



# Renewable Energy Guidance for Industry

January 2022



## Authors and Acknowledgements

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## Preface

The U.S. Department of Energy's (DOE's) Better Buildings, Better Plants program (Better Plants) is a voluntary energy efficiency leadership initiative for U.S. manufacturers and water/wastewater entities. The program encourages organizations to commit to reducing the energy intensity of their U.S. operations, typically by 25% over a 10-year period. Companies joining Better Plants are recognized by DOE for their leadership in implementing energy efficiency practices and for reducing their energy intensity. Better Plants partners are assigned to a Technical Account Manager who can help companies establish energy intensity baselines, develop energy management plans, and identify key resources and incentives from DOE, other federal agencies, states, utilities, and other organizations that can enable them to reach their goals.

This document is intended to help Better Plants partners navigate the renewable energy market by providing background on renewable technologies and their benefits, as well as a wide range of purchasing options available to organizations. This guidance provides helpful information on adopting renewables by highlighting tools and resources for evaluating renewable energy projects. It also provides information on how renewable energy resources are accounted for by Better Plants reporting requirements. A separate supplemental document to this guidance is available that provides more in-depth information about renewable technologies.

This guidance document is applicable to Better Plants partners participating at both the program and challenge level. Although the guidance is primarily intended to assist companies participating in Better Plants, the methodologies and information within are applicable to any organization interested in exploring and adopting renewable energy.

For more information on the Better Plants program, please visit:

[betterbuildingssolutioncenter.energy.gov/better-plants](https://betterbuildingssolutioncenter.energy.gov/better-plants)

For more information on the Better Plants Challenge program, please visit:

<https://betterbuildingssolutioncenter.energy.gov/better-plants/better-plants-challenge>

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## 1. Introduction

Around the world, manufacturing is the backbone of a healthy economy. By taking raw materials and turning them into valuable products, manufacturing is an important catalyst of innovation, and a source of stimulus for all sorts of other economic sectors. That economic activity, however, brings significant energy demand and concerns about climate impact. According to the REN21's Renewables 2021 Global Status report, the industrial sector accounts for nearly 34% of the global total final energy consumption, and 24% of the global total direct CO<sub>2</sub> emissions as of 2020.<sup>1</sup> More than one-third of the end-use energy consumption in the United States in 2020 was in industry.<sup>2</sup> Industrial energy needs are projected to increase by 31% during the next 25 years, when they will account for about 38% of total U.S. consumption.<sup>3</sup> The industrial sector uses more delivered energy than any other end-use sector, consuming about 54% of the world's total delivered energy.<sup>4</sup> Every citizen will be affected by the change in the industry energy usage through the cost of products and services, the quality of manufactured items, economy strength, and the job market.<sup>3</sup>

Every product that we rely upon—including cars, food, medicine, and clothing—requires energy to be produced. Around 75% of the energy used in industry is for thermal end-uses, which include thermal energy used directly in the preparation or treatment of materials used in the manufacturing process (industrial process heat) such as drying, heating, steam production, refrigeration, and many other applications. The remaining share of energy is for electrical end-uses needed for machines, electric furnaces, lights, and cooling in factories.<sup>1</sup>

Energy efficiency and conservation are important tools to strengthen U.S. manufacturing competitiveness. Every dollar not spent on energy can be repurposed toward investing in the workforce or the manufactured product. Better Plants<sup>5</sup> partners know this well, having cumulatively saved more than \$8 billion and 1.7 QBtu since the start of the Better Buildings, Better Plants program. That said, the energy efficiency improvement potential alone is not sufficient to reduce the increasing demand of fossil fuels and their associated environmental impact. To reduce fossil fuel demand and carbon emissions, the industrial sector must invest in renewable energy. Renewable energy technologies can provide practical and cost-effective alternatives for process heat generation and can also be a carbon source for the production of chemical and plastics.<sup>6</sup>

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<sup>1</sup> REN21, 2021, Renewables 2021 Global Status Report (Paris: REN21 Secretariat). ISBN 978-3-948393-03-8.

[https://www.ren21.net/wp-content/uploads/2019/05/GSR2021\\_Full\\_Report.pdf](https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf)

<sup>2</sup> U.S. Energy Information Administration (EIA), 2020, U.S. Energy Consumption by Source and Sector.

[https://www.eia.gov/totalenergy/data/monthly/pdf/flow/total\\_energy\\_2020.pdf](https://www.eia.gov/totalenergy/data/monthly/pdf/flow/total_energy_2020.pdf)

<sup>3</sup> The National Academies of Sciences, Engineering, and Medicine, What You Need to Know About Energy: How We Use Energy.

<http://needtoknow.nas.edu/energy/energy-use/industry/>

<sup>4</sup> U.S. Energy Information Administration (EIA), 2016, Industrial Sector Energy Consumption, *International Energy Outlook 2016*.

<https://www.eia.gov/outlooks/ieo/pdf/industrial.pdf>

<sup>5</sup> The U.S. DOE's Better Buildings, Better Plants program (Better Plants) is a voluntary energy efficiency leadership initiative for U.S. manufacturers and water/wastewater entities. The program encourages organizations to commit to reducing the energy intensity of their U.S. operations, typically by 25% over a 10-year period. More information about the program can be found here: <https://betterbuildingssolutioncenter.energy.gov/better-plants>

<sup>6</sup> IRENA, 2015, A background paper to "Renewable Energy in Manufacturing," Abu Dhabi.

## 1.1 State of Renewable Energy

“Renewable electricity” is defined as electricity generated without fossil fuels. Renewable electricity may be derived from wind, photovoltaic (PV) cells, hydropower, tidal power, biogas, and so on. Renewable energy has transformed as an industry in recent years, accounting for the majority of capacity additions in power generation today. Tens of gigawatts of wind, hydropower, and solar PV capacity are installed worldwide every year in the renewable energy market, which is worth more than \$100 billion annually. The global new investment in renewable power and fuels reached \$363 billion in 2020 (2% more than in 2019).<sup>7</sup> Money allocated to renewables was over two times the total investment committed to coal, natural gas, and nuclear power (Figure 1). In the United States, the total capacity of different renewable energy deals from 2016 to 2020 was of 21.78 GW. Details of these deals, based on the database of corporate renewable deals by the Clean Energy Buyers Association (CEBA), are presented in Appendix A. Also, examples of Better Plants partners with 100% renewable electricity commitments are provided in Appendix B.

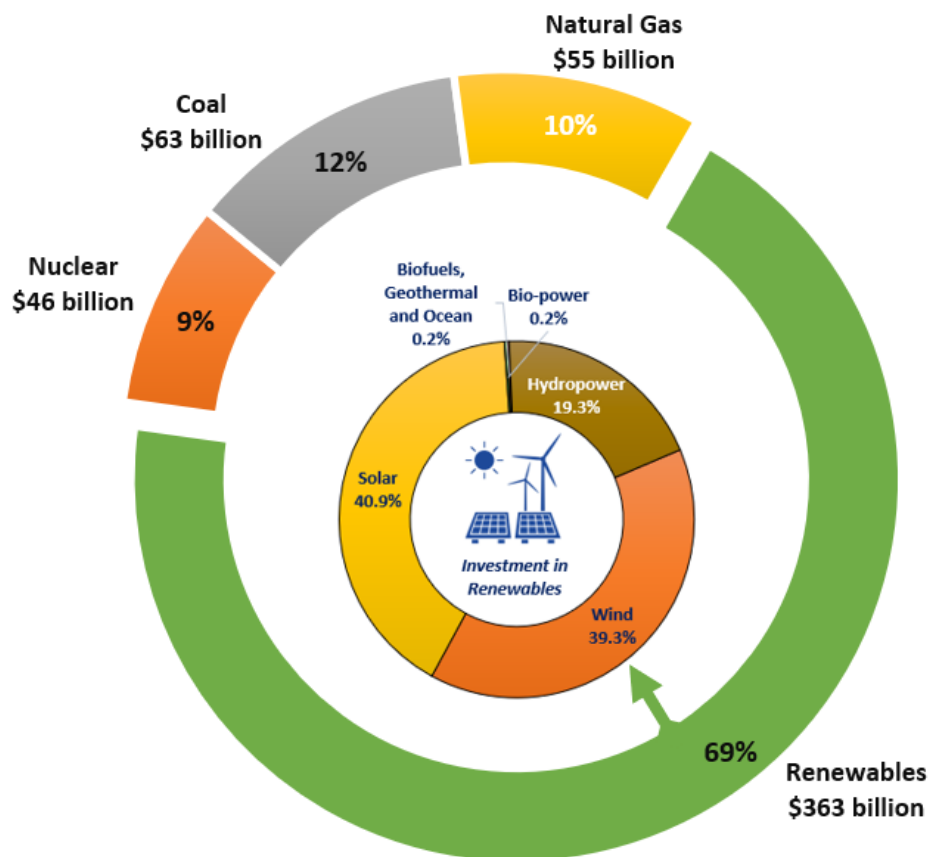


Figure 1: Global investment in new power capacity by type (renewables, natural gas, coal, and nuclear power) in 2020. Source: BloombergNEF.

Major companies are installing and procuring renewable electricity to power their activities, driven in part by the declining costs of renewables such as solar and wind, and by compliance with social and

<sup>7</sup> Estimation by BloombergNEF

environmental standards (including a low-carbon energy supply).<sup>8</sup> Figure 2 shows the capacity of renewable energy resources and the average growth rate for some of the resources from 2010 to 2020. Although hydropower has the highest capacity, wind and solar power are growing rapidly with 14% and 35% average growth rates, respectively.

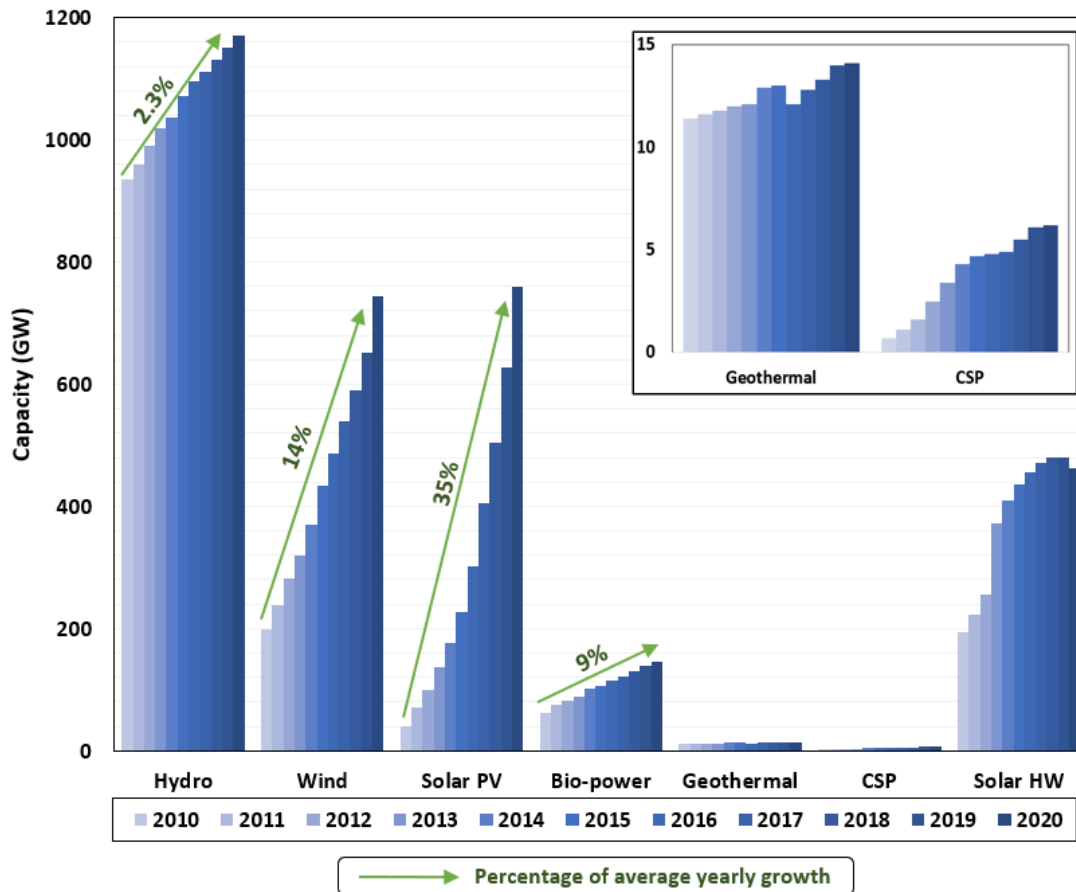


Figure 2: Global renewable energy capacity by resource, and the average growth rate from 2010 to 2020.<sup>9</sup> CSP: concentrating solar power. Solar HW: solar hot water.

Although renewable energy over the past decade has been marked by explosive growth and a rapid decline in costs, other forms of electricity generation such as coal, nuclear power, and natural gas still make up most of the market. Based on REN21's 2021 report,<sup>9</sup> renewables contributed 11.2% to the global energy consumption and 29% to the global electricity generation in 2020. Renewable energy meets around 14.8% of the global total final energy consumption in the industrial sector, broken down to 13.3% of bioenergy (biomass), 1.45% of renewable electricity, and 0.05% of solar and geothermal heat. Figure 3 shows the breakdown share of renewables in the U.S. electricity production by the end of 2020, and projections of the U.S. electricity mix by 2050. Given the rapid rate of change and the continuous declines in the capital costs for solar and wind power supported by federal tax credits and higher state-level

<sup>8</sup> Deign, J., 2020, Mining companies cozy up to renewables, not just for cost, GTM, February 26, 2020.

<https://www.greentechmedia.com/%20articles/read/mining-companies-renewables-cost>

<sup>9</sup> REN21, 2021, Renewables 2021 Global Status Report (Paris: REN21 Secretariat). ISBN 978-3-948393-03-8.

[https://www.ren21.net/wp-content/uploads/2019/05/GSR2021\\_Full\\_Report.pdf](https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf)

All other reports (i.e., 2014–2020 reports) are available here: <https://www.ren21.net/reports/global-status-report/>

renewables targets, renewable energy resources will be the largest contributor in the U.S. electricity generation mix by 2050. The U.S. Energy Information Administration's (EIA's) Annual Energy Outlook 2020 presented a projection of 42% share of renewables in the electricity generation mix as of 2050.<sup>10</sup> Other sources of the U.S. electricity generation will be declining as of 2020. From 40% to 36% for natural gas, from 19% to 11% for nuclear, and from 19% to 11% for coal, see Figure 3. The U.S. DOE has also set a goal to reduce the electricity grid emissions by 100% in 2050 compared with 2005 as stated in the [Solar Futures Study](#).<sup>11</sup>

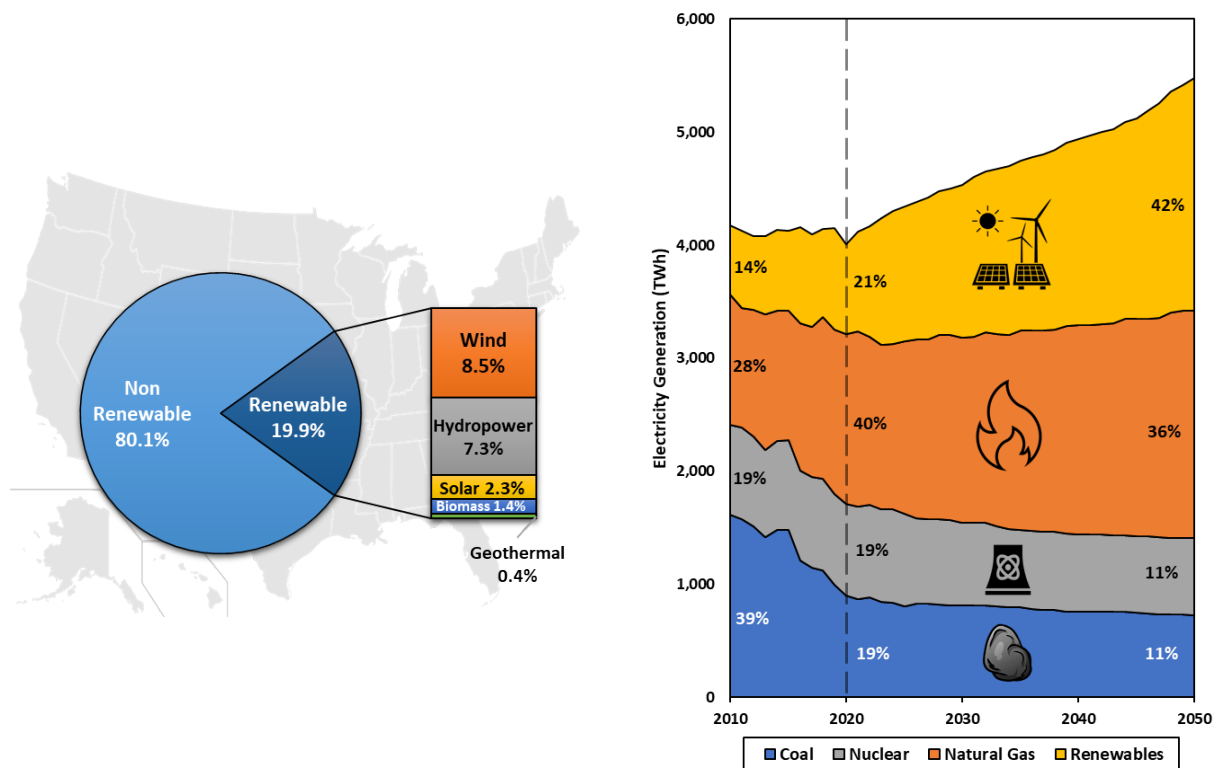


Figure 3: Renewable energy share of U.S. electricity production by 2020,<sup>12</sup> and projection of the U.S. electricity generation mix by 2050.<sup>13</sup>

Within the industrial sector, the most energy-intensive subsectors—those with the highest process temperatures—also use the lowest shares of renewable energy. The sectors with the highest penetration of renewables are pulp and paper (46%), wood products (37%), and food industries (27%); in each of these sectors, bioenergy supplies more than 75% of the renewable energy, and renewable electricity accounts for the remainder.<sup>14</sup> Overall, bioenergy supplies around 7% of global industrial energy use, renewable electricity (including electricity for heat) accounts for slightly less, and geothermal and solar thermal heat

<sup>10</sup> U.S. Energy Information Administration (EIA), 2021, Annual Energy Outlook 2021.

