Arizona Military & Energy Land Use Plan

Prepared for:
Federal, state, and local government entities; energy developers; electric utilities; tribes; and all branches of the military in Arizona.

"This study was prepared under contract with the City of Surprise with financial support from the Office of Economic Adjustment, Department of Defense. The content reflects the views of the City of Surprise and its participating partners and does not necessarily reflect the views of the Office of Economic Adjustment."

Prepared by:
Arizona State University
January – 2018

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Project Overview & Assessment

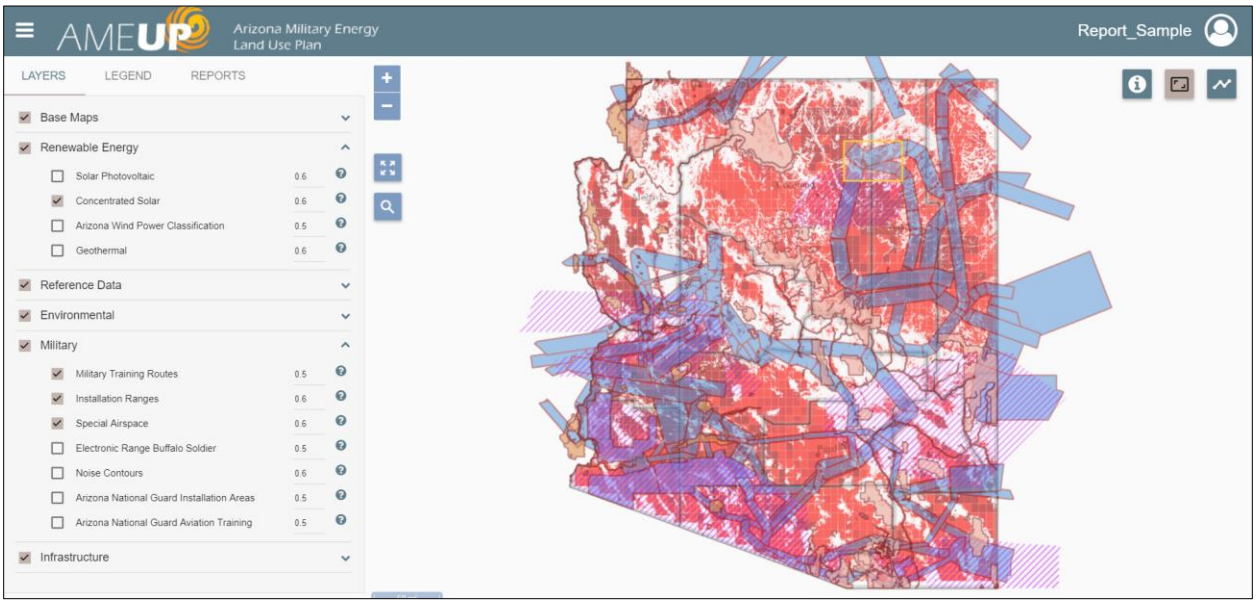
The Arizona Military & Energy Land Use Plan (AMEUP) was created to help the military identify renewable energy projects early in the development process, as they sometimes pose a risk of encroachment. The military owns and operates four percent of Arizona's land, but utilizes several times that amount for training purposes. Many renewable energy projects do not have a thermal component, and thus are not required by Arizona law to obtain a Certificate of Environmental Compatibility by the Arizona Corporation Commission (ACC). Projects without the thermal component do to not require ACC notification, which usually triggers notification to associated parties and therefore allows some of these projects to be developed from start to finish without any formal notice to the military.

Encroachment on military facilities and training routes take three forms: direct, indirect, and perceived. Each of these bring their own set of issues for the military, and each can be addressed by maintaining open lines of communication between the military and developers looking to build in Arizona. AMEUP was designed to provide early notification of new development during the siting process, thereby helping developers avoid areas that may impede the military mission.

Direct encroachment occurs when an action, proposed action, or an action's direct impacts will impair a military installation or its mission by interfering with operations. It is the most apparent type of encroachment and will typically pose a more immediate threat to military operations, whereas the effects of indirect encroachment are generally subtle and spread out over time. For instance, the possibility of a military aircraft crashing into a wind or solar tower is a type of direct encroachment. Unfortunately, accidents like this have occurred. As an example, four people were killed in 2014 when their plane collided with a wind turbine, whose warning light had malfunctioned making it difficult to see[i]. Without a process that properly notifies the military of energy development under a Military Training Route (MTR), this type of risk of collision with vertical obstructions hinders training and by extension, national security.

Other types of direct encroachment include, but are not limited to: glare and light pollution from solar projects that may alter the training or approach path of military aircraft; interference with troop movement and daily operations resulting from the placement of renewable energy projects and transmission lines; and electromagnetic interference associated with renewable energy projects and with transmission lines themselves. In the case of the SunZia merchant transmission line being constructed through Fort Huachuca, it was found that military personnel had to be at least 1.5 km away from transmission lines for the interference levels to be low enough for military testing to continue, essentially creating a 3 km buffer around the line inside of which no military electronic testing could occur.

The AMEUP web tool (tool) has addressed direct encroachment concerns through a variety of approaches. First and foremost is the siting tool and corresponding reports. If a developer uses the tool to site a project on land that is under an MTR or near a military installation, regardless of whether the military owns the land or not, that developer is provided with relevant contacts. These include county, state, and federal level contacts that should be involved in the permitting process, and a military contact that can let a developer know whether or not their chosen site represents a risk to base operations. The areas of notification for the military include any space under an MTR, any area on military owned land, and areas of special use airspace. Additional buffer zones have also been placed around military installations that have been specifically designated by each military branch. For example, the National Guard will now be notified of any energy development within 5 miles of their installations in Arizona.



The map above was taken directly from the AMEUP web tool, and showcases a few of the many data layers included to identify to developers where renewable resources are in relation to military operations.

Unreported renewable energy projects also represent a threat from indirect encroachment. This occurs when an action, proposed action, or the like results from an action or proposed action that will cause impairment or create a greater burden on a military facility by greater oversight, regulation and/or cost. Indirect encroachment typically affects military operations in unforeseen ways. For example, excessive development on the habitat of an endangered species can force migration onto military bases, which often have a vested interest in keeping areas undeveloped for training purposes[ii]. In some cases, the military installation becomes a refuge of last resort for a species that the installation must now pay to protect, a cost to the U.S. Department of Defense (DoD) that increases each year.

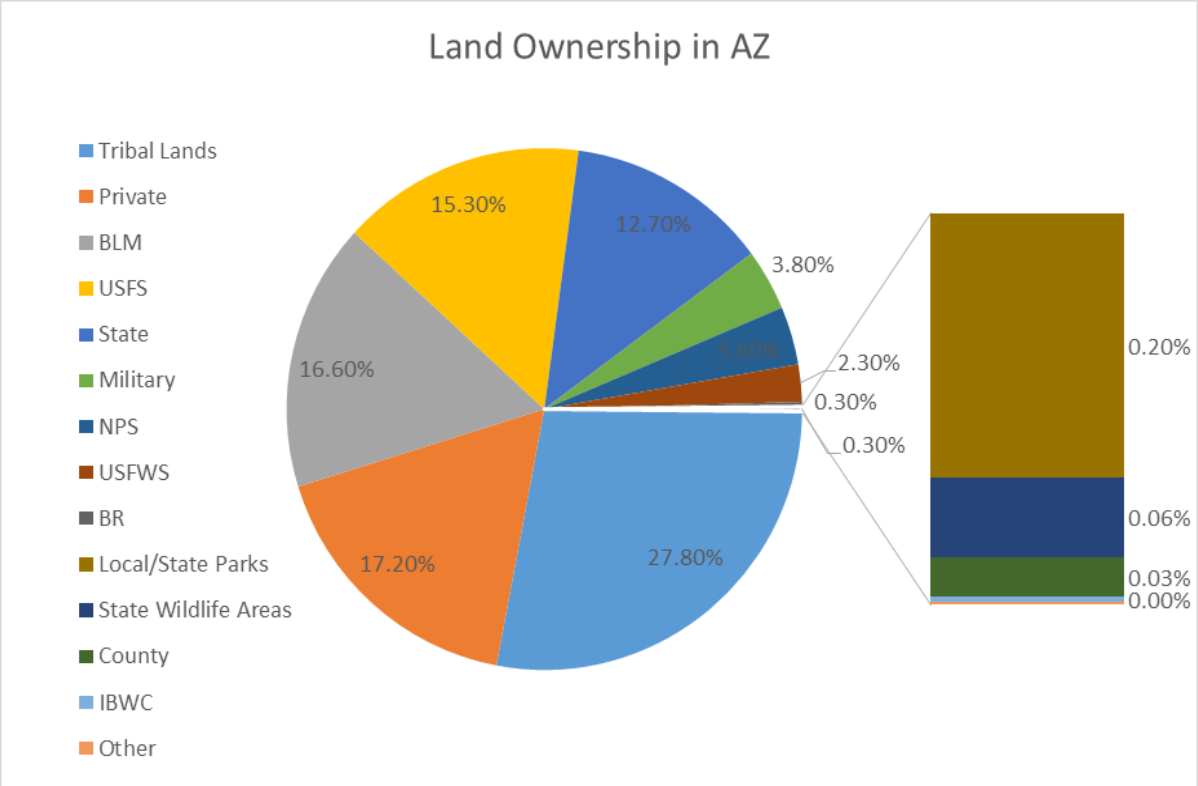
In 2003, approximately $50 million was spent by the DoD on threatened and endangered species. Only nine years later, the DoD estimated the amount to be $73 million. As of 2013, the military was responsible for protecting around 420 federally listed species and an average of 15 threatened and endangered species per acre that the military owned. This is almost seven times as many threatened and endangered species per acre that the U.S. Forest Service must protect. Other types of indirect encroachment might include: issues with access to private lands that the military does not own but nonetheless utilizes for training; other infrastructure built for the personnel maintaining renewable energy projects that may or may not affect military operations; as well as the development of transmission lines near military training areas paving the way for future development to access those lines, in the same way that the building of a road might be followed by houses and accompanying infrastructure.

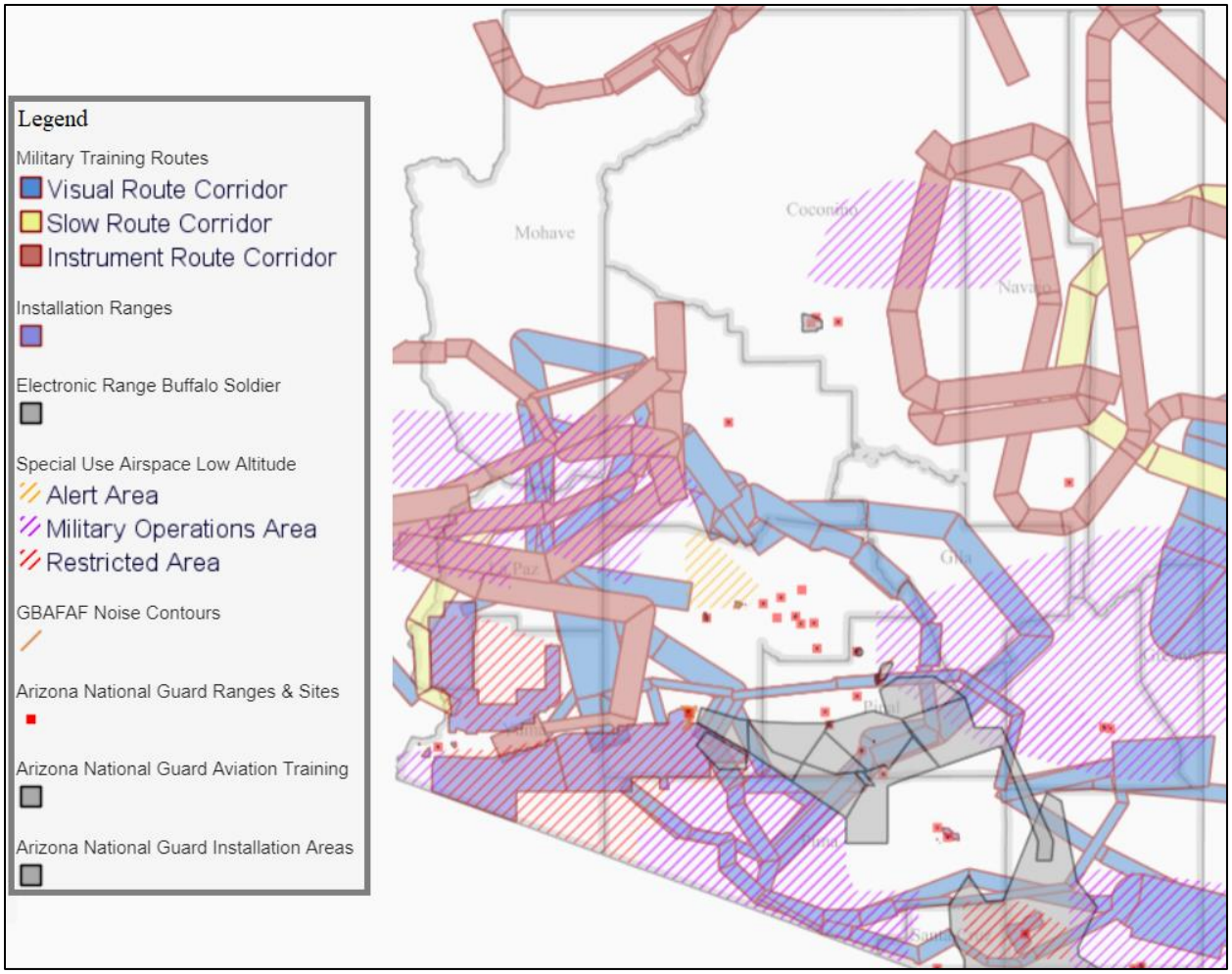
AMEUP has addressed indirect encroachment through two primary avenues. The first is accomplished through early notification of the military. In much the same way that direct encroachment concerns are more easily identified and dealt with by establishing early communication, indirect encroachment can be prevented by a developer working with the military to determine whether their project siting can have any unforeseen impacts on military installations or training. AMEUP has also worked to prevent migration of threatened or endangered species onto military land by including a layer of areas that pose environmental concerns.

Included in the tool are: areas of critical environmental concern; endangered species and critical habitat areas; and Western Electricity Coordinating Council risk classifications These environmental layers are accompanied by a report and a link to the Arizona Game & Fish Web tool that provides more detailed information. Combining these data layers not only helps to prevent unforeseen and lasting negative impacts on the military, but also makes the AMEUP Web tool much more useful to developers and planners during the siting process of their project.

The final type of encroachment is perceived encroachment. It is defined as conditions whereby an action or proposed action may trigger an increased level of scrutiny or the perception of impairment to a military facility, even if there is no evidence of direct or indirect encroachment. Perceived encroachment is the easiest to address as it can be avoided by the dissemination of information to all relevant parties. When a project ignores the military presence around it during the proposal process, that military installation must decide on its own how to deal with new development that can potentially alter its training and day-to-day operations. If a military entity is made aware of a project's scope and extent during the siting process, perceived encroachment is much less likely to occur. It is by notifying the military of nearby development and by initiating a flow of information between military entities and developers that perceived encroachment concerns are avoided.

These types of encroachment can present problems to the military mission and to national security as a whole. In Arizona, this issue is particularly sensitive as privately owned land is the second largest demographic of land jurisdiction in the state, second only to tribal lands. Renewable energy and transmission projects are often built on private land to bypass time consuming federal processes such as the National Environmental Policy Act (NEPA). Although the military owns approximately 4 percent of the land in Arizona, their training areas and special use airspaces encompass a large portion of the state, as shown in the map on the next page.





AMEUP's early notification of proposed development to the military will only be successful if developers use it as a first step in their planning process. To this end, the AMEUP team was in constant contact with all relevant parties in Arizona's various levels of government and in the private sector. Several meetings were held with representatives from Tucson Electric Power, Arizona Public Service, Salt River Project, and with Arizona G&T Cooperatives to better understand what would make our web tool as useful to utility-scale development as possible. We created a layer specifically designed for developers to easily identify sites, during the siting and permitting process, that pose the least amount of military interference. This has been accomplished by adding infrastructure layers that are typically difficult for developers to access, such as transmission lines, pipelines, and electric substations.

Members of the AMEUP team met with Thomas Chenal, Chairman of Arizona's Power Plant and Transmission Line Siting Committee, who agreed to issue a procedural order that would require energy projects (of 100 megawatts or more) and transmission projects (of 115,000 volts or more) to provide military notification to help bridge this information gap until our web tool is online and

functional. AMEUP has also identified actions that the military can take to be proactive about early notification of transmission and renewable energy, such as sending representatives to attend the Biannual Transmission Assessment hosted by the Arizona Corporation Commission. This is a meeting of major developers, held every two years, to discuss proposed transmission lines and utilization of those currently existing.

AMEUP Project Stakeholders are listed below. Team members met with more than 35 government and private entities to obtain input to make this web tool effective, secure and easy to use.

AMEUP Project Stakeholders

Military

Military Leaders – all branches
- Arizona Department of Emergency and Military Affairs
- Arizona Military Affairs Commission
- Arizona Commanders Summit
- Aerospace and Defense Alliance
- Western Regional Partnership

Federal Government Organizations

- Bureau of Land Management
- Federal Aviation Administration

Tribal Leaders

- Tribal Solar Working Group
- Arizona's 22 Tribes• Arizona Committee on Indian Affairs

City, County Leaders

- Arizona League of Cities and Towns
- Arizona League of Counties
- County/City/Town Council, Manager, Planner

Subject Matter Experts

- Bureau of Land Management
- Arizona State Land Department

Arizona House of Representatives
- Military Affairs and Public Safety Committee
- Rural and Economic Development Committee
- Energy, Environment and Natural Resources Committee

Arizona State Senate

- Public Safety, Military and Technology
- Energy Committee
- Natural Resources Committee
- Rural Affairs and Environment Committee

Arizona Governor's Office

- Military and Public Safety Policy Advisor
- Energy and Environment Policy Advisor
- Local Governments Policy Advisor
- Indian Affairs Policy Advisor

Utilities

- Arizona Public Service
- Tucson Electric Power
- Salt River Project• Cooperatives

Non-Government Organizations

- Four Corners Wind Resource Center
- Tribal Solar Working Group
- Arizona Aerospace and Defense Alliance
- Arizona Solar Energy Industries Association

According to the U.S. Energy Information Administration, by the end of 2018, large-scale solar capacity is estimated to increase by 11 percent; and large-scale wind capacity by 9 percent[iii]. AMEUP is a proactive web tool to help address potential encroachment from future renewable energy development. It is strengthened with a best practices plan to establish early and on-going communication with the military and it identifies gaps in policy that may be changed to streamline the process. This application will save time and money, for all relevant parties, in issues that could

have led to lengthy legal battles over land use. It incorporates input from a diverse group of entities to ensure its on-line effectiveness, security and utilization for developers planning to build utility scale renewable energy projects. By providing layers of previously hard to retrieve information at one website, AMEUP may revolutionize how government and private entities in Arizona engage in locating sites for development and interacting with each other.

Case Studies

Southline Transmission Line and the Fort Huachuca Buffalo Soldier Electronic Testing Range

Introduction

In 2009, Southline Transmission, LLC (project proponent) began researching potential route alternatives for the Southline Transmission Project (project) across Arizona's southernmost counties. Preliminary investigations in New Mexico with the White Sands Military Range alerted the project team to the numerous military facilities located in Arizona and the potential for conflicts with the transmission project. Various types of facilities and operations within the project's proposed corridor represented potential issues and concerns that needed to be addressed. An existing transmission line located within the Fort Huachuca Buffalo Soldier Electronic Testing Range (BSETR) was identified as a corridor that could be utilized or upgraded. The construction, operation and maintenance of this upgraded line were recognized as having potential impacts to military operations, including military training visual routes or areas of electronics and communications training. The project team worked with Fort Huachuca and the military clearinghouse to better understand the military's sensitivities to the electromagnetic field, evaluate the opportunities and constraints of the existing corridor and transmission lines, and explore possible approaches to upgrading the line that would mitigate the concerns voiced by the military.

The project team also hosted several public informational meetings in the fall of 2011 to provide early public notification of the project and to initiate outreach with interested stakeholders on routing options. The project proponent engaged with the military in a pre-NEPA scoping process that resulted in the submittal of a "proposed project" to the Bureau of Land Management (BLM) and Western Area Power Administration (WAPA) which included the military's concerns.

STAKEHOLDERS INTERVIEWED

Bill Kipp, Partner at Black Forest Partners (Project Developers): Bill was primarily responsible for the project's permitting, financial model and negotiations with partners and potential off-takers.

Mark Mackiewicz, National Project Manager with Bureau of Land Management: Mark was the BLM's primary contact for the project and oversaw all aspects of the permitting process

Matt Walsh, Executive Liaison Officer for the Commanding General – Fort Huachcua: Matt collated input from various stakeholders across the project corridor and its various activities to generate a single aggregated response.

Mark Wieringa, Environmental Protection Specialist, Western Area

In 2014, the BLM and WAPA released a Draft Environmental Impact Statement (EIS). Public and agency comments on the Draft EIS resulted in route variations and change in the Agency Preferred Alternative in the Final EIS. While the local military facilities had concerns with the route variations, and had expressed reservations regarding the changes in the Agency Preferred Alternative, the determination of the alignment by the BLM and Western was ultimately decided by weighing a number of tradeoffs involving other agencies interests.

Case Study Overview/Purpose

The purpose of this case study is to evaluate the scoping and planning process associated with the Project, which traverses public and private lands. This information is intended to ultimately inform the development of an online mapping tool for use in the planning process for energy projects that potentially encroach onto military installations and adjacent lands. Several key players in the planning process have been solicited for interviews in connection with this case study, including military personnel from Fort Huachuca and BSETR, BLM, WAPA, and the project proponent.

This case study is valuable in that it describes how preliminary investigation of project alignments and footprints and pre-NEPA scoping by the proponent can result in location and design decisions that mitigate concerns brought forth by the military and other stakeholders. Among other things, Fort Huachuca expressed concerns in the pre-scoping process that the use of the existing transmission line would negatively impact BSETR's ability to conduct mission activities. The military identified where interference would likely occur and where mitigation would be needed. Early due diligence studies and research activities helped the project team to anticipate these and other military concerns and design its proposed project to mitigate them. The case study further reveals that, although local discussions were critical to understanding the needs of the military, earlier coordination with DoD decision makers at the at the national level would have benefited both parties. The viewpoint of the DOD was that the Agency Preferred Alternative developed by the BLM and WAPA in the Final EIS placed an excessively high priority on mitigating and accommodating environmental and community concerns but under-considered potential impacts on the military.

Project Overview

The project was designed to collect and transmit electricity across southern New Mexico and southern Arizona to meet local and regional power needs within the growing Desert Southwest. The project facilitates the bidirectional transmission of power both west and east along its route, thereby relieving congestion, strengthening the existing electrical system, and improving

transmission access for local renewable and other energy sources. The project consists of a 370-mile electric transmission line and associated facilities in southern New Mexico and Arizona and includes the construction of new transmission lines and upgrades to existing transmission lines. The project has two sections:

i. a new 249-mile double-circuit 345-kilovolt (kV) transmission line and associated facilities beginning in Doña Ana County, New Mexico and traveling west into Cochise County, Arizona (the "New Build Section"); and
ii. the upgrade of approximately 121 miles of two existing WAPA 115-kV line segments to double-circuit 230-kV line segments located in Cochise, Pima, and Pinal counties, Arizona, and short segments of new transmission lines and associated facilities needed to interconnect the upgraded WAPA lines to existing substations (the "Upgrade Section").

Federal, state, and local agencies involved in the scoping, planning, and compliance process include:

- Bureau of Land Management (Lead Agency)
- Western Area Power Administration
- U.S. Army Corps of Engineers
- Bureau of Reclamation
- Department of Defense Clearinghouse
- U.S. Environmental Protection Agency
- DOD Fort Huachuca
- National Park Service
- U.S. Forest Service (Coronado National Forest)
- U.S. Fish and Wildlife Service
- Arizona Game and Fish Department
- Arizona State Land Department
- New Mexico Department of Game and Fish
- New Mexico State Land Office
- Cochise County, Arizona
- Greenlee County, Arizona
- Graham County, Arizona
- City of Sierra Vista, Arizona
- Doña Ana County, New Mexico

In April 2012, the BLM published a notice of intent to prepare an EIS for the project and in May initiated a 90-day public and agency scoping period. Two agency scoping and six public scoping meetings were held in May 2012, with the results of the findings being published in September 2012 in a final scoping report.

In May 2014, the BLM published its Draft EIS for the construction of the proposed project. Comments by agencies and the public resulted in minor edits to the Final EIS (FEIS). Most notably in the FEIS was the inclusion of route variations to minimize impacts to the Willcox Playa and to reduce potential conflicts with Pima County economic development efforts. The new route variations had been evaluated by Fort Huachuca-BESTR during the process of selecting a Proponent Proposed alignment and subsequently the Draft EIS. However, the local military entities did not believe that they were adequately involved in the revising of the alternatives in the FEIS process, nor were prior concerns given much acknowledgement as the route variations were selected. Ultimately, the Agency Preferred Alternative did not change the military analysis disturbance areas and impacts estimates presented in Chapter 2 or in the analysis of impacts in Chapter 4 of the Draft EIS. The project did receive, however, a letter of acceptance from the DOD (on file in the FEIS).

In August of 2016, BLM and WAPA concluded their joint development of the Federal review process which resulted in a FEIS and Record of Decision (ROD).

The project team is now initiating a process with landowners to establish land rights and is conducting preconstruction activities in anticipation of the start of construction in late 2017. It is anticipated that the project will go into service in 2018-2019.

