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RE-Powering America's Land Initiative Discussion Paper

The Value of Existing Infrastructure for Renewable Energy Development

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EPA RE-Powering Discussion Paper

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Contents

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1. Introduction

The size of a renewable energy project, its ability to readily interconnect with the surrounding power grid, the ease or difficulty of the construction process, and the physical security of the project all depend greatly on the infrastructure in place. The existing infrastructure at a site can make millions of dollars of difference in project installation and operating costs and can even determine the outright economic viability of a renewable energy project.

Existing infrastructure can be a critical, positive differentiator for many of the formerly contaminated lands, landfills, and mine sites whose reuse is facilitated by EPA's RE-Powering America's Land Initiative. This paper is targeted at the types of infrastructure commonly found on RE-Powering sites and characterizes where, and to what extent, this infrastructure affects the prospects for site redevelopment.

Where beneficial infrastructure exists on RE-Powering sites, it can reduce project installed costs by approximately \$45 to \$113 per kW_{AC} of renewable capacity, compared to otherwise similar sites lacking this infrastructure. That value represents 3% to 7% of total installed costs[1] for solar and wind projects.

To develop those metrics and understand their context and limitations, the paper is organized to answer the following key questions:

- What are the main types of existing infrastructure on RE-Powering sites and why are they valuable for renewable energy development?
- Which sites are likely to have existing infrastructure?
- How much is the existing infrastructure worth?
- What steps can be taken to maximize the benefits of existing infrastructure?

Snapshot of Existing Site Infrastructure That Can Support Renewable Energy Development

Broadly, there are five types of infrastructure that may be present on formerly contaminated lands, landfills, and mine sites and offer value to the development of renewable generation projects.

- **Electricity transmission and distribution system equipment –** Nearby substations with unused capacity and other grid equipment to accommodate the injection of new electricity output can greatly reduce or eliminate the grid upgrade or line extension costs otherwise required.
- **Road or other site access –** Existing roadways to and within sites can be essential to construction and to maintenance over the 20+ years of renewable project operation. Adjacent rail lines or waterways can also lower equipment delivery costs.
- **Physical security –** Due to the value of generation equipment, existing physical and/or electronic security equipment lowers expenditures.
- **Dormant power generation –** Out-of-service generation assets at a site may be re-purposed as part of biogas or biomass projects or aid in the construction process for other renewable technologies.
- **Civil and structural facilities –** Unused buildings, water supply connections, storm water drainage systems, and other existing features can avoid the need to construct expensive new facilities.

[1] Installed costs include all costs involved with the direct deployment of the renewable energy project such as all equipment; transportation of equipment to the site; land rights; installation labor; professional services labor for design, engineering, legal, finance, etc.; interconnection to the transmission or distribution grid; permits and other fees; taxes; and profit. Capital costs is sometimes used as a synonym for installed costs, but the latter is the terminology used in this discussion paper. This discussion paper steps through the elements of this calculation and Appendix A provides additional detail and references.

2. Types of Infrastructure on RE-Powering Sites and Why They Are Valuable

This section provides examples of five types of infrastructure that commonly exist on former contaminated lands, landfills, and mine sites and describes the roles such infrastructure serve in the development and operation of renewable energy projects. The land itself at RE-Powering sites, while often valuable, is not considered infrastructure for the purposes of this paper. Solar and, to a lesser extent, wind technologies are emphasized as they are the most common technologies deployed on RE-Powering sites.

2.1 Electricity Transmission and Distribution System Equipment

Transmission and distribution equipment is often the most valuable type of infrastructure for renewable development. For generation projects of the medium to large scale (1 MW+ in capacity) typical at RE-Powering sites, the distance to a viable point of interconnection (POI) with the power grid and the ability of the grid to accommodate new renewable generation without triggering major upgrade costs are among the most important factors in project feasibility. Beyond distance to POI and the condition of substations, the condition of other existing grid equipment including transformers and reclosers is important.[2] Even if grid equipment has been under-used or dormant due to the elimination of a prior industrial or mining activity at the site, it will still be valuable if it is in working condition or can be readily refurbished.

