MITIGATING VISUAL IMPACTS OF UTILITY-SCALE ENERGY PROJECTS

Joseph J. Donaldson, ASLA, PLA, Chief Landscape Architect/Environmental Planner, Ecology and Environment, Inc.[1]

Abstract.—Visual resources are often a focal point of controversy and uncertainty and are becoming a growing concern for agencies, developers, and the public alike for the variety of utility-scale energy projects, including transmission, substation, power plant, and renewable energy projects. Agencies are increasingly challenged to interpret and enforce regulations for visual resources and balance multiple and often conflicting purposes for public lands. Developers are challenged by uncertainties about visual impacts of their proposed projects, strong public reactions and opposition, and how impacts can best be mitigated cost effectively. The public is most often concerned about impacts to views, changes to visual character and quality, and the effects of these on their property values and quality of life. Developers and utilities are finding that facility sites and potential transmission routes are increasingly constrained and agency requirements for mitigating visual impacts are expansive and costly. This paper focuses on approaches, processes, and techniques for mitigating visual impacts of utility-scale energy projects and explores the effectiveness of some commonly employed mitigation techniques.

VISUAL ISSUES FOR UTILITY-SCALE ENERGY PROJECTS

Public concerns about how proposed projects may change the visual character and impact the visual quality of an area are often key elements of controversial projects and sometimes the focal point of controversy (Smardon and Pasqualetti 2017). Because of their industrial appearance and geometric and linear forms and lines, utility-scale energy facilities often contrast strongly with their surroundings in both natural and rural landscapes and are of particular concern for how they impact scenery in these environments. In addition to direct effects on scenic views in more natural and rural areas, the public is often concerned about how a proposed project will affect their existing views and thus impact their quality of life and property values.

Federal, State, and local government agencies are increasingly challenged to interpret and enforce policies and regulations for protecting scenic character and quality within their management jurisdiction. Generally, these challenges occur when proposed projects are considered for permitting approvals, typically with public input opportunities, through: Federal, State, or local environmental compliance processes; State siting board reviews; or local plan amendments, zone changes, or conditional use permits. Issues involving visual/scenic impacts are especially challenging for agencies, such as the Bureau of Land Management (BLM) and USDA Forest Service (FS), that are responsible for balancing multiple and often conflicting purposes for public lands. However, they can be even more problematic for State and local agencies that lack established procedures or formal systems for assessing visual/scenic impacts.

Energy project developers, including both merchant developers and public utilities, are challenged by uncertainties about the visual impacts of their proposed projects, strong public reactions and opposition, and costs to mitigate these impacts. Of particular concern for developers are unknown mitigation requirements that could prove costly and may be imposed through project approval and permitting processes. Developers are finding that potential facility sites and transmission routes are increasingly constrained, and public demands and agency requirements for mitigating visual impacts are becoming expansive and costly. As an example, one recent 250 megawatt (MW) photovoltaic (PV) solar project now operating in California had 146 conditions of approval imposed by the county (California County Planning Directors Association 2012).

[1] Contact information: 7440 South Creek Road, Suite 400, Sandy, UT 84093, 801-561-1036, ext. 6261, jdonaldson@ene.com.

It is therefore beneficial for project developers and agencies alike to understand which visual impact mitigation techniques may be applicable and are likely to be required, which are most effective at reducing visual impacts, and what the potential costs may be. It is equally important for the public to be made aware of these parameters early in the process in order to help focus public input. Potential benefits include more accurate assessment of project feasibility, reduced public opposition and agency resistance, avoidance of project delays, and greater certainty about project design and viability.

MITIGATION

Mitigation actions are specific, feasible measures to avoid or substantially reduce significant environmental effects. For utility-scale energy projects, including transmission and pipeline projects, mitigation may consist of applicant-proposed measures that are incorporated in the project design or agency-imposed measures that are generally required as part of project approval. Agency-imposed measures are most often identified as mitigation measures but sometimes are identified as conditions of approval, a term more often associated with local government agency approvals.