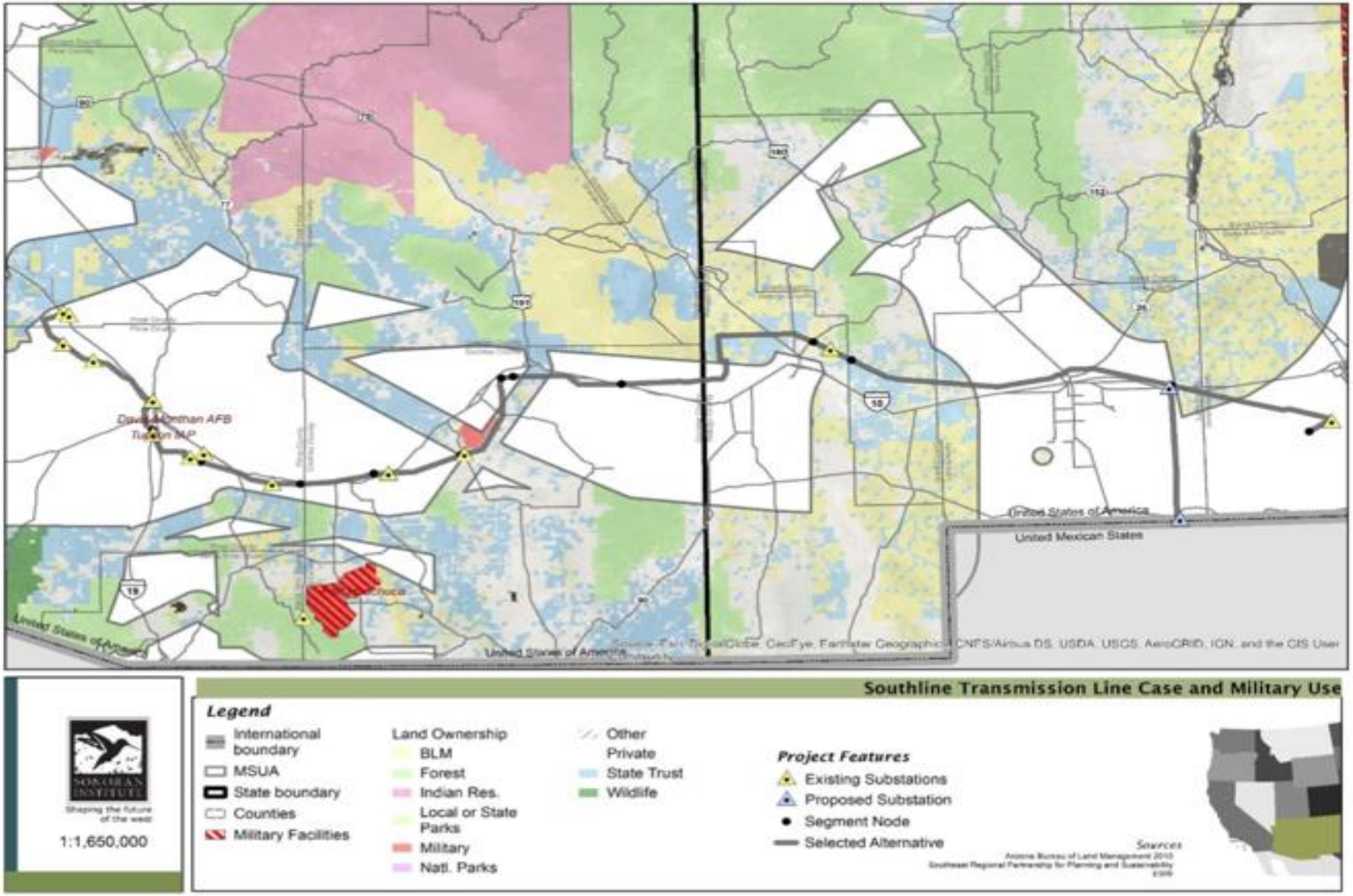
Direct Encroachment

Direct encroachment is a condition whereby an action, proposed action, or an action's direct impacts will impair a military installation or its mission by interfering with operations. The threat of direct encroachment as a result of construction of the project would impact a number of military activities. Primarily for Fort Huachuca, it would impact unmanned aircraft systems training and avionics systems testing, and the ability of the military to conduct training jumps. The Western National Guard Aviation Training Site also uses this airspace for training. Electromagnetic interference from the project transmission lines also created a potential conflict at BESTR and Fort Huachuca that was studied in depth, although ultimately no conclusive interference conflicts were identified. In this regard, a mapping and visualization tool could ideally incorporate the effects of the "tunnel of interference" created by the transmission lines (which is different from the corona effect) that would need to be circumvented by testing activities. In studies done at Fort Huachuca, personnel who were testing this environment had to be less than 1.5 kilometers (km) from the lines for the threshold of interference to be low enough for testing activities to occur, essentially creating a minimum 3-km linear buffer zone along the length of the lines in the area in question that would have to be avoided by the military.

A report was produced by the DOD Siting Clearinghouse and others, but no clear conclusions were drawn as to the exact source of interference. Incidentally, there was allegedly a separate study on the gradients of signal strength in another geographic area near the project but information regarding that study was apparently not shared with Fort Huachuca.

Indirect Encroachment

Indirect encroachment is a condition whereby an action, proposed action, or the like results from an action or proposed action will cause impairment or create a greater burden on a military facility through greater oversight, regulation and/or cost. At Fort Huachuca, another indirect encroachment concern was the project's potential threat to electronic proving grounds which are not located on the Fort but used to fulfill its military mission. Situated in a high-elevation bowl among mountain ranges, the proving grounds are free of transmission lines, cell towers or solar arrays. Although the initial construction of the proposed lines may or may not have presented a direct obstacle, some staff at fort Huachuca feared that it would effectively create a new corridor where other elements could be constructed and therefore threaten future military activities in the area. In one staffer's words, "What else will be hung on the lines and how will it be used for other purposes in the future? This could introduce unknown and/or unforeseen consequences from energy generation such as unseen electronic waves and electromagnetic interference. It's like putting in a road, which will inevitably be followed by houses, infrastructure development, etc."



Map of Selected Alternative-New Build and Upgrade (from BLM Record of Decision 2016)

Regulatory Process

The National Environmental Policy Act (NEPA) was established in 1970 and requires federal agencies to prepare Environmental Assessments (EAs) and (EIS) that state the potential impacts to the environment as a result of federal actions. In the case of the project, the formal NEPA process started in April 2012 when the BLM published its notice of intent to prepare the EIS for this project. The BLM's purpose and need for the project was established by regulatory obligations and directives and current energy development trends.

Most significant to this case study is that the project proponent identified early the need to engage with certain stakeholders and agencies and initiated a stakeholder and public engagement strategy prior to the start of formal Federal environmental review process. This did not occur without a fair amount of ground work conducted by the Southline project team early in the concept development stages.

From the start, the project team knew they would need to work with the military early in the conceptual design stage to understand the issues and concerns in New Mexico and the White Sands Missile Range (WMSR). The proponent first engaged with the WMSR, who then identified numerous other military facilities and interests in Arizona that existed within the vicinity of the corridor that the team should contact. The information provided by WSMR was invaluable and allowed the project team to identify and engage early with the military to understand the potential impacts of the transmission line on the military's mission within the state of Arizona. The project team did not have a resource or database to identify these military assets and the necessary contacts within each organization. In essence, the WSMR acted as the informational clearinghouse for military interests in this project. Receiving this information upfront allowed the project team to work with the military to better understand the implications of upgrades or changes to the existing WAPA line that bisected the BSETR. This understanding resulted in a design that mitigated potential impacts to the military and its activities that would take place in the BSETR.

After establishing the military as a primary stakeholder, the project team began to target other stakeholders and public groups and moved forward with a pre-NEPA scoping process. This gave them an opportunity to identify and address issues and concerns associated with either new construction or upgrading of existing facilities. Such early identification and engagement of the public and stakeholders has not been the standard operational procedure for energy/transmission projects in the recent past and clearly benefited the project.

The project proponent's identification of significant stakeholders such as Fort Huachuca and the BESTR was critical to conducting a planning process that anticipated issues of concerns and addressed them prior to the submittal of a proposed project to the designated federal NEPA lead agency.

While the early engagement that the project proponent established with the military helped to mitigate many issues and concerns at the design stage, this proactive cooperation with the military was not carried forward when the project transitioned to the formal NEPA process and the BLM and Western assumed their federal roles as joint lead agencies.

From the military's perspective, a disconnect emerged among the BLM, the Arizona Game and Fish Department (AZGFD), the local communities, and the military facilities within the project vicinity. Moreover, some felt that higher value was placed on conservation lands managed by agencies such as the BLM, AZGFD, and USFWS than on military lands. The military's concern that priorities of other agencies are given greater attention than those of the military is a familiar theme in the development of energy and transmission line projects.

Summary

The project is an excellent case study in how to engage the military early in a proposed energy/transmission line project. The project proponent acknowledged that they had no understanding of the process of public engagement with the military as a whole and had no idea which agencies, military facilities and interests existed within the footprint of their conceptual project except for the WSMR. Their engagement with other military facilities and interests was generated by the WSMR directing them to various military contacts in Arizona.

The project team felt that their approach to working with local and regional interests and stakeholders, instead of lobbying federal and national level agencies/stakeholders, allowed them to gain support for their project by working with the military to identify during the project development stage where the conflicts, issues and concerns might be with the military and facilities.

Access upfront to a database that collectively showed layers of ownership, land use, management, areas of concern and contacts for various agencies and stakeholders would have been beneficial to the team. It would have been valuable to have this type of information in a database that was readily available and up-to-date.

From the military's perspective, they believed that information about military bases, operations and missions are available in one way or the other to the public (via the County). The feedback from the military is that it would only be of value if agencies, stakeholders and land managers used it and encouraged proponents of projects to access the tool in the beginning of the project development. The sense is that the projects which have a federal nexus will eventually include a consultation with the military, and hopefully earlier than later. The military was more concerned about the proliferation of energy and transmission projects which occur on private, or quasi-public lands (State Trust Lands) and are private in nature and smaller in scale. It is believed that these projects may have a greater impact on the military as they are more likely to go forward through the county and the Arizona Corporation Commission (ACC) without any review by the military to assess the direct or indirect impacts of an energy/transmission project on the military.

A tool such as the one being developed as part of the AME-UP project would be valuable to project proponents who are developing energy/transmission projects and are earnest about identifying areas of conflict and compatibility. It is critical that a tool such as this becomes accepted and used as a baseline of information, so private and public proponents of projects can have the necessary resources to identify and anticipate issues, conflicts, opportunities and develop strategies to reduce the risk of encroachment to military installations and operations in the state of Arizona.

Fort Huachuca Solar Array

A Case Study for the Arizona Military Energy & Land Use Plan (AME-UP)

The U.S. Department of Defense is committed to finding ways to increase its use of renewable energy at military installations. The introduction and details set forth in this Case Study are drawn directly from a fact sheet created by U.S. Army Office of Energy Initiatives. Fort Huachuca, Arizona, is referenced in the latter half of this case study as "the Fort".

Introduction

In 2014, the U.S. Army Office of Energy Initiatives (OEI) and Fort Huachuca partnered with the General Services Administration (GSA) and Tucson Electric Power (TEP) to develop a large-scale renewable energy solar project to supply approximately 18-megawatts (MW) alternating current, or about 25 percent of Fort Huachuca's electricity requirements. In December 2014, the project became operational. Today, more than 57,000 solar panels at the site supply renewable energy to Fort Huachuca and the Southern Arizona grid.

The Fort Huachuca solar project established a new and streamlined path for innovative partnering between the military, other federal agencies, private industry and utility service providers.

The Army is committed to partnering with industry and utilities on renewable energy projects that will strengthen the resiliency of military installations through increased security and sustainability.

Fort Huachuca is contributing to the Army's goal of deploying one gigawatt of renewable energy by 2025.

STAKEHOLDERS INTERVIEWED

Erik Bakken, Senior Director of Transmission and Environmental Services for Tucson Electric Power: Eric was involved in the siting of the Fort Huachuca solar project. He worked closely with Department of Defense and personnel at the Fort to find the best site for this project. He also assisted with the siting of the distribution line connecting the solar array to the substation on the base.

Mathew Walsh, Executive Liaison Officer to the Commanding General- Fort Huachuca: Matt had only a minor role in the Fort Huachuca project. However, he was able to provide feedback on this project. He suggested that the individual who oversaw the installation was no longer employed at the Fort.

Case Study Overview/Purpose

The purpose of this case study is to evaluate the scoping, planning and site selection process associated with the project. This project is unique in that it is a renewable energy project that was created out of a partnership between the military, other federal agencies, private industry and a utility provider, which traverses public and private lands. This information is intended to ultimately inform the development of an online mapping tool for use in the planning process for energy projects that potentially encroach onto military installations and adjacent lands. Several key players in the project planning process have been solicited for interviews in connection with this case study, including military personnel from Fort Huachuca and TEP.

This case study is valuable in that it demonstrates how early collaborative engagement with the military and other agency stakeholders can uncover concerns, address them and result in location and design decisions that mitigate concerns brought forth by the military and other stakeholders. Early due diligence studies and research activities helped the Project team to anticipate these and other military concerns and design its proposed project to mitigate them. The case study further reveals that, although local discussions were critical to understanding the needs of the military, earlier coordination with the Department of Defense (DOD) on a national level would have benefited both parties. The viewpoint of the DOD was that the Agency Preferred Alternative developed by the BLM and Western in the Final EIS placed an excessively high priority on mitigating and accommodating environmental and community concerns and under-considered potential impacts on the military.

Project Overview

This project reflects the Army's commitment to enhancing mission effectiveness and providing a sustained, comprehensive strategy for energy security. It promotes the Army's energy security objectives and the utility's renewable energy goals. The Army initially identified a 155-acre parcel of land for the development of this solar PV project:

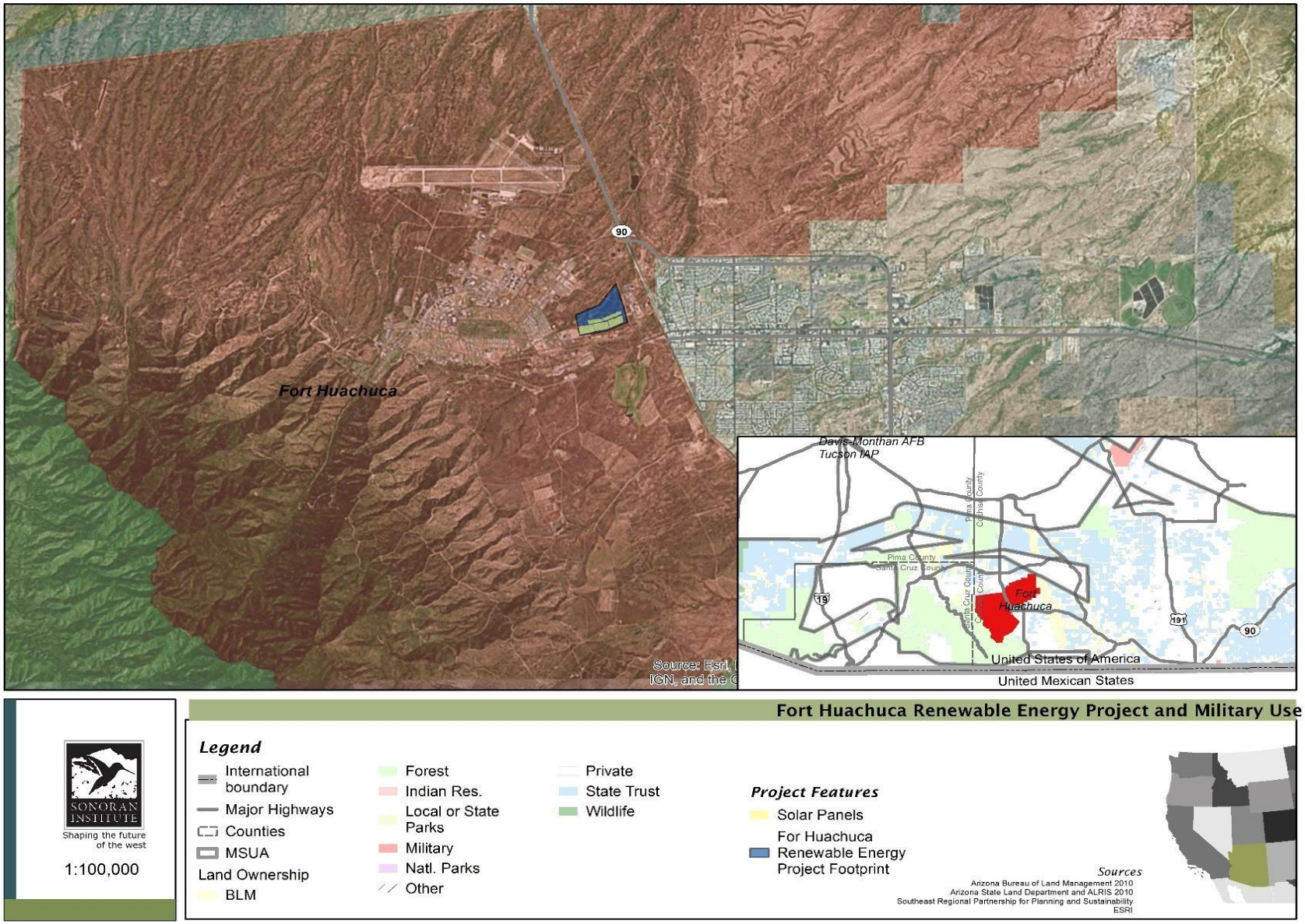
- The project is located on approximately 68-acres of land in the Fort Huachuca cantonment area.
- The Army and TEP signed a 30-year easement to facilitate the project.
- TEP contracted with industry partner E. ON for the system's design, engineering, procurement and construction management.
- TEP funds, owns and operates the solar project and the Army purchases energy through an existing GSA Area-wide contract at Arizona Corporation Commission-approved rates, securing renewable energy at no additional cost.

- As the utility provider, TEP streamlined the interconnection process through its Fort Huachuca substation, thereby reducing interconnection costs and improving system reliability.

The agencies and players involved in the scoping, planning and compliance process include:

- Department of Defense Clearinghouse
- U.S. Environmental Protection Agency
- DOD Fort Huachuca
- Army Energy Initiatives Task Force
- General Services Administration

Map of Fort Huachuca Renewable Energy Project



Direct Encroachment

The concerns with this project were all related to direct encroachment into the military installation and possible interference with military operations. Concerns identified by stakeholders included:

- Glare from the panels and its potential impact on the approach patterns of planes.
- Interference with military operations due to additional electromagnetic emissions.
- Interference with the movement of troops and day-to-day operations resulting from the placement of solar installation and the transmission line that connects the project to the grid.

In addition to minimizing interference with the movement of troops, there was desire to minimize the project's impact on the ecologically diverse San Pedro Valley. Although the Fort has been at its current site for over 100 years and there are few "greenfield's" present, there was an effort to find a location that was previously used. However, there were also concerns about certain historic uses of sites under consideration and the potential for buried explosive materials and other subsurface hazards.

Indirect Encroachment

None were identified in this project

Regulatory Process

An environmental study was completed on this project in March 2014. It is unclear if a new NEPA study was initiated or if the action was covered under a previous NEPA study. TEP worked extensively with the Fort to scope the project and understand concerns. Due to its location in the San Pedro valley, the Fort already experiences a level of public and federal scrutiny on operations and the impact on the ecology of the area. Given the location of the Fort in an ecological diverse area, siting the panels was a sensitive issue and consideration was given to terrain and prior use of the area.

Summary/Outcome

As a result of the early planning efforts and involvement of Fort personnel, all site-specific concerns were addressed or adequately mitigated prior to the project's completion. TEP, which sought to address operational and environmental sensitivities at the project site, helped gather input and coordinate action among key stakeholders. Through an iterative process, project

locations were suggested and reviewed in an extraordinarily collaborative and exemplary manner.

The solar installation's location on the military installation itself necessitated direct interaction with the Fort. From the Fort's perspective, this project's location was perhaps the most important aspect of the project. Other issues that were identified which may have been resolved with the use of an online mapping tool were identification of large singular parcels of land instead of small contiguous parcels, knowledge on previous land use, and access to historical "as-built" information about potential parcels. The availability of this information and access to it would have contributed to a more informed decision making process and site selection process.

Overall, the Fort Huachuca solar array was a highly successful project. TEP owns, operates, and sells power to Fort that is generated on the project site. This arrangement is new and unique to the Fort and is becoming a model for similar projects at other military facilities.

Quartzite Solar Energy Project

A Case Study for the Arizona Military Energy & Land Use Plan (AME-UP)

Introduction

The project is a fully permitted site on federal lands managed by the BLM situated about 10 miles north of Quartzite, Arizona. (Figure 1). The project, if developed, will feature a 100 megawatt (MW) concentrated solar thermal tower that is 653 feet tall and supporting facilities that cover approximately 1,675 acres of land. The Record of Decision (ROD) for the project was approved by the BLM on May 30, 2013. The project has not yet been constructed as no power purchase agreement (PPA) has been achieved from a utility provider. The project's permitting was pursued by its owner/developer, Solar Reserve LLC (Proponent).

Case Study Overview/Purpose

This case study provides an overview of activities associated with the development of the Quartzite Solar Energy Project (Project) near Quartzite, Arizona, that relate to the project's potential impacts on military missions. In particular, the study examines practices developed in connection with the project to help limit the amount of uncertainty to the developer and manage potential conflicts between the project and Arizona's ongoing military missions.

This case study describes the process that emerged to ensure that the project was compliant with the permitting requirements of the overseeing agency and highlights strategies aimed at addressing conflicts between the military and the project developer. In general, the process was fairly straight-forward, the appropriate agencies were contacted, and concerns raised by military stakeholders were ultimately addressed to the satisfaction of all parties.

STAKEHOLDERS INTERVIEWED

Andrew Wang, Director of Development, Solar Reserve LLC: Andrew was the representative for the Project Proponent and was responsible for the permitting of the project.

Eddie Arreola, Supervisory Project Manager, Bureau of Land Management Arizona: Eddie was responsible for the BLM's portion of the project review and approval, including necessary revisions to the Resource Management Plan (RMP).

Kevin O'Berry, Intergovernmental Liaison, 56 FW Range Management Office (Barry M. Goldwater Air Force Range): In addition to his role at the Barry M. Goldwater Range, Kevin is the chairman of the environmental working group of range managers in Arizona. He coordinates broad multi-installation process cooperation and facilitates stakeholder dialogue around common issues.

Charles (Mike) M. Hamilton, Environmental Planner, Marine Corps Installations West: Mike was the military contact for the Marine Corps who facilitated the military review and comment on the Project.

In general, all parties that were interviewed on this project agreed that a tool would be useful to help project developers identify potential conflicts between proposed renewable energy projects and existing military land uses and to facilitate earlier detection and resolution of such conflicts.

Project Overview

In early 2011, Solar Reserve LLC was seeking a site to construct a 100 MW solar thermal facility. While they initially filed an application for a 24,000-acre site in La Paz County on BLM land about ten miles north of Quartzite, their eventual application was for just over 1,600 acres of Sonoran Desert land. The project permitting process was led by WAPA with significant input and participation from the BLM.

As a part of the scoping process, the project applicant, through a routine application to the Federal Aviation Administration (FAA) for a "Determination of No Hazard" finding, discovered that the original 24,000-acre site was near to, and partially within, a Military Training Route (MTR).[1] The FAA connected the applicant to the Southwest Department of Defense Regional Coordination Team (a predecessor to the current Officer of the Assistant Secretary of Defense [OSD] Siting Clearinghouse[2]).

At the time, the point of contact at that office was Kevin O'Berry. He forwarded the request to the appropriate installation who operated in that airspace, Marine Corps Air Station Yuma. The request was then forwarded on to the appropriate review office for the Marine Corps, which is located in Camp Pendleton near San Diego California. It was then reviewed by the aviation branch for its potential impact to military missions. Comments were ultimately returned to Mike Hamilton, who coordinated the review process, and the comments were returned to the applicant.[3]

The agencies and players involved in the scoping, planning and compliance process include:

- Western Area Power Administration
- Bureau of Land Management - Yuma Field Office
- U.S. Army Corps of Engineers
- US Army Garrison-Yuma Proving Grounds
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- Federal Aviation Administration
- Arizona Game and Fish Department
- Arizona Department of Environmental Quality

The comments regarding the project's potential impacts on the MTR were provided to the federal reviewer and applicant, who ensured that the issues were addressed prior to submitting the Draft EIS. As a result of the input, the site was refined from the original 24,000 acres to the final site location of about 1,600 acres.[4] This final location and scope resolved all known concerns voiced by the military community. Today, they have no outstanding objections to the project.[5]

In October 2011, WAPA released the Draft EIS. The Final EIS was released in December 2012 with little revisions as public and agency comments did not substantially modify any of the alternatives or the environmental analysis in the Draft EIS.

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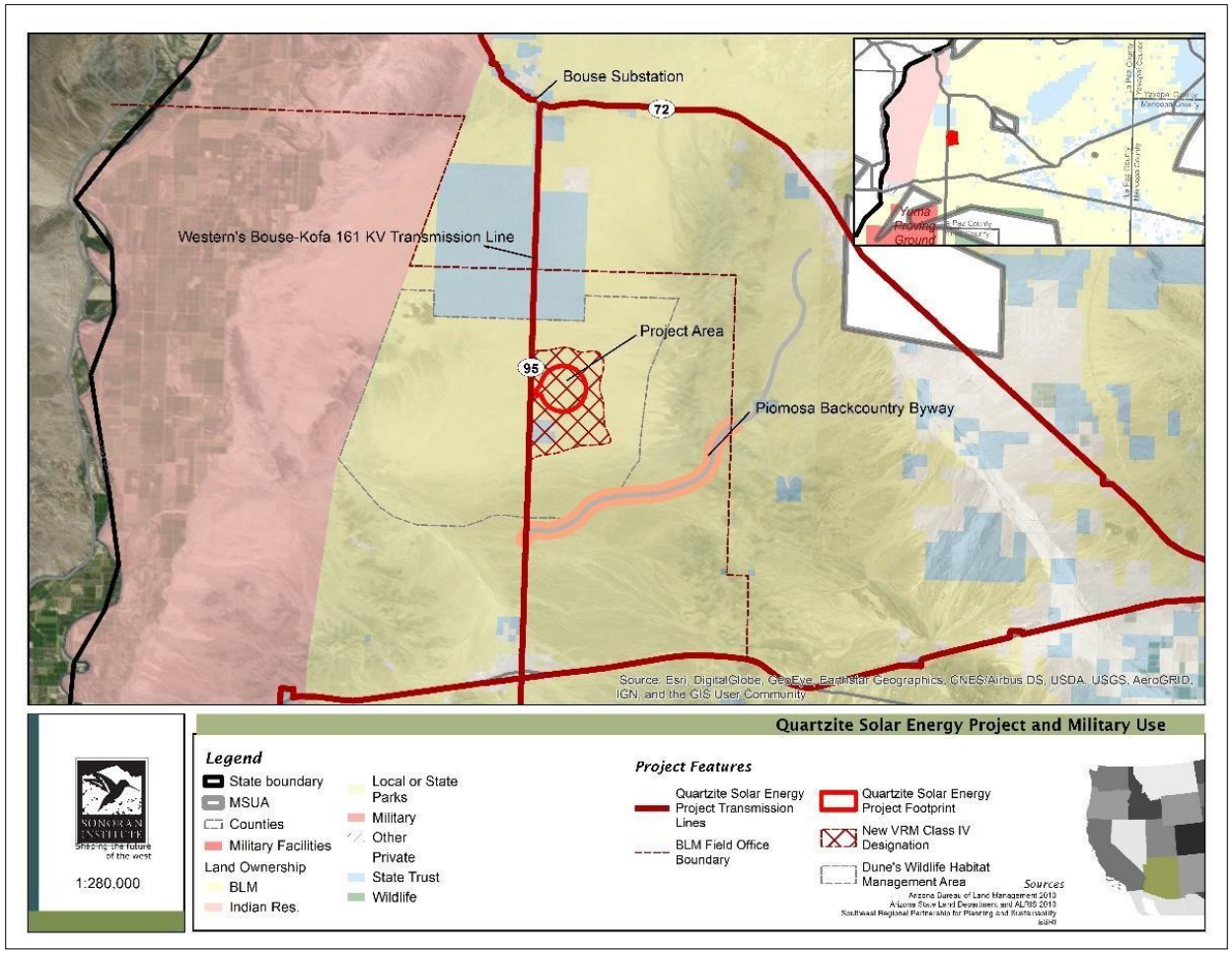
1 Interview with Andrew Wang
2 http://www.acq.osd.mil/dodsc/
3 Interview with Mike Hamilton
4 Interviews with Mike Hamilton and Eddie Arreola
5 Interview with Mike Hamilton

Map of Quartzsite Solar Project (Record of Decision, BLM 2013)



Direct Encroachment

Direct encroachment is a condition where an action, proposed action, or an action's direct impacts will impair a military installation or its mission by interfering with operations. The project raised a few specific encroachment concerns that had to be addressed prior to receiving resolution from the appropriate military office. They can be placed into three areas of concern:

- **Vertical obstruction**. The proposed 653-foot tower that is the central feature of the project would create a vertical obstruction if placed within an MTR[6]. As originally proposed, the 24,000-acre site was partially within military training airspace. The final site of 1,600 acres was sited so as to eliminate the possibility of overlap.[7]

- **Thermal plume**. The extreme temperature of the project tower would create a thermal plume that could interfere with military testing and training operations. Though this concern was raised, the finding was that the project posed no measurable risk.[8]
- **Light pollution**. There was some concern that the tower could create pollution from the glow of the heat on the top of the structure or from security lighting. The deserts in this area are dark and provide a realistic environment for testing at night. This concern was addressed satisfactorily.[9]

Indirect Encroachment

Indirect encroachment is a condition whereby an action, proposed action, or the likely results from an action or proposed action will cause impairment or impose a greater burden on a military facility through increased oversight, regulation and/or cos.