For projects without nearby, suitable grid infrastructure, developers must underwrite substantial investments in design, study and ultimately construction costs to reach a POI and to ensure that the grid can operate safely and reliably after their renewable project is interconnected (NALGEP, 2012, page 15). This principle applies equally to renewable projects connecting to transmission and distribution systems.[3]

Many RE-Powering sites have transmission and distribution grid infrastructure on-site or nearby due to their history as industrial, mining, or landfill sites requiring power for operations, their proximity to transmission corridors, or their locations near population centers with surrounding electricity requirements. For this reason, there are numerous examples of RE-Powering sites that have leveraged existing grid infrastructure to lower the cost of renewable development including:

- A combined 39 MW wind and solar project on a former Bethlehem Steel Plant (Figure 1) in upstate New York with a substation on-site (EPA, 2012; Buffalo News, 2014).

[2] Transformers ramp voltage up (for efficient movement of power over long distances) or down (as power gets closer to end-use), and reclosers are circuit breakers that detect and interrupt momentary faults and restore service after brief outages. For more information on common types of equipment for transmission and distribution grids, see Eaton, http://www.cooperindustries.com/content/public/en/power_systems/markets/utility.html (accessed April 2020).

[3] Transmission networks consist of high-voltage power lines – often transmitting 100 kilovolts (kV) or more – designed to carry power efficiently over long distances. Distribution networks, operated exclusively by utilities, deliver power at lower voltages (typically transmitting 35 kV or less) and over shorter distances to the consumer. Renewable generation projects can connect at either the transmission or distribution level.

- A 10 MW landfill solar project in California that is less than 1,000 feet from the POI and “will be able to connect to existing electrical infrastructure without requiring significant extensions” (San Bernardino County, 2015, pages 25 and 29).
- A 2.3 MW solar project as part of a microgrid at a Vermont landfill where “no upgrades to (the utility’s) substation were required to accommodate an installation” (EPA, 2016a).
- A 1.5 MW potential solar development on a landfill in Colorado that was approved by the county in 2017 and benefits from a Rural Electric Association power line bisecting the site (Loveland Reporter-Herald, 2017).

Figure 1: Existing Grid Infrastructure at Former Bethlehem Steel Plant

Photo credit: Landscape Architecture Magazine, 2012

While existing transmission and distribution infrastructure accelerates renewable energy development, its absence impedes development as shown in Massachusetts, where the second phase of a solar project was deemed infeasible partly due to $1 million of new infrastructure costs needed to interconnect the project (Falmouth Enterprise, 2017).

2.2 Road or Other Site Access

Solar projects preferably have three types of physical access: (1) a road (or rail line or waterway) leading to the main site entrance, (2) a road around the perimeter of the solar project, and (3) an internal road network providing access to the substation, inverter(s), and solar array. The internal roads facilitate construction as well as planned (e.g., inspecting and cleaning) and unplanned (e.g., replacing damaged equipment) operations and maintenance. RE-Powering sites with existing access roads are likely to have reduced development costs.

Figure 2: Rail Access at Martin-Marietta, Sodyeco Superfund Site

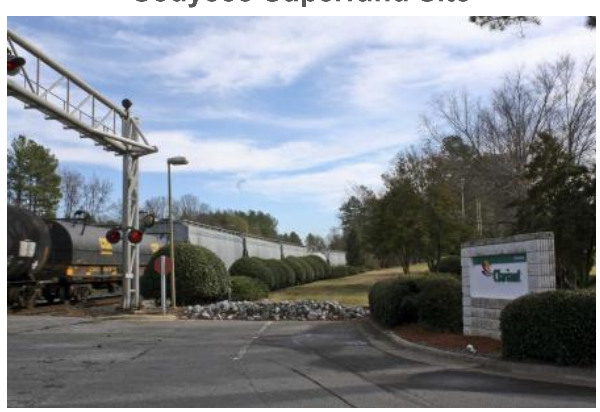

Photo credit: EPA, 2017b

For example, the Martin-Marietta, Sodyeco, Inc. Superfund site in North Carolina (Figure 2) utilized nearby rail and interstate highway access to enhance development for its reuse plan that includes a landfill solar project, an aerobic digester, and a biofuel conversion facility (EPA, 2015; EPA, 2017b).

Road access is also important for wind development, as noted for a 16 MW project at a former petroleum refinery in Wyoming (EPA, 2011). For biomass projects fueled by off-site feedstock, ongoing transportation access to feedstock is essential for operations.

2.3 Physical Security

Because renewable energy involves expensive investments, it is critical to protect equipment from theft and damage. It is also important to prevent personal harm to workers, visitors, and trespassers on sites. To offer that protection, a typical solar project will have several, or all, of the following physical security components: strong fence, access gate with lock, surveillance cameras, alarm system, closed-circuit monitoring, and incident response mechanisms. Even if a RE-Powering site does not have up-to-date electronic security components, it could have fencing, gates, and other useful physical security features.