Mitigation measures generally fall in one of five categories, which largely correspond to levels of mitigation effectiveness. These categories are:

- Avoid. Avoid taking certain actions or parts of actions.
- Minimize. Limit degree or magnitude of action.
- Rectify. Repair, rehabilitate, or restore.
- Reduce or eliminate. Preserve or maintain during life of action.
- Compensate. Replace or provide substitute resources (Bass et al. 2001).

Avoiding the impact altogether is generally considered most effective because it fully mitigates the impact (Apostol et al. 2017). Minimizing the impact may be the most common type of mitigation and results in reducing its intensity or magnitude, rarely eliminating it altogether. Rectifying is commonly used but is usually long-term as the impacts generally persist for some time. Reducing or eliminating impacts may be effective as long as preservation and/or maintenance activities continue. Mitigation measures involving compensation may be recommended or required where it is recognized that impacts cannot be avoided or substantially reduced. Use of compensatory mitigation measures appears to be on the increase (Smardon and Palmer 2017).

VISUAL MITIGATION MEASURES FOR ENERGY PROJECTS

Visual mitigation measures for energy projects fall broadly into three categories: siting, design, and special circumstances. Siting measures for visual mitigation generally entail effective siting that either avoids visually sensitive areas entirely or limits the magnitude of visual impacts through locating the project so that it blends with its surroundings or is fully or partially screened from important views. Design measures for visual mitigation generally entail applications of various treatments, techniques, materials, or finishes that help blend project features with their surroundings or screen them from important views. Measures for special circumstances entail various techniques that may be applied in unique situations or limited areas to avoid, minimize, or offset visual impacts. These various measures for visual mitigation of energy projects are discussed in more detail below.

Siting Measures

Siting measures for visual mitigation include techniques such as avoiding sensitive scenic areas, avoiding high visibility features such as ridge tops and focal areas, colocating facilities with other facilities of similar type and scale (e.g., siting an LNG facility or power plant in an already industrialized area or routing a transmission line close to and paralleling an existing transmission line of similar scale), avoiding “skylining” structures, and locating facilities out of primary view cones for both mobile and stationary views (Apostol et al. 2017; Bureau of Land management 2013).

Siting measures are best applied during project planning as applicant-proposed measures or possibly as siting or route alternatives. When required by agencies as conditions of project approval after project engineering and design, they can be costly or create project delays since they often involve relocating project elements, which requires additional engineering and environmental investigations, or other changes to the project footprint. Because structures and their foundations must be custom-designed to fit terrain and subsurface conditions specific to their unique locations, even a small change in location of one structure can have a substantial snow-balling effect on relocating other facility structures. This is especially true for wind turbines, where repositioning one turbine can affect the generation efficiency of other nearby turbines, and transmission structures, where repositioning one structure can have a cascading effect on the locations of adjacent structures in a whole segment of the transmission line. Even small adjustments to structure locations may entail substantial redesign and construction costs.

Design Measures

Design measures for visual mitigation may apply to mitigating visual impacts during project construction or operation or both. They may be applied during project planning and design as applicant-proposed measures or be required by agencies as conditions of project approval. Also, they may be generally applied to the entire project or to large areas or selectively applied to particular locations or activities.

The costs of design measures can vary substantially depending on the nature of the measure, how extensively it must be applied, and whether ongoing maintenance is required. Some measures require higher initial costs but little ongoing investment of time or resources through operation. Others require ongoing or periodic maintenance costs that can be expensive over time. Still others, such as site restoration, are routinely applied as best management practices and serve multiple purposes for mitigation (Bureau of Land Management 2013). As with siting measures, design measures can be costly or create project delays when required by agencies as mitigation measures or conditions of project approval.