<https://www.eia.gov/outlooks/aeo/pdf/00%20AEO2021%20Chart%20Library.pdf>

<sup>11</sup> U.S. Department of Energy – Solar Energy Technologies Office – Solar Futures Study:

<https://www.energy.gov/eere/solar/solar-futures-study>

<sup>12</sup> U.S. Energy Information Administration (EIA), 2021, September 2021 Monthly Energy Review.

[https://www.eia.gov/totalenergy/data/monthly/pdf/sec7\\_5.pdf](https://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf)

<sup>13</sup> Epp, B., 2020, Industrial sector sees record-breaking capacity additions in 2019, Solarthermalworld, April 26, 2020.

<https://www.solarthermalworld.org/news/industrial-sector-sees-record-breaking-capacity-additions-2019>

<sup>14</sup> Based on IEA, 2020, World Energy Statistics and Balances. <https://www.iea.org/reports/key-world-energy-statistics-2020>

have negligible shares. By the end of 2020, solar heat systems in industrial processes supplied more than 792 MW thermal energy worldwide.<sup>13</sup> Direct use of renewables for industrial process heat occurs mainly in low-temperature applications, and renewables face limitations in meeting heat demands directly above 200°C to 400°C.

## 1.2 Renewable Energy Technologies

Renewable energy technologies include solar energy, wind power, biogas, hydropower, and fuel cells that use renewable fuels. Each of these technologies is further described in a separate supplemental document<sup>15</sup> associated with this guidance, and a brief comparison of the common renewable energy systems is presented in Table 1 with advantages and disadvantages of each technology.

Table 1: Comparison of common renewable energy technologies.<sup>16,17,18,19</sup>

Criteria	Solar energy			Wind energy	Biogas	Hydro-power	Geothermal
	PV	Thermal (without CSP*)	CSP				
Capital cost	High	Low	High	High	Medium	High	Medium
Operation cost	Low	Low	Medium	Low	Low	Medium	Medium
Maintenance cost	Medium	Low	Medium	Medium	Medium	High	Medium
End-of-life recycling cost	High	Medium	High	Medium	High	High	Medium
Land required	High	Low	High	Medium	Low	High	Low
Risk of Intermittent Supply	High	High	Medium	High	Medium	Low	Low
Environmental impact	Low	Low	High	Low	Low	Medium	Low
Implementation requirements	Medium	Low	High	Medium	Medium	High	Medium
Maintenance level	Medium	Low	Medium	Medium	High	High	Low
Geographically dependent	High	Medium	High	High	Low	High	High
Difficulty of Installation	Low	Low	High	Medium	Medium	High	Medium

\*CSP: Concentrating Solar Power

<sup>15</sup> Abbas, A., Price, C., Nandy, P., Wenning, T., 2022, Renewable Energy Guidance for Industry: Supplemental Document, ORNL/SPR-2021/2027, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

<sup>16</sup> World101, Sources of Energy: A Comparison. <https://world101.cfr.org/global-era-issues/climate-change/sources-energy-comparison>

<sup>17</sup> EnergyFive, What are Renewable Energy Sources? <https://energyfive.net/2017/10/06/what-are-renewable-energy-sources/>

<sup>18</sup> Ye Li, Development of A Procedure for Predicting Power Generated from A Tidal Current Turbine Farm, Doctoral Thesis. [https://www.researchgate.net/publication/299410602\\_Development\\_of\\_a\\_procedure\\_for\\_predicting\\_power\\_generated\\_from\\_a\\_tidal\\_current\\_turbine\\_farm/figures?lo=1](https://www.researchgate.net/publication/299410602_Development_of_a_procedure_for_predicting_power_generated_from_a_tidal_current_turbine_farm/figures?lo=1)

<sup>19</sup> Gattani, Manoj, P. K. Sahoo, and Parag Diwan. "Theoretical and mathematical development of gate operated two stroke magnetic piston engine." International Journal of Applied Engineering Research 11.9 (2016): 6787-6793. [https://www.researchgate.net/publication/305618536\\_Theoretical\\_and\\_mathematical\\_development\\_of\\_gate\\_operated\\_two\\_stroke\\_magnetic\\_piston\\_engine/figures](https://www.researchgate.net/publication/305618536_Theoretical_and_mathematical_development_of_gate_operated_two_stroke_magnetic_piston_engine/figures)

## Solar Energy

Different technologies are currently being used to convert sunlight to useful energy (could be electric or thermal), some of which are solar PV, concentrating solar power, passive solar, solar water heating, and solar process heat. The most common of these technologies is solar PV for electricity generation. In a solar PV system, sunlight is converted into electricity by using a semiconducting material that absorbs sunlight. Multiple solar cells (usually 60, 72, or 96 cells) arrayed in a solar module (also known as a “solar panel”) are used for this purpose. When multiple solar panels are connected together in series, it is called “string,” and usually, several strings are connected (in parallel) to build a solar PV array. Commercially available solar panels have a wattage range between 350 and 400 W with efficiency in the range of 15-20%.<sup>20,21</sup> Solar PV systems can generate electricity while being grid-connected or in standalone mode (off-grid), and they usually have energy storage (batteries) and another conventional (or renewable) source of generation as a backup.

On the other hand, concentrating solar power (CSP) is an electricity and heat generation technology that uses mirrors to reflect and concentrate the sunlight into a receiver to generate heat that is capable to increase the temperature of a thermal energy carrier (known as heat transfer fluid, HTF) like water, oil, or molten salt which then can be used directly as hot water or steam, or indirectly to run a turbine and generate electricity or for a heat a process.

## Wind Energy

Historically, windmills were used to mill grains by employing the wind or airflows caused by the temperature variation on the earth’s surface. Recently, these airflows are being captured by wind turbines to generate electricity. The concept of wind turbines is to rely on converting the kinetic energy—as a result of the turbine’s rotational motion, which occurs when the wind hit the turbine’s blades—into mechanical energy and then to electric energy through an electric generator, which is driven by a shaft connected on the other side with a gear box to increase the rotational speed of the shaft. Newer wind turbines are capable of generating electricity 90% of the time in a year.<sup>22</sup>

## Biogas

Biogas is a renewable energy resource that is produced naturally from the decomposition of organic matter by bacteria in an oxygen-free environment. A blend of methane (50%–70%), CO<sub>2</sub> (30%–40%), and other gases is released when matter decomposes anaerobically. The high methane content of biogas makes it flammable and suitable as an energy source for heat and electricity generation. Recovering energy from biogas has a myriad of environmental benefits. Methane has nearly 30 times the heat trapping ability of CO<sub>2</sub>. Capturing biogas from waste streams instead of releasing it into the atmosphere as landfill gas reduces emissions. The microbes involved with anerobic digestion reduce the toxicity of waste, lowering the risk of groundwater pollution. Burning biogas also displaces the need for fossil fuel consumption, reducing the release of sequestered carbon. Finally, the remaining waste sludge can be used or sold as an organic fertilizer in agricultural industries.

<sup>20</sup> National Renewable Energy Laboratory, H1 2021 Solar Industry Update: <https://www.nrel.gov/docs/fy21osti/80427.pdf>

<sup>21</sup> Energy Sage, Most efficient solar panels: solar panel cell efficiency explained: <https://news.energysage.com/what-are-the-most-efficient-solar-panels-on-the-market/>

<sup>22</sup> American Clean Power Association, Wind power facts. <https://cleanpower.org/facts/wind-power/#>

Using biogas as a renewable fuel source also has several financial benefits. Biogas can reduce natural gas consumption, thus lowering utility bills for a facility. The breakdown of organic materials also reduces the quantity of waste, which lowers waste disposal costs. Finally, biogas can be used for on-demand energy to substitute for gaps in other renewable energy streams (e.g., wind and solar) or reduce grid energy demand during high price periods.

### **Hydropower**

The principle of hydropower is the extraction of kinetic and potential energy from water flow (in a river or dam) to convert it into mechanical energy and then to electrical power by utilizing the head and the volume flow rate. The hydro turbine is not a new concept but increasing demand for renewable energy has contributed to increased interest in further innovation, optimization, and application of the technology.

Currently, hydropower energy supplies 16.8% of the global electricity. By comparing with other renewables, hydropower is the most significant contributor with a power capacity of 1,170 GW and generated power of around 4,370 TWh/year as of 2020.<sup>23</sup> Even though the growth rate of hydropower is not as high as wind and solar sources, hydropower accounts for almost 40% of the total renewable energy sources in the world.

### **Geothermal Energy**

Geothermal energy is heat derived from below the Earth's surface, which can be harnessed as a carbon-free, renewable energy around the clock with a small physical footprint. Geothermal energy can be used as a steady heat source for heating and cooling purposes or for electricity generation. Industrial applications of geothermal energy include food dehydration (drying), gold mining, and milk pasteurizing.

Geothermal is divided into three types based on how it's used:

- Geothermal heating and cooling (e.g., district heating)
- Geothermal heat pumps (GHP)
- Geothermal electricity production

## **1.3 Energy Efficiency and Renewables**

Although investing in renewables would significantly help corporations achieve their sustainability goals, the recommended approach is that industry should first focus on strengthening their competitiveness through energy efficiency and conservation. First, companies that are new to energy efficiency can often identify and actualize meaningful savings by focusing on low- or no-cost energy efficiency opportunities. Such opportunities, along with more sophisticated and capital-intensive opportunities, can be uncovered through energy audits and by surveying the operations in a facility and studying the energy flows across various industrial systems. Second, industry can often reduce energy consumption and/or recover the energy by reclaiming the wasted energy throughout the facility. Third, companies may also look into replacing old-fashioned and inefficient processes (when possible and feasible) with new innovative technology that is highly energy-efficient within the context of a systems approach. Fourth, companies

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<sup>23</sup> REN21, 2021, Renewables 2021 Global Status Report (Paris: REN21 Secretariat). ISBN 978-3-948393-03-8.  
[https://www.ren21.net/wp-content/uploads/2019/05/GSR2021\\_Full\\_Report.pdf](https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf)

can implement renewable energy, whether it is an on-site generation system, a renewable electricity purchase or both.

These four steps (Figure 4) are the best practice to follow to minimize the size and capacity of the on-site renewable energy project (or purchase less renewable electricity) and reduce the initial investment for the project. An example showing the importance of considering energy efficiency first for a solar PV system installation is provided in Useful Tip 1.

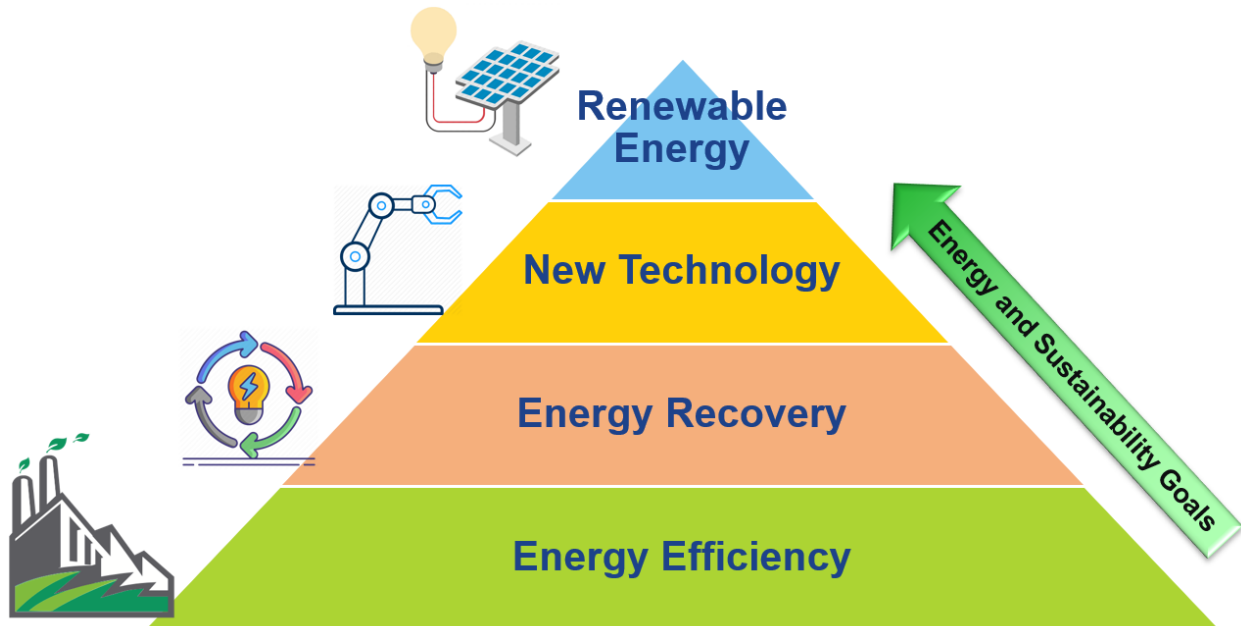
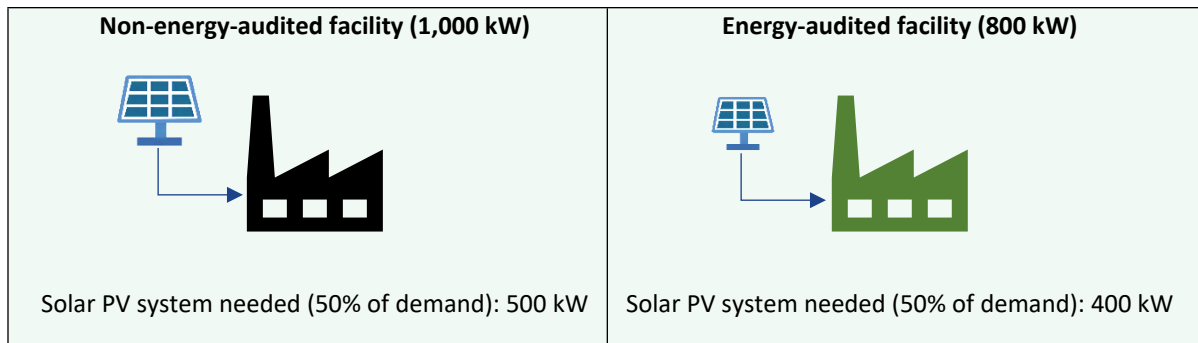


Figure 4: Steps toward implementing a renewable energy project.

#### Useful Tip 1: Energy Efficiency Comes First!

**Understanding how to size a PV system:** It is recommended to reduce the facility's energy demand to the minimum possible before installing a solar PV system. Doing so will help reduce the system capacity needed, as well as the capital investment of the solar PV system. The facility's energy demand can be reduced by identifying potential energy efficiency opportunities that will help reduce unnecessary losses and help realize the maximum possible energy output of the system.

As an example, the average electricity demand for a facility was 1,000 kW, and the renewable energy plan was to cover 50% of the demand. However, after conducting an energy audit, the facility's demand was reduced to 800 kW. So instead of installing a 500-kW solar PV system, a 400-kW system will achieve the company's target with lower investment. However, if additional energy efficiency measures were implemented in the future and, as a result, the demand was further reduced, then excess power could be sold back for the grid (if possible), or the power could be stored for demand events and thus prevent costly demand charges.



When it comes to energy efficiency, the U.S. Department of Energy's (DOE's) Advanced Manufacturing Office provides multiple helpful tools and resources, which can be found in Appendix C.

## 1.4 Why Manufacturers are Deploying Renewables

When evaluating renewables, manufacturers may consider several advantages over fossil fuel energy. Among these are a variety of environmental, economic, and corporate social responsibility benefits. The benefits of investing in renewable energy are explained further in this section.

### *Corporate Social Responsibility*

One of the key driving forces for an organization to allocate resources into renewables is lessening its environmental impact. This can be done by internal initiatives from shareholders and employees or externally for stakeholders and customers, which will promote the organization's reputation, as well as increasing the brand credibility. Also, the involvement in renewable energy projects can be helpful for obtaining international standard certifications such as ISO-14001 for environmental management or ISO-50001 for energy management.



Investing in renewable energy is one way to set a company as a civic leader where such an action represents the company's commitment to comply with its socio-environmental goals, which also show the company's intention to be innovative and to minimize the risk in the long-term. Being a leader in renewable energy may also attract a talented workforce, improve the morale of employees and their retention, and increase productivity.

A further merit of considering investing in renewable energy projects is a company can distinguish its products by marking them with a stamp or logo to claim that the product was made with a clean and environmentally friendly source of energy. In some cases, in which customers are looking to environmentally improve their supply chain, such products have an additional marketing feature. For instance, Steelcase, a Better Plants partner and a furniture manufacturer, adopted sustainability-based criteria to evaluate the performance of its suppliers by using scorecards, where utilizing renewable energy is considered to be one of the best practices.

### **RE100**

RE100 is a global corporate renewable energy initiative lead by The Climate Group in partnership with Carbon Disclosure Project in which companies commit to use 100% renewable energy electricity. The primary goal of the initiative is to accelerate the shift to clean energy, ensuring cleaner healthier future

along with a zero-carbon grid. Corporations commit to switch to 100% renewable energy in the shortest time possible, with 2050 being the latest for companies with interim goals.