For example, the 10 MW Exelon City Solar project in Chicago involved the construction of a fence with a 1.3 mile perimeter to enhance safety and prevent further dumping at the site (EDI). While this quality of fencing did not exist previously at the site, the choice to install it on what was the largest urban solar project in the country at the time of its 2010 dedication demonstrates that such infrastructure has particular value near population centers.

2.4 Dormant Power Generation

Though not likely to be found at many RE-Powering sites, the presence of dormant diesel, natural gas, or combined heat and power generators can have value in site redevelopment. If these assets can be refurbished and restarted in a cost-effective manner, they can provide power to a site's support facilities, lighting, security apparatus, and other miscellaneous electricity loads. If a biomass or biogas project is being developed, the dormant assets might be re-purposed directly for renewable power generation.

2.5 Civil and Structural Facilities

There may be civil or structural facilities of value at a RE-Powering site, including unused buildings, loading docks, water supply connections, and storm water drainage infrastructure. For example, unused buildings can house solar project inverters and battery storage devices, which provide value to the renewable developer. Another example is an existing water supply connection that could be re-activated at a much lower cost than establishing a new utility connection.

Existing storm water drainage infrastructure can be especially important in reducing the complexity and costs of a solar project by reducing the need for regrading and soil disturbance mitigation. The careful, 100-year event analysis of storm water drainage required for some solar projects and the benefits of having adequate existing drainage infrastructure is demonstrated in the approval documentation for a 1.6 MW solar project at a Massachusetts landfill (MassDEP, 2012).

In contrast to the examples above, there may be other circumstances when existing civil or structural facilities impede renewable project development if they are physically in the preferred path for project construction.

3. Finding Valuable Infrastructure Among RE-Powering Sites

While there may be a substantial amount of valuable infrastructure on RE-Powering sites, it is not evenly distributed among those sites nor equally valuable in all locations. Some sites are closer to transmission and distribution interconnection points than others, and some are in urban areas or in other locations, such as remote locations with building restrictions, that are challenging for greenfield renewable energy projects. Prior uses of the sites include industrial, landfills, mining, and other activities that cause potential land contamination, and these differences in prior use can also affect the viability and costs of renewable project development.

Below is a brief synopsis of where the most valuable existing infrastructure may reside within the RE-Powering site portfolio.

Locations near substations: While the distance to a substation alone does not provide information on the capacity of that substation to absorb new renewable generation, it is a good indicator of where developers may encounter low line extension costs and more choices in POI. The free RE-Powering Mapper tool provides distance to nearest substation, as well as several other important screening criteria for RE-Powering sites, and is available at https://www.epa.gov/re-powering/re-powering-mapping-and-screening-tools.

Locations near urban areas: A large proportion of RE-Powering sites are within three miles of urban areas (EPA, 2016b).[4] Given that construction costs and complexity can be higher in urban areas than elsewhere, storm water drainage systems and other civil and structural facilities are likely to be particularly valuable in these areas. Security measures like fencing and gates may be more valuable in urban areas as well (EDI). Urban sites also tend to have more choices on POI, due to the prevalence of on-site and adjacent electricity consumption loads compared to rural sites. Data on distance to urban area can be obtained from EPA's RE-Powering Mapper.

Remote locations with building restrictions: For RE-Powering sites in remote areas with restrictions on new construction (e.g., desert habitats), the presence of existing external and intra-site road access, even in less than perfect condition, can help greatly in moving the personnel and equipment required for solar or wind project construction and operations.

4. Estimating Benefits from Existing Infrastructure

Table 1 provides rough estimates of the cost savings that existing infrastructure may offer to developers of renewable generation on RE-Powering sites. These are estimates of the average

[4] The 2016 EPA discussion paper indicated that more than 92% of RE-Powering sites passing screens for applicability to community solar programs are within three miles of an urban area. While the current discussion paper on existing infrastructure is not restricted to community solar projects, the community solar data from 2016 indicate that RE-Powering sites are often close to population centers.

installed cost of building required infrastructure, if it is not already present. For any given RE-Powering site, the actual value of the existing infrastructure may be higher or lower than these estimates.