Design measures typically applied for mitigating visual impacts of energy projects are listed below in categories of their primary application for either construction or operation (Bureau of Land Management 2013). Some of these measures may be applicable during both project phases. Rather than being comprehensive, this list is intended to summarize the types of design measures typically applied for mitigating visual impacts of energy projects. Other design measures undoubtedly exist. Furthermore, this list is not intended to provide actual wording for mitigation measures.

A sampling of typical design measures for visual mitigation during project construction includes the following:

- Use existing access roads wherever possible and minimize construction of new access roads.
- Minimize improvements to existing access roads.
- Restore access roads used for construction that are not required for operation and maintenance.
- Use overland “drive and crush” travel for access within clearly delineated routes whenever possible.
- Minimize extent of cut and fill slopes.
- Limit vegetation clearing and ground disturbance to areas required for construction.
- Minimize vegetation trimming and removal.
- Preserve/maintain existing vegetative screening.
- Select low visibility locations for laydown and staging areas or screen these when located in visually sensitive areas.
- Round slopes.
- Minimize lighting required for construction activities, laydown and staging areas, and maintenance activities; use the minimum necessary to ensure safety and security for nighttime activities.
- Light areas only as required for safety and security in accordance with Occupational Health and Safety Administration standards.
- Shield and orient lighting downward to eliminate offsite light spill; use motion-activated sensors and/or timers for construction lighting.
- Reclaim/revegetate/restore temporarily disturbed areas (including access roads, laydown and staging areas, temporary work areas, etc.).

A sampling of typical design measures for visual mitigation during project operation includes the following:

- Use finishes and products that minimize or eliminate surface glare (e.g., dulled and/or dark painted or stained surfaces, textured surfaces, nonspecular conductors).
- Select finishes and colors that are appropriate to their location and context and help blend features with the surroundings (e.g., use colors

selected from BLM's color chart [Bureau of Land Management 2013]).

- Treat exposed rock and soils to darken and reduce color contrast (e.g., Natina Products, Permeon™, desert varnish).
- Match design form, height, texture, and color of any existing structures as much as feasible.
- Minimize structure heights.
- Screen from sensitive receptors using berms, vegetation, or other techniques.
- Minimize vegetation clearing and trimming.
- Maintain access roads for operation and maintenance at the minimum standards needed for safety and accessibility.
- Create varied vegetation edges for cleared areas and rights-of-way (e.g., for pipeline and transmission rights-of-way, create edges that are sinuous horizontally and layered vertically).
- Minimize lighting required for permanent facilities; light areas only as required for safety and security in accordance with Occupational Health and Safety Administration standards.
- Shield and orient lighting downward to eliminate offsite light spill; use motion-activated sensors and/or timers for lighting.

Measures for Special Circumstances

Increasingly, public interests and agencies are recommending what may be termed innovative, progressive, or special mitigation measures to avoid, minimize, or offset visual impacts of energy projects. In some cases, agencies are requiring these measures in unique or special circumstances or limited areas as conditions of project approval (Smardon and Palmer 2017). Some of these measures may be costly and others may actually avoid or offset the costs of more traditional or standard mitigation measures. Measures for special circumstances include a variety of creative techniques to mitigate visual impacts of energy projects, including compensatory mitigation, offsite enhancement, special finishes, unique and artistic structure and screening designs, and placing transmission lines underground or underwater.

Compensatory mitigation is being applied more frequently, especially in and near urban areas where large numbers of viewers are affected; sites and routes are constrained; and views from residences, trails, parks, and other sensitive viewing locations may be impacted (Kling et al. 2017). Compensatory measures may take various forms, including monetary payments, provision of community amenities, establishment of scenic reserves, and offsite scenic enhancements. Monetary payments may be made to communities, neighborhoods, individuals, nonprofit organizations, or special interests for what amounts to a "taking" of views. Ideally, funds are applied to local efforts to provide aesthetic enhancements to offset visual and other impacts of a proposed project. In some cases, community amenities have been provided in the form of trails, trailheads, staging areas, parks (especially linear parks that parallel transmission lines), and rest areas along trails. Interpretive exhibits, plantings, restrooms, parking areas, and other features may be part of the overall amenity intended to offset or compensate for impacts to views and visual character. Decisions for some key legal cases appear to indicate that agency-imposed compensatory mitigation measures must be directly related to mitigating the actual visual impacts (Smardon and Karp 1993). However, in certain situations, discussions and negotiations with project developers in the early stages of project planning may also yield innovation solutions designed to offset visual impacts.