No known concerns of indirect encroachment were raised in connection with the project. Though habitat for the Mojave fringe-toed lizard was impacted, and mitigation was required, there were no populations of this species under management near the project site.

Perceived Encroachment

Perceived encroachment refers to conditions whereby an action or proposed action may trigger an increased level of scrutiny or the perception of impairment to a military facility even if there is no evidence of direct or indirect encroachment. No known concerns of perceived encroachment were caused by the QSE project.

Regulatory Process

The National Environmental Policy Act was established in 1970 and it requires executive federal agencies to prepare Environmental Assessments (EAs) and Environmental Impact Statements (EIS) that state the potential impacts to the environment as a result of federal actions. The Draft EIS was released in November 2011, Final EIS in December 2012, and the Record of Decision (ROD) occurred in May 2013 (BLM. 2016). The project was approved through a ROD dated May 2013. Today, there are no known issues associated with the encroachment.

The project required a land use plan amendment through the BLM and an EIS to facilitate the amendment. It additionally required an interconnection to WAPA's transmission system at the Bouse-Kofa 161 kilovolt transmission line.[10] The EIS studied both the interconnection and the proposed change from a Visual Resource Management Class III to Class IV, to support an energy generating facility of this magnitude.

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6 "U.S. Marine Corp Comment No. 2-1 Received the lat/longs and the project will not have an impact on our mission, it does fall within the northern side of the MTR so we will require proper lighting and notification of all phases of construction. Response to U.S. Marine Corp Comment No. 2-1 Comment noted. QSE will be required to comply with all applicable Federal Aviation Administration lighting regulations, and will continue to confer with the Department of Defense and provide the requisite notifications."

7 Interviews with Kevin O'Berry, Andrew Wang, Eddie Arreola, and Mike Hamilton

8 Interview with Mike Hamilton

9 Interview with Mike Hamilton

10 BLM Arizona. Draft Environmental Impact Statement for the Quartzsite Solar Energy Project and Proposed Yuma Field Office Resource Management Plan Amendment. BLM Arizona. Retrieved at https://www.blm.gov/style/medialib/blm/az/pdfs/energy/qsep/deis.Par.57056.File.dat/Intro.pdf

Summary

Through the series of interviews conducted in connection with this case study, the following conclusions can be made to support the use of the AME-UP tool:

There is a need for additional information to identify encroachment at an earlier stage of the siting and permitting process. Representatives from the military community, land management agency, and energy industry agreed unanimously that would be helpful to have information on a public platform that can inform the siting of energy projects prior to engagement in a formal permitting process. Having the appropriate contact information for relevant stakeholders and agencies would be valuable. Although the FAA eventually reached the appropriate contacts in the military community, a faster and more direct and streamlined process would have benefit all parties involved. Fortunately, the OSD Energy Clearinghouse facilitates these requests today. The Clearinghouse was not in place in 2011 when the project was in scoping process. There should be a procedure for the vetting of the full range of encroachment concerns voice by the military. In this case study, the following concerns were identified that were evaluated by military personnel: light pollution, vertical obstruction in military airspace, thermal plume, and impacts to endangered species. It would be helpful to incorporate information about these potential conflicts into a mapping resource. There is value in using a shared resource. It was noted that various agencies have their own data and that there are sometimes differences in that data among agencies. Having a common map that is recognized across federal, state, and local agencies that all could reference to identify and resolve potential concerns would be valuable.

Lastly, there is a need for a clear metric, such as a map, that would identify an easy-to-understand system where green was clear of concern, yellow raised an issue that could possibly be addressed through dialogue with the appropriate military agency, and red would note a serious challenge that may not be resolvable through coordination. Similar maps have been completed for specific regions and issue related concerns, but having a consolidated database map would lead to an improved ability to identify and mitigate potential conflicts with the military.

A tool such as the one being developed as part of the AME-UP project would be valuable to project Proponents such Western who are involved in delivering power projects. It is critical that a tool such as this becomes accepted and used as a baseline of information, so private and public proponents of projects can have the necessary resources to identify and anticipate issues, conflicts, opportunities and develop strategies to reduce the risk of encroachment to military s and operations in the state of Arizona.

SunZia Southwest Transmission Project

A Case Study for the Arizona Military Energy & Land Use Plan (AME-UP)

"The SunZia project is a case study on how not to do NEPA and how not to deal with the military."

- Command Group Representative, White Sands Missile Range

"From a developer's perspective, the tool will only be as good as the data that the military provides."

- Assistant Project Manager, SunZia Southwest Transmission Project

Introduction

In December of 2010, the cooperating agencies involved in the SunZia Southwest Transmission Line Project (Project) as it relates to White Sands Missile Range (WSMR) in New Mexico and Fort Huachuca in Arizona were assembled to begin the process of scoping appropriate routes for the lines to be constructed. As a result of this scoping exercise, agencies including the US Fish and Wildlife Service, US Forest Service and White Sands Missile Range made recommendations to the Bureau of Land Management (BLM), the lead agency in the NEPA process, for alternative routes on the basis that the routes proposed by the applicant, SunZia, traversed sensitive areas and would jeopardize military training activities and areas of conservation concern. These alternatives were included in the Draft EIS which reflected the proponent's alternatives as the agency's preferred alternative.

Case Study Overview/Purpose

The purpose of this case study is to describe the scoping process and planning of the SunZia project, which traverses public and private lands, to inform the development of an online mapping tool for use in the planning process for energy projects near

STAKEHOLDER INTERVIEW

Douglas Dobbin, Planner with Plans Group at White Sands Missile Range: Douglas is a primary point of contact between WSMR and SunZia for the "Plan of Development".

Tom Finnegan, Co-Chair of State Military Affairs Commission: Tom has been involved from the beginning of the project and made recommendations on behalf of the Arizona State Military Affairs Commission.

Cindy Freeman[1], Assistant Project Manager, SunZia Southwest Transmission Project: Cindy was involved in the development of applications for permitting and assisted Tom Wray in managing the scope, schedule and budget for this project.

Dan Hicks, former Chief of Staff at White Sands Missile Range: Dan worked at White Sands Missile Range for 34 years and, as "Number 2" in the Command Group, was the main representative of the command position.

Matt Walsh, Executive Liaison for Command Group at Fort Huachuca: Matt collated input from various stakeholders near the project area and to generate a single aggregate response.

Tom Wray, Project Manager for SunZia Southwest Transmission Project: Tom reported to the development committee on the project and managed the scope, schedule and budget of the project, focusing on pre-construction, licensing and permitting.

1 This interviewee has not provided feedback on our interview and as such

military installations. Several key players in the process have been solicited for interviews, and in connection with this case study, including military personnel from WSMR, Fort Huachuca and the project applicant, SunZia.

This case study is valuable as it shows how engaging the military early and continuously in the scoping process is an important component of the route alternative selection process. The military (Fort Huachuca and WSMR) identified during the formal scoping process the potential conflicts with the route alternatives presented by the BLM and the project proponent. Additionally, during the NEPA scoping process other federal agencies recommended that the BLM look at alternatives to mitigate their concerns about resource impacts.

In addition to the concerns of the military, comments were received from the public during the scoping period which ranged from objections to the need for the project, concerns with the large size of the project footprint, impacts the project would have on environmentally sensitive areas and local communities, and requests the lines be placed underground to avoid visual and biological impacts. None of these comments resulted in a change to the BLM's preferred route alternative.

Project Overview

The overarching purpose of the SunZia project is to increase transmission capacity in the region, which would relieve transmission congestion and allow for additional electricity to be generated and transported to western power markets in the Desert Southwest. The preferred alternative route selected by BLM is approximately 515 miles long, and other alternative routes range between 460-542 miles in length. The line would originate at a new substation called SunZia East in Lincoln County, New Mexico, and terminate at the Pinal County Substation in Pinal County, Arizona. Notably, this western terminus has received its regulatory permits and approvals and will be constructed by the Salt River Project and other entities. This is due to the fact that stand-alone structures such as this one do not fall under the same regulations or permitting procedures as the transmission line(s) that tie into it. Additionally, three intermittent substations on private or state lands would also be constructed: Midpoint Substation in Luna County, NM; Lordsburg Substation in Hidalgo County, NM; and Willow-500 kV Substation in Graham County, AZ. The transmission project would feature two new, single-circuit 500 kV transmission lines located within a right- of-way up to 1000 feet wide.

The typical span between towers for such a line is 1,400 feet, which means that three to four towers per mile would be required for each of the two lines. These tower structures range between 100-175 feet in height. In total, the project would run through the following counties: Grant,

Hidalgo, Lincoln, Luna, Sierra, Socorro and Torrance counties in New Mexico and Cochise, Graham, Greenlee, Pima and Pinal counties in Arizona. This is notable because the communication between county planning and zoning personnel and the military installations in question varied widely and contributed to a lack of understanding and increased conflict in New Mexico over potential impacts on WSMR and the Northern Expansion Area (NEA) in Socorro County. In contrast, plans in Cochise County, Arizona, were run through Fort Huachuca for direct consultation and this communication prevented misunderstanding and headed off conflict in early stages of planning. The agencies and players involved in the scoping, planning and compliance process include:

- Bureau of Land Management (Lead Agency)
- Bureau of Land Management (Lead Agency)
- US Army Corps of Engineers
- Department of the Army, Fort Bliss
- Department of the Army, White Sands Missile Range
- US Air Force, Holloman Air Force Base
- US Fish and Wildlife Service
- US National Park Service
- Department of Defense Siting Clearinghouse, Office of the Deputy Under Secretary (Installations and Environment)
- New Mexico State Land Office
- New Mexico Spaceport Authority
- Arizona State Land Department
- Arizona Game and Fish Department
- Arizona Department of Transportation
- Department of the Army, Fort Huachuca
- Bureau of Indian Affairs

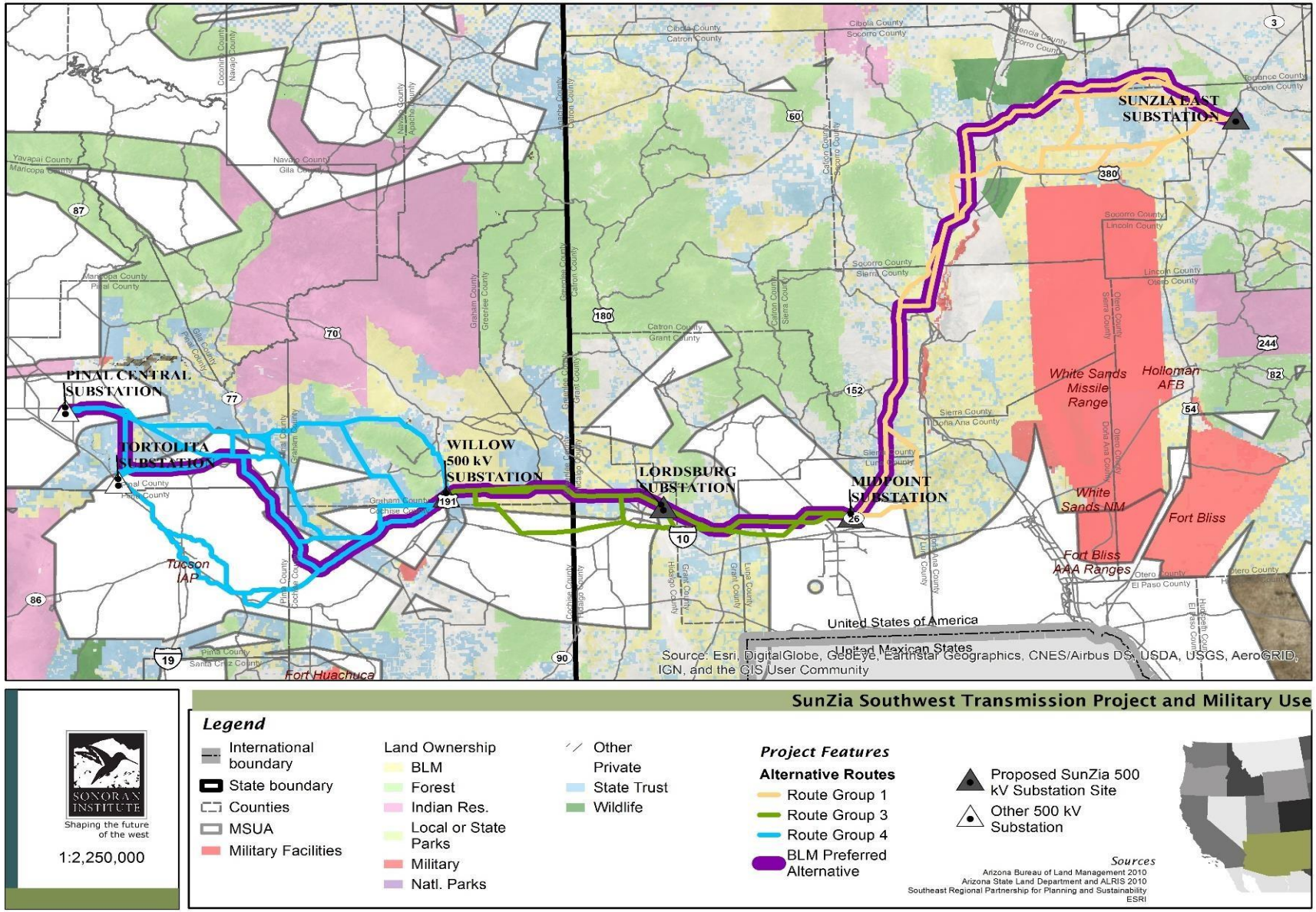
Direct Encroachment

Direct encroachment is a condition whereby an action, proposed action, or an action's direct impacts will impair a military installation or its mission by interfering with operations. The threat of direct encroachment as a result of construction of the transmission lines in the case of WSMR includes physical impediment to low-flying aircraft due to the height of the lines in the NEA. The area has no roads, no infrastructure, and no aerial lines above 35 feet high and the tallest building in the area is a 42-foot high launch pad. The construction of lines over 100 feet high and towers up to 175 feet high would present direct interference to low-altitude flights and could also cause damage to the lines themselves, thereby interrupting power transfer and causing greater maintenance and operational concerns. The NEA also note Areas of Conservation and Environmental Concern (ACECs) identified by the military, but this route remained the preferred

route by SunZia and BLM. In one military official's words, "The physical impediment of the transmission line poles was critical and a major obstacle in performing military operations."

Another direct encroachment concern was electromagnetic interference. This was an issue at WSMR and Fort Huachuca that was studied in depth, yet no conclusive results were obtained. In this regard, it would be useful to have a mapping and visualization tool that identified areas affected by the "tunnel of interference" created by the transmission lines (which is different than the corona effect) that would need to be circumvented by testing activities. In studies done at Fort Huachuca, personnel who were testing this environment had to be less than1.5 kilometers (km) from the lines for the threshold of interference that would be low enough for testing activities to occur, essentially creating a minimum 3km linear buffer zone along the length of the lines in the area in question that would have to be avoided by the military. A report produced by the DOD Siting Clearinghouse and others concluded that there were sources of interference and that the interference was strong enough to present negative impacts or encroachment to the military mission. However, no conclusive evidence was documented that could pinpoint the exact source of the interference. Incidentally, there was a study on the gradients of signal strength in another geographic area but this information was apparently not shared with Fort Huachuca.

Map of Proposed Route and BLM Preferred Alternative (Final EIS, May 2013)



At Fort Huachuca, another direct encroachment concern was the potential threat to the Buffalo Soldier Electronic Proving Grounds, which are not located on the Fort but are used to fulfill its military mission. Situated in a high-elevation bowl among mountain ranges, the proving grounds consist of no transmission lines, cell towers or solar arrays. While the initial construction of the proposed lines may or may not have presented a direct obstacle, the fear among staff at the Fort was that the project might create a new corridor where other elements could be constructed in the future that threatened military goals. In the words of one official, "What else will be hung on the lines and how will it be used for other purposes in the future? This could introduce unknown and/or unforeseen consequences from energy generation such as unseen electronic waves and electromagnetic interference. It's like putting in a road, which will inevitably be followed by houses, infrastructure development, etc."

In 2014, a joint program called Sentinel Landscapes was started among federal agencies including DOD, US Department of Agriculture and US Department of the Interior. A Sentinel Landscape is a large landscape anchored by a military installation and in conjunction with conservation and protected lands to identify conservation "hotspots" near military installations at the landscape scale. Thus far, only five Sentinel Landscapes have been designated throughout the country, one of which is anchored by Fort Huachuca. Two of the three critical testing areas used in the electronic proving grounds near Fort Huachuca fall within this landscape yet face the threat of encroachment from the transmission lines.

This is notable because it is a major issue in terms of encroachment, though it is not a physical barrier that can be seen on the landscape. In terms of incorporating this element into a mapping tool, which would likely be very valuable to installations that require this type of electronic proving, some degree of confidence in the "tunnel" of interference, including its voltage levels, frequencies and energies that might be created could be displayed as a buffer around the prospective corridor based on sound science and testing.

Indirect Encroachment

Indirect encroachment is a condition whereby an action, proposed action, or the like results from an action or proposed action will cause impairment or create a greater burden on a military facility through greater oversight, regulation and/or cost. In the case of WSMR and the NEA, the installation involves contractual agreements with the ranchers and residents who own and live on the lands where testing occurs. During construction of the lines and into the future with maintenance activities on the lines, the applicant wanted its personnel to have the same access to these areas as the landowners and also be able to live on these lands for days or weeks at a time during the course of the work.

This created a lot of tension and neither the landowners nor the installation wanted this to occur and was not apprised of this desire on the part of the applicant, whereas the applicant had planned for this as part of the project's logistics with expectations and the assumption that it would be permissible. This may not present an impact on the activities of WSMR in and of themselves, but access to the lands that they do not own and access to these lands via contractual agreements with private landowners could become compromised and thus jeopardize the fulfillment of its mission as well as affect long-term relationships with its neighbors.

Regulatory Process

The National Environmental Policy Act was established in 1970 and it requires all federal agencies to prepare Environmental Assessments (EAs) and Environmental Impact Statements (EISs) that state the potential impacts to the environment as a result of federal actions. In the case of the SunZia project, this process began on May 29, 2009, when the BLM published its notice of intent to prepare the EIS for this project. The BLM's purpose and need for the project is established by regulatory obligations and directives and current energy development trends.

In May 2012, the Bureau of Land Management (BLM) published its draft Environmental Impact Statement (EIS) for the construction of the SunZia electrical transmission line project that would transfer renewable energy supplies from north-central New Mexico to load centers in southern Arizona.

While the agency scoping process was followed, the necessary ongoing and continuous collaboration and consultation required to address and mitigate agencies concerns and evaluate and provide analysis of the WSMR recommended alternative alignments were not pursued by the BLM.

Despite the early engagement of the various agency stakeholders in the scoping process and the identification of an acceptable route alternative, the Draft EIS did not include the recommendations from agency stakeholders and the WSMR. Upon review of the Draft EIS by the WMSR, comments were registered with the BLM which expressed concern that the Draft EIS did not address concerns regarding impacts to the mission, need to meet safety requirements and did not include an alternatives analysis that captured reasonable alternatives instead it eliminated reasonable alternatives that were proposed by the WSMR. The Department of Defense (DOD), who had not been involved in the agency scoping process, responded to the Draft EIS in November 2012. The DOD registered serious concerns with the project and offered mitigation options pertaining to an area that is designated as restricted and special use airspace by WSMR. This area, known as the Northern Expansion Area (NEA), is used for a range of military activities

including electromagnetic testing and low-flying aircraft and would be traversed by the transmission line per the BLM's preferred alternative. Areas within the NEA are privately owned, yet controlled by the DOD through a formal agreement with the Federal Aviation Administration (FAA).

In March 2013, the Under Secretary of Defense for Acquisition, Technology and Logistics objected to the routing through the NEA in the BLM's preferred alternative and again offered mitigation options. As a result of this objection, a Technical Working Group was convened in April 2013 to consider the concerns from DOD and examine other suitable routing options. Two months later, in June 2013, the BLM published the Final EIS which retained the route through the NEA despite objections from DOD and the ongoing efforts of the working group which was composed of DOD subject matter experts and the Department of Energy's Idaho and Pacific Northwest National Laboratories.

The publishing of a Final EIS in June 2013, resulted in a period of intense negotiations, conversations and subsequent studies examined the possibility of burying a portion of the transmission lines in the NEA to avoid conflict with testing activities as well as the commissioning of an independent study to assess the DOD's mission-related concerns related to the effects of transmission lines on low-altitude flights particularly those involving threat-representative cruise missile target drones. The report concluded that the transmission lines could present an obstruction to low-altitude test flights and that these low-altitude flights could result in damage to the lines as well.

As a result of the independent study and one conducted by the project proponents, the Secretary of Defense determined that a five-mile portion of the transmission lines needed to be buried and, in June 2014, DOD informed the Department of Interior that three segments totaling at least five miles of buried lines were necessary to ensure that low-altitude flights in the NEA could continue without obstruction. The applicant agreed to bury the lines at a higher cost rather than explore the alternative route options suggested by DOD. This alternative was accepted by the BLM who then began an Environmental Assessment (EA) to identify and assess new impacts that might result from the burial of the lines. Subsequently the Record of Decision was issued in January 2015.

By all accounts, a mapping and visualization tool would be a valuable asset in all phases of planning for a project such as this –particularly in the early stages of scoping – but more importantly is the need for continual engagement with federal and cooperating agencies, on a national and local level, to ensure issues and concerns are heard, addressed, examined, evaluated

and analyzed and mitigation solutions and recommendations are communicated back to the federal stakeholders and cooperating agencies.

Perhaps a tool such as this could present the information gathered from all federal stakeholders and land managers on an objective level and allow project proponents to understand the issues, concerns and potential impacts to resources and evaluate the tradeoffs to selecting a route alternative.

Additionally, this tool could be very useful if it could incorporate information on every type of interference. Some types of interference may not be suitable for public consumption because they involve classified or sensitive information or may not lend themselves to easy integration into the tool, such as electromagnetic interference. However, information about such types of interference could be extremely useful for potential power companies when they are deciding to avoid an area because military testing is going on at various altitudes. In other words, the tool would need a sort of "y-axis" to complement the "x-axis" of features on the ground and express various heights and "invisible" barriers that compromise the military mission.

Summary

The most significant opportunity to improve the line siting process is associated more closely with the BLM NEPA process. It is critical for the applicant and the cooperating agencies to have a climate of cooperation and integrity in terms of adherence to the NEPA process itself. From the military perspective, improved and consistent communication and an understanding of mutual perspectives would have led to better solutions for all parties concerned and resulted in the project being finalized in a shorter time frame. Having a mapping tool is one thing, but having early and ongoing discussions is critical.

As an update to the project, the issues at WSMR and Fort Huachuca have not been resolved. The burial of lines in the NEA at White Sands is scheduled to happen on private lands and the logistics of construction activities and personnel in proximity to private homes and ranches has not been fleshed out. The degree to which the lines that intersect areas of military exercises will interfere with electronic testing is currently unknown at both installations, despite studies that have been completed by military personnel and outside researchers. The issue of greatest concern that cannot be addressed because it is not yet known are forthcoming threats that DOD must respond to through new technology and/or activities and how these new developments in operational function will be impacted not only by existing lines and structures, but also additional elements that would make use of the corridors cleared by the SunZia project.

Legal Landscape

Troy Rule, Professor of Law
Sandra Day O'Connor College of Law

A primary goal of the AME-UP web tool is to help the DOD and private developers to avoid disputes and costly litigation over military-imposed airspace restrictions affecting renewable energy development. Many utility-scale renewable energy projects feature tall towers or wind turbines sited in remote locations where military personnel have historically conducted training operations. Such projects can thus create conflicts between the DOD and developers over use of the land and low-altitude airspace involved.

Although the DOD is empowered to restrict activities on private property as necessary to conduct its operations and protect national safety and security, the United States Constitution requires the DOD to pay just compensation to private citizens whenever such restrictions effectively take private property. In some instances, a DOD restriction on low-altitude airspace that is imposed solely to preserve that airspace for a government use can raise challenges under the Takings Clause of the Fifth Amendment to the U.S. Constitution. The Takings Clause prohibits governments from taking "private property. for public use, without just compensation." Well-established case law and decades of eminent domain proceedings involving airspace are strong evidence that low-altitude airspace rights are indeed "property" under the Takings Clause. Accordingly, the DOD risks triggering compensable regulatory takings when it severely restricts renewable energy development on private property solely to protect airborne military activities.

Low-Altitude Airspace as Private Property

Private landowners have long held property interests in the low-altitude airspace above their land. As the following article excerpt describes, property laws have long recognized landowners' interests in the airspace immediately above their land:

> …The origins of modern airspace law date as far back as the 1300s, when the Italian jurist Cino da Pistoia wrote, "*Cuius est solum, eius est usque ad coelum*," or "[to] whomsoever the soil belongs, he owns also to the sky." This simple "*ad coelum* doctrine" distributes airspace rights based on ownership of the surface land situated immediately below the space. The doctrine appeared in Coke's commentaries and in Blackstone's commentaries, securing its place within English and American common law...