The estimates are presented on both a per kW of generating capacity basis and as a percent of total installed costs. For the percentage data, the “Estimated Infrastructure Value per kW” columns in Table 1 are divided by the installed cost of each renewable energy technology. That installed cost is $1,729/kW$_{AC}$ for solar projects and $1,610/kW$_{AC}$ for wind projects.[5] Descriptions of the calculations and sources for each “Estimated Infrastructure Value per kW” are in the appendix.

Due to the extremely wide variation in the extent and condition of infrastructure on any given RE-Powering site and its value - together with the equally large variation in the types of renewable technology configurations that can be deployed, regional differences in costs, distinctions in interconnection costs among transmission and distribution grid operators, and the disparate needs of surrounding communities - the data in Table 1 should be viewed only as illustrative. Before investing any significant time or cost in a renewable energy opportunity, developers or other interested parties should conduct their own due diligence in calculating and securing the benefits from existing infrastructure. Finally, while existing infrastructure often lowers renewable project development costs, it can increase those costs if it must be removed, improved, or it constrains design and engineering choices.

[5] The installed costs were derived from National Renewable Energy Laboratory (NREL) solar (NREL, 2018b, page 36) and wind (NREL, 2018a, page 8) reports. Solar installed costs are an average of fixed-tilt and single-axis tracking 10 MW$_{DC}$ PV configurations and are converted from direct current to alternating current for consistency with wind costs using NREL’s conversion ratio of 1.33 kW$_{DC}$ to 1.00 kW$_{AC.}$ (NREL, 2018b, page 38) That conversion ratio is the average of the fixed-tilt and single-axis tracking conversion ratios in the NREL PV report. The 10 MW size was used for solar project calculations in this paper because that size is closer to the typical size of a RE-Powering solar project than the larger (50 MW and 100 MW) project sizes also available in the NREL PV report.

Table 1: Rough Estimates of Existing Infrastructure Value for Renewable Development

Cost Mitigated by Existing Infrastructure	Estimated Infrastructure Value Per kW_{AC} of Solar Capacity	Estimated Infrastructure Value Per kW_{AC} of Wind Capacity	Estimated Infrastructure Value as a % of Total Solar Installed Cost	Estimated Infrastructure Value as a % of Total Wind Installed Cost
Transmission or Distribution Line Extension[6]	$13 to $27	$13 to $27	0.8% to 1.6%	0.8% to 1.7%
Transmission or Distribution System Upgrade	$32 to $48	$32 to $48	1.9% to 2.8%	2.0% to 3.0%
Access Road Construction	$0 to $10	$0 to $10	0.0% to 0.6%	0.0% to 0.6%
Physical Security	$0 to $15	N/A	0.0% to 0.9%	N/A
Dormant Power Generation	N/A	N/A	N/A	N/A
Storm Water Drainage System	$4 to $8	N/A	0.2% to 0.5%	N/A
Other Civil and Structural Facilities	$0 to $5	$0 to $5	0.0% to 0.3%	0.0% to 0.3%
Total	***$49 to $113***	***$45 to $90***	***2.8% to 6.5%*** *(differs from total of rows above due to rounding)*	***2.8% to 5.6%***

[6] The cost estimates for line extensions on this row and for system upgrades on the row below are based on sources that emphasize transmission-level interconnections of renewable projects with the power grid. In individual project circumstances, there will typically be cost differences depending on whether the renewable project intends to interconnect at the transmission versus the distribution level, though individual POI issues are as likely to affect cost differences as transmission vs. distribution distinctions.

5. How to Utilize Infrastructure Benefits

For a RE-Powering site to be developed with a solar, wind, or other renewable energy project, it must offer one or more meaningful benefits that are not found on other sites. Existing infrastructure at RE-Powering sites is not a benefit in itself, but it can create benefits that are valuable to renewable energy developers, if the answer to one or more of the following questions is positive.

Does the infrastructure:

1. Make a project viable in an electricity market where other sites are simply not viable (e.g., have minimal prospects for transmission grid, utility, or community approval)?
2. Greatly speed project development?
3. Substantially reduce installation costs?

Below are four steps that developers and other parties involved in a potential renewable energy project can take to gather the information needed about the benefits of existing infrastructure at RE-Powering sites. Following these steps will also help secure infrastructure benefits.