Another form of compensatory mitigation is the set-aside or establishment of scenic reserves where scenic quality would be protected in perpetuity (Kling et al. 2017). The intent of this mitigation would be to offset visual impacts from a proposed project that could not otherwise be mitigated effectively on site. Offsite scenery enhancement may be part of this mitigation or could occur in other areas, for example a National Forest that would benefit from visual "restoration."

In some limited areas or for certain project features where special circumstances exist (e.g., an immediate foreground view from a residence), painting all or parts of project elements may be appropriate. Painting and other special finishes can be expensive to maintain and are known to peel, fade, or otherwise lose their effectiveness over time. A commitment to long-term maintenance, a detailed maintenance program (and possibly monitoring), and recorded agreements should be included as part of mitigation measures that rely on maintenance of painting or other coloring or finishes to reduce visual impacts. For transmission lines, it can also be problematic for a utility to take a line out of operation to repaint a structure, even for a brief period. Thus, visual enhancements involving painting or other applied finishes should be used cautiously. However, innovations and advances in materials, paints, and finishes may improve the viability of this mitigation technique in the future.

Another measure that arguably could be applied in some special circumstances to mitigate visual impacts is the use of unique and artistic structure and screening designs (see Alster, this proceedings). A number of large power generation facilities in Europe and some in the United States have been designed as large art or sculptural features or "disguised" to look like office buildings. For example, the 605 MW Metcalf Energy Center near San Jose, CA, is designed to look similar to office buildings in the vicinity of the facility (California Energy Commission 2000). For some energy facilities, such as substations and transmission facilities located in urban areas, innovative and artistic screening has been employed to mitigate visual impacts and provide amenities for communities. The use of artistic screening as an alternative to more traditional vegetative screening, berms, walls, and fences has merit, especially in locations that have limited space for plantings and berms and where views may be sensitive and frequent.

In addition, design competitions sponsored by power transmission companies in Iceland and England in recent years have highlighted innovative and imaginative designs for transmission structures (Alster, this proceedings; Bustler 2011; T&D World Magazine 2011). While some are fanciful and unlikely to be feasible, others have the potential to be built and may help mitigate visual impacts by providing a more interesting and aesthetic alternative to traditional, industrial structure designs, at least for projects traversing visually sensitive areas or with high numbers of viewers. For a 2008 competition sponsored by Landsnet, an Icelandic power transmission company, and the Association of Iceland Architects, new 220 kV transmission structures were designed in the form of humans in various poses (Alster, this proceedings). The design submitted by Choi+Shine received honorable mention in the competition and a subsequent award from the Boston Society of Architects (Bustler 2011). A 2011 competition, sponsored by England's Department of Energy and Climate Change and British power company National Grid, attracted 250 entries and resulted in several designs that are being seriously evaluated to use to mitigate visual impacts of transmission projects (British Broadcasting System 2011, T&D World Magazine 2011).

One measure that is gaining traction both as a siting and design measure to mitigate visual impacts is the placement of transmission lines underground or underwater. Underwater transmission lines have been considered viable and cost effective for some time, with a variety of these lines in operation worldwide. With recent advancements in the technology, undergrounding is becoming more viable in certain situations and is being applied more often. However, construction costs for undergrounding are quoted by various sources as ranging from 4 to 20 times higher than traditional overhead transmission (Edison Electric Institute 2012, NEI Electric Power Engineering 2009, Public Service Commission of Wisconsin 2011). The higher costs are due to a variety of factors ranging from terrain types and subsurface conditions to connection and underground access requirements. Utilities also highlight difficulties accessing lines for inspections, maintenance, and repairs.