> The United States Congress and the courts clarified the scope of landowners' airspace rights in the early twentieth century when airplanes began taking to the skies. Federal legislation enacted during that period carefully defined "navigable airspace," which generally encompasses all space situated more than 500 feet above the ground, and designated that space as a nationally-shared common area for modern flight. Although the Supreme Court acknowledged navigable airspace legislation in *United States v. Causby* in 1946, characterizing navigable airspace as a "public highway" for air travel, the Court emphasized that landowners still held property interests in the non-navigable airspace above their parcels. In the Court's words, a "landowner owns at least as much of the space above the ground as he can occupy or use in connection with the land[,]" and the "fact that he does not occupy it in a physical sense—by the erection of buildings and the like—is not material" to determining the scope of ownership. In the decades since *Causby*, courts' frequent recognition of private airspace rights in the context of view easements, condominium laws, and solar access easements has left little doubt that rights in non-navigable airspace are a legitimate form of property and that sub-adjacent landowners inherently possess those rights.
>
> * * *
>
> Courts' unwavering treatment of airspace rights as property under eminent domain law is further evidence that landowners hold property interests in the non-navigable airspace above their land....
>
> Public agencies routinely pay just compensation to acquire airspace interests through eminent domain, engaging in essentially the same process they use to take interests in surface land. For instance, governments have been condemning airspace easements near airports for flight paths since shortly after the advent of modern aviation. Most airplanes require lengthy stretches of low-altitude airspace for takeoffs and landings, so takings of airspace easements through eminent domain often accompany airport construction and expansion projects…T[he] long history of airspace easement condemnations is further evidence that airspace rights are legally protected property under the Takings Clause.

Troy A. Rule, *Airspace and the Takings Clause*, 90 WASH. U. L. REV. 421, 426-29 (2012).

In sum, private landowners hold legally cognizable property rights in the low-altitude airspace immediately above their land, including rights against government takings.

Regulatory Takings Risk

Because landowners hold property interests in the low-altitude airspace above their parcels, DOD restrictions on renewable energy development imposed solely to preserve low-altitude airspace for military use can potentially trigger compensable takings under the Takings Clause. The Nevada Supreme Court found a regulatory taking under a comparable set of facts in *McCarran International Airport v. Sisolak*, 137 P.3d 1110 (Nev. 2006). In that case, private owners of land near the McCarren International Airport in Las Vegas sought compensation from Clark County, Nevada, for new municipal height restrictions that the County imposed to accommodate the airport's expansion. Even though the restricted airspace above portions of the landowners' private property was outside of the airport's new runway flight path and planes would only unintentionally traverse it on rare emergency situations, the majority in *Sisolak* held that the restrictions triggered a compensable regulatory taking. The majority seemed to attach relevance to the fact that the height restrictions compelled the landowners below to give up possessory use of the affected airspace so that it could serve a specific public use.

The facts in *Sisolak* are closely analogous to those of instances when the DOD seeks to prohibit renewable energy development on private land because of potential impacts on airborne military activities. It is therefore prudent for the DOD to be cognizant of and respect the limits on its authority to restrict private land uses. Even when conflicts with developers do not end in takings litigation, they can create unnecessary expense for the DOD and potentially erode goodwill. Such was the outcome when the DOD aggressively sought to restrict the development an Oregon wind energy project. To quote from a book describing that project:

> One of the most highly-publicized clashes between a wind energy developer and U.S. military interests involved the $2 billion Shepherds Flat project in the U.S. state of Oregon in 2010. When the Shepherds Flats project was announced, it promised to be the largest wind farm in the country, involving more than 300 commercial-scale turbines. Less than two months before its developer planned to break ground on the project, the [Federal Aviation Administration (FAA)] issued a [Notice of Presumed Hazard (NPH)] that prohibited the erection of any turbines in the vast project area.
>
> The FAA's objection to the Shepherds Flat project was based on concerns from the US Air Force that the project could interfere with its antiquated radar station in Fossil, Oregon, about 50 miles away. Delays associated with the FAA's NPH threatened to kill the enormous project, which had already been nine years in the making. After senators from the state of Oregon and members of President Barack Obama's cabinet put significant

> pressure on the DOD, military officials ultimately retracted its objections to the Shepherds Flat project, enabling it to proceed.
>
> In many cases, military interests can easily avoid conflicts between their radar and private wind energy development by installing relatively inexpensive upgrades to aging radar systems. With the help of researchers, the DOD ultimately concluded that such upgrades could prevent radar interference problems near the Shepherds Flat project. The UK has also been upgrading its radar systems to prevent interference with wind energy development. Studies have shown that the cost of such radar upgrades is often far less than a wind farm's potential benefits…

Troy A. Rule, SOLAR, WIND AND LAND: CONFLICTS IN RENEWABLE ENERGY DEVELOPMENT 34-35 (2014).

Recognizing the constitutional limitations outlined above, the Arizona state legislature established a "Military Installation Fund" in 2004 to help fund the government's acquisition of private property rights by eminent domain or otherwise to help preserve activities at existing military installations in the state. *See generally* ARIZ. REV. STAT. § 26-262 et seq. (2015). The statute that established this fund specifically requires that 80% of it be spent on such activities as the "[a]cquisition of private property for the purpose of preserving a military installation" and on the "preserving [of] real estate from development…in…accident potential zones…and in areas as required to support a military installation." ARIZ. REV. STAT. §§ 26-262G.1(a)-(b) (2015). In instances where a conflict between DOD activities and a proposed renewable energy project on private land is not resolvable through voluntary negotiations, eminent domain proceedings funded at least partially through this fund might provide the DOD an alternative means of resolving them.

The AME-UP Web Tool as a Preventative Strategy

The AME-UP web tool is appealing in that it can help the DOD and developers to avoid conflicts over renewable energy development before the conflicts even arise. The web tool gives developers access to convenient and detailed information about potential military-related conflicts much earlier in the development process. It will also help to steer developers away from the most conflict-prone geographic areas of the state and will promote the early communication with DOD officials necessary to sidestep or mitigate conflicts before they ripen into contentious disputes.

Economic Impact Studies

Economic Impact of Arizona's Planned Renewable Energy Projects

Introduction

With abundant wind, sunshine and vacant land, Arizona is among the most attractive states for renewable energy development. Utility-scale renewable energy projects bring capital investment, jobs and additional tax revenues to Arizona's economy. A detailed assessment of such economic impacts can help stakeholders to look beyond energy production to see the bigger picture around these projects.

This report seeks to assess the state-level economic impacts of 21 planned or existing renewable energy projects in Arizona. Impacts examined in this report include job creation, tax revenue and business activity (such as land leasing, material purchasing and service purchasing). The report first introduces the basic methodology, data, and assumptions used and then presents the results.

Methodology

This report uses the Jobs and Economic Development Impact (JEDI) models to assess economic impacts of renewable energy projects in Arizona.

The JEDI Models were developed by MRG & Associates for the National Renewable Energy Laboratory (NREL). They are spreadsheet tools that estimate the economic impacts generated from the construction and operation of renewable power projects. For example, building a photovoltaic power plant not only increases demand for solar panels; it also increases the demand for construction labor, transportation services and other supply inputs. After the plant starts operating, it generates long-term jobs, revenue, and other economic benefits.

To estimate the economic impact of a project, the JEDI models apply standard input-output multipliers and local consumption and employment patterns. Multipliers and pattern data used in JEDI models are provided by Minnesota-based IMPLAN Group. These multipliers and patterns estimate the overall scale of economic impacts as a function of project size.

The injection of capital into a project usually triggers several rounds of spending and employment that result in an overall impact to local employment, output, and resident income. As income and employment rise, so does local spending (Implan 2004). Through this mechanism, investment on one renewable energy project can cause a ripple effect that benefits other sectors of local economy, some of which are distant from the project.

In addition to the multipliers, the JEDI model also uses data about the costs of building and operating renewable energy plants and consumption data on spending patterns associated with the project. Such data and patterns are used as initial inputs to estimate economic activities generated by a project.

Data and Assumptions

This report assesses four different types of energy projects: onshore wind energy projects, utility-scale photovoltaic (PV) solar energy projects, concentrated solar power (CSP) projects and transmission lines. Each type of project is analyzed using a specified JEDI model. Each model requires a unique set of descriptive data and uses a distinct set of assumptions.

One common parameter required by all models is the construction date. Most planned projects in our research do not yet have a specific start date. Developers of some of them have obtained an Environment Impact Statement (EIS) from either the Arizona Corporation Commission (ACC) or the Federal Bureau of Land Management (BLM). Some are still in the process of applying for an EIS. Other projects only exist as initial plans or blueprints. To make estimated impacts comparable, we use a general assumption that construction will start in 2017 for all such planned projects.

Another set of important parameters used by all JEDI models is called the "local share". The local share represents the percentage of any given expenditure spent within the state where the project is sited. Detailed local spending shares are usually regarded as business secrets and hard to find. When data for these parameters are not available, the analyses in this report use the default assumptions of the JEDI project. JEDI default inputs are generally representative of aggregate national industry averages and are derived from interviews with project developers, local government officials, utilities, and others in the power generation sector.

The projects assessed in this report are listed in Table 1 below:

Project Type	Project Name	Location	Status
Wind	Dry Lake Wind	Navajo County	Existing
Wind	Perrin Ranch Wind	Coconino County	Existing
Wind	Red Horse Wind	Cochise County	Existing
Wind	Mohave County Wind Farm	Mohave County	Planned
Wind	Boquillas Wind Project	Coconino County	Planned
Wind	Yavapai Ranch	Yavapai County	Planned
Solar PV	Agua Caliente	Yuma County	Existing
Solar PV	Arlington Valley	Maricopa County	Existing
Solar PV	Mesquite Solar	Maricopa County	Existing
Solar PV	Sonoran Solar	Maricopa County	Planned
Solar PV	Maricopa Solar Park	Maricopa County	Planned
CSP	Solana Generating Station	Maricopa County	Existing
CSP	Crossroads	Maricopa County	Planned
CSP	Quartzsite	La Paz County	Planned
CSP	Harquahala Valley Solar Tower	Maricopa County	Planned
CSP	Environmission Tower	La Paz County	Planned
CSP	Solar Wind Down Draft Tower	Yuma County	Planned
CSP	Hualapai Valley Solar	Mohave County	Planned
Transmission	Centennial West	Northern AZ	Planned
Transmission	Sunzia Southwest Transmission Project	Southern AZ	Planned
Transmission	Southline Transmission Project	Southern AZ	Planned

Table 1: Assessed Projects

1. Onshore wind energy projects

To calculate economic impacts, the JEDI land wind model requires the following descriptive parameters of a land wind project: year of construction, number of projects, turbine size and turbine number. If not specifically provided, JEDI automatically calculates construction and operation/maintenance costs of the project. The basic information used in this assessment was gathered from various public information sources, including ACC and BLM reports, project websites and local government records.

According to NREL reports (Tegen, 2010), American Wind Energy Association reports (AWEA, 2015) and information available on online business catalogs, there is no manufacturer of utility-sized wind turbines in the state. This assessment therefore assumes that none of the turbines or ancillary equipment items comprising the projects would be purchased in-state. For assumptions regarding more generic purchases of construction materials, labor and services, we use the default assumption of the JEDI project.

The descriptive data of the assessed onshore wind energy projects are listed below in Table 2:

Name	Construction year	Capacity (MW)	Number of Projects	Turbine size (kW)	Construction cost ($/KW)
Dry Lake Wind	2008	127	1	2100	1587
Perrin Ranch Wind	2012	99.2	1	1600	2000
Red Horse Wind	2013	30	1	1875	3300
Mohave County Wind Farm	2013	425-500	1	1500-3000	1600
Boquillas Wind Project	2008	127	1	2300	787
Yavapai Ranch	Planned	99	1	1222	N/A

Table 2: Land Wind Projects

2. Photovoltaic (PV) Projects

To calculate economic impacts of a PV project, the JEDI PV Model requires the following descriptive parameters: year of construction, project type (utility, large commercial, small commercial or residential), solar Module type (thin film or crystalline), system tracking (fixed mount or single axis), average system size and system number. If not specifically provided, JEDI automatically estimates construction and operation maintenance costs of the project.

The local spending shares for four of the five PV projects assessed in this report were not available. The Mesquite Solar Project purchased 70 of its 700 MW solar panels from the Suntech panel plant in Arizona before the plant was closed in 2013. For other projects, the assessments use the JEDI model's assumption that panels are purchased locally and manufactured out of state. For purchases of other construction materials, labor and services, the assessments use the default assumptions of the JEDI project.

The descriptive data of the assessed PV projects are listed below in Table 3:

Name	Construction Year	Capacity (MW)	Construction Cost ($/KW)	Material	Tracking
Agua Caliente	2011	290	6207	Thin film	Fixed
Arlington Valley	2011	250	N/A	Crystalline	Single Axis
Mesquite Solar	2011	700	4000	Crystalline	Fixed
Sonoran Solar	Planned	300	N/A	N/A	N/A
Maricopa Solar Park	Planned	300	N/A	N/A	N/A

Table 3 PV Projects

3. Concentrated Solar Power (CSP) Projects

To calculate the economic impacts of a CSP project, the JEDI CSP Model requires the following descriptive parameters: solar direct normal resource, year of construction and project capacity. If not specifically provided, JEDI automatically estimates construction and operation/maintenance costs of the project.

Solana, the only operating CSP project assessed in this report, purchased its reflective mirrors from the local company Rioglass, Inc. For other projects and expenditures, the assessments use JEDI default local share parameters. The assessments' data inputs on the solar direct normal resource were based on a database at solarenergylocal.com.

The descriptive data of the assessed CSP projects are list below in Table 4:

Name	Construction Year	Capacity (MW)	Solar Direct Normal Resource (KWh/m^2/day)	Construction Cost ($/KW)
Solana Generating Station	2010	280	7.54	7143
Crossroads	Planned	150	7.54	
Quartzsite	Planned	100	7.7	
Harquahala Valley Solar Tower	Planned	290	7.6	5000
Environmission Tower	Planned	200	7.7	
Solar Wind Down Draft Tower	Planned	600	7.43	2500
Hualapai Valley Solar	Planned	340	7.99	

Table 4: CSP Projects

4. Transmission Lines

To calculate the economic impacts of transmission lines, the JEDI Transmission Model requires the following descriptive parameters: year of construction, line type, line length (in state), terrain type and population density. For more accurate assessments, the assessments included detailed information about substations and rights of way (ROW) information when these were available. Otherwise, they used default JEDI parameters.

The descriptive data of the assessed transmission projects are listed below in Table 5:

	T-Line Status	Size	Line Length (Miles)	Terrain Class	Population Density Class	Substations needed	ROW
Centennial West	Planned	600KV DC	400	Flat/ Mountainous	Rural	1 new	N/A
Sunzia Southwest Transmission Project	Planned	500KV AC	200	Flat/ Mountainous	Rural	3 new	90% Public, 10% Private
Southline Transmission Project	2017	230KV AC and 345KV AC	230KV 120, 345KV 60	Flat/ Mountainous	Rural	10 upgraded	60% Public, 40% Private

Table 5: Transmission Lines

Assessed Economic Impacts

Economic impacts generated by the JEDI Model include fulltime equivalent jobs, earnings and economic output. Results are generated for two distinct periods: construction and operation. Each phase's results include three parts: onsite impact, supply chain impact and induced impact. The model generates the total impact of the construction period and the annual impact during the operation period of a project. All earnings and economic output data are expressed in 2015 dollars.

1. Onshore Wind Projects

The estimated economic impacts of the six land wind projects are shown in Tables 6-1, 6-2 and 6-3. The planned Mojave County Wind Farm project's capacity may range from 425 to 500 MW, so each of those two values were used to calculate a range of possible economic impact.

Jobs (job-year)	Dry Lake	Perrin Ranch	Red Horse	Mohave County	Boquillas	Yavapai Ranch
Construction						
On-site	78	68	46	211-249	79	66
Supply chain	232	228	114	782-920	247	193
Induced	151	148	75	505-594	161	126
Total	461	444	235	1,498-1762	486	385
Operation (Annual)						
On-site	7	6	3	19-23	7	9
Supply chain	8	6	2	27-31	8	7
Induced	7	6	2	24-28	7	6
Total	23	18	7	69-82	23	22

Table 6-1: Job impacts of wind projects

Earnings (Million $)	Dry Lake	Perrin Ranch	Red Horse	Mohave County	Boquillas	Yavapai Ranch
Construction						
On-site	$4.9	$4.3	$2.9	$13.5-15.9	$5.0	$4.2
Supply chain	$14.6	$14.3	$7.2	$49.1-57.8	$15.5	$12.1
Induced	$8.1	$7.9	$4.0	$27.1-31.9	$8.6	$6.8
Total	$27.6	$26.6	$14.1	$89.7-105.6	$29.1	$23.0
Operation (Annual)						
On-site	$0.5	$0.4	$0.2	$1.3-1.5	$0.5	$0.6
Supply chain	$0.5	$0.4	$0.1	$1.6-1.8	$0.5	$0.4
Induced	$0.4	$0.3	$0.1	$1.3-1.5	$0.4	$0.3
Total	$1.4	$1.1	$0.4	$4.1-4.9	$1.4	$1.3

Table 6-2: Earnings impact of wind projects

Output (Million $)	Dry Lake	Perrin Ranch	Red Horse	Mohave County	Boquillas	Yavapai Ranch
Construction						
On-site	$5.4	$4.8	$3.1	$15.2-17.8	$5.5	$4.6
Supply chain	$42.2	$41.5	$20.7	$142.3-167.4	$44.9	$35.0
Induced	$23.2	$22.7	$11.5	$77.6-91.3	$24.7	$19.3
Total	$70.8	$69.0	$35.4	$235.1-276.5	$75.1	$58.9
Operation (Annual)						
On-site	$0.5	$0.4	$0.2	$1.3-1.5	$0.5	$0.6
Supply chain	$2.4	$1.9	$0.6	$7.9-9.3	$2.4	$2.0
Induced	$1.2	$0.9	$0.3	$3.7-4,4	$1.2	$1.0
Total	$4.1	$3.2	$1.1	$12.9-15.2	$4.1	$3.6

Table 6-3: Output impact of wind projects

The six onshore wind projects were collectively estimated to support between 3,509 and 3,773 job-years during their construction phase and 162 to 175 jobs per year during their operation period. In aggregate, these projects were estimated to generate $210.1-$226.0 million in earnings and $544.3-$585.7 million of economic output for the state during construction. During operation, the estimated annual earnings and output were $9.7-$10.5 million and $29.0-$31.3 million, respectively. The results also reveal that most of the economic impacts generated by the wind projects were induced and supply chain impacts, which account for approximately 80% of the total impact.

The differences in results among the assessed projects were generally a function of differences in construction costs and operation costs. The primary driver of such differences is variations in project scale and turbine size.

2. PV Projects

The estimated economic impacts of the five PV project are shown in Tables 7-1, 7-2 and 7-3. The planned Sonoran and Maricopa Solar Park projects have not finished their final design, therefore it is not year clear whether they will use thin film solar panels or Silicon Crystalline solar panels. It is also not yet known whether those panels will be fixed at a specific angle or rotating around a single axis. The assessments therefore estimated their economic multiple times at two different scenarios: the cheapest thin film-fixed mount scenario and the most expensive crystalline-single axis scenario. This approach produced a range of possible construction costs. Neither the panel type nor the mounting type materially affects operation costs.

Jobs (job-year)	Agua Caliente	Arlington Valley	Mesquite	Sonoran	Maricopa Solar Park
Construction Phase					
On-site	6981	4664	10463	4366-5597	4366-5597
Supply Chain	4992	3451	6806	2787-4141	2787-4141
Induced	3807	2370	4831	1988-2844	1988-2844
Total	15779	10486	22100	9141-12583	9141-12583
Operation Phase					
On-site	52	46	129	55	55
Supply Chain	15	13	37	16	16
Induced	12	11	30	13	13
Total	78	70	196	84	84

Table 7-1: Job Impacts of PV Projects

Earnings (Million $)	Agua Caliente	Arlington Valley	Mesquite	Sonoran	Maricopa Solar Park
Construction Phase					
On-site	$450.7	$272.6	$621.0	$259.7-327.1	$259.7-327.1
Supply Chain	$316.5	$199.3	$393.7	$161.3-239.2	$161.3-239.2
Induced	$198.0	$123.5	$251.4	$103.4-148.2	$103.4-148.2
Total	$965.2	$595.4	$1266.2	$524.4-714.5	$524.4-714.5
Operation Phase					
On-site	$3.1	$2.7	$7.8	$3.3	$3.3
Supply Chain	$1.0	$0.9	$2.6	$1.1	$1.1
Induced	$0.6	$0.6	$1.6	$0.7	$0.7
Total	$4.7	$4.3	$11.9	$5.1	$5.1

Table 7-2: Earnings Impacts of PV Projects

Output (Million $)	Agua Caliente	Arlington Valley	Mesquite	Sonoran	Maricopa Solar Park
Construction Phase					
On-site	$672.0	$442.5	$946.7	$392.5-531.0	$392.5-531.0
Supply Chain	$764.2	$496.4	$983.1	$402.8-595.7	$402.8-595.7
Induced	$370.0	$231.8	$473.4	$194.9-278.1	$194.9-278.1
Total	$1806.1	$1170.7	$2403.2	$990.1-1404.8	$990.1-1404.8
Operation Phase					
On-site	$3.1	$2.8	$7.8	$3.3	$3.3
Supply Chain	$2.5	$2.3	$6.4	$2.7	$2.7
Induced	$1.1	$1.0	$2.9	$1.2	$1.2
Total	$6.8	$6.1	$17.0	$7.3	$7.3

Table 7-3: Output impacts of PV Projects

The five PV projects were estimated to support between 66,647 and 73,531 job-years during construction, and 512 jobs annually during operation. In aggregate, the projects were likewise estimated to generate $3875.6-$4257.6 million in earnings and $7360.2-$8189.6 million of

economic output for the state during construction. During operation the estimated annual earning was $21.3 million. Estimated annual local economic output was $30.4 million.

In comparison to the onshore wind projects assessed above, a much larger share (about 40%) of the total economic impacts generated by PV projects were attributable to on-site impacts. Supply-chain and induced impacts combined accounted for about 60% of the total impact.

3. CSP Projects

The estimated economic impacts of the eight CSP projects are shown in Tables 8-1, 8-2 and 8-3.

Jobs (job-year)	Solana	Crossroads	Quartzsite	Harquahala	Enviro-mission	Solar Wind	Hualapai
Construction Phase							
On-site	2752	1270	863	2383	1672	4769	2,774
Supply Chain	2591	983	668	1845	1294	3692	2,147
Induced	2197	917	623	1719	1206	3441	2,001
Total	7540	3170	2153	5947	4172	11,902	6,922
Operation Phase							
On-site	87	57	45	89	68	159	101
Supply Chain	54	36	28	55	44	87	61
Induced	28	19	15	28	22	46	31
Total	168	112	87	173	134	292	193

Table 8-1: Job Impacts of CSP Projects

Earnings (Million $)	Solana	Crossroads	Quartzsite	Harquahala	Enviro-mission	Solar Wind	Hualapai
Construction Phase							
On-site	384.1	177.3	120.4	332.6	233.3	665.7	387.2
Supply Chain	177.2	65.3	44.4	122.6	86.0	245.3	142.7
Induced	112.3	46.9	31.8	87.9	61.7	175.9	102.3
Total	673.6	289.5	196.6	543.1	381.0	1086.9	632.1
Operation Phase							
On-site	4.9	3.3	2.7	5.0	4.0	8.6	5.6
Supply Chain	3.2	2.2	1.7	3.3	2.6	5.2	3.6
Induced	1.5	1.0	0.8	1.5	1.2	2.4	1.7
Total	9.6	6.5	5.2	9.8	7.7	16.2	10.9

Table 8-2: Earnings Impacts of CSP Projects

Output (Million $)	Solana	Crossroads	Quartzsite	Harquahala	Enviro-mission	Solar Wind	Hualapai
Construction Phase							
On-site	490.5	226.4	153.8	424.7	297.9	849.9	494.3
Supply Chain	656.4	229.2	155.6	429.9	301.5	860.2	500.3
Induced	320.9	133.9	90.9	251.2	176.2	502.6	292.3
Total	1467.7	589.4	400.3	1105.7	775.6	2212.8	1286.9
Operation Phase							
On-site	4.9	3.3	2.7	5.0	4.0	8.6	5.6
Supply Chain	11.3	7.6	5.9	11.6	9.2	18.3	12.8
Induced	4.2	2.8	2.2	4.3	3.4	7.0	4.8
Total	20.4	13.8	10.8	20.9	16.5	33.9	23.2

Table 8-3: Output Impacts of CSP Projects

The seven CSP projects were estimated to support 30,094 job-years during construction, and 857 jobs annually during operation. In aggregate, these projects were estimated to generate $2.748 billion in earnings and $5.595 billion of economic output for the state during construction. During operation their estimated annual earnings were $48.6 million dollars. The estimated annual local economic output was $102.6 million dollars.

During the construction phase, about 35% of the jobs and economic output impacts of these projects were generated onsite and onsite earnings impacts accounted for approximately 50% of the total earnings impacts. During operation phase, onsite job and earnings impacts accounted for about 50% of total annual impacts, while the on-site economic output impact only accounted for about 20% of the total.

4. Transmission Projects

The estimated economic impacts of the three transmission line projects are shown in Tables 9-1, 9-2 and 9-3. The Arizona portion of the Southline project features 120 miles of 230KV AC line and 60 miles of 345KV AC line. The assessments in this report divided the Southline project into two parts with different voltages, estimating both with the JEDI transmission model and then adding results of the two parts together to generate an estimate of the entire line's impact.

Limited by the estimation option provided by JEDI, the assessments had to estimate the 600KV DC Centennial Project using parameters of a 500KV line. Compared to a 500KV DC transmission line, a 600KV line typically costs more and uses more land. Therefore, the economic impact of a 600KV line is likely more than that of a 500KV line. Accordingly, the estimated results of the Centennial Project are likely a lower-end baseline of actual economic impacts.

One important parameter used in estimating the economic impact of a transmission line is the type of terrain crossed by the line. The type of terrain involved can greatly affect the cost of building transmission lines. Unfortunately, terrain information was not available for the three projects assessed in this report. The assessments below therefore calculated a range of impacts by running assessments of the same project multiple times with different types of terrain. Terrain type does not materially affect operation costs.