1. Select renewable technology configurations and project sizes that match the existing infrastructure. For example, thin-film solar panels and solar racking that rotates to track the sun require more land area than fixed-tilt projects using crystalline-silicon panels.[7] If the existing road, physical security, or storm water drainage system is space-constrained, that suggests the most compact solar system design may be optimal. The capacity of nearby grid infrastructure also can affect technology selection – if that infrastructure can only accommodate 5 MW of new capacity before triggering expensive upgrades, consider selecting a technology and design that maximizes profit given the 5 MW capacity constraint.
2. Obtain information on the capacity of nearby transmission and distribution system infrastructure to absorb additional renewable generation by requesting interconnection pre-application reports, reviewing utility hosting capacity analyses, and reviewing transmission and distribution queue information, if such information is readily available.
3. Understand how the soft costs (permitting fees, engineering costs, and expenditures of project development time) may be reduced or increased depending on how existing infrastructure is used. For example, the duration (and the internal and external costs) of the interconnection study process may be substantially reduced if existing infrastructure allows for an interconnection application that passes initial screens. Conversely, removal of existing infrastructure or re-design of a renewable energy project to avoid that infrastructure may impose delays and additional design and engineering costs.

[7] While thin-film systems typically require more land area than crystalline-silicon systems to achieve the same capacity, there may be other reasons to choose thin-film, such as cost or certain types of performance. For tracking systems, while they require more land and cost more than fixed-tilt systems of the same capacity, they have higher annual electricity output.

4. For site owners, avoid narrow procurements that are overly prescriptive technically (e.g., that specify exact equipment, or infrastructure, that must be used and how systems are to be configured). It is critical to attract developers or engineering, procurement, and construction firms that have an understanding of both renewable energy development at the scale desired and also an understanding of the specific challenges and opportunities (including the potential benefits of infrastructure reuse) of RE-Powering sites.

Appendix: Notes on Estimated Infrastructure Values

Table 2, below, contains explanatory notes for how the per kW values for existing infrastructure on RE-Powering sites were estimated.

Table 2: Notes on Existing Infrastructure Values Estimated for RE-Powering Sites

Cost Mitigated by Existing Infrastructure	Estimated Infrastructure Value Per kW_{AC} of Renewable Energy Capacity	Notes on Estimates of Value Per kW
Transmission or Distribution Line Extension	**$13 to $27**	NREL models transmission line extensions for utility-scale solar projects at up to $.02/$watt_{DC}$, which is equivalent to $20/$kW_{DC}$, or $27/$kW_{AC}$ (NREL, 2018b, page 31 for line extension costs and page 38 for DC to AC conversion as the "inverter loading ratio"). The DC to AC capacity conversion ratio of 1.33 kW_{DC} to 1.00 kW_{AC} applied for these calculations is the average of the fixed-tilt and single-axis tracking conversion ratios in the NREL PV report. For reference, the upper-end value on line extension costs ($27/$kW_{AC}$) is 17% of the total cost of wind project electrical infrastructure of $160/$kW_{AC}$ that should include line extensions, interconnections with the grid (see cost category below in this table), and numerous other wiring, control, and safety components[8,9] (NREL, 2018a, page 8). In this discussion paper, we apply a range from one-half to the full value of that NREL solar line extension cost to account for variation in whether line extensions are partially or fully avoided by the location of existing infrastructure (e.g., substations with extra capacity).
Transmission or Distribution System Upgrade	**$32 to $48**	This value is estimated at the lower end of the range NREL presents for the combined permitting, inspection, and interconnection (PII) costs of utility-scale PV projects, plus and minus 20% to account for variation in the value of existing site infrastructure. NREL puts the lower end of PII costs at $.03/$watt_{DC}$, which is $30/$kW_{DC}$, or $40/$kW_{AC}$ (NREL, 2018b, page 31). That value ($.03/$watt_{DC}$) is also identical to the standalone development interconnection costs that NREL used three years prior when it provided a more granular

[8] The sub-categories of installed costs in the NREL reports are based on 100 MW_{DC} solar and 200 MW_{AC} wind project sizes, though the solar report also contains full installed costs for several smaller project sizes (5 MW, 10 MW, and 50 MW). In the solar report, NREL defines utility-scale systems as greater than 2 MW in capacity (NREL, 2018b, page vi).

[9] For further reference, the estimated costs are $1.2 to $2.1 million per mile to "reconductor" a typical 69 kV single circuit line to upgrade its carrying capability (before cost multipliers for uneven terrain, urban areas, etc.) in California (CAISO, 2017). That means that for a 100 MW_{AC} renewable energy project, the cost would be $12 to $21/$kW_{AC}$ per mile.