Although more expensive, undergrounding may have other advantages besides visual mitigation that include maintenance of property values; compatibility with land use requirements; political palatability; perceived reduction of exposure to electric and magnetic fields (EMFs); reduced width requirements for rights-of-way and associated lower costs for acquisition; lower costs for maintaining rights-of-way due to fewer restrictions for vegetation edge maintenance and less area to maintain; and reduced vulnerability to extreme weather events, fires, and terrorist attacks, potentially resulting in reduced outages and greater reliability (Edison Electric Institute 2012). Also, undergrounding transmission may provide viable options in dense urban areas where limited space is available for infrastructure. However, potential avoided costs and savings related to many of these advantages are difficult to calculate and are often not considered in reports of higher costs of undergrounding transmission lines; instead, the higher costs are generally calculated based on initial construction costs or costs of conversion from overhead to underground (Edison Electric Institute 2012).

With advances in the technology, underground polymer insulated cable (XLPE) is now rated up to 550 kV for AC lines; however, underground high voltage AC lines are generally limited to distances of up to about 40 miles (Faulkner 2013). Most underground AC transmission lines currently in place or being built run short distances of several hundred feet to several miles. Underground portions of AC transmission lines that have been built recently include the 6.9-mile underground segment of the 345 kV Middleton-Norwalk line in Connecticut and the 6.2-mile underground segment of the 230 kV Sunrise Powerlink line in California. Each was placed underground at a considerably higher cost than an overhead line to reduce or eliminate visual impacts.

High voltage DC (HVDC) lines can be substantially longer and carry much higher power loads (Faulkner 2013). A number of HVDC transmission lines are currently in operation throughout the world, most of which run underwater. Some, such as 320-mile 600 kV HVDC Champlain Hudson Power Express (90 miles underground and 230 miles underwater), are in the planning stages (Transmission Developers 2017). Still other proposed projects are considering alternatives for undergrounding and evaluating their feasibility.

CONCLUSION

While visual impacts are often the focus of public and agency concerns for utility-scale energy projects, a variety of techniques exists to help mitigate these impacts. Some techniques are fairly standard and routinely applied across broad types of energy projects. Other techniques can add substantial project costs but may be suitable in specific situations or limited areas. Perhaps the best mitigation derives from avoiding visual impacts to the greatest degree possible through a collaborative approach that: engages project developers, agencies, and public interests; fosters trust; improves understanding of constraints and opportunities; and helps anticipate issues early in the planning process so that feasible alternatives and appropriate mitigation solutions can be identified. Project developers are then better able to integrate applicant-proposed measures as part of the proposed project and avoid agency-imposed mitigation that can be costly and can cause project delays. This approach, if properly applied, has the potential to result in reduced public and political opposition, greater certainty and less risk for the project proponent, and a more efficient and timely process for project review and approval. Ultimately, this approach provides a greater potential for reducing visual impacts of utility-scale energy projects and protecting the visual character and quality of the landscape.

LITERATURE CITED

Alster, E.B. 2018. **Reclaiming visual stewardship in Tucson, Arizona: Is it possible?** In: Gobster, P.H.; Smardon, R.C., eds. Visual resource stewardship conference proceedings: landscape and seascape management in a time of change. Gen. Tech. Rep. NRS-P-183. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 213-229.

Apostol, D.; McCarty, J.; Sullivan, R. 2017. **Improving the visual fit of renewable energy projects.** In: Apostol, D.; Palmer, J.; Pasqualetti, M.J.; Smardon, R.; Sullivan, R., eds. 2017. The renewable energy landscape: preserving scenic values in our sustainable future. New York, NY: Routledge: 176-197. https://doi.org/10.4324/9781315618463

Bass, R.E.; Herson, A.I.; Bogdan, K.M. 2001. **The NEPA book: a step-by-step guide on how to comply with the National Environmental Policy Act. 2nd edition.** Point Arena, CA: Solano Press Books. 475 p.