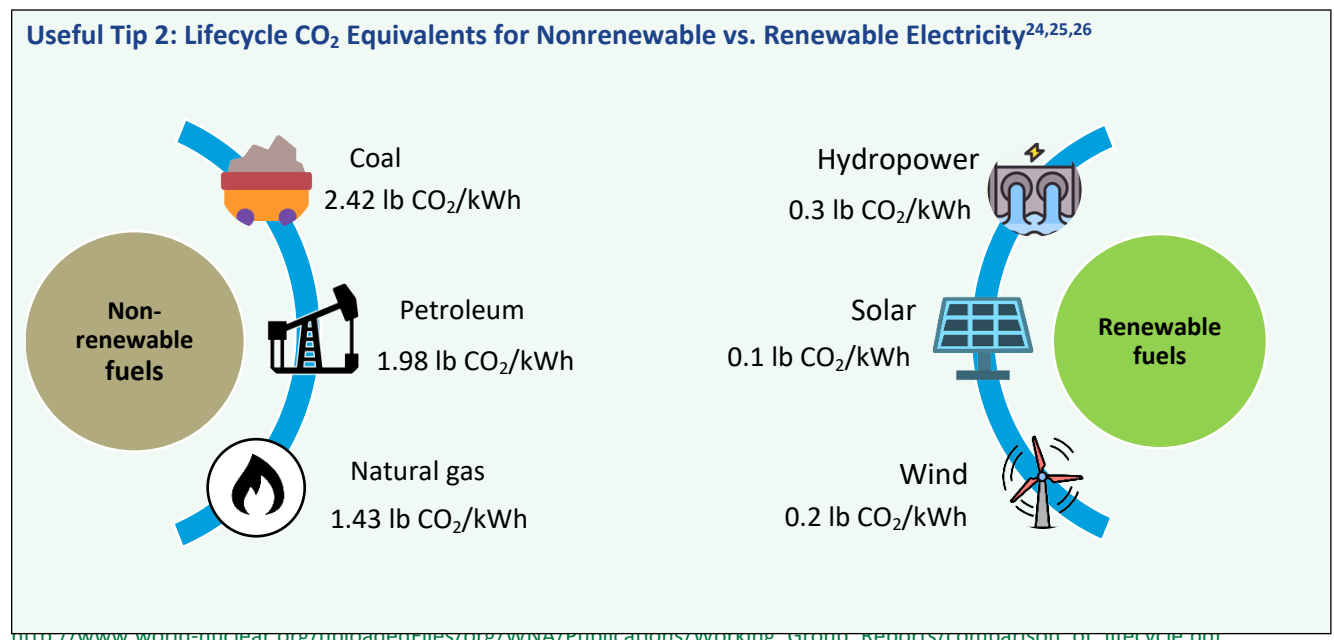
Several Better Plants partners are currently involved in the RE100 initiative. For example, Estée Lauder Companies recently achieved net-zero emissions and sourced 100% renewable electricity globally for its direct operations, reaching the target it set on joining RE100. Schneider Electric has committed to sourcing 100% renewable electricity across all its global operations by 2030. Similarly, Steelcase expanded its renewable energy investments equivalent to 100% of its global electricity consumption in 2014.

### Science-based targets

The Science-Based Targets initiative (SBTi) helps companies set goals to reduce GHG emissions. Science-based targets provide companies with a clearly defined path to reduce emissions in line with Paris Agreement goals. These goals are necessary efforts to keep global temperature increases under 2°C. More than 1,000 businesses around the world are already working with SBTi. Organizations are required to set Scope 1 and 2 reduction targets and even set Scope 3 reduction targets if their Scope 3 emissions are high. After developing a science-based target in line with SBTi criteria, organizations present to SBTi for official validation, and then communicate and disclose their leadership. For more information, please refer to the [Better Plants Resources for Achieving Science Based Targets](#) document.

### Environmental Benefits

The environmental advantages of renewable energy are manifested mainly in lowering greenhouse gas (GHG) emissions and reducing air pollution. Renewable energy can reduce the water environmental impact when compared with conventional power generation, as well. Generally, most renewable energy sources produce little to no GHG emissions. Even if the life cycle emissions of renewables were considered (i.e., emissions from manufacturing, installation, operation, and decommissioning a renewable energy technology), the associated GHG emissions with renewable energy will be minimal. A comparison of lifecycle CO<sub>2</sub> equivalents of fossil fuel vs. renewable electricity is presented in Useful Tip 2.



### Reducing water environmental impacts

Most renewable energy technologies do not consume water and have a negligible impact on local aquatic ecosystems. Conventional power generation often requires water for fuel extraction, steam production, and power plant cooling. The release of spent cooling water increases the temperature of local water resources, which can alter aquatic ecosystems. In contrast, most renewable energy systems do not consume water or release it into the environment. A study by Lawrence Berkeley National Laboratory (LBNL) and the National Renewable Energy Laboratory (NREL) estimated 8,420 gal of water withdrawal and 270 gal of water consumption to be saved for adding 1 MWh of renewable electricity to the grid.<sup>27</sup> Also, employing renewable energy technologies will have a positive impact on the public health where air and water are less polluted by coal and natural gas.

### Economics

Undoubtedly, investing in renewables has environmental benefits. In addition, it can lead to increased business profits. On average, companies that invest in renewable energy save thousands of dollars a year.<sup>28</sup> Technological innovations have led to dramatic declines in the cost of wind and solar technologies since 2000. These cost decreases have stimulated demand, thus contributing to higher sales volumes and larger economies of scale, which has further reduced production costs. This has allowed renewable energy to become more affordable to more organizations.



With the lower capital costs of renewable energy resources and tax credits, the levelized cost of electricity (LCOE) of the utility-scale renewable energy generation systems is declining to reach below the fossil fuel cost range, especially for hydropower, solar PV, and onshore wind power with large generation capacities ( $\geq 300$  MW). Figure 5 shows the LCOE of different renewable energy technologies compared with the fossil fuel cost range. The definition of “LCOE” is explained in Useful Tip 3, along with the LCOE equation and a simple example.

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<sup>27</sup> Wiser, R., et al., 2016, A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards, NREL/TP-6A20-65005, Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory.

<http://www.nrel.gov/docs/fy16osti/65005.pdf>

<sup>28</sup> U.S. Environmental Protection Agency, 2018, Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy: A Guide for State and Local Governments, Part One: The Multiple Benefits of Energy Efficiency and Renewable Energy, Washington, DC.

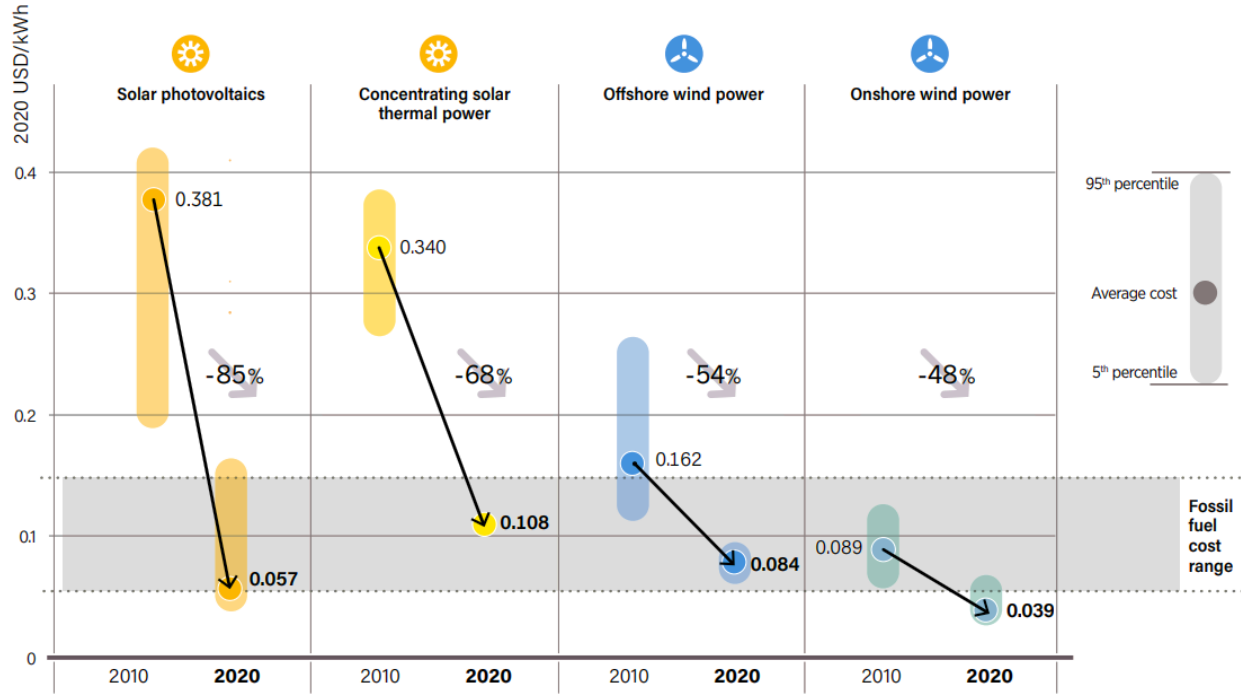


Figure 5: Global LCOE from newly commissioned utility-scale renewable power generation technologies.<sup>29</sup> Source: IRENA.

<sup>29</sup> REN21, 2021, Renewables 2021 Global Status Report (Paris: REN21 Secretariat). ISBN 978-3-948393-03-8. [https://www.ren21.net/wp-content/uploads/2019/05/GSR2021\\_Full\\_Report.pdf](https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf)

### Useful Tip 3: Definition of LCOE

The LCOE, or “levelized cost of energy,” is defined as the average cost of electricity generation over the lifetime of an electricity generation system, and it can be calculated by dividing the total lifetime costs by the total lifetime generated electricity.<sup>30</sup> The LCOE is an indicator to benchmark different technologies of electricity generation. The LCOE “represents the average revenue per unit of electricity generated that would be required to recover the costs of building and operating a generating plant during an assumed financial life and duty cycle.”<sup>31</sup> Multiple parameters such as “capital costs, fuel costs, fixed and variable operations and maintenance costs, financing costs, and an assumed utilization rate”<sup>31</sup> can be included in the total cost. A simple example of LCOE is presented in Figure 6.

The LCOE is calculated as<sup>32</sup>

$$LCOE = \frac{\text{Total cost over lifetime}}{\text{Total electrical energy produced over lifetime}}$$

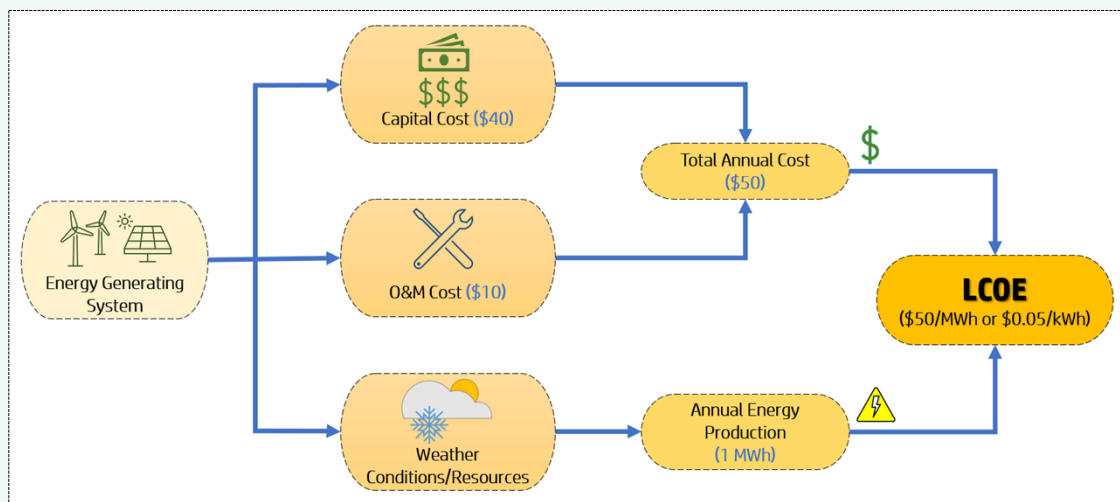


Figure 6: Simplified example of LCOE.<sup>33</sup>

Useful Tip 4 provides an example of the reduction in the cost of solar power. Similar dramatic cost reductions have been observed for wind technologies. Increasingly across the country, the cost of renewable energy has hit record lows and can be cost-competitive with other energy sources.

<sup>30</sup> Lai, C. S., and McCulloch, M. D., 2017, Levelized cost of electricity for solar photovoltaic and electrical energy storage, *Applied Energy* 190: 191–203. DOI: [10.1016/j.apenergy.2016.12.153](https://doi.org/10.1016/j.apenergy.2016.12.153)

<sup>31</sup> U.S. Energy Information Administration (EIA), 2021, Levelized Costs of New Generation Resources in the Annual Energy Outlook 2021. [https://www.eia.gov/outlooks/aeo/pdf/electricity\\_generation.pdf](https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf)

<sup>32</sup> Lai, C. S., Jia, Y., Xu, Z., Lai, L. L., Li, X., Cao, J., and McCulloch, M. D., 2017, Levelized cost of electricity for photovoltaic/biogas power plant hybrid system with electrical energy storage degradation costs, *Energy Conversion and Management* 153: 34–47. DOI: [10.1016/j.enconman.2017.09.076](https://doi.org/10.1016/j.enconman.2017.09.076)

<sup>33</sup> Adapted from European Wind Energy Association, 2009, Economics of Wind Energy. [http://www.ewea.org/fileadmin/ewea\\_documents/documents/00\\_POLICY\\_document/Economics\\_of\\_Wind\\_Energy\\_March\\_2\\_009\\_.pdf](http://www.ewea.org/fileadmin/ewea_documents/documents/00_POLICY_document/Economics_of_Wind_Energy_March_2_009_.pdf)

**Useful Tip 4: Cost of Solar Power (An Example)**

Generally, installing a solar energy system requires an upfront cost, and an additional cost may be required in case a continuous renewable energy supply is needed (i.e., when adding an energy storage system). However, in 2020, the average solar power cost for a commercial size PV system (~200 kW<sub>ac</sub>) in a low solar resource location, New York city as an example, was around \$0.10/kWh, and some states with high solar resource like Arizona had a solar power cost of less than \$0.09/kWh and even less than \$0.07/kWh when considering the Investment Tax Credit.<sup>34</sup> On the other side, the average fossil fuel electricity cost in the United States for the commercial sector is \$0.11/kWh,<sup>35</sup> which means the cost of solar electricity is very competitive with the cost of fossil fuel, and yet solar power saves more cost because of the relatively constant rate and because fossil fuel electricity has an estimated inflation rate of 2.2% per year.<sup>36</sup>

Renewable energy resources provide stability and predictability over time to secure your energy costs. Many variables can change an energy bill, including fuel costs, weather conditions, regulations, and other external factors. Renewables may enable companies to procure energy at relatively fixed rates in the long-term. For example, generating or receiving energy from storage during peak demand can help avoid costly demand charges and the ensuing ratcheting fees from peak demand consumption. In addition, employing renewable energy generation systems with energy storage will provide companies with a reliable and resilient supply of electricity by mitigating the effect of local power outages caused by natural disasters or difficulties with fuel supply, which help avoid interruptions in production and profit. Finally, having a renewable energy system installed may give your business tax breaks such as the federal investment tax credit.

**Development of American Clean Energy Jobs**

Renewable energy provides a significant and growing number of jobs in the United States each year. When companies seek renewable energy options, more investments in renewables will take place, which will help the nation to meet the energy demand with domestic resources and help the local economy growth by increasing the domestic final demand and creating high-paying job opportunities. In 2020, according to IRENA's estimates, the renewable energy sector employed 756,000 people in the United States, driven by rising investments.<sup>37</sup> The number of U.S. jobs for some of the renewable energy technologies in the electric power generation sector in 2020 is shown in Figure 7.



<sup>34</sup> Feldman, David, Vignesh Ramasamy, Ran Fu, Ashwin Ramdas, Jal Desai, and Robert Margolis. 2021. U.S. Solar Photovoltaic System Cost Benchmark: Q1 2020. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-77324. <https://www.nrel.gov/docs/fy21osti/77324.pdf>

<sup>35</sup> U.S. Energy Information Administration (EIA), 2021, August 2021 Electric Monthly Update. <https://www.eia.gov/electricity/monthly/update/print-version.php>

<sup>36</sup> Investopedia, 2020, How to Profit from Solar Energy. <https://www.investopedia.com/articles/personal-finance/042315/how-profit-solar-energy.asp>

<sup>37</sup> International Renewable Energy Agency (IRENA), Renewable Energy and Jobs, Annual Review 2020 report. [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Sep/IRENA\\_RE\\_Jobs\\_2020.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Sep/IRENA_RE_Jobs_2020.pdf)

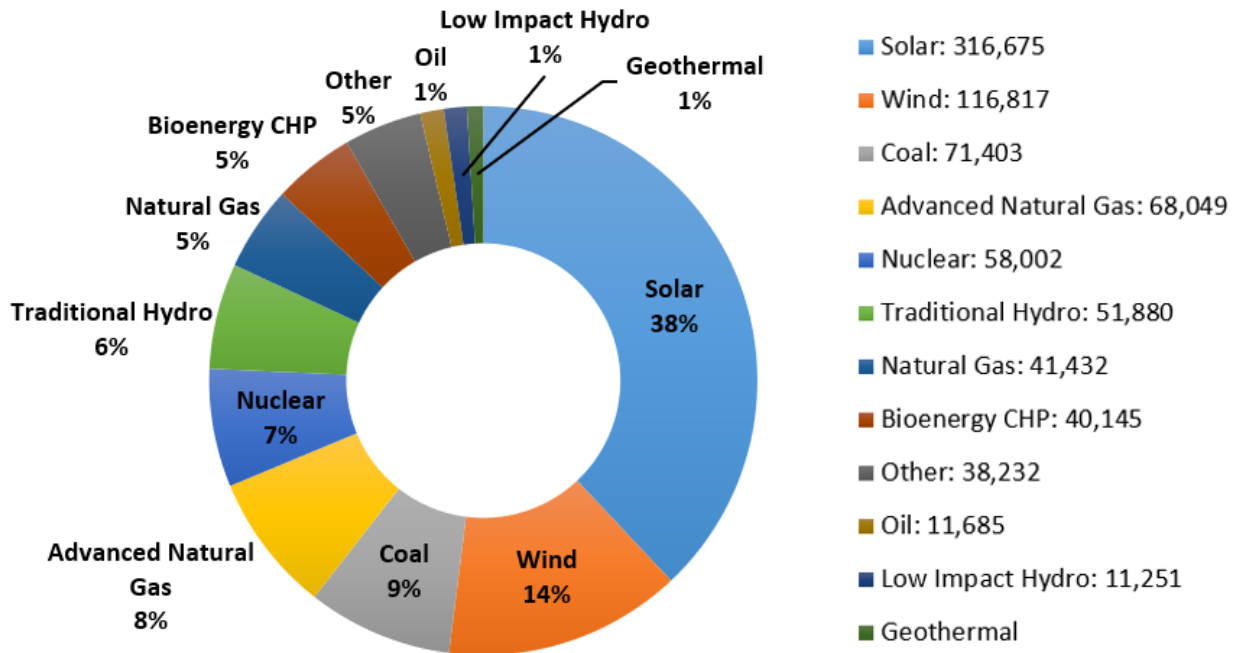


Figure 7: U.S. jobs in the electric power generation sector: employment by technology application in 2020.<sup>38</sup> Source: The 2021 U.S. Energy & Employment Report.

