osti/65938.pdf.

BNEF (Bloomberg New Energy Finance). 2016a. *Mexico’s Auction Results in Record Low PV Prices*. Research note, October 4. https://data.bloomberglp.com/bnef/sites/14/2017/01/BNEF_MexicosSecondPower_SFCT_FNL_B.pdf.

———. 2016b. *Corporate Renewable Energy Procurement Monthly: October 2016.* https://data.bloomberglp.com/bnef/sites/14/2016/10/BNEF_Corporate_Renewable_Energy_Procurement_Monthly_October_2016.pdf.

———. 2017. *Corporate Renewable Energy Procurement Monthly: January.*

Bonugli, Celina. 2017. "States Use Renewable Energy to Win Corporate Business." World Resources Institute blog, February 3. http://www.wri.org/blog/2017/02/states-use-renewable-energy-win-corporate-business.

Braslawsky, Jared, Todd Jones, and Mary Sotos. 2016. *Making Credible Renewable Electricity Usage Claims*. Technical advisory group briefing. London: The Climate Group. http://media.virbcdn.com/files/62/53dc80177b9cc962-RE100CREDIBLECLAIMS.pdf.

Burkhardt, Jesse, Ryan Wiser, Naïm Darghouth, C.G. Dong, and Joshua Huneycutt. 2015. "Exploring the Impact of Permitting and Local Regulatory Processes on Residential Solar Prices in the United States." *Energy Policy* 78:102–112. https://doi.org/10.1016/j.enpol.2014.12.020.

Chadbourne. 2013. "Synthetic Power Contracts." Article, April. https://www.chadbourne.com/SyntheticPowerContracts_projectfinance.

Cochran, Jaquelin, Lori Bird, Jenny Heeter, and Douglas J. Arent. 2012. *Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience*. NREL/TP-6A20-53732. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy12osti/53732.pdf.

Commonwealth of Virginia State Corporation Commission. 2016. "Application of Virginia Electric and Power Company: Final Order." Case no. PUE-2015-00108. http://www.scc.virginia.gov/docketsearch/DOCS/3b0%2401!.PDF

Couture, Toby D., David Jacobs, Wilson Rickerson, and Victoria Healey. 2015. *The Next Generation of Renewable Electricity Policy: How Rapid Change is Breaking Down Conventional Policy Categories*. NREL/TP-7A40-63149. Golden, CO: Clean Energy Solutions Center. http://www.nrel.gov/docs/fy15osti/63149.pdf.

David Gardiner & Associates. 2013. *Power Forward: Why the World's Largest Companies are Investing in Renewable Energy.* Geneva: World Wildlife Foundation. http://assets.worldwildlife.org/publications/507/files/original/Power_Forward_FINAL_hi_res.pdf?1357935348&_ga=1.104868096.206895736.1490202219.

DLA Piper. 2016. "Corporate Power Purchase Agreements (PPAs): What Are They?" June 22. https://www.dlapiper.com/en/uk/insights/publications/2016/06/renewable-energy-global-paper/what-are-corporate-power-purchase-agreements-ppa/.

Dominion. 2017. "Solar Energy Generation." Accessed April. https://www.dom.com/about-us/making-energy/renewables/solar/virginia-and-north-carolina-solar-projects.

Edwards, Devon, Dan Mitler, Amy O'Meara, Bryn Baker, Joshua Kaplan, Susanne Fratzscher, and Marty Spitzer. 2016. *Corporate Renewable Energy Procurement: A Snapshot of Key Trends, Strategies and Practices in 2016*. Geneva, Switzerland: World Wildlife Fund. http://www.corporateecoforum.com/wp-content/uploads/2016/10/CEF-WWF-2016-Corporate-renewable energy-Procurement_FINAL.pdf.

Ernst and Young 2016. *Meeting the Renewable Energy Target: Innovative Approaches to Financing Renewables in Australia*, March.

http://www.ey.com/Publication/vwLUAssets/meeting-the-renewable-energy-target/$FILE/EY-meeting-the-renewable-energy-target.pdf.

Feldman, David, Anna M. Brockway, Elaine Ulrich, and Robert Margolis. 2015. *Shared Solar: Current Landscape, Market Potential, and the Impact of Federal Securities Regulation*. NREL/TP-6A20-63892. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy15osti/63892.pdf.

Frankfurt School, UNEP Centre, BNEF. 2016. *Global Trends in Renewable Energy Investment 2016*, http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf.

Gomez, Ana Sofia. 2016. "Sourcing Energy in Mexico Brings Challenges for Procurement." My Purchasing Center, December 5. http://www.mypurchasingcenter.com/mro-indirect/blogs/sourcing-energy-mexico-brings-challenges-procurement/.

Guevara-Stone, Laurie. 2016. "Amazon and Dominion Virginia Power Reach Breakthrough Renewable Energy Agreement." Rocky Mountain Institute blog, June 3. http://blog.rmi.org/blog_2016_06_03_amazon_and_dominion_va_power_reach_breakthrough_re_agreement.