Jobs (job-year)	Centennial	Sunzia	Southline
Construction			
On-site	2,608-3,366	1,575-2,068	675-877
Supply chain	510-656	299-395	147-190
Induced	914-1,124	439-577	213-275
Total	4,032-5,146	2,313-3040	1,035-1,343
Operation (Annual)			
On-site	33	16	14
Supply chain	9	5	4
Induced	9	5	4
Total	51	25	22

Table 9-1: Job impacts of transmission projects

Earnings (Million $)	Centennial	Sunzia	Southline
Construction			
On-site	$190.8-245.5	$113.6-149.6	$50.1-65.1
Supply chain	$32.0-41.1	$18.8-24.9	$9.3-12.0
Induced	$47.9-58.6	$22.5-29.6	$11.0-14.2
Total	$270.7-345.3	$154.9-204.1	$70.4-91.3
Operation (Annual)			
On-site	$2.5	$1.2	$1.1
Supply chain	$0.5	$0.2	$0.2
Induced	$0.5	$0.2	$0.2
Total	$3.5	$1.7	$1.6

Table 2: Earnings impact of transmission projects

Output (Million $)	Centennial	Sunzia	Southline
Construction			
On-site	$203.6-262.2	$119.8-158.0	$54.7-71.0
Supply chain	$89.0-114.3	$52.4-69.2	$26.0-33.7
Induced	$136.8-167.6	$64.4-84.6	$31.4-40.5
Total	$429.4-544.1	$236.6-311.9	$112.0-145.2
Operation (Annual)			
On-site	$2.5	$1.2	$1.1
Supply chain	$1.9	$0.9	$0.8
Induced	$1.5	$0.7	$0.6
Total	$5.9	$2.9	$2.6

Table 3: Output impact of transmission projects

The three assessed transmission projects were estimated to support between 7,380 and 9,529 job-years during their construction period and 98 jobs per year during their operation. In aggregate, these projects were estimated to generate $496.0-$640.7 million in earnings and $778.0-$1,001.2 million dollars of economic output for the state during construction. During operation, the estimated annual earnings of the projects was $6.8 million. The estimated local economic output of the projects was $11.4 million.

In both phases, onsite economic impacts accounted for more than 50% of the total impact generated by transmission projects. Onsite job and earnings impacts accounted for approximately two-thirds of the total impacts, while onsite output accounted for about half of total output impact.

Differences in results among projects were generally a function of variations in transmission line lengths and construction costs.

5. Running Projects

Seven of the 21 projects assessed in this report are already in operation. Accordingly, assessments were conducted to estimate the summary impact of these seven existing projects. The results are shown below in Table 10.

	Agua Caliente	Arlington Valley	Mesquite	Dry Lake	Perrin Ranch	Red Horse	Solana	Total
Construction								
Jobs	15779	10486	22100	461	444	235	7540	57045
Earnings	$965.2	$595.4	$1,266.2	$27.6	$26.6	$14.1	$673.6	3568.7
Output	$1,806.1	$1,170.7	$2,403.2	$70.8	$69.0	$35.4	$1,467.7	7022.9
Operation								
Jobs	78	70	196	23	18	7	168	560
Earnings	$4.7	$4.3	$11.9	$1.4	$1.1	$0.4	$9.6	33.4
Output	$6.8	$6.1	$17.0	$4.1	$3.2	$1.1	$20.4	58.7

Table 10: Economic Impacts of Running Projects

The seven running projects were estimated to have supported 57,045 job-years during construction, and 560 jobs every year during operation. In aggregate, these projects were estimated to generate $3.5687 billion of earnings and $7.0229 billion of economic output for the state during construction. During operation, the estimated annual earnings generated by these projects were $33.4 million. The estimated local economic output generated was $58.7 million.

6. Planned Projects

Fourteen of the 21 assessed projects are planned projects that are currently in various stages of development. Some projects, such as Southline Transmission Lines and Sonoran Solar Project, have already obtained EISs from regulatory agencies. Some others, such as the Enviromission Tower, exist only in concept. The estimated economic impacts of these projects are summarized in Table 11.

	Mohave County	Boquillas	Yavapai Ranch	Sonoran	Maricopa Solar Park	Crossroad	Quartzsite
Construction							
Jobs	1,498-1762	486	385	9141-12583	9141-12583	3170	2153
Earnings	$89.7-105.6	$29.1	$23.0	$524.4-714.5	$524.4-714.5	$289.50	196.6
Output	$235.1-276.5	$75.1	$58.9	$990.1-1404.8	$990.1-1404.8	589.4	400.3
Operation							
Jobs	69-82	23	22	84	84	112	87
Earnings	$4.1-4.9	$1.4	$1.3	$5.10	$5.10	6.5	5.2
Output	$12.9-15.2	$4.1	$3.6	$7.30	$7.30	13.8	10.8

Table 11: Economic Impact of Planned Projects

Harquahala	Enviromission	Solar Wind	Hualapai	Centennial	Sunzia	Southline	Total
5947	4172	11,902	6,922	4,032-5,146	2,313-3040	1,035-1,343	62297-71594
543.1	381	1086.9	632.1	$270.7-345.3	$154.9-204.1	$70.4-91.3	4815.8-5356.6
1105.7	775.6	2212.8	1286.9	$429.4-544.1	$236.6-311.9	$112.0-145.2	9498.0-10592.0
173	134	292	193	51	25	22	1302-1315
9.8	7.7	16.2	10.9	$3.50	$1.70	$1.60	76-76.8
20.9	16.5	33.9	23.2	$5.90	$2.90	$2.60	152.8-155.1

Table 11: Economic Impact of Planned Projects (cont'd)

The 14 planned projects, if fully constructed, were estimated to support between 62,297 and 71,594 job-years during construction and 1302-1315 jobs per year during operation. In aggregate, these projects were estimated to generate $4.815.8-$5.356.6 billion of earnings and $9.4980-$10.5920 billion of economic output for the state during construction. During operation, the estimated annual earnings generated by these projects were $76-$76.8 million. Estimated local economic output generated was $152.8-$155.1 million.

7. Lifetime impact analysis

The estimated running lifespan of an onshore wind energy project assessed in this report was 20 years (Slattery, 2011). PV Solar energy power plants' lifespan was estimated to be about 30 years (Fthenakis & Kim, 2010). CSP projects also had a lifespan of about 30 years (Burkhart, Heath & Turchi, 2011). Transmission projects could last longer with appropriate maintenance, but the land leases of these projects were all 50 years. Based on these additional assumptions, it is possible to estimate the lifespan economic impact of these renewable energy plants. The results of this analysis are shown below in Table 12.

	Dry Lake	Perrin Ranch	Red Horse	Mohave County	Boquillas	Yavapai Ranch	Agua Caliente
Jobs (job-year)	921	804	375	2878-3402	946	825	18119
Earnings (Million $)	55.6	48.6	22.1	171.7-203.6	57.1	49	1106.2
Output (Million $)	152.8	133	57.4	493.1-580.5	157.1	130.9	2010.1

Table 12: Lifetime Impact of Projects

Arlington Valley	Mesquite	Sonoran	Maricopa Solar Park	Solana	Crossroads	Quartzsite
12586	27980	11661-15103	11661-15104	12580	6530	4763
724.4	1623.2	677.5-867.5	677.5-867.6	961.6	484.5	352.6
1353.7	2913.2	1209.1-1613.8	1209.1-1613.9	2079.7	1003.4	724.3

Table 12: Lifetime Impact of Projects (cont'd)

Harquahala	Enviromission	Solar Wind	Hualapai	Centennial	Sunzia	Southline
11137	8192	20662	12712	6582-7696	3563-4290	2135-2443
837.1	612	1572.9	959.1	445.7-520.3	239.9-289.1	150.4-171.3
1732.7	1270.6	3229.8	1982.9	724.4-839.1	381.6-456.9	242.0-275.2

Table 12: Lifetime Impact of Projects (cont'd)

Total	Existing Total	Planned Total	Wind Total	PV Total	CSP Total	Transmission Total
177612-186171	73365	104247-112806	6749-7273	82007-88892	76576	12280-14429
11828.3-12385.5	4541.7	7286.6-7843.8	404.1-436.0	4808.8-5188.9	5779.8	836.0-980.7
23190.9-24311.6	8699.9	14491.0-15611.7	1124.3-1211.7	8695.2-9504.7	12023.4	1348.0-1571.2

Table 12: Lifetime Impact of Projects (cont'd)

During their lifetimes, the 21 assessed projects were estimated to support a total of between 177612 and 186,171 job-years. In aggregate, these projects were estimated to generate $11.828-$13.855 billion in earnings and $23.191-$24.312 billion of economic output for the state.

The seven existing projects were estimated to support 73,365 jobs. In aggregate, these projects were estimated to generate $4.5417 billion in earnings and $8.6999 billion of economic output for the state. The 14 planned projects were estimated to support between 104,247 and 112,806 jobs. In aggregate, these projects were estimated to generate $7.2866-$7.8438 million of earnings and $14.491-$15.612 billion of economic output for the state.

The assessed wind projects were estimated to support between 6749 and 7273 jobs. In aggregate, these projects were estimated to generate $404.1-$436.0 million dollars in earnings and $1.1243-$1.2117 billion of economic output for the state.

The assessed PV projects were estimated to support between 82,007 and 88,892 jobs. In aggregate, these projects were estimated to generate $4.8088-$5.1889 billion in earnings and $8.6952-$9.5047 billion of economic output for the state.

The assessed CSP projects were estimated to support 76,576 jobs. In aggregate, these projects were estimated to generate $5.7798 billion in earnings and $12.023 billion of economic output for the state.

The assessed transmission projects were estimated to support between 12,280 and 14,429 jobs. In aggregate, these projects were estimated to generate 836.0-980.7 million in earnings and $1.3480-$1.5712 billion of economic output for the state.

Conclusion

This analysis uses the NREL JEDI-Wind, JEDI-PV, JEDI-CSP, and JEDI-Transmission models to estimate the gross jobs, earnings, and economic outputs resulting from 21 planned or existing renewable energy projects in Arizona. Project-specific information about local purchase hiring percentages was used in the assessments when available. When such data was not available, the assessments used default parameters provided in the JEDI models.

In all, it is estimated that these projects would support between 177,612 and 186,171 job-years during their lifetime. In addition, it is estimated that these projects would generate $11.828-$12.386 billion in earnings and $23.191-$24.312 billion of economic output for the state during their lifetime.

In terms of total jobs, earnings, and economic output, the greatest impacts of these renewable energy projects analyzed here were generated during the construction and installation phase. This is due to the fact that these facilities are highly capital-intensive and require large amounts of land, capital and labor to build and install.

Because of the advanced technologies used in today's renewable energy projects, operation and maintenance of these projects does not require a large workforce and thus the total economic impact generated by these facilities during their operation is smaller than the total generated during construction. However, the jobs and associated earnings and economic output associated with operating the projects are expected to last throughout the projects' lifetimes (estimated to be 20–50 years).

During the construction phase, these projects were estimated to support between 119,342 and 128,639 jobs. In aggregate, these projects were estimated to generate $8.3845-$8.9253 billion in earnings and $16.521-$17.615 billion of economic output for the state.

During the operational phase, these projects were estimated to continue to support between 1,862 and 1,875 direct and indirect jobs and generated approximately $109.4-$110.2 million in earnings and $211.5-$213.8 million in economic output annually throughout their lifetimes.

Consistent with their shares of total project investment, CSP and PV projects account for the largest share of the economic impacts. Each accounted for approximately 40% to 45% of the total lifetime

impact of the assessed projects. Transmission projects accounted for about 8%, and wind projects accounted for about 5%.

Supply-chain impacts and induced economic impacts made up the majority of economic impacts generated by the wind, PV and CSP projects. For transmission projects, onsite impacts accounted for more than half of the total impact.

Baseline conditions in relation between current energy development and economic development in Arizona

Introduction

This report summarizes the current status of energy development in Arizona, including consideration of both renewable energy power plants and traditional fossil fuel-fired power plants. The report also reviews the existing literature on the relationship between energy development and broader economic development.

Review of Existing Literature

To assess the relationship between energy development and broader economic development in Arizona, this report estimates the economic impacts of existing Arizona power plants using Jobs and Economic Development Impact (JEDI) models. It also assesses the potential economic impacts of building new power plants, categorizing power plants in Arizona into five types by primary energy sources: water, coal, nuclear, gas and renewable energy.

The JEDI model has been extensively used for years to study multiple types of energy projects. Many informative research papers about the economic impacts of electricity production have been published. Goldber et al. (2004) and National Renewable Energy Laboratory (2004) introduced the JEDI model as an easy-to-use quantitative tool for measuring the economic impacts of various kinds of power plants. Regional Economics Applications Laboratory (2001) also studied the environmental and economic impacts of different types of energy resources. Tegen (2006) compared the economic impacts of natural gas, coal and wind power projects in Arizona, Colorado, and Michigan. World Bank (2011) published reports on the economic impacts of CSP energy projects in Middle East and North Africa.

The existing literature on the impact of nuclear power plants is limited and divided. Some literature focuses on the measurable economic impact of nuclear power plants. National Energy Institute's 2004 study of Arizona's Palo Verde nuclear power plant used IMPLAN data and models similar to the JEDI model to estimate the annual economic impacts of Palo Verde at the county, state and national levels. By contrast, some other literature has questioned existing assessments of economic impacts of nuclear power plants. Burke (2012) argued that prior estimates of the costs and economic impacts of nuclear power plants were mostly inaccurate and biased and failed to consider wider impacts including environmental impacts and social impacts.

Methodology

This report uses the JEDI models to assess economic impacts of several planned and existing renewable energy projects in Arizona.

The JEDI Models were developed by MRG & Associates for the National Renewable Energy Laboratory (NREL). They are spreadsheet tools that estimate the economic impacts generated from the construction and operation of renewable power projects. For example, building a photovoltaic power plant not only increases the demand for solar panels; it also increases the local demand for construction labor, transportation services and other supply inputs. After the plant starts operating, it generates long-term jobs, capital and other local economic benefits. The ultimate magnitude of these economic benefits depends partly on how much of project's demands can be satisfied by producers and suppliers within the local economy.

To estimate the economic impact of a project, the JEDI models apply standard input-output multipliers and information about local consumption/employment patterns. Multipliers and pattern data used in JEDI models are provided by Minnesota-based IMPLAN Group. These multipliers and patterns estimate broader economic benefits as a function of a renewable energy project's type and size.

The injection of capital into a project usually triggers several rounds of spending and employment that result in an overall impact to local employment, output, and resident income. As income and employment rise, so does local spending (Implan 2004). Through this mechanism, investment in one renewable energy project can cause a ripple effect that benefits other sectors of local economy, some of which are distant from the project.

In addition to the multipliers, the JEDI model uses data and inputs about costs of building and operating renewable energy plants and consumption data that describes spending patterns of such projects. These data and patterns are used as initial inputs to estimate economic activities generated by a project.

Energy Development in Arizona

Overview

Arizona is the home of iconic vistas and distinctive natural beauty. It hosts the Grand Canyon and Monument Valley on Colorado Plateau in the north and east and the deserts of the Basin and Range region in the south and west. The Mogollon Rim cuts across the state, forming the southern boundary of the Colorado Plateau and creating the area that has the state's best wind energy

resources. Although its higher areas receive more precipitation, most of Arizona has a semiarid climate. Abundant sunshine gives the entire state some of the nation's greatest solar energy generating potential.

Natural gas

Most of the natural gas consumed in Arizona is imported from other states via pipelines that enter at the Arizona-New Mexico border. The electric power sector consumes more than two-thirds of the state's total natural gas consumption.

Coal

Almost two-fifths of the electricity generated in Arizona's is produced in coal burning plants. The state's largest coal-fired facility is Navajo Generating Station, which is also the state's second-largest power plant.

Electricity

The Palo Verde Nuclear Generating Station is the nation's largest nuclear power plant. Arizona gets more than one-fourth of its electricity generation from nuclear power, meaning that nuclear energy is second only to coal as the source of electric energy in the state. Natural gas-fired power plants generate another fourth of the state's electricity, and renewable energy generating facilities and devices provide the rest.

Arizona generates more power than it consumers and exports its surplus electricity to consumers in nearby states. As electricity generation and exportation expands, the state's electricity transmission system becomes increasingly congested. Accordingly, developers in Arizona are presently working on multiple new transmission line projects.

Renewable energy

Arizona has one of the world's largest solar PV power plants. It also has the best solar energy resources in the United States.

The bulk of Arizona's renewable energy generation comes in the form of hydroelectric generation at facilities near the Glen Canyon Dam and Hoover Dam on the Colorado River. However, increasing amounts of other types of renewable energy sources are coming online in Arizona. The state's most significant source of expansion of renewable energy generating capacity in recent years has been solar energy.

Arizona’s first commercial solar photovoltaic (PV) plant opened in 1997. The largest solar PV facility of the world is located in Yuma, Arizona. Some other solar facilities in Arizona use concentrating solar power technologies to generate power. Arizona presently ranks second in the nation in total installed solar electric capacity. However, solar energy contributed less than 3% to Arizona’s net electricity generation in 2014.

Arizona has some commercially viable wind energy resources, which are found mainly along the Mogollon Rim. The state’s first commercial-scale wind farm commenced operations in 2009, and wind provides only a small fraction of the state’s total net generation.

Arizona's current renewable energy standard requires that an increasing percentage of the electricity sold in the state come from renewable energy sources. The state’s overall goal is for its regulated utilities to source at least 15% of their electricity from renewable energy resources by 2025.

Economic Impact of Existing Power Plants in Arizona

1. Coal Plants

There are six operating coal-fired power plants in Arizona, as shown below in Table 1. Their combined generating capacity is 6,419 MW.

	Capacity (MW)	Power Factor	Heat Rate	Operating year
Cholla	839.9	0.9	10659	1962-1981
H Wilson Sundt Generating Station	173.3	0.85	11442	1967
Apache Station	408	0.85	10793	1979
Navajo	2410	0.9	10136	1974-1976
Coronado	821.8	0.9	10625	1979-1980
Springerville	1765.8	0.9	10272	1985-2009

Table 1: Coal fueled power plants in Arizona

All of the plants listed above except generators No. 3 and 4 of Springerville were built prior to 2006, so this report assesses only the operation and maintenance-related impacts of these facilities. For Springerville, the analysis counts the construction impact of its generators No. 3 and 4. The estimated economic impacts of these plants are shown in Table 2:

	Jobs	Earnings (Million $)	Outputs (Million $)
Cholla	379	25.2	69.7
H. Wilson Sundt Generating Station	76	5.5	13.1
Apache Station	180	13.0	31.0
Navajo	1088	78.1	188.4
Coronado	371	26.6	64.3
Springerville O&M	797	53.2	178.0
O&M Total (Annual)	2891	201.6	544.5
Springerville Construction	8847	743.4	1456.5

Table 2: Economic Impact of coal fueled power plants in Arizona

The state's six coal fueled power plants are estimated to support 2,891 jobs annually during operation. During operation, their estimated annual earnings were $201.6 million and their estimated annual local economic output was $544.5 million. In the past decade, construction of coal fueled power plants has generated 8,847 job-years. In aggregate, these projects were estimated to generate $743.4 million in earnings and $1.4565 billion of economic output for the state.

2. Hydro Plants

There are 6 operating utility-scale hydro power plants in Arizona, as listed below in Table 3. Their total generating capacity is 2,840 MW.

Plant name	Type	Capacity (MW)
Arizona Falls	Conventional	0.75
Davis Dam	Conventional	254.8
Glen Canyon Dam	Conventional	1312
Hoover Dam (AZ)	Conventional	1040
Horse Mesa	30MW conventional, 100MW pumped storage	130
Mormon Flat	9MW conventional, 54MW pumped storage	63
Waddell	Pumped storage	40

Table 3: Hydro power plants in Arizona

All 6 of the state's operating hydroelectric generating stations were built before 2006, so the analyses in this report assess only their operation and maintenance impacts. The annual economic impacts of these power stations are listed in Table 4:

	Jobs	Earnings (Million $)	Outputs (Million $)
Arizona Falls	1	0.05	0.12
Davis Dam	125	7.9	20.9
Glen Canyon Dam	645	40.9	107.6
Hoover Dam (AZ)	512	32.4	85.3
Horse Mesa	64	4.1	10.7
Mormon Flat	31	2.0	5.2
Waddell	20	1.2	3.3
Total	1397	88.5	233

Table 4: Economic Impact of hydro power plants in Arizona

The six hydro power plants were estimated to support a total of 1,397 jobs annually during operation. During operation, the estimated annual earnings are $88.5 million and their estimated annual local economic output is $233 million.

3. Nuclear Plants

The only operating nuclear plant in Arizona is Palo Verde Nuclear Generating Station, which was commissioned in 1986. Palo Verde is the largest power plant in the United States by capacity. It has a nameplate capacity of 4.2GW and a capacity factor of 98%.

Based on data from a 2004 Nuclear Energy Institute study, the annual economic impact of Palo Verde is shown in Table 5. All numbers are converted to 2016 dollars, using an estimated inflation rate of 1.97% per year.

State Economic Impacts	Direct	Induced	Total
Output (Million $)	908.8	202.2	1111.1
Labor Income (Million $)	245.2	69.5	314.7
Jobs	2385	1800	4185

Table 5: Economic Impact of Palo Verde plants in Arizona

Every year, Palo Verde generates an estimated $1.1111 billion in economic output and $314.7 million in labor income. It supports an estimated 4,185 jobs statewide every year.

4. Natural Gas Plants

There are 25 operating utility-scale natural gas-fired power plants in Arizona, as listed below in Table 6. Their combined capacity is 15,894 MW. Several plants are divided into different rows on the Table because their generator sets differ in power factors and operating years.

Plant Name	Nameplate Capacity (MW)	Nameplate Power Factor	Operating Year
Agua Fria 1	222.9	0.9	1975
Agua Fria 2	223.9	0.85	1958
Apache Station	252.7	0.85	1963
Arlington Valley Energy Facility	715	0.85	2002
Black Mountain Generating Station	121	0.85	2008
Coolidge Generation Station	720.6	0.85	2011
Demoss Petrie	85	0.85	2001
Desert Basin	646.1	0.85	2001
Douglas Power Station	16	0.85	1972

Gila River Power Block 3	1238	0.85	2003
Griffith Energy LLC	654.4	0.85	2002
H Wilson Sundt Generating Station	384.2	0.85	1972
Harquahala Generating Project	1325.1	0.9	2004
Kyrene	573.7	0.85	2002
Mesquite Generating Station Block 1	1383.2	0.85	2003
North Loop	107.8	0.85	1972
Ocotillo	333.4	0.85	1972
Red Hawk	1140.3	0.85	2002
Saguaro 1	78.3	0.9	2002
Saguaro 2	106.2	0.85	1972
Santan 1	414	0.9	1974
Santan 2	622.1	0.85	2005
Santan 3	289.9	0.85	2006
South Point Energy Center	708	0.85	2001
Sundance	605	0.85	2002
Sundevil Power Holdings - Gila River	1238	0.85	2003
Valencia	108	0.85	1989
West Phoenix 1	396	0.9	1976
West Phoenix 2	811.4	0.85	2001
Yucca 1	206.3	0.9	1971
Yucca 2	121	0.85	2008
Yuma Cogeneration Associates	62.6	0.9	1994

Table 6: Gas-fired power plants in Arizona

Of the state's 25 gas plants, only four were built or partly built in the last decade. For those four plants, the analysis in this report estimates their economic impacts during construction. For others, the analysis only estimates their operation and maintenance economic impacts.

The estimated economic impacts of these projects are shown below in Table 7 and Table 8:

During operating years (annual)	Jobs	Earnings(Million $)	Output(Million $)
Agua Fria	93	$6.06	$13.38
Apache Station	38	$2.49	$5.49
Arlington Valley Energy Facility	108	$7.03	$15.52
Black Mountain Generating Station	18	$1.19	$2.63
Coolidge Generation Station	109	$7.08	$15.63
Demoss Petrie	13	$0.84	$1.85
Desert Basin	97	$6.36	$14.03
Douglas Power Station	3	$0.16	$0.35
Gila River Power Block 3	187	$12.18	$26.88
Griffith Energy LLC	99	$6.43	$14.20
H Wilson Sundt Generating Station	58	$3.78	$8.34
Harquahala Generating Project	202	$13.20	$29.31
Kyrene	87	$5.65	$12.46
Mesquite Generating Station Block 1	208	$13.61	$30.03
North Loop	16	$1.05	$2.32
Ocotillo	50	$3.28	$7.23
Red Hawk	172	$11.22	$24.75
Saguaro	28	$1.82	$4.03
Santan	63	$13.10	$28.97
South Point Energy Center	107	$6.97	$15.37
Sundance	91	$5.95	$13.14
Sundevil Power Holdings - Gila River	187	$12.18	$26.88
Valencia	16	$1.05	$2.32
West Phoenix	60	$11.93	$26.37
Yucca	31	$3.24	$7.19

Yuma Cogeneration Associates	10	$0.63	$1.39
Total	2147	$158.30	$349.70

Table 7: Annual O&M economic impacts of gas fueled power plants in Arizona

During construction period	Jobs	Earnings(Million $)	Output(Million $)
Coolidge Generation Station	1,903	$172.04	$368.21
Santan 3	766	$69.29	$148.31
Yucca 2	320	$28.91	$61.88
Black Mountain Generating Station	320	$28.91	$61.88
Total	3309	$299.20	$640.30

Table 8: Economic impact of constructing new gas fueled power plants

In the past decade, constructing gas fueled power plants supported an estimated 3,309 job-years in Arizona. Newly-built gas fueled power plants contributed an estimated $299.20 million in earnings and $640.30 million in economic output.

Operations and maintenance of current gas fueled power plants in the state supported approximated 2,150 jobs annually. They generated an estimated $158.46 million in earnings and $350.05 million in economic output.

5. Renewable Energy Plants

There are seven operating renewable energy power plants in Arizona and 14 in various stages of planning or development, as shown in Table 9.

	Energy Type	Capacity
Agua Caliente	Solar PV	290 MW
Arlington Valley	Solar PV	250 MW
Mesquite	Solar PV	700 MW
Agua Fria Generating Station + Rogers Substation	Solar PV	0.3 MW
Amonix	Solar PV	2 MW
APS STAR Center & Small Solar Across Arizona	Solar PV	22 MW

APS/SunEdison Prescott	Solar PV	10 MW
Avalon I	Solar PV	35 MW
Avalon II	Solar PV	21.5 MW
Avra Valley	Solar PV	34.3 MW
Badger Solar Power Plant	Solar PV	15 MW
Chino Valley Solar PV Plant	Solar PV	19 MW
Cogenra	Solar PV	1.4 MW
Copper Crossing Solar Ranch + Sandstone Solar	Solar PV	65 MW
Cotton Center Solar PV Plant	Solar PV	17 MW
DeMoss Petrie Solar	Solar PV	.5 MW
Desert Star Solar Plant	Solar PV	10 MW
E.On Tech Park	Solar PV	6.6 MW
Foothills Solar PV Plant	Solar PV	35 MW
Fort Huachuca Phase I	Solar PV	17.2 MW
Gato Montes Solar	Solar PV	6 MW
Gila Bend Solar PV Plant	Solar PV	32 MW
Gillespie Solar PV Plant	Solar PV	15 MW
Hyder I Solar PV Plant	Solar PV	16 MW
Hyder II Solar PV Plant	Solar PV	14 MW
Luke AFB Solvar PV Plant	Solar PV	10 MW
Paloma Solar PV Plant	Solar PV	17 MW
Picture Rocks	Solar PV	25 MW
Prescott Airport	Solar PV	3 MW
RE Ajo 1	Solar PV	5 MW
Saddle Mountain PV Plant	Solar PV	15 MW
Saguaro Solar Power Plant	Solar PV	1 MW
Solon Praire Fire	Solar PV	5 MW
Springerville	Solar PV	6.5 MW
Sundt Augmentation	Solar PV	5 MW
UASTP I	Solar PV	1.6 MW
UASTP II	Solar PV	5 MW
Valencia	Solar PV	13.2 MW
White Mountain Solar	Solar PV	10 MW
Novo BioPower Plant	Biomass	14 MW
NW Regional Biogas Project	Biomass	3 MW

Snowflake White Mountain Biomass Plant	Biomass	14 MW
Glendale Energy Power Plant	Biomass	2.8 MW
Los Reales	Biomass	4 MW
Dry Lake	Wind	127
Perrin Ranch	Wind	99.2
Red Horse	Wind	30
Solana	Solar CSP	280

Table 9: Renewable energy power plants in Arizona

We calculated the summary impact of these planned and existing projects. The results are shown below.