<sup>38</sup> National Association of State Energy Official and Energy Futures Initiative, 2021, 2021 U.S. Energy & Employment Report. <https://www.energy.gov/sites/default/files/2021-07/USEER%202021%20Main%20Body.pdf>

## 2. Obtaining Renewables for Your Organization

Various options to implement renewable energy in an organization can generally be divided into self-generation (on-site or off-site) and purchases of renewable electricity. Corporations can own or lease renewable energy projects, which will either generate electricity on-site (behind the meter) or at an off-site location. Renewable electricity can usually be purchased through several supply options available to corporations in today's market, and some examples of these options are power purchase agreements (PPAs), renewable energy credits or RECs, and green tariffs through your utility provider. This section will discuss the mechanisms and technologies of both options in detail.

### 2.1 Roadmap of Implementing Renewable Energy Projects

To proceed with the optimum renewable energy system or option, the renewable energy target of the organization needs to be determined. Considering the goals of key decision-makers will lead the process of selecting the suitable renewable energy project. To better estimate the required amount of renewable energy that will align with the organization goals, collecting data for the current energy consumption pattern and total energy consumed per facility can be helpful. Once the previous steps are considered, a procurement strategy can be developed to help align the renewable energy target with the available renewable energy projects/options. This process is presented in Figure 8.

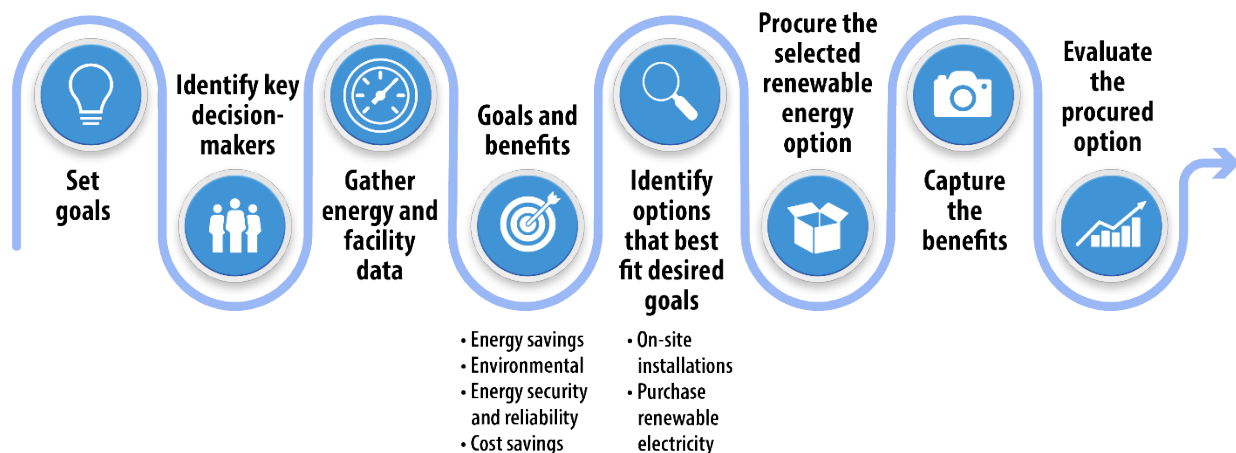


Figure 8: Steps for selecting a renewable energy project.<sup>39</sup>

### 2.2 Energy Intensity Tracking with Renewable Energy Within the Better Plants Program

Properly accounting for electricity generated from renewables is extremely important when baselining and tracking energy. As explained in the Better Plants [Energy Intensity Baselining and Tracking Guidance](#) document, in general, renewable electricity generated (from any source generated without fossil fuel) and consumed on-site should be accounted for using a 1.0 primary multiplier, assuming meters are in

<sup>39</sup> Adapted from U.S. Environmental Protection Agency, 2018, Guide to Purchasing Green Power: Renewable Electricity, Renewable Energy Certificates, and On-site Renewable Generation. [https://www.epa.gov/sites/production/files/2016-01/documents/purchasing\\_guide\\_for\\_web.pdf](https://www.epa.gov/sites/production/files/2016-01/documents/purchasing_guide_for_web.pdf)

place that can track the renewable electricity separate from the grid-purchased electricity. If on-site generated renewable energy is exported, a credit using a 3.0 multiplier should be used.

For sites with renewable sources of energy, the variable nature of renewables and the interchange between the electric grid 3.0 site-to-source multiplier and the renewable energy 1.0 multiplier can cause a facility's source energy consumption to change substantially without any relationship to changes in site energy usage patterns.

### On-site generated by-products used as fuel

Facilities that generate by-products used as a fuel source (e.g., hydrogen from ethylene production, blast furnace waste gas) may choose to include or exclude the energy produced in their models. If included, an estimate of the heat content and metering of the fuel are required. If metering of the fuel cannot be done or is cost-prohibitive, metering of the electricity generated is acceptable.

### Biomass

Biomass fuels are made up of organic materials from renewable sources such as sawdust, manure, and certain dedicated crops. The use of biomass as a fuel source is increasing in the United States as companies seek to reduce GHG emissions. However, biomass fuels typically contain more moisture than fossil fuels, resulting in lower combustion efficiencies. A conversion from fossil to biomass fuel can therefore decrease the efficiency of equipment such as boilers and potentially have negative impacts on energy intensity even though carbon emissions have been reduced.

The effect of moisture on biomass fuel heating values is given in Equation 1, where  $HHV_d$  is the dry higher heating value and  $M$  is the decimal wet mass fraction of the biomass fuel.<sup>40</sup> As seen, greater moisture content decreases the  $HHV$  of a given biomass fuel, which could decrease the overall heating value of a biomass fuel mixture. In addition, water content may reduce the efficiency of the boiler system itself.

#### Equation 1: Effect of moisture content on biomass higher heating values

$$HHV = HHV_d \times (1 - M)$$

As an example, consider a cement plant that want to introduce renewable fuels by using a pecan shell -as a biomass fuel- and coal mixture to fire its process kiln. Nut shells typically have an  $HHV$  between 8,000 and 8,500 btu/lb<sup>41,42</sup> and a moisture content of 5%–15%, which is below that of the approximately 10,500 to 15,000 btu/lb of coal.<sup>43</sup> Thus, the moisture and lower heating value of the fuel mixture mean that although the plant may use less coal, it burns more total fuel. Similar conditions can be observed in foundries when furnaces use coke as a biomass fuel.

<sup>40</sup> Boundy, B., Diegel, S., Write, L., and Davis, S., 2011, *Biomass Energy Data Book*, 4th Edition. Technical Report ORNL/TM 2011/4446. Oak Ridge National Laboratory, 2011. <https://info.ornl.gov/sites/publications/files/Pub33120.pdf>

<sup>41</sup> Perea-Moreno, M. A., Manzano-Agugliaro, F., Hernandez-Escobedo, Q., & Perea-Moreno, A. J., 2018, Peanut Shell for Energy: Properties and Its Potential to Respect the Environment. *Sustainability*, 10(9), 3254. <https://doi.org/10.3390/su10093254>

<sup>42</sup> Littlefield, B., 2010, *Characterization of pecan shells for value-added applications* (Doctoral dissertation). <https://etd.auburn.edu/handle/10415/2260>

<sup>43</sup> National Research Council. 1995. *Coal: Energy for the Future*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/4918>

<https://www.nap.edu/read/4918/chapter/16#273>

Increase in energy intensity may discourage companies from using biomass fuels. However, accounting for changes in energy intensity is very important when some or all of a facility's fuel sources are converted from fossil fuels to biomass. Because of the variety of biomass fuel types, all possible situations cannot be addressed in this guide. The basic principle, however, is that companies may adjust their baseline energy consumption to counteract the energy penalty they incur when increasing amounts of biomass are substituted for natural gas or other fossil fuels. To do this, baseline year data should be adjusted to assume the same percentage (based on heating value) of biomass was burned as the reporting year (replacing some of the fossil fuel that was burned during the baseline year) for the energy use(s) consuming the biomass fuel (e.g., a boiler system). If the moisture content of biomass changes over time, similar adjustments should be made. A useful table of heat content ranges for common biomass fuels is contained in Appendix A of the *Biomass Energy Data Book* published by the U.S. Department of Energy's Oak Ridge National Laboratory.<sup>44</sup>

#### Example: Energy Accounting with Biomass Adjustments

The Acme Flooring Duluth facility has a boiler system that burned 100% coal during its baseline year (2018). In 2020, the Duluth facility began using a fuel mixture consisting of 10% biomass and 90% coal, with the biomass being purchased from outside the facility boundary. Burning the biomass reduces the boiler efficiency. To account for this, the Duluth facility will need to take the following steps:

1. Determine coal consumption and quantity of steam generated by the boiler in the baseline year.
2. Estimate consumption of the fuel mixture (coal plus biomass) that would have been needed to generate the baseline year amount of steam with the 90% coal/10% biomass fuel mix.
3. Estimate the baseline consumption adjustment, which equals the hypothetical estimated fuel mixture consumption value for the baseline year minus the actual coal consumption value for the baseline year.

Biomass adjustments should always be made to the baseline year and reported in the baseline adjustment entry box in the Better Plants annual reporting form.

#### Energy generated from waste incineration

Facilities that use waste incineration to generate energy resources (e.g., hot water, electricity) should include this energy stream in their annual reports if it accounts for more than 5% of total energy consumption. The principles outlined in the preceding section on biomass fuel consumption also apply to energy resources generated using waste incineration. Better Plants partners can use the waste reporting form to calculate the energy recovered from incineration. Please consult with your Technical Account Manager to fill out the form.

#### Energy as a product

Energy not being used at the plant, within facility boundaries, can be directed away and accounted for either as an energy export or an energy product. For reporting purposes, the maximum allowable energy export is limited to the quantity of energy delivered to the facility boundary. This ensures that a facility cannot be counted as a negative consumer of an energy type. Energy exports are converted to primary

<sup>44</sup> Boundy, B., Diegel, S., Write, L., and Davis, S., 2011, *Biomass Energy Data Book*, 4th Edition. Technical Report ORNL/TM 2011/4446. Oak Ridge National Laboratory, 2011. <https://info.ornl.gov/sites/publications/files/Pub33120.pdf>

energy using the same site-to-source multiplier as the energy type that was delivered (e.g., 3.0 for electricity).

Some facilities (e.g., wastewater treatment plants, paper mills) may be able to generate a surplus of on-site generated energy to sell. When a facility reaches net-zero primary energy status, any excess energy delivered to another entity is accounted for as an energy product. In other words, whenever exported energy is greater than the total energy entering the boundary or generated on-site combined, the net amount of energy leaving the facility is treated as a product. Energy products are included as relevant independent variables in baseline models and use the same primary energy multiplier as the on-site-generated energy type (e.g., 1.0 for on-site solar panels).

As an example, consider a facility that purchases 25 GWh of electricity from the grid and produces 100 GWh of electricity from an on-site wind farm. The facility consumes 50 GWh and exports a total 75 GWh of electricity. This facility could claim a maximum of 25 GWh of energy export with the remaining 50 GWh counted as an energy product. Although this facility would be a net-zero energy consumer, its reported primary energy is reported as

$$\text{Primary Electric Energy} = \underbrace{(3 \times 25 \text{ GWh})}_{\text{Grid}} + \underbrace{(1 \times 100 \text{ GWh})}_{\text{Wind}} - \underbrace{(3 \times 25 \text{ GWh})}_{\text{Export}} - \underbrace{(1 \times 50 \text{ GWh})}_{\text{Product}} = 50 \text{ GWh}$$

For more information and accounting guidelines on energy products, see the [DOE Energy Intensity Baseline and Tracking Guidance](#) and the [SEP Measurement and Verification Protocol for Industry](#).<sup>45</sup>

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<sup>45</sup> Superior Energy Performance 50001™ Measurement and Verification Protocol, October 29, 2019.

## 2.3 Checklist for On-site Renewable Energy Projects

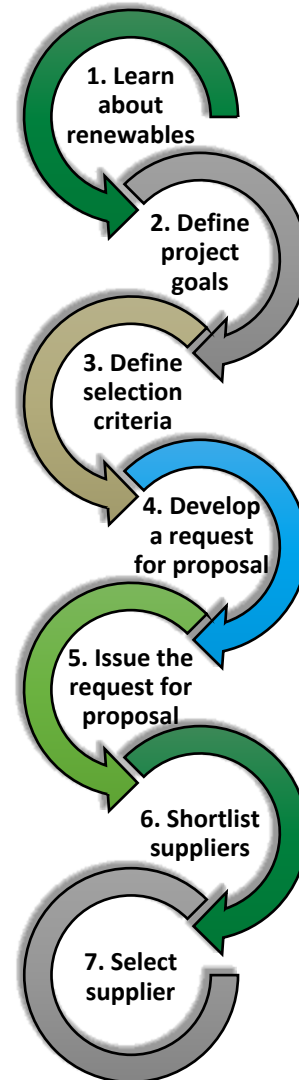
Many stakeholders are interested in investing in renewable energy due to its environmental and economic benefits for corporations, however, since the approach to procure on-site renewable energy projects may be vague, below checklist highlights best practices to choose a renewable energy supplier. In many companies, the procurement staff may have established steps for issuing solicitations. These steps are not intended to replace or relativize established corporate procurement protocols.

**1. Learn about renewables:** The development and installation of a renewable energy system requires an understanding of the technology, its financing options, and the procurement process.

**2. Define project goals:** To have a successful project, you will need to define your goals and objectives. This will allow providers to tailor their bid responses to your company's needs and demonstrate how they can successfully meet your goals.

**3. Define selection criteria:** Develop a scoring system for the bids based on the evaluation criteria most important to your company and form an evaluation committee to review bids. The evaluation committee can be made up of representatives from multiple perspectives, including procurement, engineering, facilities, finance, and sustainability offices. A final provider selection will be based on the total number of points awarded by the evaluation committee. The selection criteria can be based on the following list of project characteristics, but weighing the criteria will depend on your company's priorities:

- ✓ Project cost effectiveness: The project meets company financial savings targets and provider's bid matches or exceeds the competitor bids. The bid clearly communicates the financial benefits of the project using the financial metrics requested in the request for proposal (RFP) (e.g., US dollar per kilowatt, US dollar per kilowatt-hour, net present value)
- ✓ Technical approach/system design: The system design meets RFP specifications or provides additional value to the customer through customized design.
- ✓ Implementation schedule: The provider can construct the project to meet incentive deadlines and accommodate building schedule.
- ✓ Company qualifications/project experience: The company has experience installing similar projects in (1) location (in state or for specific utility), (2) project design (roof vs. carport vs. ground), and/or (3) system size.



- ✓ Project team, team experience, and approach: The team is qualified with past experience installing projects of similar location, design, and size. The team clearly communicated the design and construction approach.

**4. Develop an RFP:** An RFP notifies commercial providers that your company is receiving bids for a certain renewable energy project. The RFP allows your company to outline the bidding process and contract terms and communicate project specifications to providers that submit proposals. The company can issue a request for qualifications prior to the RFP and use the same weighing process to identify four to five qualified bidders. Having a short list of top bidders efficiently expedites the evaluation process and allows your company to focus on answering questions from the providers most likely to win the project.

**5. Issue the RFP:** Respondents have a minimum of two weeks to respond to the request for qualifications and have three to four weeks to respond to the RFP. Adequate response time is necessary to receive quality bids.

**6. Shortlist suppliers:** Depending on the number and quality of bids received, you may decide to shortlist suppliers and interview the two to three finalists, or award the project based solely on the RFP responses.

**7. Select supplier:** The evaluation committee uses the predetermined selection criteria (and interview results, if applicable) to evaluate RFP responses. Company decision-makers can expect a satisfactory proposal from the final supplier that closely aligns with your company's goals.