Cost Mitigated by Existing Infrastructure	Estimated Infrastructure Value Per kW_{AC} of Renewable Energy Capacity	Notes on Estimates of Value Per kW
		break-out of certain cost categories (NREL, 2015, page 30). For further comparison, the utility Xcel Energy Minnesota places typical distribution interconnection costs for community solar projects larger than 1 MW at $5,000 to $1 million (Xcel Energy, 2017, page 3). In Massachusetts, the range of interconnection cost upgrades was estimated between $100,000 and $2 million+ for solar landfill projects (MassDOER, 2012, page 22). The wide range for interconnection costs reinforces both the great variation in renewable energy projects themselves and the high value, in certain circumstances like those highlighted in section 2 of this paper, of being able to reduce interconnection costs if sufficient infrastructure is already in place. If new substation equipment is required for large renewable energy projects, the cost can range from $12.5 million for a 69 kV substation to $15 million for a 230 kV substation (CAISO, 2017). The information in this section means that if a RE-Powering site can avoid new substation construction or significant upgrades, it can potentially save the developer millions of dollars, and its infrastructure value could significantly exceed the estimate at left.
Access Road Construction	**$0 to $10**	This value is estimated at up to one-fifth of the total site access and staging costs of $48/kW that NREL reports for wind projects (NREL, 2018a, page 8). The one-fifth estimate is based on the observation that access roads are only a portion of site access and staging costs, which should also cover establishing a staging area, securing materials before they are installed, and building temporary platforms related to system installation and that any existing access roads may need improvements to accommodate the renewable energy project. NREL, on pages 6-7 of the same report, notes that equipment transportation costs, which may be reduced by RE-Powering site infrastructure are also in other categories. For further reference, the construction cost of a simple, bi-directional 12-foot wide shared use path is estimated at $287,393 per mile by the Florida Department of Transportation (FDOT, 2019). In cases where access roads built specifically for RE-Powering sites would not be the primary means of transporting materials and installation labor, the value of the access roads would be minimal.

Cost Mitigated by Existing Infrastructure	Estimated Infrastructure Value Per kW_{AC} of Renewable Energy Capacity	Notes on Estimates of Value Per kW
Physical Security	**$0 to $15**	The author's industry research puts the cost of chain-link fencing with barbed wire and privacy slats (six feet in height) at $15/linear foot. For a 4,000 kW_{AC} solar project of 22 acres with a perfectly square layout, the perimeter would be 3,916 feet and cost $59,000 (or $15/$kW_{AC}$) to secure. Any configuration other than perfectly square would be more expensive to fence and increase this infrastructure value. The acreage per kW data are for fixed-axis PV systems of 1,000–20,000 kW (NREL, 2013, page v). Exterior gates and electronic security systems on RE-Powering sites may provide additional value. For solar projects in areas where physical security is of low importance, fencing may be of minimal value as it would be on most wind projects.
Dormant Power Generation	**Rarely Applicable to Solar and Wind Projects**	Though dormant power generation may be very valuable in some cases (e.g., directly for biomass or biogas projects or when support facility power is needed for any project), it is not likely to be present and in condition to be easily refurbished at many RE-Powering sites. For reports on the value of mid-sized fossil fuel generation units, see EPA, 2017a and EPRI, 2003.
Storm Water Drainage System	**$4 to $8 (solar)** **$0 (wind)**	This is an estimate based on professional judgment for a 2,000–5,000 kW_{AC} solar project. It reflects drainage requirements for a comparable greenfield site and not the added drainage needs for remediation that may be present on formerly contaminated lands, landfills, or mining sites. For comparison, urban storm water best management practices imply a cost of approximately $17 per kW_{AC}.[10] Wind projects do not create acres of impermeable surfaces parallel to the ground that can substantially change storm water drainage patterns like solar projects and, therefore, this type of infrastructure will be of limited value for wind projects.
Other Civil and Structural Facilities	**$0 to $5**	Due to the extremely wide range of facilities in this category, a cautious estimate is used here based on professional judgment.

[10] This calculation is based on best management practices construction costs of $8,709 for 5-acre sites plus $1,329 in administrative costs per site, inflated to the current year and assuming that solar projects cover 5.5 acres per 1,000 kW_{AC} (EPA, 1999, page 6-40). For inflation adjustments, please see U.S. Bureau of Labor Statistics, *CPI Inflation Calculator*, https://data.bls.gov/cgi-bin/cpicalc.pl (accessed April 2020).

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Note: Website links to all references were accessed in March 2020.