Haihe University Renewable Energy Research Institute. 2013. *Study on Green Power Voluntary Purchasing Mechanisms* (Chinese). Energy Foundation. http://www.efchina.org/Attachments/Report/reports-20130602-zh/reports-20130602-zh.

Hassett, Timothy C., and Karin L. Borgerson. 2009. *Harnessing Nature's Power: Deploying and Financing On-Site Renewable Energy.* Washington, D.C.: World Resources Institute. http://www.wri.org/sites/default/files/pdf/harnessing_natures_power.pdf.

Heeter, Jenny, Ravi Vora, Shivani Mathur, Paola Madrigal, Shushanta K. Chatterjee, and Rakesh Shah. 2016. *Wheeling and Banking Strategies for Optimal Renewable Energy Deployment: International Experiences.* NREL/TP-6A20-65660. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy16osti/65660.pdf.

IDFC (International Development Finance Club). 2014. *Scaling Up Renewable Energy Investments.* Frankfurt am Main, Germany: International Development Finance Club.

IEA (International Energy Agency). 2011. *Deploying Renewables 2011: Best and Future Policy Practice.* Paris: International Energy Agency.

———. 2016. *World Energy Balances 2016*. Paris: International Energy Agency. http://www.iea.org/bookshop/724-World_Energy_Balances_2016.

IREC (Interstate Renewable Energy Council). 2013. *Simplifying the Solar Permitting Process: Residential Solar Permitting Best Practices Explained.* Latham, NY: Interstate Renewable Energy Council. http://www.irecusa.org/wp-content/uploads/2013/09/expanded-best-practices.pdf.

IRENA (International Renewable Energy Agency). 2015. *Renewable Power Generation Costs in 2014*. Abu Dhabi: International Renewable Energy Agency. http://www.irena.org/DocumentDownloads/Publications/IRENA_renewable energy_Power_Costs_2014_report.pdf.

———. 2016. *The Power to Change: Solar and Wind Cost Reduction Potential to 2025*. Abu Dhabi: International Renewable Energy Agency. http://www.irena.org/DocumentDownloads/Publications/IRENA_Power_to_Change_2016.pdf.

———. 2017. *Renewable Power Generation Costs in 2016*. Abu Dhabi: International Renewable Energy Agency.

Japan Agency for Natural Resources and Energy. 2017. "What Does Liberalization of the Electricity Market Mean?" Accessed April. http://www.enecho.meti.go.jp/en/category/electricity_and_gas/electric/electricity_liberalization/what/.

Jiménez, Mariana. 2016. *Second Auction Lowers Renewable Prices Further*. Renewable Energy Mexico, October 4. http://www.renewableenergymexico.com/second-auction-lowers-renewable-prices-further/.

KPMG. 2016. *Opportunities in the Mexican Electricity Sector*. Mexico City: KPMG Mexico. https://assets.kpmg.com/content/dam/kpmg/mx/pdf/2016/09/Opportunities-in-the-Mexican-Electricity-Sector.pdf.

Kreycik, Claire, Toby D. Couture, and Karlynn S. Cory. 2011. *Innovative Feed-In Tariff Designs that Limit Policy Costs.* NREL/TP-6A20-50225. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy11osti/50225.pdf.

Krishnan, Deepak Sriram, and Ashok Kumar Thanikonda. 2015. "Assessing the Impact of Karnataka Electricity Regulatory Commission's Open Access Order for Solar Power Generators in Karnataka." World Resources Institute India Working Paper, November. http://www.wri.org/sites/default/files/Assessing_the_Impact_of_KERC_Solar_Order.pdf.

Krishnan, Deepak Sriram, and Carrie Dellesky. 2016. "Bangalore's Airport to Become a Leader in Solar Energy Production." World Resources Institute blog, September 27. http://www.wri.org/blog/2016/09/bangalores-airport-become-leader-solar-energy-production.

McKenna, M. 2017. Carbon Disclosure Project. Data provided via email, February 10.

Müller, Simon, Adam Brown, and Samantha Ölz. 2011. *Renewable Energy: Policy Considerations for Deploying Renewables*. Paris: International Energy Agency. https://www.iea.org/publications/freepublications/publication/Renew_Policies.pdf.

NE21. 2016. "Jinko Solar Assists TCL to Establish Green Supply Chain." (Chinese.) http://www.ne21.com/news/show-85637.html.

NREL (National Renewable Energy Laboratory). 2015. "Renewable Electricity: How Do You Know You Are Using It?" http://www.nrel.gov/docs/fy15osti/64558.pdf.

NREL OpenEI/ Office of Energy Efficiency & Renewable Energy (EERE) 2017, http://en.openei.org/wiki/Main_Page

O'Shaughnessy, Eric, Chang Liu, and Jenny Heeter. 2016. *Status and Trends in the U.S. Voluntary Green Power Market (2015 Data)*. NREL/TP-6A20-67147. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy17osti/67147.pdf.