## 2.4 Purchasing Renewable Electricity

There are many ways to obtain renewable energy, even if a company does not have the capital to invest in on-site generation. This section details several options for incorporating more renewables into a facility's energy portfolio. Several renewable electricity supply options are available to corporations in today's market. Each supply option has its own set of unique features, and corporations should consider these different factors when determining the option that works best for them. The availability of different supply options grant companies the opportunity to achieve their sustainability goals by allowing the selection of a tailored renewable electricity procurement plan or multiple supply options with consideration for policies, electricity markets, and the company's financial and operation conditions. All renewable electricity supply options listed below include the generation of renewable energy credits or RECs.

The two main renewable electricity supply options categories are retail supply and project-specific supply. Retail supply options are usually short-term commitments that include the purchase of commercially available renewable electricity products in the form of utility resource mix products or RECs with a specific volume or based on a percentage from the total electricity consumption from utilities, REC marketers, or competitive electricity suppliers. Retail supply options are not tied to any specific renewable energy project and can be changed by the provider during the contract period. Alternatively, the project-specific supply options are generally tied to a specific renewable energy generation project with a long-term contract commitment that involves the purchase of customized products negotiated between the consumer and supplier. Usually, the volume of the purchased products is defined as a portion or all generation output of that specific project. All renewable electricity purchasing options are described in further detail in this section.

In 2019, about 7.8 million customers procured about 164 million MWh of renewable energy through green power markets; the greatest volume sold were the unbundled RECs at 68.7 million MWh (41.8% of market sales) followed by PPAs (25.8%) and Competitive Green Power (15.0%) as shown in Figure 9. This figure can help realize the available renewable electricity options, customer preferences, and current common mechanisms being used.

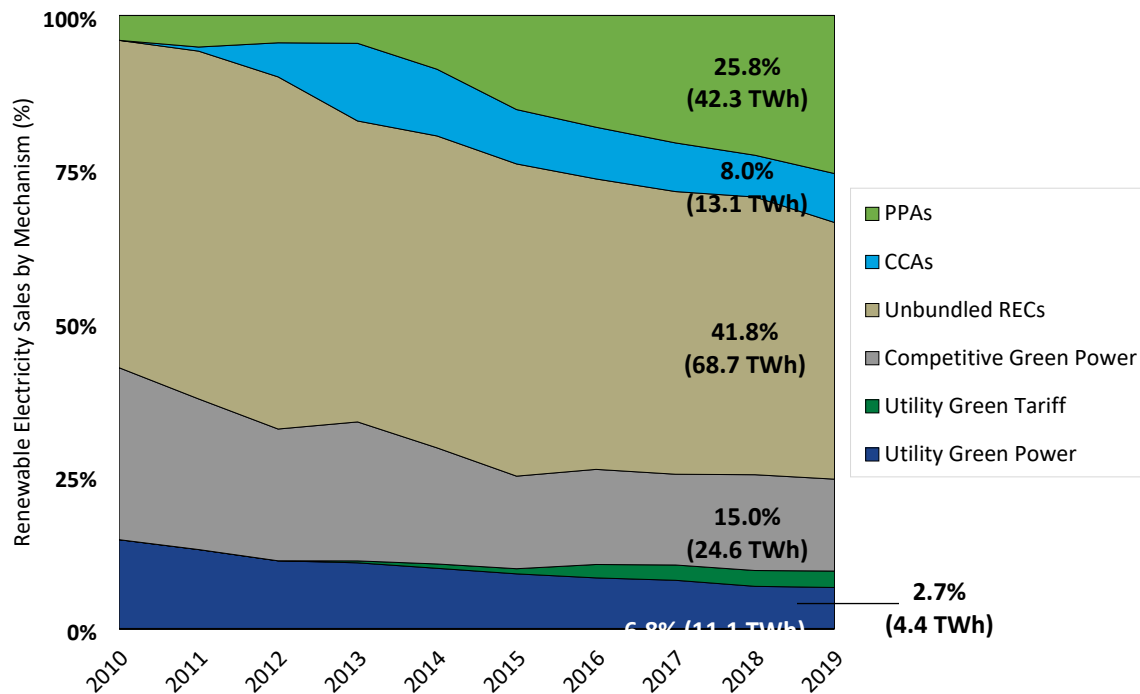


Figure 9: Renewable electricity sales in the voluntary market (see Box 5) by mechanism.<sup>46</sup>

#### Box 5: Voluntary vs. Compliance Renewable Energy Markets

In the compliance market, consumers receive and can purchase renewable energy through the standard electricity service from their utility since some states ask or mandate utilities to supply a certain share of their electricity from renewable energy resources. Whenever that selling and buying process happens in a state that mandates utilities, this is called a “compliance market.” On the other side, in the voluntary market, consumers in states that do not mandate renewable energy can choose—voluntary—to purchase renewable electricity through the different available mechanisms that will best align with the consumer goals. In addition, if consumers need to purchase more renewable energy than what is required by certain states, then it is considered a participation in the voluntary market.

#### Regulated and Deregulated Electricity Markets

For corporations with facilities in multiple states, learning more about the difference between regulated and deregulated energy markets before making a decision on investing in renewable energy technologies

<sup>46</sup> Adapted from Heeter, J., and O'Shaughnessy, E., 2019, Status and Trends in the Voluntary Market. National Renewable Energy Laboratory, Golden, Colorado. <https://www.nrel.gov/docs/fy21osti/77915.pdf>

would be important. In the regulated electricity market, consumers do not have the choice to select the utility or power provider—rather the market being totally under utilities’ control, where the utility guarantees power delivery to customers through the grid with an authorization from a public regulator—and each customer will then be bound to that utility. Regulated markets cover most of northwestern, southeastern, and western (except California) United States.

In the deregulated electricity markets, other than utilities, market contributors can own power plants and transmission lines where generators will sell the generated electricity to a wholesale market, which will be purchased by retail energy suppliers and resold to customers. Electricity will be transmitted through the grid by either the utility company or a transmission company. In this market, generated electricity from independent power producers is open for competition, and customers can choose their electricity provider, which brings competitive rates, more flexibility, and diverse generation options, including renewable energy.

This market is managed by an independent system operator (ISO) or regional transmission organization (RTO), and both ISOs and RTOs are managed by the ISO/RTO Council. Your utility company still ensures the power is distributed reliably. Nine ISOs/RTOs serve two-thirds of electricity consumers in the United States and more than 50% of Canada’s population.<sup>47</sup> Six of the regional markets (CAISO, ERCOT, ISONE, NYISO, PJM, and SPP)<sup>48</sup> are in the United States, two markets (AESO and IESO)<sup>49</sup> are in Canada, and one market (MISO)<sup>50</sup> is shared between the two countries. These markets are shown in Appendix D. Also, the status of the electricity market in each state is shown in Figure 10. The markets are not necessarily clearly distributed between states; some states are partially regulated or partially deregulated for industrial customers.

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<sup>47</sup> ISO/RTO Council: <https://isorto.org/>

<sup>48</sup> **CASIO**: California ISO. **ERCOT**: Electric Reliability Council of Texas. **ISONE**: ISO New England. **NYISO**: New York ISO. **PJM**: PJM Interconnection, PJM stands for Pennsylvania, New Jersey, and Maryland, however, PJM interconnection serves 13 states and D.C. **SPP**: Southwest Power Pool.

<sup>49</sup> **AESO**: Alberta Electric System Operator. **IESO**: Ontario Independent Electric System Operator

<sup>50</sup> **MISO**: Midcontinent ISO



companies with land constraints to invest in renewable generation as the location of the PPA project and the energy consuming facility are not required to be in the same location.

The two main types of PPAs are physical PPAs (P-PPAs) and virtual PPAs (V-PPAs), and their structure dictates how energy is delivered and how emissions/energy savings are counted.

### P-PPAs

In a P-PPA, the energy generated from a renewable energy project and the associated RECs are delivered directly to the manufacturing facility (Figure 11). This can be done either by constructing the project on site or by working with regional electric transmission and distribution (T&D) companies to construct a link between the facility and the renewable energy. The facility agrees to pay the renewable developer a fixed price for the delivered energy and continues to pay their utility company for grid power to fill gaps caused during high demand or low renewable energy generation. Overall, the PPA reduces costs by replacing grid purchased electricity with less expensive renewable energy.

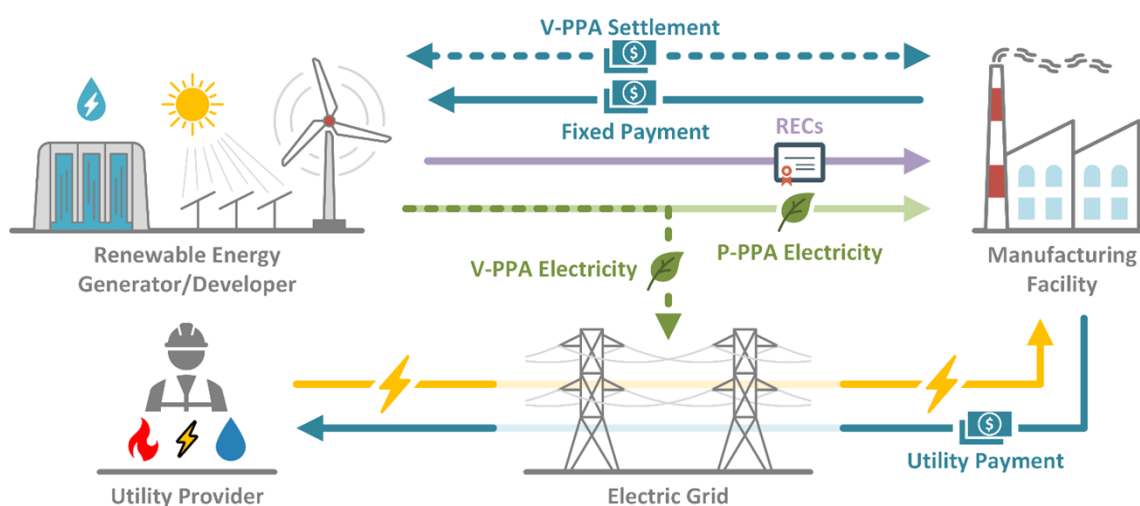


Figure 11: V-PPAs and P-PPAs differ in how renewable energy is delivered to a manufacturing facility.

P-PPA projects can be included in energy reporting for multiple programs if companies retain the associated RECs. For science-based targets, P-PPAs are counted as a reduction in Scope 2 carbon emissions. For Better Plants, an on-site P-PPA reduces the site-to-source energy multiplier from 3.0 to 1.0 in a company's energy baseline.<sup>51</sup> If the energy is generated off-site (e.g., a wind farm 10 miles away), a similar reduction in multiplier is possible and can be determined by working with the T&D operator to determine delivery losses. Be sure to consult your Technical Account Manager for assistance if you have any questions.

There are typically three options for P-PPAs at the end of the service contract: extend, purchase, or remove. Extending the P-PPA simply continues the current relationship for a predetermined period. As part of this renewal, upgrades to the generation equipment or expansion of capabilities can be negotiated. Some P-PPA contracts may offer the option to purchase the equipment at fair market value at certain points during the agreement. Purchasing the equipment places O&M burden of the equipment on the

<sup>51</sup> Technical Account Managers can help Better Plants partners integrate PPAs within their baseline/annual reports.

manufacturing facility. In the final option, the energy generating equipment is removed either by the developer or the manufacturing facility (based upon the terms of the P-PPA agreement). After removal, the manufacturing facility receives all its energy from the grid/utility provider.

### V-PPAs

In a V-PPA (also known as a “financial PPA”), the energy generated from a renewable energy project is delivered to the grid while the RECs are given to the manufacturing facility. The facility agrees to purchase a predetermined amount of renewable energy at a fixed price but continues to pay its utility for all its electricity. As the name suggests, V-PPAs have no effect on the source of electrons entering a manufacturing facility; the facility is greener because of the associated RECs. The renewable developer/generator sells the green electricity to a wholesale market and, depending on the agreement, there will be a monthly settlement. If the electricity sells for more than the agreed upon fixed rate, the manufacturing facility receives the difference. If it sells for less, the manufacturing facility pays an additional amount to cover the difference. In this way, the PPA partner always receives the agreed upon fixed rate for the energy generated.

For many corporate reporting activities, V-PPAs are considered as a reduction in Scope 2 carbon emissions because of the associated RECs. For Better Plants, however, V-PPAs are excluded from energy baselines. Facilities using a V-PPA still purchase all their power from the utility through the electric grid. Therefore, the standard 3.0 site-to-source multiplier is used. Although the addition of more green energy to the grid will in practice reduce this multiplier, there is no practical way to determine this benefit.

RECs, P-PPAs, and V-PPAs have unique risks and benefits that must be considered before entering into an agreement. Key differences among these types renewable energy purchases are described in Table 2. When purchasing renewable power, the right team is essential to understand and plan for these considerations. Accountants, line operators, engineers, and representatives from the local power utility are all needed to make an informed decision and ensure the energy needs of a manufacturing facility are being met.

*Table 2: Key considerations before entering a PPA.*

Considerations	P-PPAs	V-PPAs	RECs
Location	Energy generation must occur in a wholesale electric power market. The manufacturing facility must be in a deregulated power market.	Energy generation must occur in a wholesale electric power market. There are no restrictions on manufacturing site location.	There are no restrictions on location.
Regulations	Approval is required from the Federal Energy Regulatory Commission to purchase power from producer or a preauthorized third party.	V-PPAs are subject to reporting, recordkeeping, and registration requirements for swap agreements under the Dodd-Frank Wall Street Reform and Consumer Protection Act.	Subject to reporting, record keeping, and registration requirements for swap agreements under the Dodd-Frank consumer protection and reform act.

Considerations	P-PPAs	V-PPAs	RECs
Market risk	The cost for energy is fixed as part of P-PPA contract subject to a price escalator due to maintenance costs, retail energy cost increases, and so on.	The V-PPA floating energy price is heavily affected by market conditions. Additional risk management may be required.	The cost of RECs may fluctuate and is dependent on the source of the green energy. Companies should purchase RECs certified by a third party.
Energy management <sup>52</sup>	The purchaser takes possession of power and is responsible for its distribution, and can oversee T&D of energy internally or with a third party.	T&D considerations are not required for V-PPAs because no power is delivered to the purchaser.	No power is delivered to the manufacturer or the seller.
Benefits	Generated renewable electricity is delivered to the manufacturing facility with its associated RECs, and utility costs are reduced with P-PPAs.	Generated renewable electricity is distributed to the grid; however, its associated RECs are obtained by the manufacturing facility, and there might be a revenue stream depending on the market prices.	Scope 2 emissions are reduced.

### Locations for PPAs

Both P-PPAs and V-PPAs have restrictions on locations for facilities and generation sites. Renewable energy from a PPA must be delivered to consumers in a deregulated energy market (Figure 10) through one of the seven independent grid operators in the United States (also known as “ISOs/RTOs”). Therefore, sites for energy generation are limited to regions in a wholesale electric power market (Appendix D). Because P-PPAs also require a facility to purchase energy from an entity other than their utility, they are suitable only for deregulated markets. Because V-PPAs deliver their energy to the grid, facilities entering into the agreement have virtually no locational constraints.

### Renewable Energy Credits

The two main outputs associated with any renewable energy project are energy generation and environmental improvements. Both of these benefits can be monetized and sold separately on the open market. Generated energy is usually sold to the electric grid or can be delivered directly to a manufacturing facility. The environmental benefits of the renewable energy (i.e., reduced carbon emissions and fossil fuel usage) are sold as renewable energy credits or RECs.

Each REC represents the benefits associated with 1 MWh of generated renewable energy and has several attributes, including the type of renewable energy, the emissions associated with that energy, and the grid to which the energy was delivered. A company can purchase these RECs and therefore own the environmental benefits associated with that energy. An energy stream is considered renewable (or “green”) only if the consumer has possession of the associated RECs. For example, a company that

<sup>52</sup> For Better Plants partners who are involved in the 50001 Ready Program, please consider that proceeding with a PPA may affect the energy procurement task (depending on the aspects of the signed PPA) since a new source of power is delivered to the purchaser where energy consumption and demand level may be changed. The PPA is then to be considered as a legal document that needs to be followed under the 50001 Ready Program.

consumes 100 MWh of electricity from a fossil fuel powered electric grid but that has purchased 100 RECs from a wind project is considered 100% powered by wind. Figure 12 shows the range of energy and REC prices in different ISO/RTO markets for September 2020 to present the rough cost of RECs in the United States.

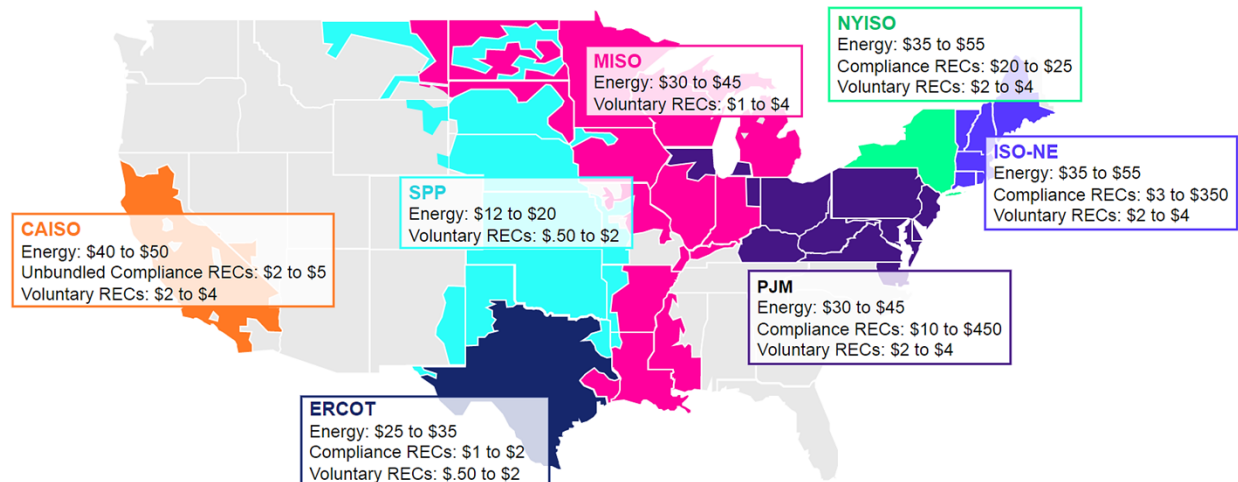


Figure 12: Energy and RECs market pricing (US dollar per megawatt-hour) for September 2020.