	Power Source	**Jobs**		**Earnings**		**Output**	
		Construction	O&M	Construction	O&M	Construction	O&M
Agua Caliente	PV	15779	78	$965.2	$4.7	$1,806.1	$6.8
Arlington Valley	PV	10486	70	$595.4	$4.3	$1,170.7	$6.1
Mesquite	PV	22100	196	$1,266.2	$11.9	$2,403.2	$17.0
Agua Fria Generating Station + Rogers Substation	PV	16	1	$0.9	$0.008	$1.8	$0.01
Amonix	PV	112.5	1	$6.9	$0.04	$13.1	$0.06
APS STAR Center & Small Solar Across Arizona	PV	1238	7	$75.8	$0.4	$144.5	$0.6
APS/SunEdison Prescott	PV	562	3	$34.5	$0.2	$65.7	$0.3
Avalon I	PV	1970	11	$120.6	$0.7	$229.8	$1.0
Avalon II	PV	1210	7	$74.1	$0.4	$141.2	$0.6
Avra Valley	PV	1930	11	$118.2	$0.7	$225.2	$1.0
Badger Solar Power Plant	PV	844	5	$51.7	$0.3	$98.5	$0.4
Chino Valley Solar PV Plant	PV	1069	6	$65.5	$0.4	$124.8	$0.5
Cogenra	PV	80	1	$4.8	$0.03	$9.2	$0.04

	Power Source	Jobs		Earnings		Output	
Copper Crossing Solar Ranch + Sandstone Solar	PV	2932	18	$180.3	$1.1	$341.5	$1.6
Cotton Center Solar PV Plant	PV	956	5	$58.6	$0.3	$111.6	$0.5
DeMoss Petrie Solar	PV	28	1	$1.7	$0.01	$3.3	$0.02
Desert Star Solar Plant	PV	562	3	$34.5	$0.2	$65.7	$0.3
E.On Tech Park	PV	366	2	$22.4	$0.1	$42.7	$0.2
Foothills Solar PV Plant	PV	1970	11	$120.6	$0.7	$229.8	$1.0
Fort Huachuca Phase I	PV	968	5	$59.3	$0.3	$112.9	$0.5
Gato Montes Solar	PV	338	2	$20.7	$0.1	$39.4	$0.2
Gila Bend Solar PV Plant	PV	1800	10	$110.3	$0.6	$210.1	$0.9
Gillespie Solar PV Plant	PV	844	5	$51.7	$0.3	$98.5	$0.4
Hyder I Solar PV Plant	PV	900	5	$55.1	$0.3	$105.1	$0.5
Hyder II Solar PV Plant	PV	788	4	$48.2	$0.3	$91.9	$0.4
Luke AFB Solvar PV Plant	PV	562	3	$34.5	$0.2	$65.7	$0.3
Paloma Solar PV Plant	PV	956	5	$58.6	$0.3	$111.6	$0.5
Picture Rocks	PV	1407	8	$86.2	$0.5	$164.2	$0.7
Prescott Airport	PV	173	1	$10.1	$0.08	$20.0	$0.1
RE Ajo 1	PV	281	2	$17.2	$0.1	$32.8	$0.1
Saddle Mountain PV Plant	PV	844	5	$51.7	$0.3	$98.5	$0.4
Saguaro Solar Power Plant	PV	56	1	$3.4	$0.02	$6.6	$0.03
Solon Praire Fire	PV	281	2	$17.2	$0.1	$32.8	$0.1
Springerville	PV	366	2	$22.4	$0.1	$42.7	$0.2
Sundt Augmentation	PV	281	2	$17.2	$0.1	$32.8	$0.1
UASTP I	PV	90	1	$5.5	$0.03	$10.5	$0.05
UASTP II	PV	281	2	$17.2	$0.1	$32.8	$0.1
Valencia	PV	743	4	$45.5	$0.3	$86.7	$0.4
White Mountain Solar	PV	562	3	$34.5	$0.2	$65.7	$0.3

	Power Source	Jobs		Earnings		Output	
Novo BioPower Plant	Biomass	115	57	$8.4	$2.5	$14.0	$7.2
NW Regional Biogas Project	Biomass	39	21	$2.8	$0.9	$4.8	$2.2
Snowflake White Mountain Biomass Plant	Biomass	115	57	$8.4	$2.5	$14.0	$7.2
Glendale Energy Power Plant	Biomass	39	21	$2.8	$0.9	$4.8	$2.2
Los Reales	Biomass	48	24	$3.5	$1.1	$5.8	$2.7
Dry Lake	Wind	461	23	$27.6	$1.4	$70.8	$4.1
Perrin Ranch	Wind	444	18	$26.6	$1.1	$69.0	$3.1
Red Horse	Wind	235	7	$14.1	$0.4	$35.4	$1.1
Solana	CSP	7540	168	$673.6	$9.6	$1,467.7	$20.4

Table 10: Economic impact of renewable energy power plants

The seven operating projects in Arizona were estimated to have supported 85,768 job-years during construction and 905 jobs every year during operation. In aggregate, these projects were estimated to generate $4.3670 billion in earnings and $10.3758 billion of economic output for the state during construction. During operation, the estimated annual earnings generated by these projects were $39.3 million. Their estimated local economic output generated was $91.4 million.

Per MW Economic Impact Comparison

Based on the results above, it is possible to estimate the per MW economic impact of different energy resources in Arizona. The results of this analysis are shown below in Table 11.

Economic Impact Per MW (Annual)	Jobs	Earnings(Million $)	Output(Million $)
Coal	0.45	0.031	0.085
Hydro	0.49	0.031	0.082
Nuclear	1.00	0.074	0.265
Gas	0.13	0.010	0.022
Solar PV	0.28	0.017	0.024
Wind	0.19	0.011	0.032
Solar CSP	0.60	0.034	0.073

Table 11: Annual per MW Economic impact of different energy resources

The analysis reveals that nuclear power has the highest per MW economic impact, while natural gas has the lowest per MW economic impact. This partly reflects a difference in operation and maintenance costs. However, this calculation did not incorporate possible environmental and social positive externalities; if those costs were taken into account the result might be different.

Economic Impact of Building New Power Plants in Arizona

This Part VI estimates the potential economic impacts of building a new 100MW power plant with different energy sources in Arizona. This comparative analysis makes it possible to assess the marginal effects of developing different types of energy facilities in the state. The analysis assumes that all new power plants are built in 2017, and all dollar values are expressed in 2016 dollars.

Because there is no available JEDI model for nuclear energy plants, this analysis scales down the economic impact of the 4.2GW Palo Verde plant to generate an estimate for a new 100MW nuclear power plant. Because of economies of scale, building and operating Palo Verde would cost less than building and operating forty-two 100MW nuclear plants. Therefore, the estimated impact of the newly-built 100MW nuclear plant only marks the lower-end of the range of possible impacts. For each plant, the analysis estimates its economic impacts in three forms: jobs, earnings and output. The results include both the construction phase and the operation and maintenance (O&M) phase.

The results are shown in the following table:

Plant Energy Source	Jobs		Earnings (Million $)		Output (Million $)	
	Construction	O&M	Construction	O&M	Construction	O&M
Hydro	777	22	50.9	1.2	105.1	4.2
Coal	966	44	81.1	3.2	159.0	7.6
Gas	264	15	23.9	1.0	51.1	2.2
Nuclear		97		5.9		20.9
Wind	388	18	23.2	1.1	59.5	3.3
PV	3157	28	180.9	1.7	343.3	2.4
CSP	2153	87	196.6	5.2	400.3	10.8

This analysis reveals that, during the construction phase, building solar powered projects are likely to generate the most economic impact. During the operation and maintenance phase, nuclear power plants and CSP power projects tend generate the most economic impact.

Analysis of Potential Disruption of Military Operations from Arizona's Renewable Energy Projects

Introduction

Arizona has been the home of several military installations for decades, including Yuma Proving Ground, Luke Air Force Base and Davis-Monthan Air Force Base. In recent years, numerous renewable energy developers have sought to site new projects in Arizona. Although most renewable energy projects are compatible with military operations, some may interfere with military tests, training activities, and operational missions.

This report attempts to assess potential disruptions to military operations for 21 existing and planned renewable energy projects in Arizona. Following guidance from the Department of Defense Siting Clearinghouse (DoDSC), the report involves an assessment of five types of possible disruptions: disruption to radar operation, disruption to military flights, security disruption, electromagnetic disruption and glint/glare disruption (only from solar power projects).

Review of Existing Literature

In 2006, prior to the establishment of the DoDSC, the Office of the Director of Defense Research and Engineering published a report on the potential effects of wind farms on military readiness. In the report, the authors quoted the results of multiple tests by US and UK military entities revealing that wind farm turbines can have significant adverse effects on the functioning of radar systems. The report also identified other impacts from turbines on military readiness, including obstruction, security risk and electromagnet disruption. Accordingly, the report recommended various mitigation methods such as locating wind farms at less disruptive locations, using more "stealth" turbines, deploying upgraded radar equipment and enhancing radar software to filter out turbines.

In its first annual report to the Congress for fiscal year 2011, the DoDSC identified four types of possible disruptions to military operations: loss of military training routes, glint, electromagnetic interference and threats to long range surveillance radars. DoDSC continued to use this disruption list throughout fiscal years 2012 and 2013. In its report for fiscal year 2014, DoDSC amended the list to include loss of military training routes, glint/glare, wind turbine interference, and impact on national defense radar systems.

According to a 2013 report on renewable energy siting published by Natural Resources Defense Council and Department of Defense, renewable energy project siting decisions should consider four kinds of potential conflict areas regardless of whether a potential project site is on DoD-managed land. These locations included: (1) areas that create a safety risk (either to civilian, military or to energy personnel and assets) from DoD activities; (2) areas that would create technology interference; (3) locations which would compromise the quality of military operations or interfere with access to air, land, sea, or space; and (4) areas that create a security risk for sensitive military assets.

In 2014, Sandia National Laboratories published an inter-agency field test and experiment industry report on wind turbine-radar interference tests. In three tests performed in Minnesota and Texas from 2012 to 2013, the results indicated that primary surveillance radars (PSRs) were significantly impacted by operating wind turbines at both the detection and tracking levels for regions within and above the wind turbines. The tests also showed that mitigation measures could significantly reduce the adverse impacts of wind turbines on the functioning of radar systems.

In "Guidebook for Energy Facilities Compatibility with Airports and Airspace" (Barret, DeVita & Lambert, 2014), published by the Transportation Research Board and sponsored by the FAA, glint/glare was identified as a major type of potential interference with airports and air traffic.

Although there is not yet any definitive relationship between glint/glare and air traffic accidents, glint/glare risks warrant serious consideration as a potential threat to air operations.

Methodology

As stated above, the analysis summarized in this report sought to measure how and the extent to which renewable energy projects could interfere with military operations. The analysis applies different criterion for various types of potential interference.

Interference to Radar Operations

As described in the literature review above, wind farms and CSP projects can potentially interfere with radar operations. In the 2006 DoD report, researchers found that primary surveillance radars are the most susceptible to such interference. In further reports by Sandia National Laboratories (2014) and Jasons (2015), researchers only examined interference to primary surveillance radars.

This assessment examines the distance between wind/CSP projects and Arizona's primary surveillance radars. The ranges of these radars extend up to 200 nautical miles. Projects within this range could potentially cause interference to the operation of military radars.

Interference to Military Flights

Some types of renewable energy projects necessarily involve the erection of tall structures. The heights of utility scale wind turbines routinely exceed 400 feet. Heights of some planned solar energy collecting towers used on CSP projects exceed 2,000 feet. Because of their heights, such structures can potentially interfere with the safety and efficiency of military training flights.

This report bases much of its assessment of potential conflicts between renewable energy projects and airborne military activities in Arizona on Military Training Route (MTR) maps from Arizona Department of Real Estate. Locating existing and planned renewable energy projects on these MTR maps makes it easier to assess whether such projects could interfere with military activities.

Security Interference

If a renewable energy project is sited very close to a military facility, the increased flow of personnel and traffic in the area (especially during construction) can potentially create security hazards for such facilities as well.

According to DoDSC's 2013 siting guide to energy projects, security risks can arise when projects are located in areas that create security risks for sensitive military assets, including:

- New structures or frequent traffic in locations within visual line of sight of sensitive areas.
- Project siting or associated activities (construction, maintenance and operations) that could enable video, audio or other electronic surveillance of military activities.
- The siting of facilities in areas that present new opportunities for physical security breaches.

To assess whether a renewable energy project might cause security interference to a military operation, the analysis summarized in this report identifies projects that are close to military facilities and then considers (1) whether the project is within visual line of sight of the facilities, and (2) whether the distance between the project and military facilities is close enough to create a material risk of physical security breaches.

Electromagnetic Interference

Electric transmission projects emit a strong electromagnetic field that can also potentially interfere with the operation of military electronic devices. Because the strength of an electromagnetic field decreases as the distance to the source increases, the analysis in this report examines the distance between transmission line segments and military facilities when considering whether each transmission project may cause electromagnetic interference to military operations.

Glint/Glare Interference

In "Guidebook for Energy Facilities Compatibility with Airports and Airspace" (Barret, DeVita & Lambert, 2014), published by the Transportation Research Board and sponsored by the FAA, glint and glare from shiny objects was identified as a significant type of potential interference with airports and air traffic.

Utilizing numerous reflectors or shiny panels, CSPs and PV solar projects can create substantial amounts of glint and glare. Accordingly, a solar energy project situated close to a military airport or flight route could potentially create glint and glare interference problems at certain times of a day affecting military pilots and air traffic controllers.

To determine whether a solar project could cause glint or glare interference to military operations, the analysis summarized in this report considers the locations of solar projects and whether they are within vision range of airports or located on military training routes.

Military Operations in Arizona

There are 20 military facilities in Arizona. The names and locations of these facilities are shown in Figure 1 and Table 1.

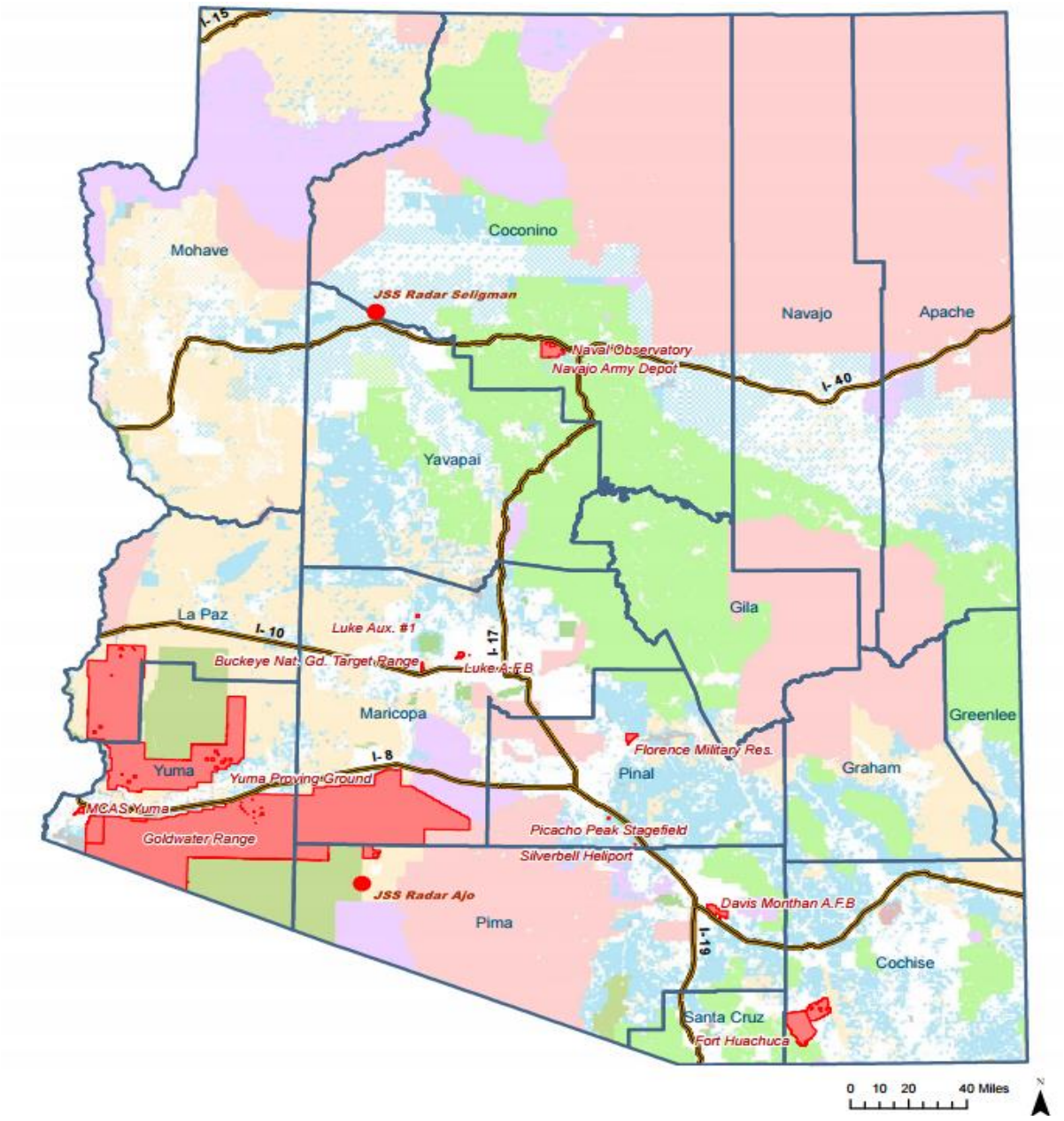


Figure 1: Military Facilities of Arizona (From Sonoran Institute)

Facility Name	Location	Branch of Military
161st Air Refueling Wing	Phoenix, Maricopa County	National Guard
162nd Wing	Tucson, Pima County	National Guard
214th Reconnaissance Group	Tucson, Pima County and Sierra Vista, Cochise County	National Guard
Arizona Air National Guard Joint Forces Headquarters	Phoenix, Maricopa County	National Guard
Barry M. Goldwater Range East	Pima, Yuma and Maricopa Counties	Air Force
Barry M. Goldwater Range West	Yuma County	Marine Corps
Buckeye National Guard Target Range	Buckeye, Maricopa County	National Guard
Camp Navajo	Bellemont, Coconino County	National Guard
Davis-Monthan Air Force Base	Tucson, Pima County	Air Force, National Guard
Florence Military Reservation	Florence, Pinal County	National Guard
Fort Huachuca	Sierra Vista, Cochise County	Army
JSS Radar Station Ajo	Ajo, Pima County	Air Force
JSS Radar Station Seligman	Coconino County	Air Force
Luke Air Force Base	Glendale, Maricopa County	Air Force
Marine Corps Air Station Yuma	Yuma, Yuma County	Marine Corps
Papago Park Military Reservation	Phoenix, Maricopa County	National Guard
Pichacho Peak Stagefield	Pinal County	National Guard
Silverbell Heliport	Pinal County	National Guard
U.S. Naval Observatory	Flagstaff, Coconino County	Navy
Yuma Proving Ground	Yuma and La Paz Counties	Army

The report "Economic Impact of Arizona's Principal Military Operations." (The Maguire Company, 2008) identifies the military industry as "[o]ne of the largest and frequently overlooked industries in Arizona" (The Maguire Company 2008, 1). Unfortunately, military facilities in Arizona that were once remote are now near cities, recreation areas, and in the path of future development.

In Arizona, the military's mission encompasses the U.S. Navy, U.S. Marine Corps, U.S. Air Force, U.S. Army, and the Arizona National Guard. All of these entities have a historic and strong connection to the state and have relied for decades upon Arizona's wide-open landscape to conduct training procedures.

Today, military operations occur in a much more complex environment and must compete with other uses of the landscape, increased population, and continual pressures on the military mission envelope, which is defined as the physical area in which military training activity occurs.

Renewable Energy Projects of Arizona

Project Type	Project Name	Location	Status
Wind	Dry Lake Wind	Navajo County	Existing
Wind	Perrin Ranch Wind	Coconino County	Existing
Wind	Red Horse Wind	Cochise County	Existing
Wind	Mohave County Wind Farm	Mohave County	Planned
Wind	Boquillas Wind Project	Coconino County	Planned
Wind	Yavapai Ranch	Yavapai County	Planned
Solar PV	Agua Caliente	Yuma County	Existing
Solar PV	Arlington Valley	Maricopa County	Existing
Solar PV	Mesquite Solar	Maricopa County	Existing
Solar PV	Sonoran Solar	Maricopa County	Planned
Solar PV	Maricopa Solar Park	Maricopa County	Planned
CSP	Solana Generating Station	Maricopa County	Existing
CSP	Crossroads	Maricopa County	Planned
CSP	Quartzsite	La Paz County	Planned
CSP	Harquahala Valley Solar Tower	Maricopa County	Planned
CSP	Environmission Tower	La Paz County	Planned
CSP	San Luis Solar Wind Down Draft Tower	Yuma County	Planned
CSP	Hualapai Valley Solar	Mohave County	Planned
Transmission	Centennial West	Northern AZ	Planned
Transmission	Sunzia Southwest Transmission Project	Southern AZ	Planned
Transmission	Southline Transmission Project	Southern AZ	Planned

This assessment estimates the potential impacts on military operations of 21 existing or planned renewable energy projects in Arizona. Seven of these are already constructed and operational; the other 14 are still in various stages of planning and development. The names and locations of these assessed planned and existing projects are shown in Table 2 and Figure 2.

Table 2. Renewable Energy Projects in Arizona

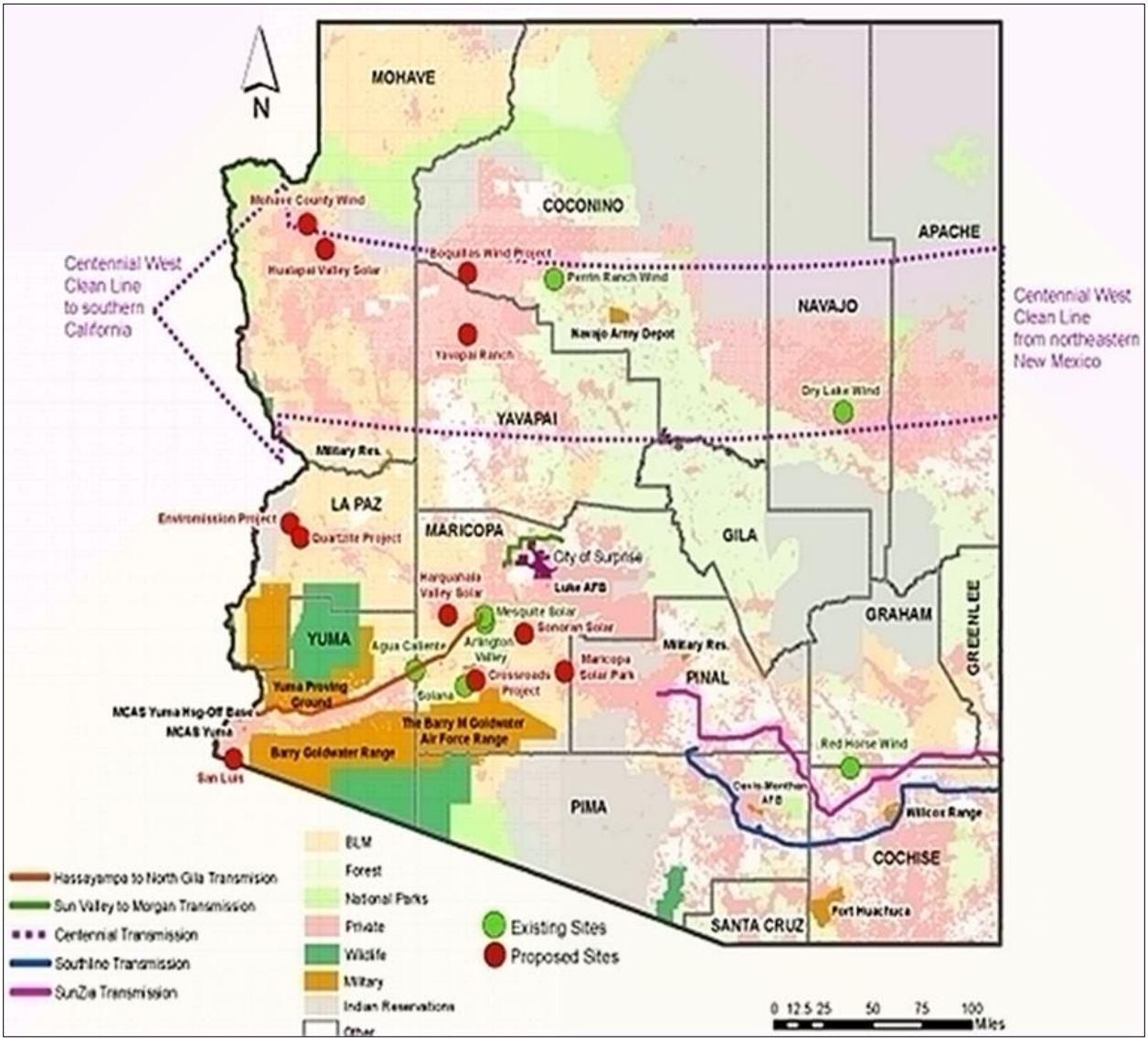


Figure 2: Locations of Assessed Renewable Energy Projects

A comparison of Figure 1 to Figure 2 reveals that many of the renewable energy projects assessed in this report are located relatively close to existing military facilities. The proximity of these projects suggests that there is potential for one or more of them to interfere with military operations. A list of potential types of interference is shown in Table 3.