British Broadcasting System. 2011. **In pictures: pylons of the future?** http://www.bbc.co.uk/news/uk-15293922 (accessed August 12, 2017).

Bureau of Land Management. 2013. **Best management practices for reducing visual impacts of renewable energy facilities on BLM-administered lands.** Cheyenne, WY: U.S. Department of the Interior, Bureau of Land Management. 342 p.

Bustler. 2011. **Choi+Shine wins BSA unbuilt architecture award for land of giants.** http://bustler.net/news/1694/choi-shine-wins-bsa-unbuilt-architecture-award-for-land-of-giants (accessed August 12, 2017).

California County Planning Directors Association. 2012. **Sample conditions of approval: appendix H to solar energy facility permit streamlining guide.** http://ccpda.org/documents/solar-issues/solar-energy-facility-permit-streamling-2012-02-03/147-appendix-h-sample-conditions-of-approval-san-luis-obispo-county/file (accessed August 19, 2017).

California Energy Commission. 2000. **Preliminary staff assessment, Metcalf Energy Center, application for certification 99-AFC-3, Santa Clara County.** Sacramento, CA: Energy Facilities Siting & Environmental Protection Division. 576 p.

Edison Electric Institute. 2012. **Out of sight, out of mind 2012: an updated study on undergrounding of overhead power lines.** Washington, DC: Edison Electric Institute. 77 p.

Faulkner, R. 2013. **AC vs. DC powerlines and the electrical grid.** http://www.theenergycollective.com/roger_rethinker/204396/ac-versus-dc-powerlines (accessed August 20, 2017).

Kling, L.; Palmer, J.; Smardon, R. 2017. **Measuring scenic impacts of renewable energy projects.** In: Apostol, D.; Palmer, J.; Pasqualetti, M.J.; Smardon, R.; Sullivan, R., eds. 2017. The renewable energy landscape: preserving scenic values in our sustainable future. New York, NY: Routledge: 198-222.

NEI Electric Power Engineering. 2009. **Underground v. overhead transmission and distribution.** http://www.puc.state.nh.us/%5C/2008IceStorm/ST&E%20Presentations/NEI%20Underground%20Presentation%2006-09-09.pdf (accessed August 19, 2017).

Public Service Commission of Wisconsin. 2011. **Underground electric transmission lines.** https://psc.wi.gov/Documents/Brochures/Under%20Ground%20Transmission.pdf (accessed Sept. 26, 2018).

Smardon, R.C.; Karp, J.P. 1993. **The legal landscape: guidelines for regulating environmental and aesthetic quality.** http://www.esf.edu/via (accessed March 28, 2018).

Smardon, R.; Palmer, J. 2017. **Engaging communities in creating new energy landscapes.** In: Apostol, D.; Palmer, J.; Pasqualetti, M.J.; Smardon, R.; Sullivan, R., eds. 2017. **The renewable energy landscape: preserving scenic values in our sustainable future**. New York, NY: Routledge: 243-257.

Smardon, R.; Pasqualetti, M.J. 2017. **Social acceptance of renewable energy landscapes.** In: Apostol, D.; Palmer, J.; Pasqualetti, M.J.; Smardon, R.; Sullivan, R., eds. 2017. The renewable energy landscape: preserving scenic values in our sustainable future. New York, NY: Routledge: 108-142.

T&D World Magazine. 2011. **Pylon design competition finalists unveiled by national grid.** http://www.tdworld.com/projects-progress/pylon-design-competition-finalists-unveiled-national-grid (accessed August 13, 2017).

Transmission Developers. 2017. **Champlain Hudson power express: project development portal.** http://www.chpexpress.com/ (accessed August 20, 2017).

The content of this paper reflects the views of the author(s), who are responsible for the facts and accuracy of the information presented herein.