Credit: Enel X.

The price of RECs may vary depending on market dynamics, such as supply and demand, and market policies, such as renewable energy mandates with which utilities must comply. If there is a significant discrepancy between REC prices in the voluntary and compliance markets, an organization may be able to leverage these differences to its financial advantage by selling its eligible renewable energy project's RECs for a higher price in a compliance market and purchasing replacement RECs from another renewable project at a lower price. This is commonly referred to as "REC arbitrage" or "REC swap."

This opportunity could arise in the case of self-generation, as well as where an organization purchases power directly from a generator (a PPA). In either case, the REC owner has the choice to keep the RECs or sell them into a compliance market where the REC value is greater. However, if the organization sells the RECs and buys replacement RECs, it will have to claim the attributes of the replacement RECs rather than the attributes of the generator that supplied the energy.

### RECs vs. carbon offsets

An important distinction should be drawn between a REC and a carbon/emissions offset. An offset is measured as 1 MT of avoided emissions as opposed to a REC, which is measured in units of energy. Whereas RECs are only associated with renewable energy generation, offsets can be created from any project that avoids the release of GHGs (i.e., carbon capture, efficiency upgrades, green energy). Unlike a REC, an offset only reduces carbon footprint and has no effect on the "greenness" of the energy streams being used by a facility. However, an offset can be applied to all emissions scopes, whereas a REC can only be applied to Scope 2 emissions.

Although RECs and offsets are both important tools in a company's energy portfolio, they should not generally be included in energy baselines for Better Plants. Both can be counted in other DOE, U.S.

Environmental Protection Agency (EPA), or state energy efficiency/environmental programs, but Better Plants is concerned with the actual power delivered to facilities. Ownership of a REC or an offset has no direct effect on delivered power and is therefore be excluded for Better Plants purposes. For more information on energy baselining and accounting for renewables, please see the [DOE Energy Intensity Baselining and Tracking Guidance](#).

### **Utility-based Supply Options**

#### **Utility Green Power Products**

In the United States, there are around 850 power utilities, which include municipal, investor-owned, and cooperative utilities (see Useful Tip 6 for different types of utilities) that offer programs to allow customers to pay an additional premium rate per kilowatt-hour to be supplied by renewable electricity bundled with RECs (green power products) instead of the traditional supply.<sup>53</sup> This is also called “green pricing.”

One main product of the utility green power is based on the percentage of use in which the customer indicates the percentage of electricity (i.e., 25%, 50%, or 100%) to be received from a renewable energy source. The second product is a block-based option in which the customer determines the number of blocks needed in a month, and each block represents a certain amount of renewable electricity, commonly known at 100 kWh blocks.<sup>39</sup> However, that amount of renewable electricity in each block (i.e., 100 kWh could be higher for large energy consumers. In the utility green power products, customers are not tied to a long-term contract.

#### **Useful Tip 6: Types of Power Utilities (Investor-Owned Utilities, Municipal Utilities, and Co-Ops)**

There are three types of power utilities in the United States: investor-owned utilities (IOUs), municipal utilities (munis), and cooperatives (co-ops).

##### **Investor-Owned Utilities**

IOUs are for-profit and privately owned organizations that have the authority to exclusively supply electricity in a specific territory. Within other utilities types, IOUs are known to be much larger and more dominate in the U.S. electricity markets, where more than 70% of homes are served by IOUs as indicated by the EIA.<sup>54</sup> Generally, IOUs have a regulated hand to run the transmission, distribution, and retail as a regulated utility. In contrast, the deregulated hand makes IOUs function as an independent power producer or energy service company.

##### **Municipal Utilities and Cooperatives**

Munis are the public utilities owned and/or operated by a city or county; they are usually much smaller than IOUs and serve one city or urban district. Co-ops were formed mostly to supply many rural areas with small populations with electricity; they are owned by their customers. Munis and co-ops are different but have similar functionalities; both are non-profit publicly owned utilities, and both report to a board of directors that are publicly elected.

##### **IOUs vs. Munis and Co-Ops**

When comparing utilities based on the number of customers, IOUs are dominant in the market regardless of there being a larger number of munis and co-ops utilities. On average, IOUs have 350,000 customers, whereas munis and co-ops have only an average of 20,000 customers.<sup>54</sup> If a customer is looking to sell electricity to utilities, electricity needs to be sold to a mass market through an IOUs.

##### **Federal Agencies: Tennessee Valley Authority (TVA) and Bonneville Power Administration (BPA)**

TVA and BPA are both governmental organizations in charge of generating and transmitting power across their regions, where the local utilities will be responsible for the distributing and retailing electricity. Originally, both were initiated for the purpose of electrifying and economically developing the northwest and the greater Tennessee regions amidst the Great Recession.<sup>55</sup> The TVA region is mainly covered by munis and co-ops; however, the BPA region has many IOUs.

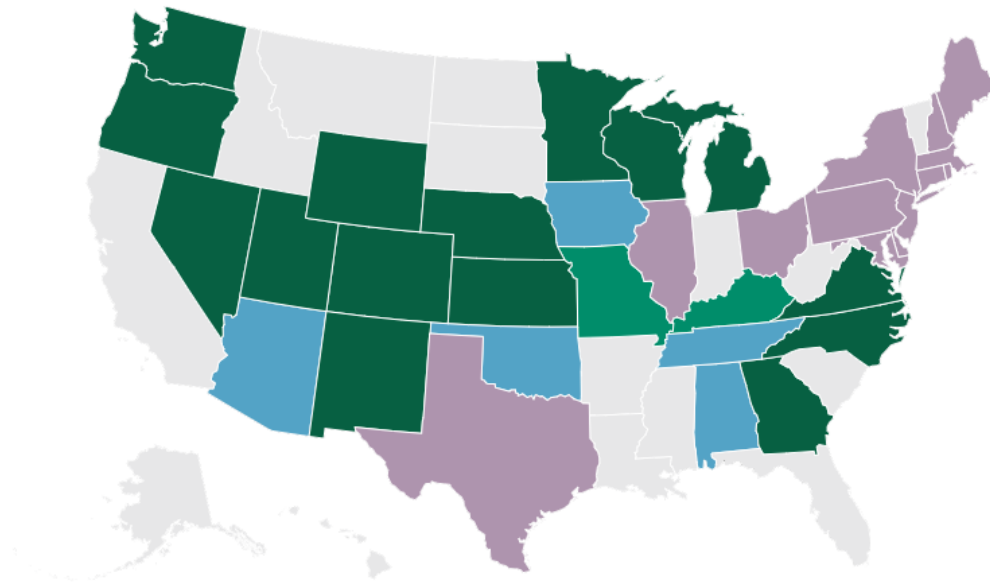
### Utility Green Tariffs

Customers in some regulated electricity markets are eligible for an optional program presented by their utility called “utility green tariffs,” which allow commercial and industrial customers to buy renewable electricity based on a specific project with a special tariff rate to help customers meet their sustainability goals, increase involvement in renewable energy, and avoid energy risks. Usually, such programs need to be approved the state public utility commissions. Utility green tariffs programs vary by state and customer, and organizations are encouraged to check with their local utility to learn if they are qualified to participate in such a program.

In this option, customers can get up to 100% of renewable electricity through their utility from an independent power producer in the same grid or from a project owned by the utility. However, some utility green tariff programs allow the customer to be directly being involved in a renewable energy project or alternatively, the utility will connect the customer with some type of PPA—usually called a “sleeved PPA”—that is signed beforehand by the utility to encourage bringing more renewable energy projects to the grid. On the other hand, some other programs give customers the choice to fix their electricity rate to a market-based (wholesale) price. Information regarding states with utility green tariffs programs as of October 2019 is provided in Figure 13.

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<sup>55</sup> GridFabric, 2020, Who's Who on the Power Grid. <https://www.gridfabric.io/blog/whos-who-on-the-grid>



### Utility Renewable Energy (RE) Deals



Figure 13: States with utility green tariff programs as of October 2019.<sup>56</sup> Credit: CEBA.<sup>57</sup>

#### Utility green tariff vs. utility green power products

Green tariff and green power products are similar in terms of the renewable power received (electricity and its associated RECs), and both options are available in traditionally regulated markets. However, these two options are unlike by means of the contract terms, characteristics of the project, availability to customers, and purchasing procedure. For example, eligible customers for green tariffs may purchase renewable electricity bundled with RECs from a certain renewable energy project based on a long-term agreement. If the customer pays a premium rate for receiving renewable electricity—usually from a blend of renewable energy resources—which will be reflected as an additional component on the electric bill without a long-term commitment, then that is defined as a “green power product.”

#### Competitive Green Power Products

In the competitive retail electricity markets, customers can purchase bundled renewable electricity (electricity and RECs; similar to the utility green power products) from a competitive electricity supplier rather than the local utility supplier; such an option is called “competitive green power products.” In this option, customers generally pay a premium rate (\$/kWh) to the competitive electricity supplier through their utility, and the total cost is then listed as an additional component on the monthly electric bill.

<sup>56</sup> Note: In states with multiple green tariffs, the green coloring indicates the furthest a green tariff has been utilized. For example, there may be multiple green tariffs with differing statuses in a state, but only one green tariff has been used to execute a renewable energy deal. For *electric retail choice*, please refer to the [EIA website](#).

<sup>57</sup> Clean Energy Buyers Association, Green Tariffs. <https://cebayers.org/programs/education-engagement/green-tariffs/>

Nevertheless, munis utilities located in the competitive markets may not allow their customers to choose an electricity provider or generation options.

Competitive green power products can be purchased partially with a certain percentage (i.e., 20%, 40%, or 100%), and these products vary based on the geographical location and on the renewable energy resource that was used to supply electricity. Commonly, utilities in most states still control billing and the transmission services since utilities supply electricity to customers through the established power lines. These products are known by their short-term agreement of less than 24 months.<sup>39</sup> Partners interested in the competitive green power products are encouraged to check the consumer information websites in the state(s) of their facility(ies) for the availability of these products to help make an informed decision.

### ***Community Choice Aggregations***

Community choice aggregation (CCA), or “municipal aggregation,” is an attractive supply option that offers communities a low price of electricity and more control on the sources of power by being exposed for more diverse renewable energy options. In this option, the power is procured from an alternative supplier on behalf of the community by its local authority. However, the community will still receive T&D and billing services by the local utility provider; the only change is the source and price of electricity. When the demand is aggregated, the community can negotiate for cheaper electricity rates (15% to 20% cheaper in some cases),<sup>39</sup> as well as receive power from renewable energy sources. To date, only 10 states have CCAs authorized; other states are actively investigating authorizing this supply option. For more information about the availability of CCAs in the United States, please visit the [Local Energy Aggregation Network \(LEAN\) Energy US](#) website.

### ***Self-Supply***

The self-supply option usually refers to the distributed generation of renewable electricity in which the consumer may install and own a renewable energy generation system on-site—or in a nearby location—that directly supplies the consumer with renewable electricity. It could also be in an off-site location, in which case electricity is delivered through the grid or sold to other consumers. In all cases, the consumer needs to retain the RECs associated with the electricity generated to claim this option as a renewable source of electricity.

Because owning a renewable energy system often requires a high capital cost, it is recommended to take advantage of state and federal incentives and tax credits (e.g., solar investment tax credit) to reduce the initial investment needed. Also, in this option, the consumer will be in charge of the O&M process of the owned system, which is an additional cost to be considered for the return on investment and payback period estimation.

### ***Shared Renewables***

Shared renewables, or “community renewables,” are a supply option that allow multiple consumers to obtain renewable electricity by either buying or leasing a share in a renewable energy generation project—owned by the community or by a third party—far from their location because of the limitation of renewable energy technologies in some regions because of resources potential, policies, or electricity markets restrictions.

Community solar is the most common type of shared renewables, which has been legislated in 20 states and Washington, DC.<sup>58</sup> Each state has its own policies, yet they all agree on allowing consumers to take advantage of the community solar option by introducing the virtual net metering (explained in Useful Tip 7). In this option, generated electricity is delivered to the grid, but participants will have a credit item on the electricity bill based on the total energy generated from their share of a community solar project. For participants who need to claim the use of renewable electricity, RECs associated with generation from their share of the shared renewable project need to be claimed by the consumer. In some states, RECs cannot be retained by the consumer and alternatively need to be sold to the utility company or other load-serving entities.

#### **Useful Tip 7: Virtual Net Metering**

Virtual net metering, or “remote net metering,” allows consumers to have a credit listed on their electric bills for the renewable energy generated from a shared off-site solar energy project by the consumers. As an example, if multiple consumers are involved in a community solar project as a “shared renewables” supply option, then virtual net metering is applied to appropriately offset their electricity consumption from an off-site renewable energy generation system.

### ***Choosing Between Renewable Energy Purchasing Options***

Several factors play a role when selecting a renewable energy purchasing option; organization goals are usually the main driver, considering energy use, key decision-maker preferences, and many other factors. For example, an organization that wants to avoid the fluctuations in fuel price might be interested in entering into a P-PPA or V-PPA. If an organization’s priority is energy reliability, then it may need to consider an on-site renewable energy generation system with energy storage. Similarly, for organizations that have facilities in multiple locations, although adopting one approach or technology for all locations may reduce transaction costs and the hassle of having multiple contracts, it may not be the right decision to maximize the energy bill savings since the potential of renewable energy technologies and their policies and regulations are highly geographically dependent.

A comparison of renewable electricity supply options is presented in Table 3. Regardless of the supply option that an organization will consider, the organization would need to own the associated RECs to claim the environmental attributes of the renewable electricity supplied. Also, each organization may need to customize supply options to successfully achieve its sustainability goals. For more information about how to decide which potential renewable energy procurement options are available for your organization—considering the location of your facilities as well as your organization preferences—please see the [EPA’s Green Power Supply Options Screening tool](#).

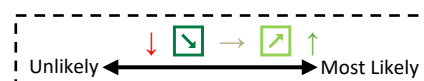
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<sup>58</sup> National Renewable Energy Laboratory, 2020, Sharing the Sun: Understanding Community Solar Deployment and Subscriptions. <https://www.nrel.gov/docs/fy20osti/76853.pdf>

Table 3: Comparison of renewable electricity supply options.

	Renewable energy supply mechanism	Characteristics								Supply option includes		
		Simple/fast transaction	Cost savings/price hedge	Requires long-term commitment	Renewable Energy generators located on-site	Supports regional renewable energy deployment	Direct impact on new supply	Supply option availability	Reduces carbon footprint <sup>1</sup>	RECs	Commodity electricity	Generating asset
<b>Retail supply options</b>	Unbundled RECs	↑	↓	↓	↓	↘	↓	↑	↑	↑	↓	↓
	Competitive Green Power	↑	→	↓	↓	→	↓	→	↑	↑	↑	↓
	Utility Green Power	↑	↓	↓	↓	→	↓	→	↑	↑	↑	↓
	CCAs	↑	↗	↓	↓	→	↘	↘	→	→	↑	↓
<b>Project-specific supply options</b>	Self-Supply	↓	↗	↑	↑	↑	↑	↑	↗	↗	↑	↑
	Shared Renewables	↗	↗	→	↓	↑	↗	↘	→	→	→	→
	Utility Green Tariffs	↘	↗	↗	↓	↑	↗	↘	↑	↑	↑	↓
	P-PPAs	↓	↑	↑	→	↑	↗	↘	↗	↗	↑	↓
	Virtual (Financial) PPAs	↓	↑	↑	↓	↓	↗	→	↗	↗	↓	↓

<sup>1</sup>Dependent on RECs ownership



## 2.5 Considerations When Generating Renewable Energy

### On-site vs. off-site generation

Besides the environmental benefits of having an on-site renewable energy generation system, doing so will also grant the consumer the advantage of reducing the cost of electric bills because many states allow net metering (see Useful Tip 8 for more information about net metering), which is a policy that regulates the process of selling excess electricity generated from an on-site renewable energy system to the grid. Moreover, adding energy storage to the renewable energy project provides a resilient source of power and can help avoid or reduce power interruptions. Additional savings can be realized by avoiding the demand cost if the system can totally operate independent from the grid. More details about energy resilience are provided in the supplemental document<sup>59</sup> associated with this guidance.

<sup>59</sup> Abbas, A., Price, C., Nandy, P., Wenning, T., 2022, Renewable Energy Guidance for Industry: Supplemental Document, ORNL/SPR-2021/2027, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

**Useful Tip 8: Net Metering**

When a grid-connected renewable energy system generates more electricity than what is needed, the excess electricity can be sold back to the grid for utility use. In compliance with the Public Utility Regulatory Policy Act of 1978, utilities are required to purchase excess electricity from small renewable energy generating systems, which are grid-connected at a rate equal to the cost of power produced by the utility. Utilities usually implement several metering arrangements; the two common arrangements are as follows:

- Net purchase and sale: Two single-direction meters are installed for this arrangement; one meter records electricity consumed from the grid, and the consumer would pay retail rate for that electricity; the other records excess generated electricity to be sent back to the grid, which is usually sold at a wholesale rate (at utilities' avoided cost). Generally, the difference between the retail and wholesale rates would be significant.
- Net metering: In this arrangement, one bidirectional meter is installed to record both electricity consumed from the grid (meter will spin forward) and excess generated electricity to the grid (meter will spin backward). By the end of the month, if the consumer used more electricity than generated, then retail price will be applied for the amount of electricity. If more electricity were generated than consumed, then the utility will buy that electricity at a retail rate, which is why applying net metering is very beneficial for consumers.