Interference Type	Source Project Type
Radar Interference	Wind, CSP
Interference to Flights	Wind, CSP, Transmission Lines
Security Interference	All
Electromagnetic Interference	Transmission Lines
Glint/Glare Interference	Solar PV, CSP

Table 3. Potential Types of Interference

Interference to Radar Operations

A map depicting the locations of both the renewable energy projects assessed in this report and Arizona's military facilities is shown in Figure 3:

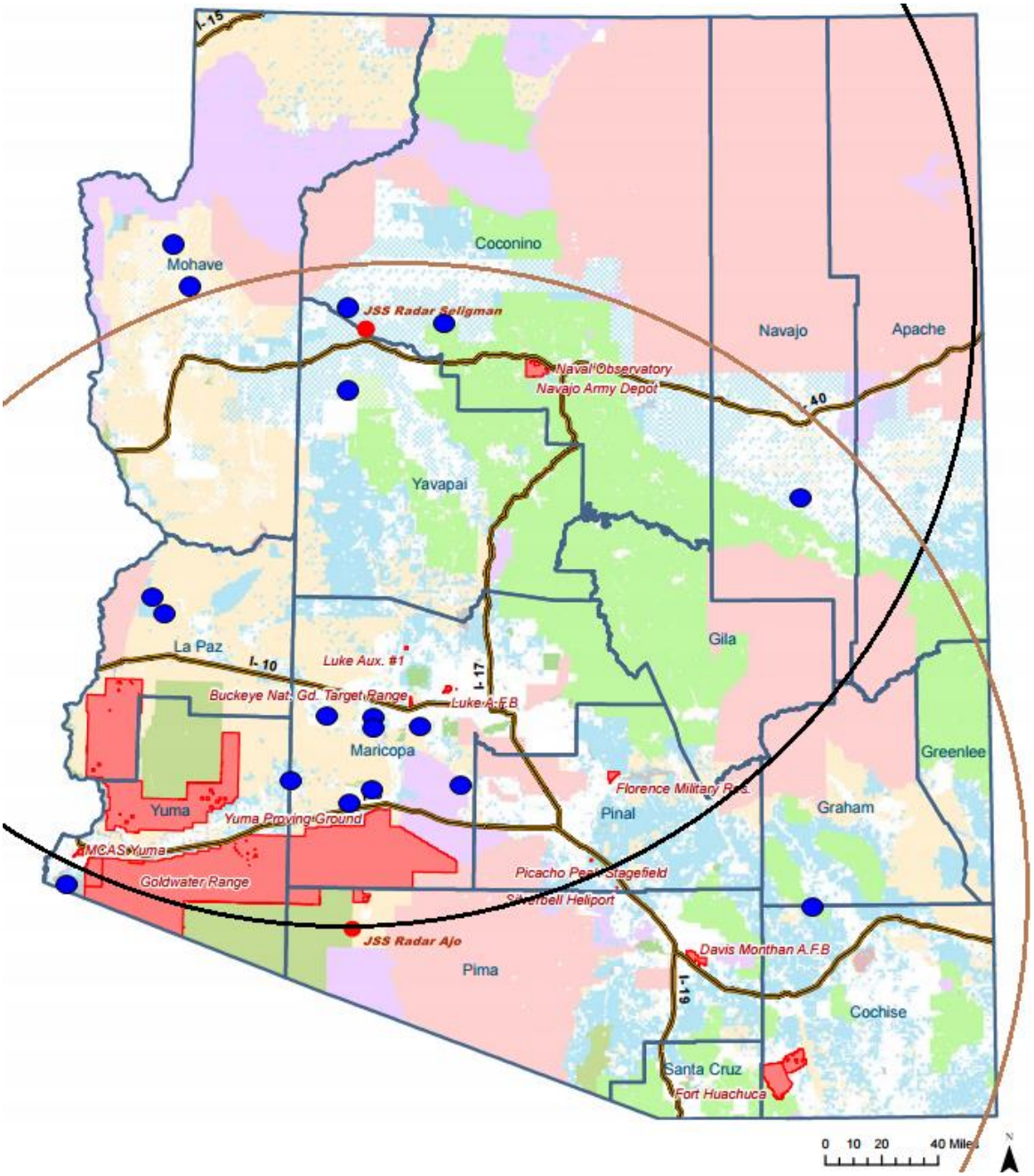


Figure 3: Arizona's renewable energy projects and military facilities

The two red dots on the map show the locations of the two Primary Surveillance radars in Arizona: JSS Station Ajo (ARSR-4 radar) and JSS Station Seligman (ARSR-3 radar). The ranges of both

radars exceed 200 nm (230 miles). The black circular line on the map shows the surveillance area of Seligman station. The brown circular line shows the surveillance area of Ajo station.

All existing and planned wind and CSP projects assessed in this report are within the range of at least one primary surveillance radar, including:

- Dry Lake Wind Project (Navajo County)
- Quartzsite Project (La Paz County)
- Environmission Tower (La Paz County)
- Red Horse Wind (Cochise County)
- Boquillas Wind (Coconino County)
- Crossroads (Maricopa County)
- Solana (Maricopa County)
- Mohave County Wind Farm (Mojave County)
- Yavapai Ranch (Yavapai County)
- Perrin Ranch Wind (Coconino County)
- San Luis Solar Wind Down Draft Tower (Yuma County)
- Hualapai Valley Solar (Mohave County)
- Harquahala Valley Solar Tower (Maricopa County)

Interference to Military Flights

To assist in analyzing the potential for interference between renewable energy projects and military flights in Arizona, the map below displays project locations on the Military Training Route (MTR) maps of relevant counties.

On these maps, MTRs are shown as grey shaded areas. If a wind or CSP solar project is located on a MTR, it may interfere military training flights.