Powers, John. 2016. "Global Green Power: How International Markets Are Changing Clean Energy." https://www.slideshare.net/JohnPowers52/global-green-power-how-international-markets-are-changing-clean-energy.

RE100. 2017. *Accelerating Change: How Corporate Users are Transforming the Renewable Energy Market*. London: The Climate Group. http://media.virbcdn.com/files/69/ddbfa4d36e1b8bd4-RE100AnnualReport2017.pdf.

Reid, G., J. Lilliestam, A. Patt, G. Schellekens, C. Mitchell, and A. Battaglini. 2010. *A Global Renewables Investment Plan*. Presented at the Delhi International Renewable Energy Conference.

Seel, Joachim, Galen L. Barbose, and Ryan H. Wiser. 2014. "An Analysis of Residential PV System Price Differences between the United States and Germany." *Energy Policy* 69:216–226.

Simpkins, Travis, Kate Anderson, Dylan Cutler, and Dan Olis. 2016. "Optimal Sizing of a Solar-Plus-Storage System for Utility Bill Savings and Resiliency Benefits." Presented at the Seventh Conference on Innovative Smart Grid Technologies, Minneapolis, Minnesota, September 6–9. http://www.nrel.gov/docs/fy17osti/66088.pdf.

Singapore Economic Development Board. 2015. "Apple to Power 100% of its Operations in Singapore with Clean Energy." News release, November 16. https://www.edb.gov.sg/content/edb/en/news-and-events/news/2015-news/apple-to-power-100-percent-of-its-operations-in-singapore-with-clean-energy.html.

Solsmart Program 2017, U.S. Department of Energy, http://www.gosparc.org/resources/, accessed May 10, 2017.

Sotos, Mary. 2015. *GHG Protocol Scope 2 Guidance: An Amendment to the GHG Protocol Corporate Standard.* Washington, D.C.: World Resources Institute. http://ghgprotocol.org/sites/default/files/ghgp/standards/Scope%202%20Guidance_Final_0.pdf.

Sunseap 2015 "Sunseap Group to Provide Clean Energy to Power 100% of Apple's Operations in Singapore – A Landmark Arrangement in Southeast Asia," Press Release, November 16. http://www.sunseap.com/sunseap-group-to-provide-clean-energy-to-power-100-of-apples-operations-in-singapore-a-landmark-arrangement-in-southeast-asia/

Tawney, Letha. 2017. "Washington State Pioneers New Model for Utility-Scale Renewable Energy." World Resources Institute blog, April 18. http://www.wri.org/blog/2017/04/washington-state-pioneers-new-model-utility-scale-renewable-energy.

Tawney, Letha, Priya Barua, Elina Bonugli, and Bryn Baker. 2017. *Emerging Green Tariffs in U.S. Regulated Electricity Markets*. Washington, D.C., and Geneva: World Resources Institute and World Wildlife Fund. http://www.wri.org/sites/default/files/Emerging_Green_Tariffs_in_US_Regulated_Electricity_Markets.pdf.

Tian, Tian, Chang Liu, Eric O'Shaughnessy, Shivani Mathur, Alison Holm, and John Miller. 2016. *Midmarket Solar Policies in the United States: A Guide for Midsized Solar Customers.* NREL/TP-6A20-66905. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy16osti/66905.pdf.

Virginia Office of the Governor. 2016. "Governor McAuliffe Announces 44 New Jobs and More than $251 Million Investment in Mecklenburg County." News release, November 9. https://governor.virginia.gov/newsroom/newsarticle?articleId=18282.

Wang, John. 2012. *Renewable Energy Projects: Tax-Exempt and Other Tax-Advantaged Financing*. Washington, D.C.: Orrick.

WWF (World Wildlife Fund), CERES, Calvert, CDP. 2017. *Power Forward 3.0: How the Largest U.S. Companies Are Capturing Business Value While Addressing Climate Change*. Geneva, Switzerland: World Wildlife Fund. https://www.worldwildlife.org/publications/power-forward-3-0-how-the-largest-us-companies-are-capturing-business-value-while-addressing-climate-change.

WBCSD (World Business Council for Sustainable Development). 2016. *Corporate Renewable Power Purchase Agreements.* Geneva: World Business Council for Sustainable Development. http://lctpi.wbcsd.org/wp-content/uploads/2016/10/corporate_renewable_ppas_scaling_up_globally.pdf.

Zhejiang DRC (Zhejiang Provincial Development and Reform Commission). 2013. "Distributed Solar Generation Pilot Promotes Innovative Models – Case Study on Jiaxing PV High-tech Industrial Park DGPV Project." (Chinese.) http://www.zjdpc.gov.cn/art/2013/12/8/art_982_606866.html.

Zhejiang Online. 2016. "Jiaxing's Biggest Fishing-PV Station Can Provide Electricity for Nearly 40,000 Households Annually." (Chinese.) http://tsxz.zjol.com.cn/system/2016/12/20/021403024.shtml.