More information about net metering rules and the availability of customer credits for excess generation in each state can be found on the [DSIRE website](#).

Under specific conditions, organizations may want or be able to own renewable electricity technologies off-site, far from their own facilities. In that case, the RECs produced need to be retained by the organization to claim the use of renewable energy. One factor to consider is that off-site renewables will involve procuring and maintaining the T&D infrastructure and the owner will be responsible for ensuring power quality and delivery (ancillary services). This infrastructure can incur significant costs. An organization may still sell the RECs associated with renewable energy generation from an on-site system, but the organization will lose its right to claim the use of renewable energy in that case, except if replacement RECs were purchased.

There are several benefits in owning off-site generation rather than on-site generation. The off-site location may have higher resource available and thus produce more energy and maximize the return on investment, and it may also better match the organizational goals if land is available, for example. In some cases, off-site generation would have more flexible regulations and permitting laws, as well as providing benefits to utilities in some areas to help solving reliability and congestion issues. In return, some incentives may be received by the utility. Finally, in markets or areas with high renewable energy incentives or with great opportunity for REC arbitrage (REC swap), an organization may sell power at a higher price.

**Distributed Generation**

In general, unless it is at utility scale, renewable energy projects are considered to be a form of distributed generation—also known as “on-site generation” or “district/decentralized energy.” Distributed generation is usually implemented for residential and commercial buildings and considered small-scale power generation system with capacity range of 1 kW and up to 10 MW. In these distributed generation systems, a distributed energy resource (DER) generates the power (electricity) nearby to the load that needs to be served without the need of a transmission network, and sometimes a DER can work as an

energy storage technology called a “distributed energy storage system.” One issue of the DER—especially when it is grid-connected—is the grid disturbance, which is caused by the uncertainty and intermittency of renewable energy resources (e.g., solar, wind) and could make the supply-demand relationship complicated, may cause reverse power flow to the transmission network, and requires advanced optimization tools to balance the network.

### ***Interconnection Process***

When a DER needs to be connected to the grid, an interconnection process must be reviewed and approved by the utility since the DER will affect the electric load and electricity flow from the grid to the customer, whether the generated electricity is being used at all or sold back to the utility. This change may affect performance and power quality of the grid as well as expose utility works’ safety to a potential risk. Following the interconnection process will lower these risks. For the facilities located within the Federal Energy Regulatory Commission jurisdiction, standards of the transmission-level interconnection are provided by the commission for small generation (less than 20 MW). Outside of that jurisdiction, each state’s public utility commission usually regulates the distribution-level interconnection.

IEEE (Institute of Electrical and Electronics Engineers) has published the [IEEE 1547 standard](#), which “provides requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection. It also includes general requirements, response to abnormal conditions, power quality, islanding, test specifications, and requirements for design, production, installation evaluation, commissioning, and periodic tests.”<sup>60</sup>

For utilities to verify that there is no safety risk or negative impact on the grid, organizations need to submit a complete interconnection process application to their local utility to be reviewed. If any negative impact is detected, the utility will ask for an additional supplemental review (Figure 14), and an additional cost might be added to the project in case new equipment is needed to protect the grid. Usually, the additional review process and equipment may be needed for complex or large projects, or with generation located in a high-density area, where the electricity transit via a complicated power lines that connect to individual customers through multiple tracks. Because the interconnection process usually takes longer than expected, it is always recommended to start the process as soon as you have enough technical information.

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<sup>60</sup> Institute of Electrical and Electronics Engineers, 2018, IEEE 1547-2018 - IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces. <https://standards.ieee.org/standard/1547-2018.html>

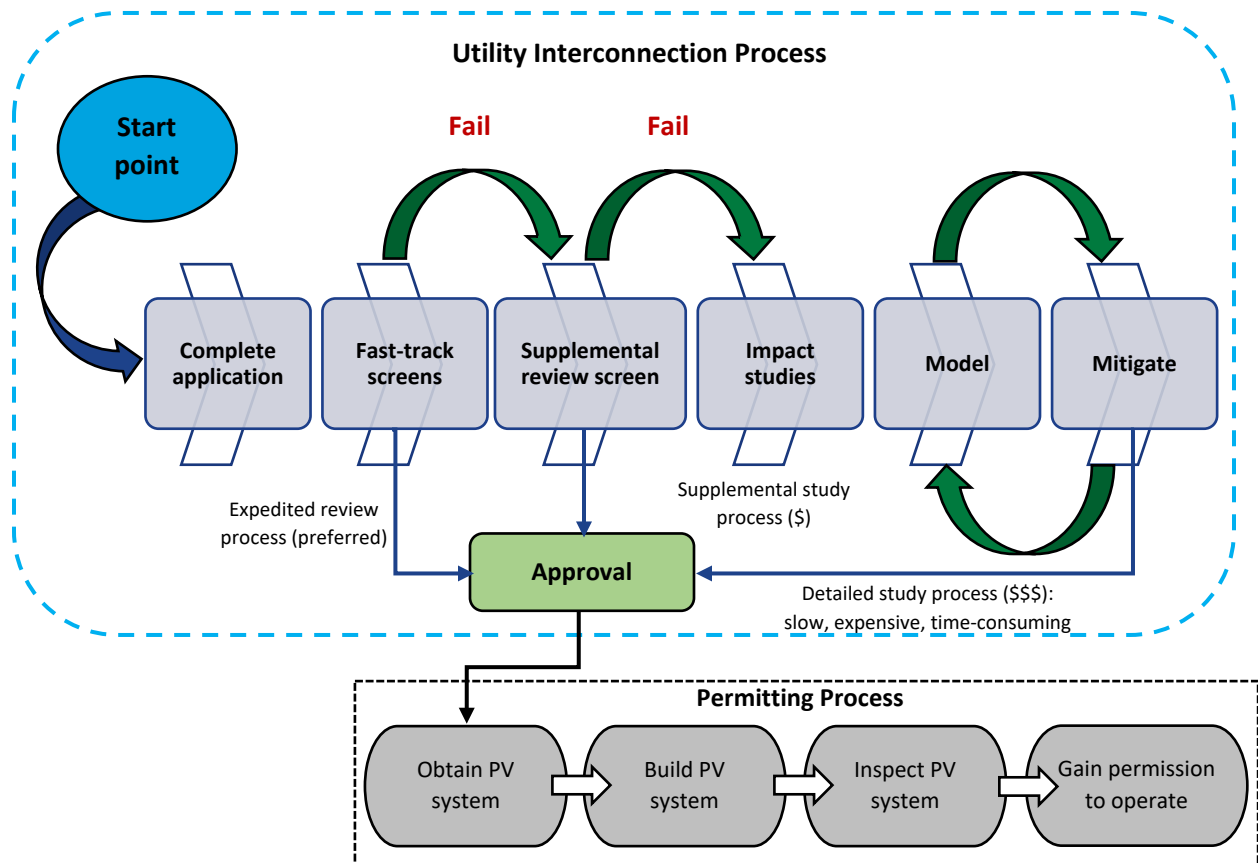


Figure 14: Utility interconnection process.

## Energy Storage

Because power supply in the electricity grid always needs to be adjusted to properly respond to changes in the demand—and because the supply is always exposed to unexpected changes and possible shut-down due to storm, overload, and many other reasons—it is advisable to employ an energy storage technology for a more reliable and flexible system. This system could help achieve some balance in the supply and demand. As an example, because there is more low-cost power supply than demand at night, energy storage systems can be used to store that excess electricity and then used again when demand is more than supply at daytime.<sup>61</sup> Because of the intermittent nature of renewable energy technologies (e.g., solar and wind), considering energy storage systems that can rapidly respond to the unexpected changes in supply can significantly improve supplying power in a more stable and smooth way to better match the demand. Also, energy storage is potentially needed for off-site and remote renewable energy generation systems to guarantee power stability, especially when these systems are completely off the grid.

Energy storage is accomplished by devices or physical media that store energy to perform a useful operation at a later time. Storing energy allows us to balance energy supply and demand. Energy storage systems in commercial use today can be broadly categorized as

<sup>61</sup> Union of Concerned Scientists, 2015, How Energy Storage Works. <https://www.ucsusa.org/resources/how-energy-storage-works>

- **Mechanical energy storage:** such as pumped-storage hydropower and flywheel energy storage
- **Electrical/ electrochemical energy storage:** such as capacitors, batteries, fuel cells, and grid storage
- **Chemical energy storage:** such as hydrogen, biofuels, and fossil fuels
- **Thermal energy storage:** such as ice storage, molten salt energy storage, and seasonal thermal storage

### *Lease vs. Buy: Pros and Cons*

When installing renewable energy equipment on-site, a key question is whether to lease or purchase the equipment. In a leasing agreement, a renewable energy company will install and manage the generating equipment on-site for the agreed upon contract length. The consumer agrees to pay the company a flat monthly fee for the right to use the energy generated from the project. The monthly fee is usually less than the consumer's current utility cost and is set based on the expected amount of energy that will be generated and the tax breaks that are available for the leaser. This arrangement is different from a P-PPA in which the energy cost is constant and not based on a kilowatt-hour usage rate.

Choosing between leasing or buying renewable energy equipment is a matter of preference and capital. Buying the equipment outright requires a large amount of upfront investment. Once the equipment is installed, however, a facility may be able to recoup costs faster by buying because the shares taken by the renewable energy partner on monthly rates and incentives are removed. Leasing equipment allows facilities that do not have large upfront capital to still save money through renewable energy. Operations and maintenance costs are shifted to the leasing partner, and the flat monthly fees from a leasing agreement make budgeting for renewable energy very simple. The return on investment with a lease agreement will be longer than with a buying agreement, but the stability may be a more important factor. Overall, any company looking to lease or buy renewable energy equipment should fully analyze both options and make decisions based on their company's preferences, budget, and outlook.

## 3. Tools and Resources for Evaluating Renewable Energy Systems

### 3.1 Software Tools

#### *System Advisor Model*

The System Advisor Model (SAM) is a free open-source software model that provides detailed hour-by-hour technical and economic analysis to help facilitate decision making for project managers, engineers, policy analysts, technology developers, and researchers involved in the renewable energy industry. SAM can estimate the long-term cost and performance of renewable energy technologies based on model results. The software is presented and frequently updated by NREL. To download the software and for more information, please visit the tool [website](#).

#### *REOpt Lite*

REOpt Lite is a free web-based tool that can help evaluating the economic and technical aspects of grid-connected solar PV, wind, and energy storage systems based on the characteristics of a specific location. REOpt Lite is the free version of the original full REOpt model that is currently used by NREL to support clients with a feasibility analysis for projects. To navigate the tool and for more information, please visit the tool [website](#).

#### *PVWatts Calculator*

NREL's PVWatts Calculator is a web-based software tool developed by NREL that offers annual and monthly electricity generation estimation for grid-connected solar PV systems based on the system's location, simple inputs, basic design parameters, and the average annual retail electricity rate. To navigate the tool and for more information, please visit the tool [website](#).

### 3.2 Other Resources

#### *DOE's Better Buildings Renewable Energy Resource Hub*

DOE's Better Buildings initiative offers renewable energy resources on the Better Buildings Solutions center in the [Renewable Energy Resource Hub](#). This hub provides helpful information on basics of renewables, how organizations can start with renewables, how to overcome technical and physical limitations and implement renewable project, in addition to some funding and financial resources. A screenshot of the homepage is shown in Figure 15.



Figure 15: Better Buildings Renewable Energy Resource Hub

### CEBA

**CEBA** is a membership association for corporations from different sectors interested in expanding their corporate renewable energy portfolio where members get access to helpful tools, resources, education, and several other programs. Members of CEBA include energy and service providers. CEBA particularly helps large-scale energy buyers with the procurement of renewable energy projects with the goal of achieving a 90% carbon-free U.S. electricity system by 2030.



### BRC

Like CEBA, **BRC** is a membership platform that encourages renewable electricity purchasing for corporations through off-site and large-scale wind and solar energy projects with the goal of procuring 60 GW of renewable energy by 2030. BRC specializes in helping corporations with scaling up PPAs and reducing PPA contract complexity.



### EPA Green Power Partnership Program

The **Green Power Partnership** is a program managed by the EPA to help corporations procure renewable energy technologies and develop renewable electricity resources with the goal of reducing the negative health and environmental impacts of traditional energy resources. Partners of this program commit to adopt renewable electricity for part or all of their annual consumption, and in return, they receive technical assistance, recognition, and updates about the status of the market.



### ***Database of State Incentives for Renewables & Efficiency (DSIRE)***

The [Database of State Incentives for Renewables & Efficiency \(DSIRE\)](#) is a comprehensive source for looking up federal, state, and local incentives and policies on energy efficiency and renewable energy with summary maps for some of the renewable energy policies such as net-metering and PPAs. This database is currently managed by the North Carolina Clean Energy Technology Center and was originally funded by DOE.

**DSIRE**®



### ***Renewable Thermal Collaborative***

The [Renewable Thermal Collaborative](#) is a global alliance of large thermal energy users to focus on scaling up renewable heating and cooling for organizations and governments to help them decarbonize their facilities.



## 4. Partner Case Studies

As of now, many Better Plants partners have already invested in renewables, both on-site (self-supply) installations or by purchasing some renewable electricity. This section presents a few case studies from some partners that have implemented renewable energy projects. These case studies are presented based on the renewable energy resources or the purchasing mechanism.

### 4.1 Solar Energy

#### *The Estée Lauder Companies*

In 2020, The Estée Lauder Companies added 3.8 MW of solar power at the corporation level to bring the global company's total to more than 5 MW of solar capacity. In the United States, a 1.45 MW ground-mounted solar array was installed in their Melville, New York site (Figure 16). This project is expected to produce more than 1,800 MWh/year of solar power and reduce 1,300 MT of CO<sub>2</sub> emissions annually. Also, at the Blaine, Minnesota facility (Figure 16), around mid-2020, the installation of 900-kW (3.6-acre) solar PV array was completed to supply 50% of the manufacturing facility's annual demand.

**ESTÉE  
LAUDER  
COMPANIES**



Melville, New York



Blaine, Minnesota

Figure 16: Solar PV projects of The Estée Lauder Companies in the United States.<sup>62</sup>

#### *Schneider Electric*

In July 2011, Schneider Electric completed the construction of a 1 MW solar farm in its Smyrna, Tennessee plant. This farm was constructed to increase the operational voltage for up to 1,000 V, which could help reduce energy losses in transmission,

**Schneider  
Electric**

<sup>62</sup> The Estée Lauder Companies, New Solar Arrays Further ELC's Commitment to Renewable Energy. <https://www.elcompanies.com/en/our-commitments/sustainability/climate-and-environment>

and improve the efficiency of the solar farm. After about two years, the solar farm contributed to reducing net electricity use by 19%.<sup>63</sup>

## 4.2 Wind Energy

### *CalPortland*

CalPortland signed a PPA for 24 MW wind turbine generation facility that consists of eight 3 MW wind turbines—as part of the Alta Wind Energy Center—to directly supply electricity to its Mojave cement plant (Figure 17). The 24 MW wind farm generates around 40,000 MWh annually, which covers 20% of the plant electricity consumption.<sup>64</sup>



Figure 17: Part of the Alta Wind Energy Center near CalPortland's cement plant in Mojave, California.<sup>65</sup>

### *Narragansett Bay Commission*

Narragansett Bay Commission installed three 1.5 MW wind turbines in Coventry, Rhode Island, which will save \$600,000 of annual electricity cost, in addition to the revenue from selling the RECs associated with generation. The Narragansett Bay Commission received the 2017 Better Project Award for that accomplishment.<sup>66</sup>



## 4.3 Hydropower

### *Los Angeles Department of Water and Power*

The Los Angeles Department of Water and Power installed a hybrid solar, wind, and pumped hydro-storage system by utilizing two big lakes, where one of them (Pyramid Lake) acts as a huge battery to store water, where water is pumped from the other lake (Castaic Lake) to Pyramid Lake in the day by using excess energy that was generated by



<sup>63</sup> Better Buildings, Schneider Electric: Solar Field and Continuous Energy Efficiency Improvement. <https://betterbuildingssolutioncenter.energy.gov/showcase-projects/schneider-electric-solar-field-and-continuous-energy-efficiency-improvement>

<sup>64</sup> Energy in Industry, CalPortland Wind Turbine System at Mojave Cement Plant. <https://www.youtube.com/watch?v=J4ERFRB6R7k>

<sup>65</sup> CalPortland, 2020, CalPortland® Signs New OK® Raw Mill Deal with FLSmidth. <https://www.calportland.com/calportland-signs-new-ok-raw-mill-deal-with-flsmidth/>

<sup>66</sup> The Narragansett Bay Commission's profile on the Better Buildings Better Plants website. <https://betterbuildingssolutioncenter.energy.gov/partners/narragansett-bay-commission>

solar and wind from different renewable energy sites. At night, water is released to run into hydroturbines and generates electricity to power tens of thousands of homes,<sup>67</sup> and the same cycle happens every day (Figure 18).



Figure 18: Pumped-storage plant of the Los Angeles Department of Water and Power in Castaic, California.<sup>67</sup>

## 4.4 Fuel Cells

### *Owens Corning*

Owens Corning have installed two 200-kW fuel cells to serve its roofing and asphalt plant in Compton, California. This installation will cover 65% of the plant's power over the year, also, it will reduce CO<sub>2</sub> emissions by about 30% because the installed fuel cells can generate electricity without any combustion. This installation mitigated power outages the plant is facing one or two times per week on average due to an overloaded local infrastructure.<sup>68</sup>



### *Honda*

Because Honda is working on energy sustainability goals, the company installed a 1 MW fuel cell system on its Torrance, California campus that will produce clean, reliable energy and significantly reduce carbon footprint from Honda's operations in the region. The system includes five 200-kW fuel cell units, which will cover 25% of the facility's electricity need and reduce CO<sub>2</sub> emissions by 18% to 25%.<sup>69</sup>



<sup>67</sup> McNary, S., 2019, How LADWP Uses Two Lakes to Store Energy Like A Giant Battery, LAist.

[https://laist.com/2019/05/13/how\\_ladwp\\_get\\_two\\_lakes\\_to\\_store\\_energy\\_like\\_a\\_giant\\_battery.php](https://laist.com/2019/05/13/how_ladwp_get_two_lakes_to_store_energy_like_a_giant_battery.php)

<sup>68</sup> Bloom Energy, Owens Corning Roofing and Asphalt Plant Powered by Bloom Energy Servers.

<https://www.bloomenergy.com/owens-corning>

<sup>69</sup> American Honda Installs 1MW Bloom Energy Server that Will Produce Clean Energy and Reduce CO<sub>2</sub> Emissions

<https://www.bloomenergy.com/honda>

## 4.5 Purchasing Renewable Electricity

### General Motors

In the U.S., General Motors purchased 41% of its electricity through renewable electricity options with a total of 1,224 GWh/year. GM's global commitment to renewable energy use began more than two decades ago and is expected to culminate by 2035; the plan is to source 100% renewable energy to meet GM's global electricity needs. Currently, GM's plan is to achieve 100% globally by 2035 and 100% of U.S. sites by 2030.<sup>70</sup> For all U.S. operations, GM has utilized the following mechanisms to achieve 41% renewable electricity:



Self-supply (kWh/year)	237,477,138
Utility green tariff (kWh/year)	117,124,000
P-PPA (kWh/year)	3,928,240
V-PPA (kWh/year)	865,661,458
<b>Total (kWh/year)</b>	<b>1,224,190,836</b>

(Source: EPA's Green Power Partnership program. Report date: 04/20/2021)

### Steelcase, Inc.

In 2019, Steelcase continued its commitment to purchasing renewable energy equivalent to 100% of its global electricity consumption. In the United States, Steelcase purchased over 113 million kWh of renewable energy. Steelcase reinforced its 100% renewable energy goal by signing a 12-year V-PPA for 25 MW of wind power from Southern Company subsidiary Southern Power's Grant Plains Wind Facility, which was fully operational in 2017. To cover the remaining consumption, Steelcase procured third-party certified RECs from wind energy facilities. Steelcase invests in RECs to help expand renewable energy development, access, and affordability.<sup>71</sup>



Unbundled RECs (kWh/year)	23,364,354
V-PPA (kWh/year)	90,351,000
<b>Total (kWh/year)</b>	<b>113,715,354</b>

(Source: EPA's Green Power Partnership program. Report date: 08/27/2020)

### Procter & Gamble

In 2010, Procter & Gamble (P&G) set two key strategies to reduce GHG emissions by 2020. First was to improve energy efficiency, which improved by 20% compared with



<sup>70</sup> General Motors, LLC profile on the EPA's Green Power Partnership website. <https://www.epa.gov/green-partner-list#GeneralMotorsLLC> Accessed on: 07/23/2021

<sup>71</sup> Steelcase Inc. profile on the EPA's Green Power Partnership website. <https://www.epa.gov/greenpower-partner-list#SteelcaseInc> Accessed on: 07/23/2021

2010; second was to move to low-carbon energy sources (i.e., renewable energy). Today, P&G purchases 100% renewable electricity in the U.S., Canada and Europe. These three markets represent more than 70% of our purchased electricity globally. The renewable energy being used by P&G comes from a diverse set of sources including geothermal, solar, wind, biomass and hydro with a mix of on-site and off-site generation. The company's largest individual contributors are a wind farm partnership in Tyler Bluff, Texas which offsets 100% of the electricity needed for the Fabric and Home Care facilities in the United States and Canada, and an on-site combined heat and power biomass facility in Albany, Georgia, which provides 100% of the steam requirements at that location.<sup>72,73</sup> Looking forward, P&G has raised the bar, committing to purchase 100% renewable electricity globally, along with ensuring their global operations are carbon neutral for the decade via natural climate solutions.

Unbundled RECs (kWh/year)	1,846,861,189
P-PPA (kWh/year)	381,471,604
V-PPA (kWh/year)	303,190,714
<b>Total (kWh/year)</b>	<b>2,530,523,507</b>

(Source: EPA's Green Power Partnership program. Report date: 03/16/2021)

### Johnson & Johnson

Johnson & Johnson has committed to consuming 35% of its electricity from renewable sources by 2020, and 100% by 2050. To accomplish these goals, Johnson & Johnson has invested deeply in renewable energy on the corporate level over the past 10 years and has executed a V-PPA for 100 MW of wind energy in Texas, which contributes in 69% purchased renewable electricity by 2020. Johnson & Johnson realized that investing in renewable power is a wise business decision not only for the environmental benefits but because it provides the company with a reliable and resilient supply of energy.<sup>74</sup>



Unbundled RECs (kWh/year)	10,946,590
Self-supply (kWh/year)	2,519,938
V-PPA (kWh/year)	417,503,858
<b>Total (kWh/year)</b>	<b>430,970,386</b>

(Source: EPA's Green Power Partnership program. Report date: 06/10/2020)

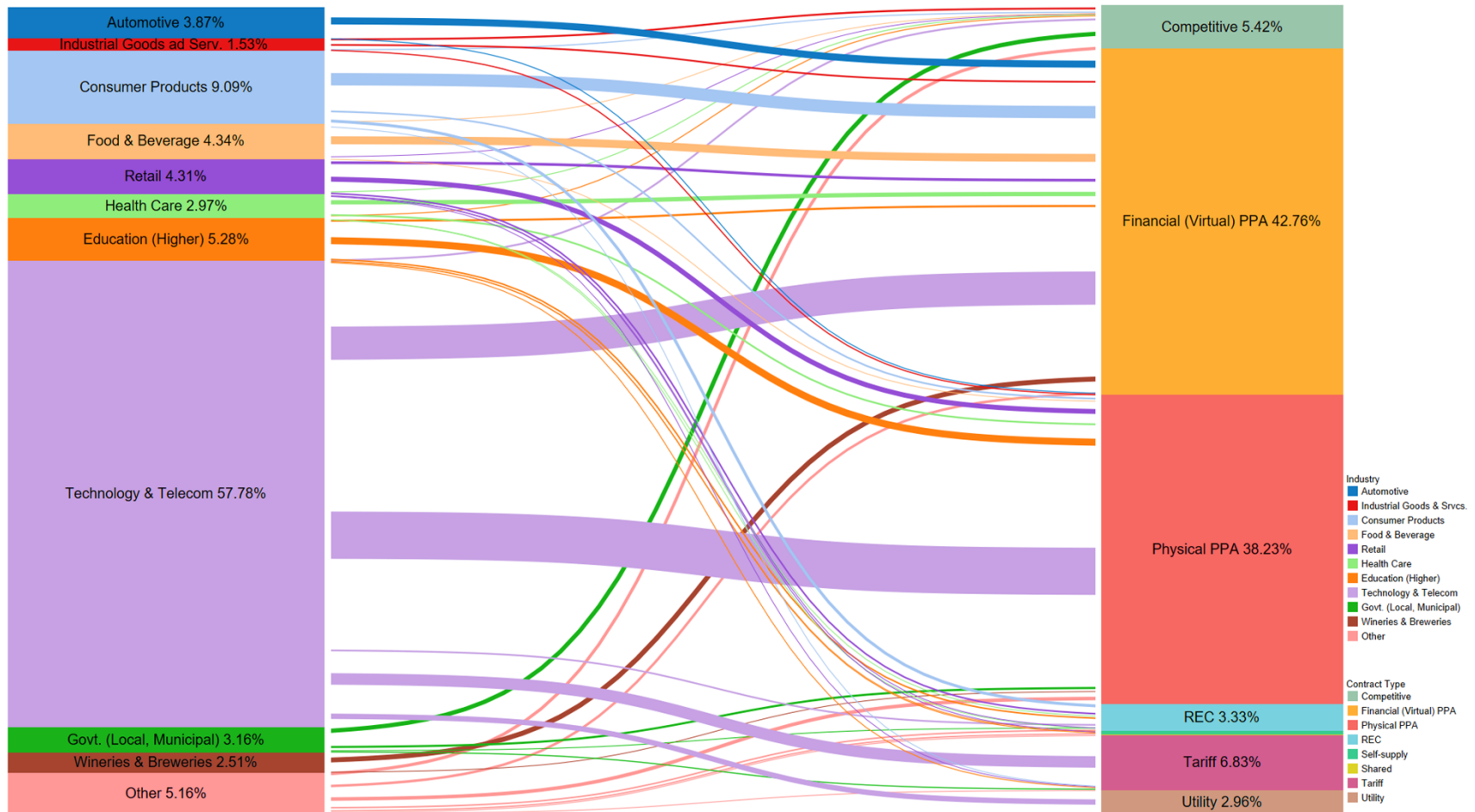
<sup>72</sup> The Procter & Gamble Company profile on the EPA's Green Power Partnership website. <https://www.epa.gov/greenpower/green-power-partner-list#TheProcterGambleCompany> Accessed on: 07/23/2021

<sup>73</sup> The Procter & Gamble Company Citizenship Report 2020: Environmental Sustainability [https://downloads.ctfassets.net/oggad6svuzkv/2lj8HlnOqaCTdcJBtwyl4z/7028f4877c4996d0109e51d555976267/citizenship\\_report\\_2020\\_environmental\\_sustainability.pdf](https://downloads.ctfassets.net/oggad6svuzkv/2lj8HlnOqaCTdcJBtwyl4z/7028f4877c4996d0109e51d555976267/citizenship_report_2020_environmental_sustainability.pdf)

<sup>74</sup> Johnson & Johnson profile on the EPA's Green Power Partnership website. <https://www.epa.gov/greenpower/green-power-partner-list#JohnsonJohnson> Accessed on: 07/23/2021

## Appendix A: Share of Purchased Renewable Electricity in EPA’s Green Power Program by Mechanism and Industry Sector

This Sankey diagram shows Green Power Partners longterm Green Power Contract (5yrs or more) to purchase green power. This chart shows 429 individual contracts which amounts to 24 million MWh green energy purchased annually.



Data Source: EPA.gov; Green Power Partnership Long Term Contracts  
Data as of April 2020

## Appendix B: Some Better Plants Partners with Commitments toward 100% Renewable Electricity<sup>75</sup>

Better Plants Partner	Commitment
	3M's target is to source 100% renewable electricity for its global operations by 2050.
	AstraZeneca has a goal to source 100% renewable electricity globally by 2025.
	The Estée Lauder Companies reached its target to source 100% renewable electricity globally for its direct operations by 2020, and intends to maintain this commitment going forward. Building upon this achievement, the company set 2030 science-based emissions reduction targets for its direct operations and value chain, positioning the company to take even more decisive action against climate change in the coming decade.
	General Mills has committed to source 100% renewable electricity across its entire global operations by 2030.
	General Motors has plans to meet the electricity needs of all its global facilities with 100% renewable sources by 2035.
	HNI Corporation has set a target to source 100% renewable electricity across its global operations by 2030.
	Intel has a goal to achieve 100% renewable electricity by 2030.
	Johnson & Johnson has set a target to power all of its facilities with renewable electricity by 2025.
	Kingspan aims to run its 80+ global manufacturing facilities on 100% renewable power on an aggregated basis over its estate by 2020.
	McCain Foods committed to sourcing 100% renewable electricity across its French Fry plants by 2030 and across its entire global operation by 2050.
	PepsiCo is committed to sourcing 100% renewable electricity across its company owned and controlled operations by 2030 and across its entire global operations by 2040.

<sup>75</sup> The RE100 initiative. <https://www.there100.org/re100-members>



P&G has set a goal to power its plants with 100% renewable electricity by 2030.



Schneider Electric is committed to sourcing 100% renewable electricity across its global operations by 2030.



Steelcase expanded its renewable energy investments equivalent to 100% of its global electricity consumption in 2014.

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## Appendix C: Better Plants Tools and Resources

**Manufacturing Energy Assessment Software for Utility Reduction (MEASUR):** This DOE tools suite helps analyze major energy using systems for energy efficiency opportunities. These systems include pumping, fans, process heating, steam and compressed air.

**Diagnostic Equipment Program (DEP):** The Better Plants Program developed a loan program to equip partners with diagnostic tools and instruments to enable partners to assess their systems and track progress.

**In-Plant Trainings (INPLTs):** These workshops are hosted at Better Plants partner sites to train employees in identifying and implementing energy saving projects found in common systems, such as compressed air, fans, steam, process heating and pumping systems, energy treasure hunts, water efficiency, industrial refrigeration, 50001 Ready, and water and wastewater treatment.

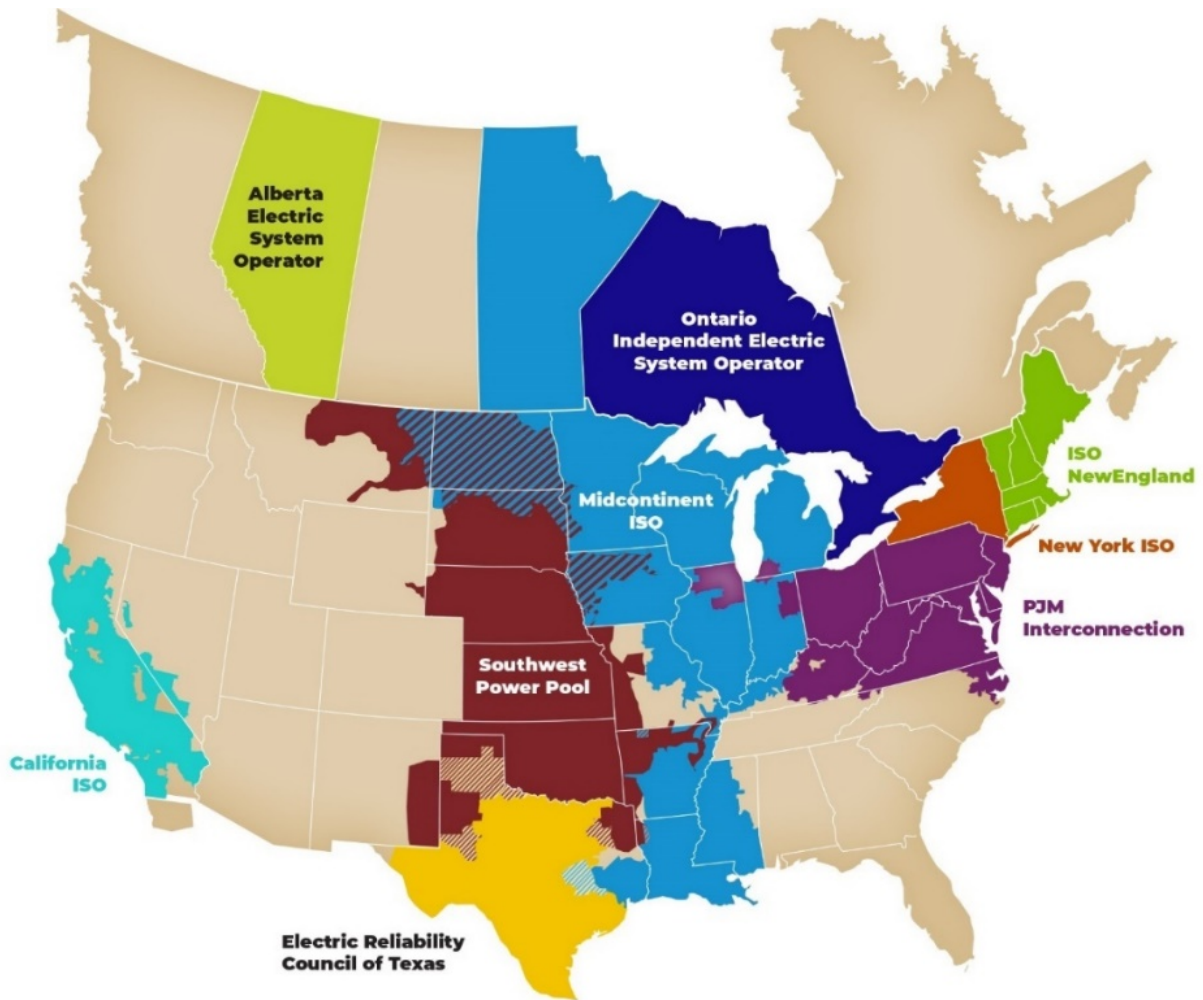
**Energy Performance Indicator Tool (EnPI):** This regression analysis based tool was developed to help Better Plants partners establish a normalized energy baseline, track and measure annual energy intensity improvement, calculate cost savings, and avoided CO<sub>2</sub> emissions at the facility and corporate levels.

**Industrial Assessment Centers (IAC):** IAC is a university-based program that provides no-cost assessments for small and medium manufacturers to save energy, reduce waste, and improve productivity. IAC centers are available in 31 universities and can provide service for all U.S. states.

**Energy Footprint Tool:** This tool was developed to help organizations implementing or involved in energy management plans through [50001 Ready](#) or [SEP 50001](#) programs to track their energy consumption at their facilities by considering large energy end-users and the parameters that affect energy use; however, this tool is also helpful for any organization interested in identifying its energy footprint.

**Plant Energy Profiler Excel:** A PEPEX is an Excel-based software tool that helps plant managers to understand energy flow (input + output) at their facility to identify energy and cost savings opportunities.

## Appendix D: Wholesale Electric Power Markets (ISOs/RTOs)



Credit: ISO/RTO Council.<sup>76</sup>

<sup>76</sup> ISO/RTO Council Official Website. <https://isorto.org/>