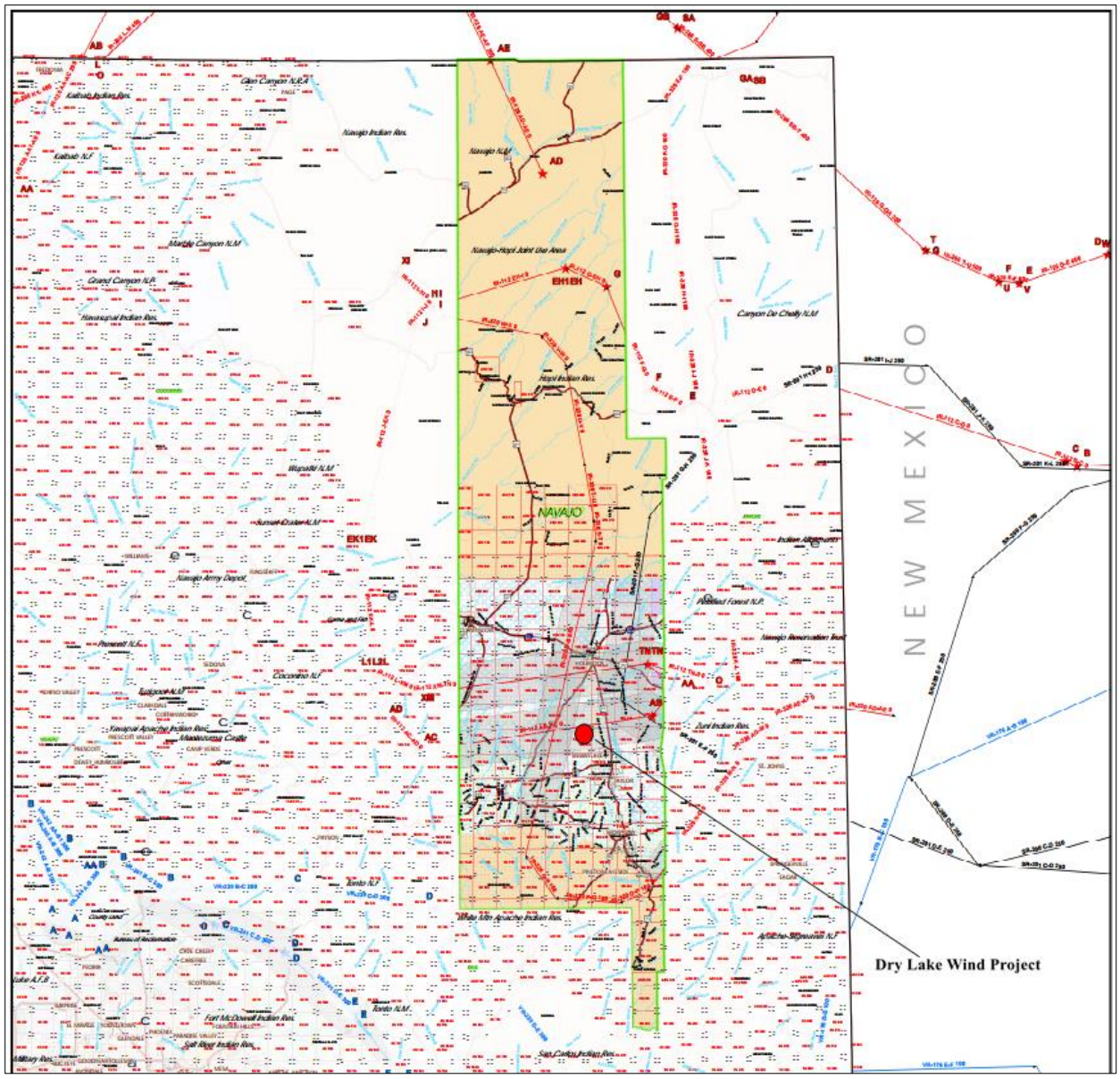


Figure 4: Navajo County MTR Map

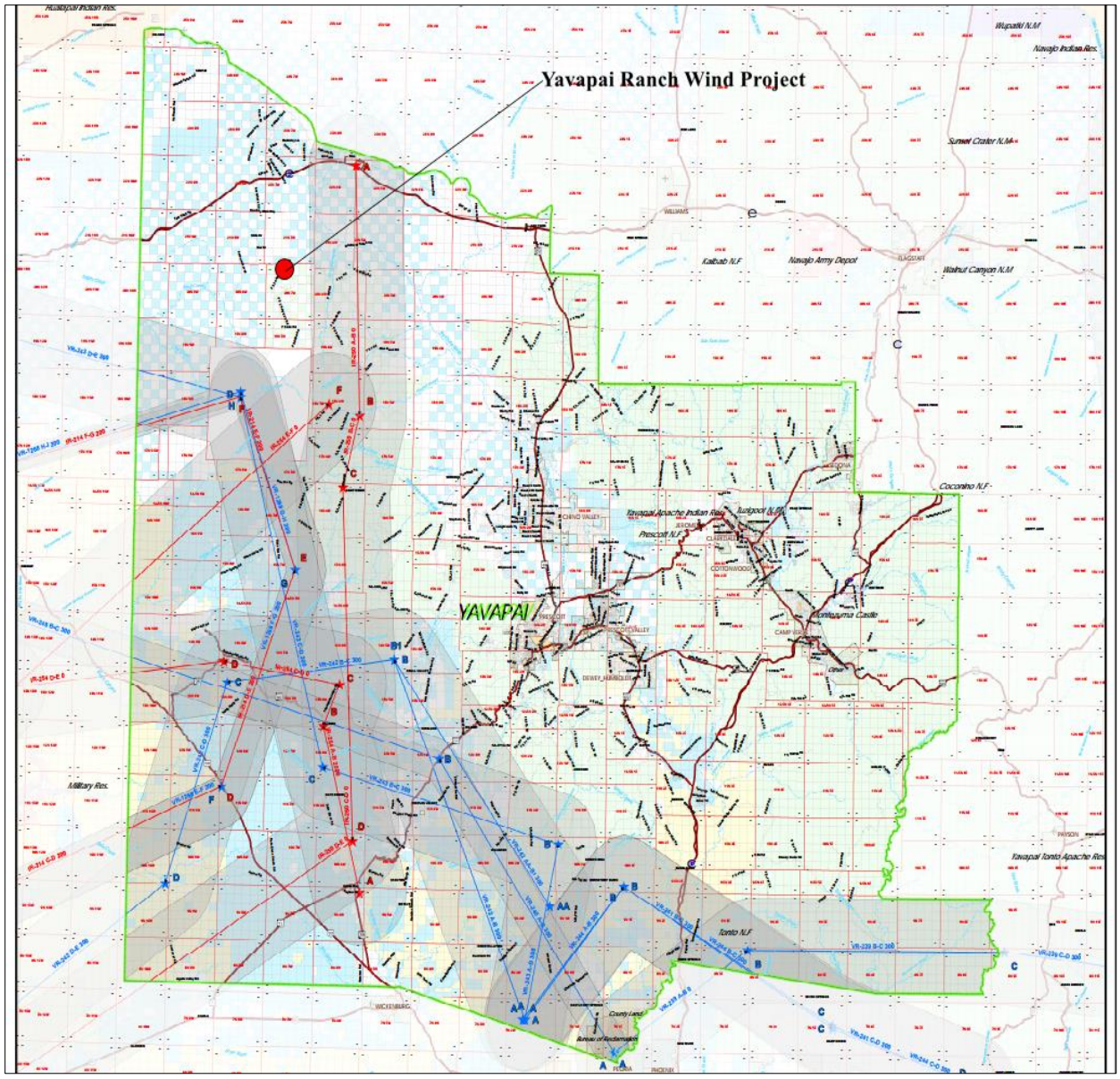


Figure 5: Yavapai County MTR Map

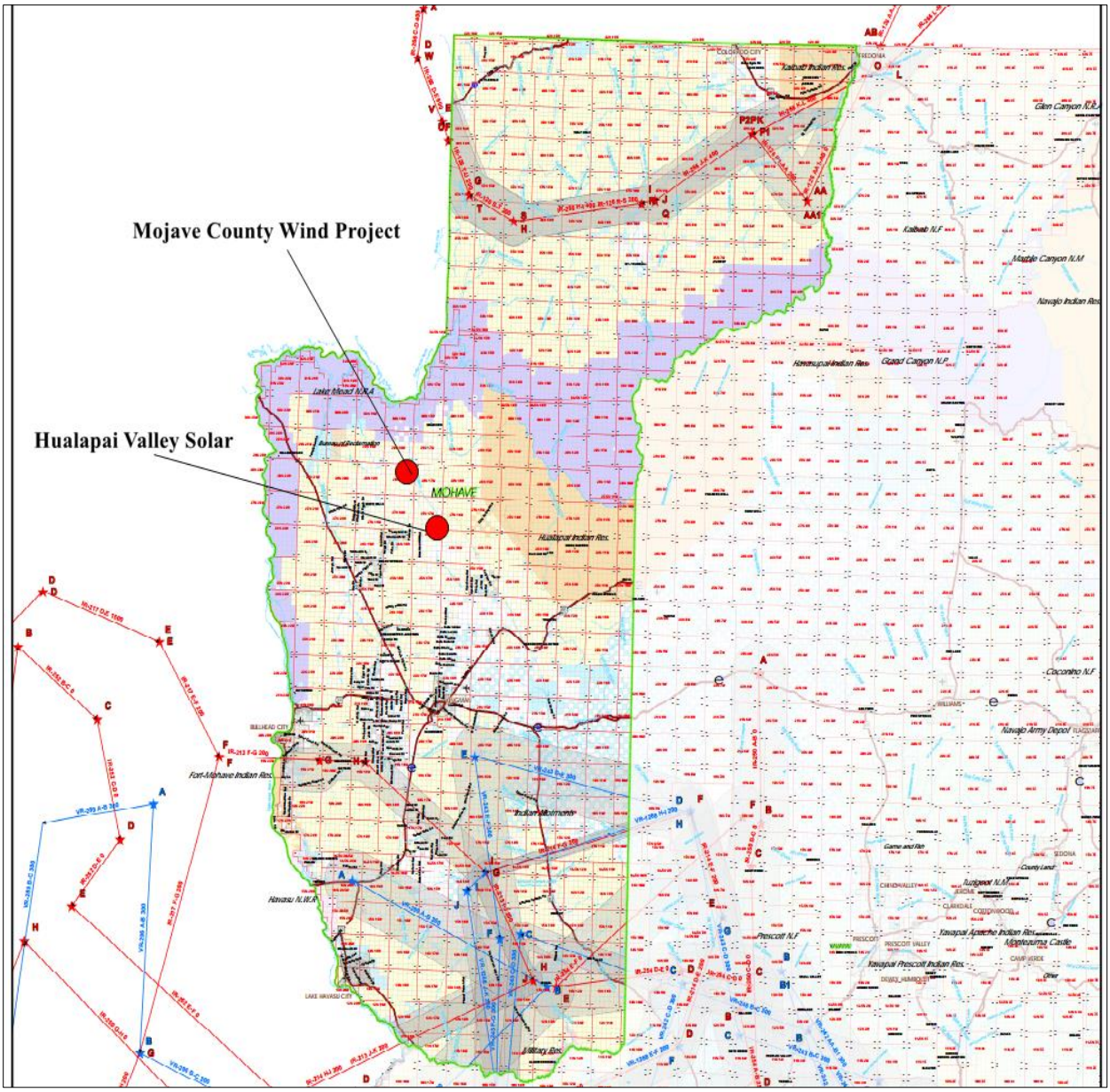


Figure 6: Mojave County MTR Map

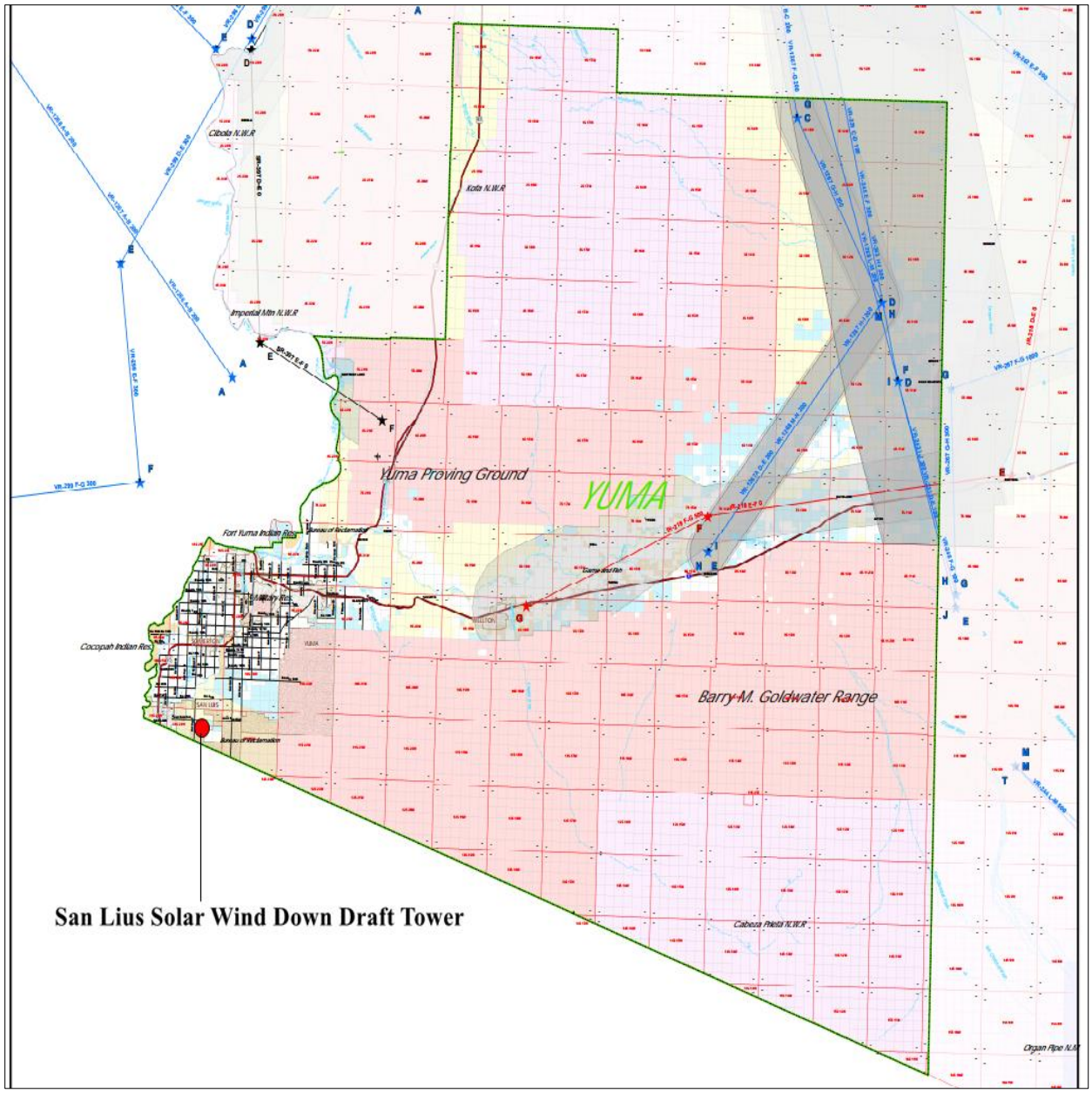


Figure 7: Yuma County MTR Map

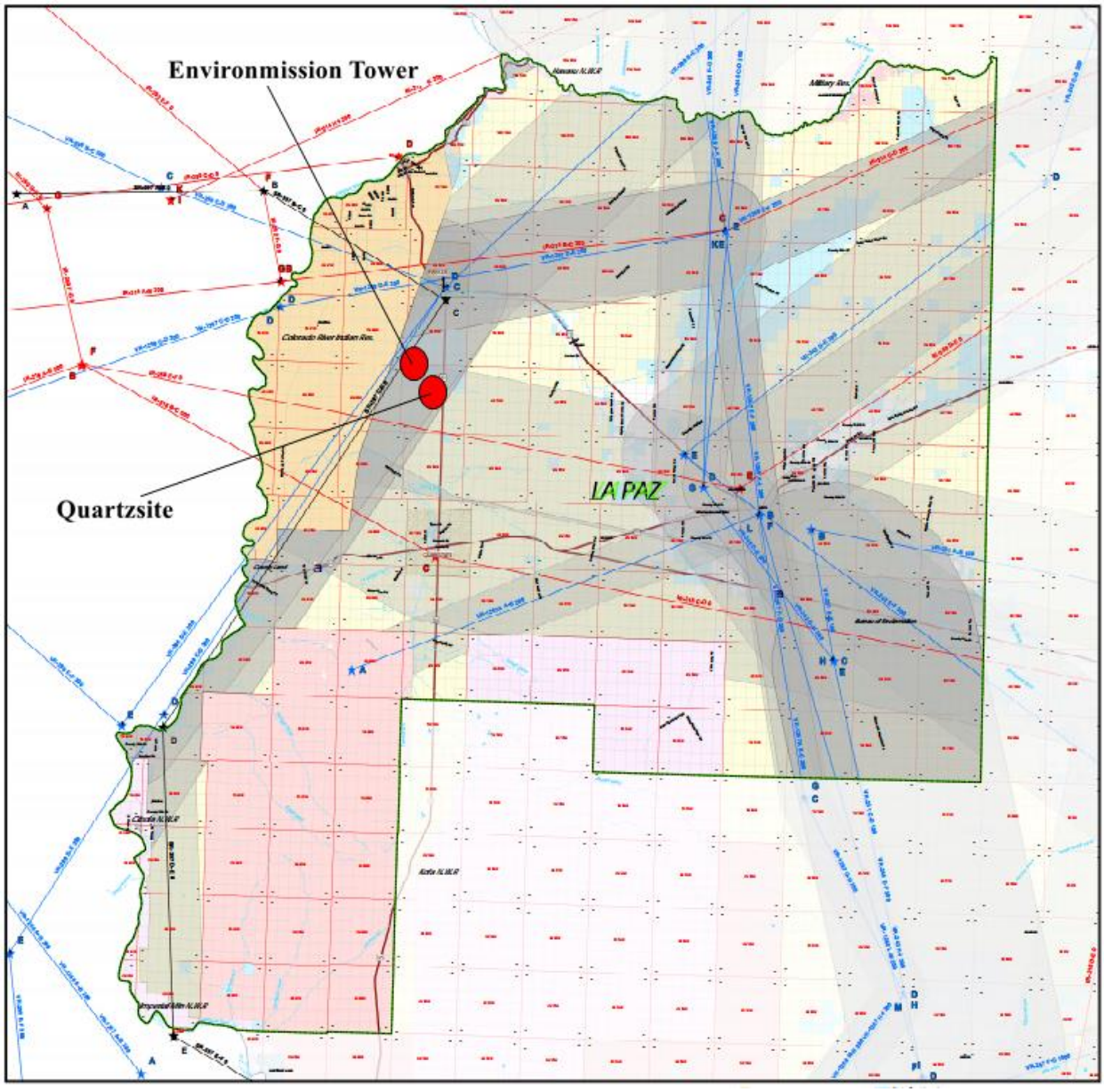


Figure 8: La Paz County MTR Map

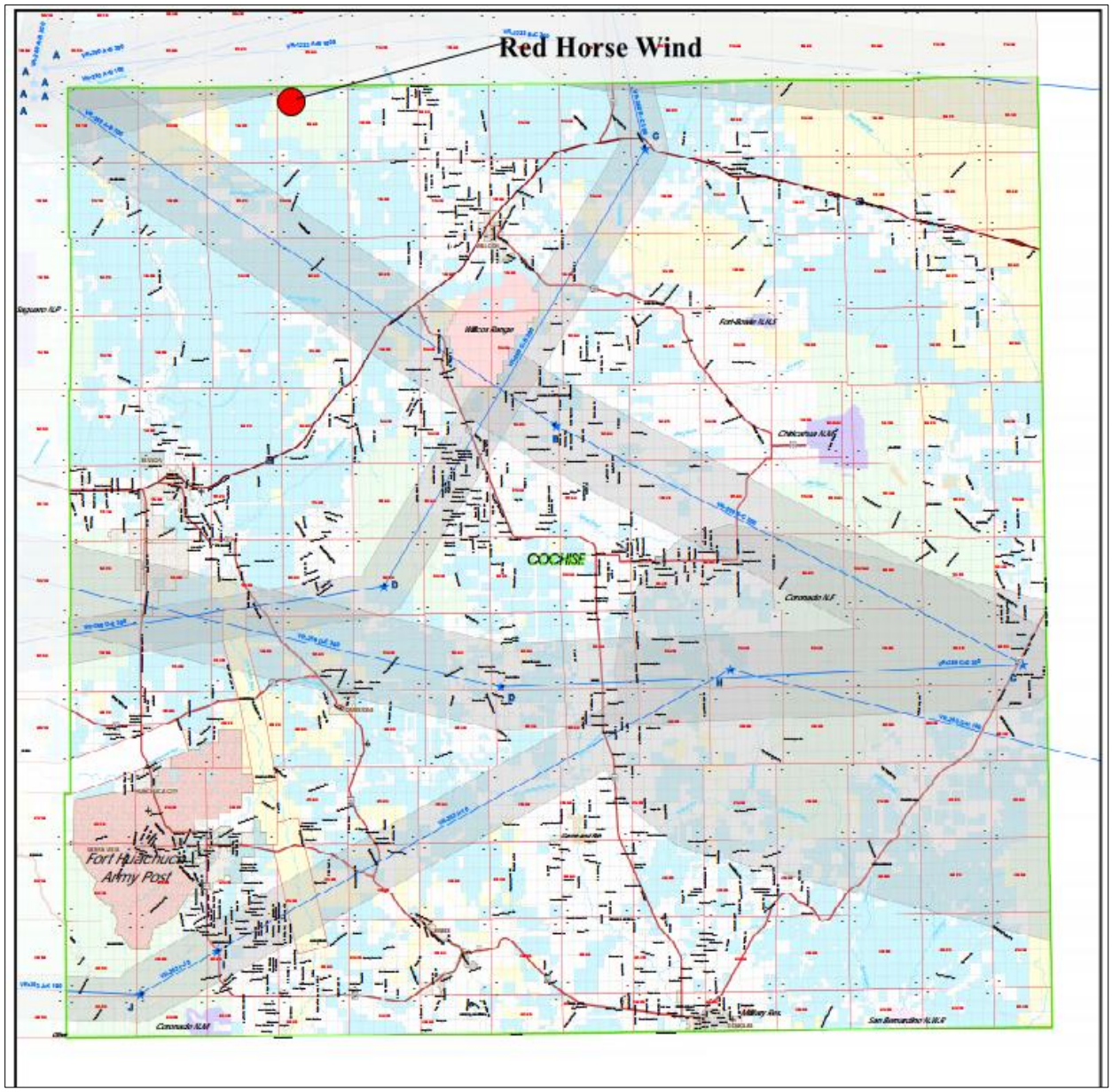


Figure 9: Cochise County MTR Map

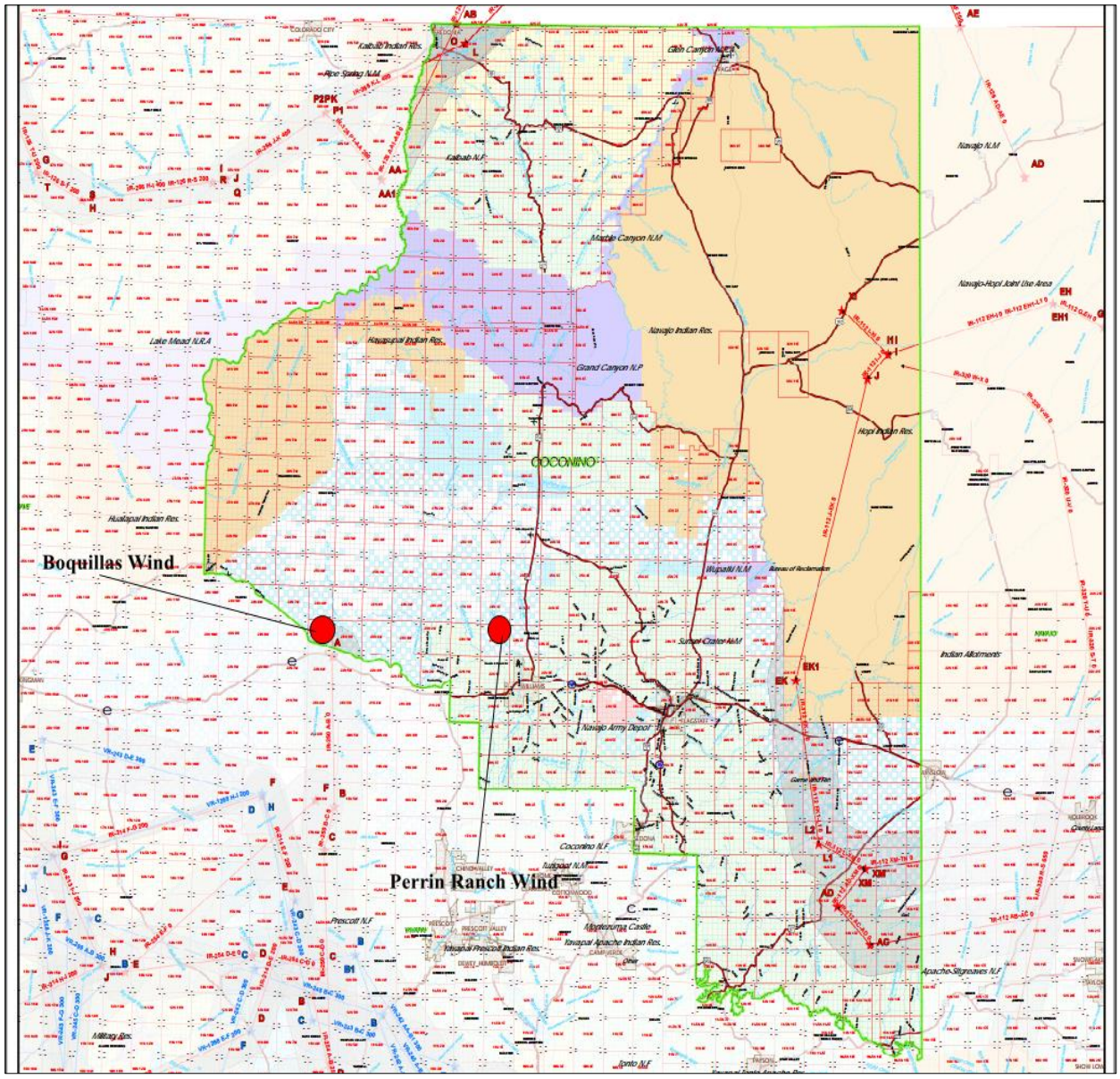


Figure 10: Coconino County MTR Map

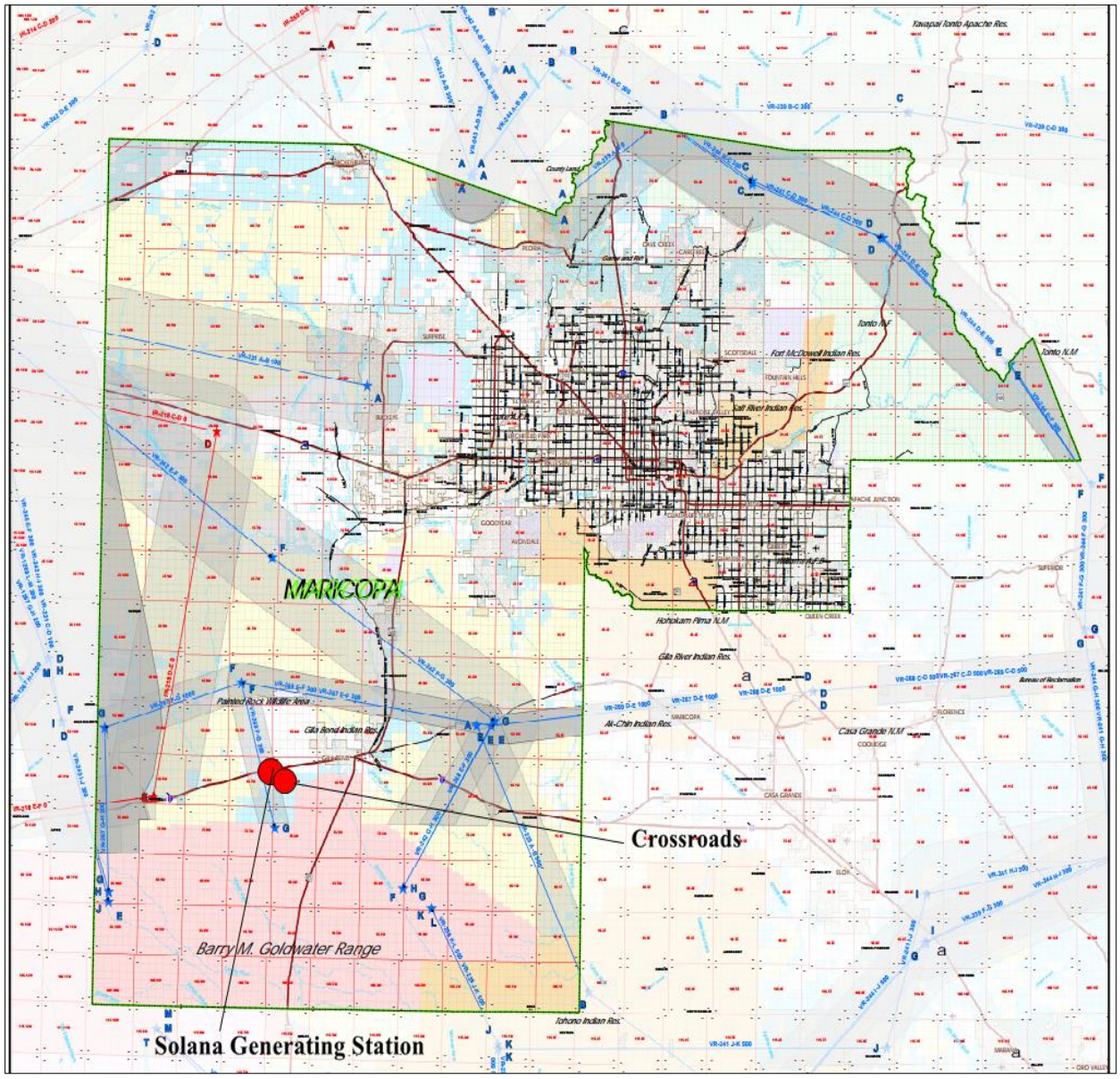


Figure 11: Maricopa County MTR Map

These maps reveal that seven of the 12 planned or existing CSP and Wind projects assessed in this report are located on existing MTR. These projects are:

- Dry Lake Wind Project (Navajo County)
- Quartzsite Project (La Paz County)
- Environmission Tower (La Paz County)
- Red Horse Wind (Cochise County)
- Boquillas Wind (Coconino County)
- Crossroads (Maricopa County)

- Solana (Maricopa County)

All these projects involve tall structures—either wind turbines or solar energy collecting towers. If not mitigated, any of these projects could potentially interfere military training flights.

All three transmission line projects assessed for this report also partly overlap with MTRs and could likewise potentially interfere with military training flights.

Security Interferences

A comparison of the energy project sites and military facilities shown in Figure 3 and Figure 12 also reveals that the following projects are located in close proximity to military facilities:

- Crossroads Project (very close to Barry M. Goldwater Range East of the Air Force)
- Solana Generating Station (very close to Barry M. Goldwater Range East of the Air Force)
- San Luis Solar Wind Down Draft Tower (very close to Barry M. Goldwater Range West of the Marine Corps)
- Arlington Valley (very close to Buckeye National Guard Target Range of the National Guard)
- Mesquite Solar (very close to Buckeye National Guard Target Range of the National Guard)
- Sonoran (very close to Buckeye National Guard Target Range of the National Guard and Luke AFB of the Air Force)
- Sunzia Southwest Transmission (very close to Davis Monthan AFB of the Air Force and Picacho Peak Stagefield of the National Guard).

Electromagnetic Interferences

The locations of both the transmission line projects assessed in this report and Arizona's military facilities are shown below in Figure 12:

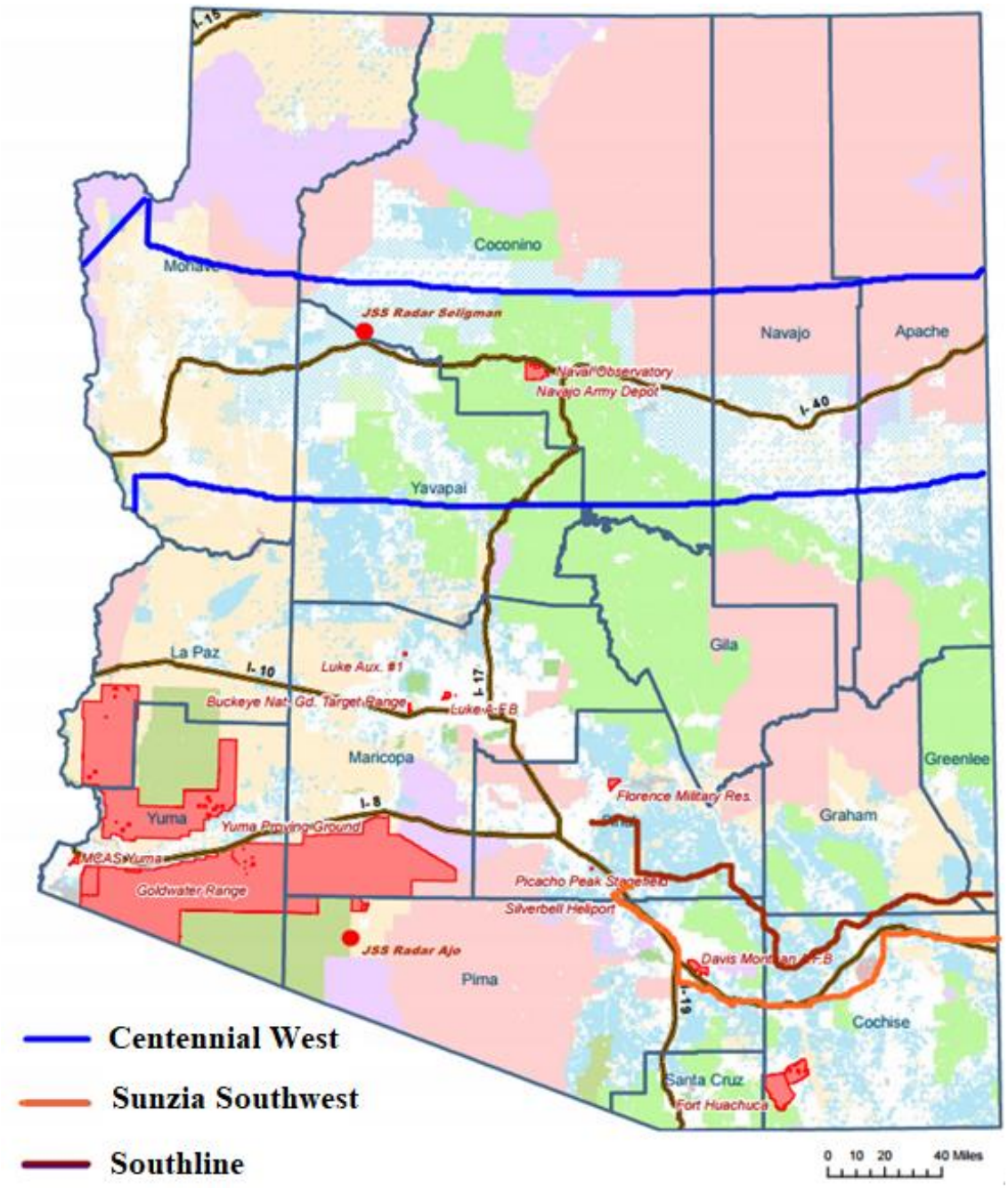


Figure 12: Assessed Transmission Projects and Military Facilities

Figure 12 reveals that the Sunzia Southwest project is very close to Davis Monthan AFB of the Air Force and Picacho Peak Stagefield of the National Guard. The shortest distances from Sunzia line segments to these two military facilities were both under 10 miles. Though a defined distance-interference relationship has not yet been established, this close proximity warrants a further inquiry into possible interference and mitigation measures.

Glint/Glare Interferences

The locations of both the solar energy projects assessed in this report and Arizona's military facilities are shown below in Figure 13:

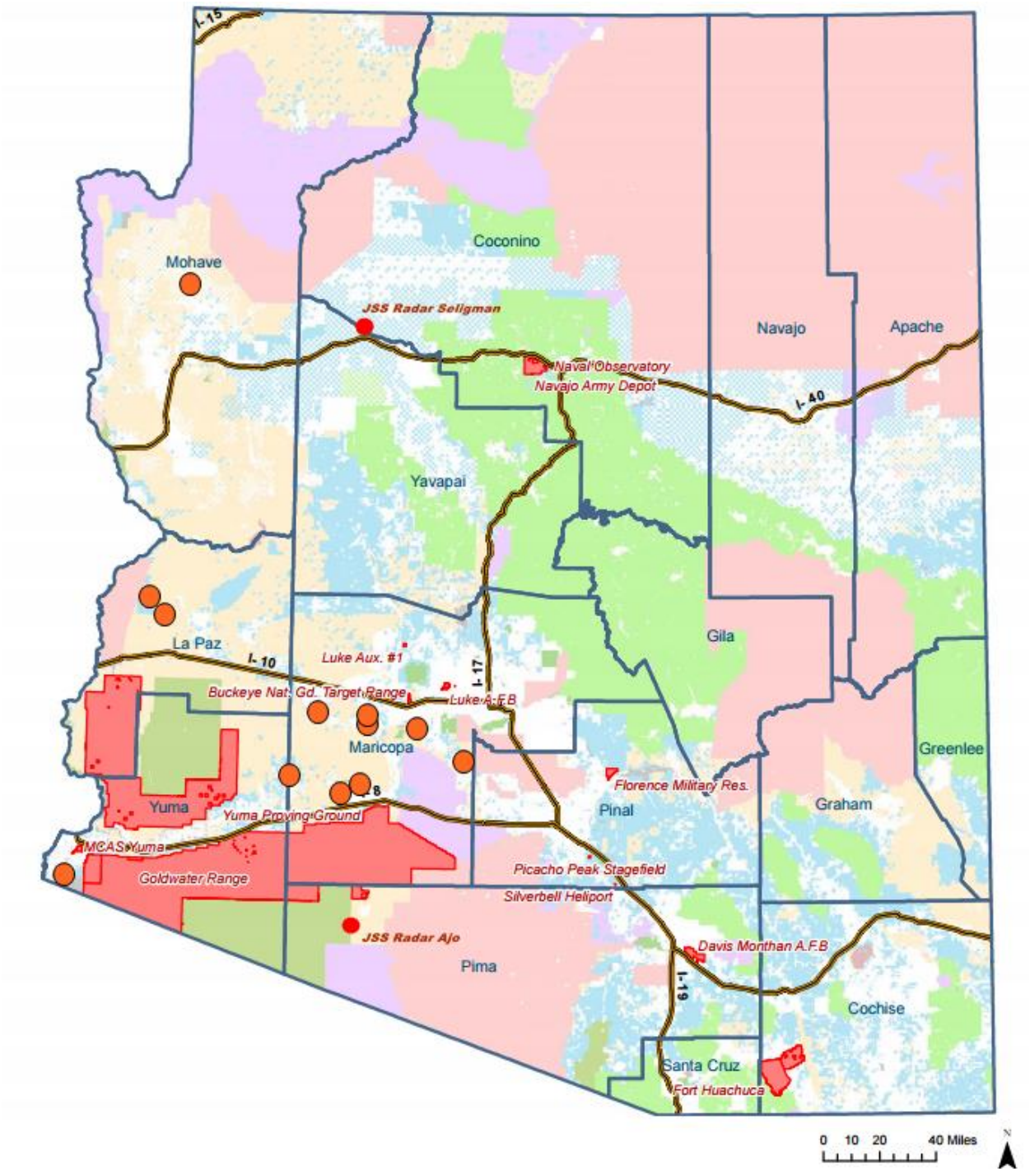


Figure 13: Assessed Solar Energy Projects and Military Facilities

As illustrated on this map, the following projects are located close to airports or MTRs:

- Agua Caliente (Yuma County)
- Quartzsite Project (La Paz County)
- Environmission Tower (La Paz County)
- Sonoran Solar (Maricopa County)
- Arlington Valley (Maricopa County)
- Crossroads (Maricopa County)
- Solana (Maricopa County)
- Maricopa Solar Park (Maricopa County)
- Mesquite Solar (Maricopa County)

The proximity of these projects to military airports and MTRs may warrant further inquiry into possible glint or glare interference risks involving these projects.

Conclusion

After reviewing the five primary types of potential interference between renewable energy projects and military operations, the analysis summarized in this report found that the following planned or existing projects may interfere with military operations in one or more ways. The findings were

Project Type	Project Name	Location	Interference Type
Wind	Dry Lake Wind	Navajo County	Radar, Flight
Wind	Perrin Ranch Wind	Coconino County	Radar
Wind	Red Horse Wind	Cochise County	Radar, Flight
Wind	Mohave County Wind Farm	Mohave County	Radar
Wind	Boquillas Wind Project	Coconino County	Radar, Flight
Wind	Yavapai Ranch	Yavapai County	Radar
Solar PV	Agua Caliente	Yuma County	Glint/Glare
Solar PV	Arlington Valley	Maricopa County	Security, Glint/Glare
Solar PV	Mesquite Solar	Maricopa County	Security, Glint/Glare
Solar PV	Sonoran Solar	Maricopa County	Security, Glint/Glare

Solar PV	Maricopa Solar Park	Maricopa County	Glint/Glare
CSP	Solana Generating Station	Maricopa County	Radar, Flight, Security, Glint/Glare
CSP	Crossroads	Maricopa County	Radar, Flight, Security, Glint/Glare
CSP	Quartzsite	La Paz County	Radar, Flight, Glint/Glare
CSP	Harquahala Valley Solar Tower	Maricopa County	Radar
CSP	Environmission Tower	La Paz County	Radar, Flight, Glint/Glare
CSP	San Luis Solar Wind Down Draft Tower	Yuma County	Radar, Security,
CSP	Hualapai Valley Solar	Mohave County	Radar
Transmission	Sunzia Southwest Transmission Project	Southern AZ	Security

Best Practices

In Developing Utility-scale Renewable Energy in Arizona

Decision-support tools are needed to efficiently guide projects toward areas that are commercially attractive for development, and away from areas important for biodiversity conservation and other resources. Using such tools in the early phase of project scoping would allow developers to select areas where they will be less likely to encounter environmental obstacles in the permitting process. These "low-conflict" locations could be prioritized for field investigations and possibly be eligible for expedited permitting or other incentives to promote projects on appropriate lands. Conservationists also benefit from early identification of areas with minimal conservation value as it might expedite the attainment of climate benefits and reduce the risk of their being perceived as obstructionist.

The Arizona Military Energy Land Use Plan (AME-UP) is a decision support tool that is intended to provide potential energy developers early notice that there may be issues or concerns about a potential project location due to military interests. A recent Sonoran Institute Report titled "Mutual Benefit; Preserving Arizona's Military Mission and the Value of Publicly-Owned Lands" evaluated the scope of military activities over the state, finding that 51.8% of the state, or about 38 million acres were covered by some military Special Use Airspace (SUA) which includes Military Training Routes, special notification areas, electromagnetic testing airspace, and other types. Development within these areas may create concerns for military interests even though the underlying land permits the construction and operation of energy projects.

For these reasons, it is best for project proponents to first evaluate whether their project is compatible with military uses by examining the occurrence of SUA around potential project locations, and having a discussion with the relevant agency to determine whether the specific size, height, technology, and other considerations would create a conflict with military uses. This extra

effort on the front-end can reduce the potential loss of resources and time related to permitting and designing a project that may receive additional scrutiny or outright opposition from military interests.

This tool is best used as a mechanism to evaluate the potential for overlap between an energy project and a military interest associated with the land or air above it. The following best practices are also intended to help project proponents navigate the complex regulatory and environmental conditions that are associated with development within Arizona. As policies tend to change over time, these best practices are intended to establish guidelines that are further expanded in resources that are linked in the text.

Understanding the history and complexity of renewable energy in Arizona

A general understanding of the renewable energy industry in Arizona can be helpful for prospective developers who may not be familiar with the landscape. Arizona, like most other regions, has experienced the uncertainty and challenges associated with energy development, which when understood can allow a project proponent to be more aware of potential pitfalls in perception within the region and specific communities. The below summary provides some context that may be helpful in informing how to best engage in local communities:

Land rush

Prior to 2008 there was little interest in utility-scale energy development. For purposes of this section, utility-scale refers to solar energy projects over 100 Megawatts (MW) in capacity. After the beginning of the Great Recession, the American Recovery and Reinvestment Act along with other ongoing federal and state incentives, promoted the development of renewable energy projects by reducing the uncertainty of their financial success and enhancing their ability to compete with legacy fossil fuel generation. This was further enhanced by mandates from various states including Arizona that required a certain amount of renewable energy to be a permanent part of the electricity portfolio. This mandate, known as a Renewable Portfolio Standard (RPS) is 15% of retail sales for Arizona by 2025 which can comprise hydroelectric, distributed (rooftop) solar, and utility-scale solar, wind, and geothermal projects.

With interest from utilities in Arizona, Nevada, and California along with incentives from the government, energy developers (many of them speculators with no proven record of development) rushed for available land within Arizona and other states in order to lock down priority spots near transmission infrastructure. These lands were largely owned by the federal government and controlled by the Bureau of Land Management, resulting in an outcry from other stakeholders including recreationists, sportsmen, and the environmental community.

Local county and city governments faced a different challenge as they had not previously anticipated any demand for large swaths of private lands for energy development, and had no formal processes for accommodating this type of project. In some cases, projects that were attractive for the local leaders were outright prohibited due to arcane language that anticipated energy development to be highly polluting and a nuisance to other nearby landowners. This situation led to a rapid overhaul of city and county long-range planning regulations and zoning ordinances to facilitate development. Though these efforts were often expedited, most communities were not prepared to accommodate large-scale projects until several years after the demand began.

The Arizona State Land Department (ASLD) controls about 12% of Arizona's land portfolio. With a mandate to generate revenue from these properties, the ASLD began to create an energy development program that would prioritize solar energy development on land with the most potential for energy generation, and properties that were available for this use. Today many projects have been developed in western Maricopa County on state trust lands that were highly suitable for this use.

BLM processes

Western Solar Plan: With the land rush underway, the BLM was struggling to make sense of the dozens of applications that were submitted for solar projects. Without the needed capacity to review all of the requests, and concerns that many of the proposed projects were not viable economically or practically due to lack of transmission capacity, significant environmental impacts, or other considerations, the BLM placed a moratorium on new applications (albeit for a brief one-month period) in order to make sense of their energy program. During the spring and summer of 2009, BLM released its Solar Energy Programmatic Environmental Impact Statement (PEIS) that continued through a process for final adoption through a Record of Decision in October of 2012.

Under the PEIS, the BLM established policy for how solar projects would be evaluated and where they could be placed in the six southwestern states including Arizona. Lands off-limits to solar were placed in exclusion areas, solar energy zones were established including two in Arizona, and other lands were placed in variance areas where applications would be considered, though more scrutiny and complexity would be associated with that process. A link to this document is below in the resources section.

Restoration Design Energy Project (RDEP): Arizona only had two Solar Energy Zones (SEZs) identified in the Western Solar Plan. Seeing the potential for the state to limit its potential for solar development, the state BLM office embarked on another plan called the Restoration Design

Energy Project (RDEP) that would screen all lands in the state other than Indian reservations to determine where might be the best place for this development. Through this process, many stakeholders were engaged including the Sonoran Institute's Arizona Solar Working Group (ASWG) who contributed significant input on environmental constraints, stakeholder views, energy potential, and other information from its cadre of conservation, utility, and industry members.

The RDEP was adopted in January of 2013, establishing one new SEZ and creating Renewable Energy Development Areas (REDAs) which are a subset of the variance areas identified in the Western Solar Plan. Overall, about 290,000 acres of BLM land are REDAs while about 1.6 million acres of land managed by other federal agencies, private landowners, and the ASLD have similar qualities and are likely highly suitable for energy development.

Solar Energy Build-out Study

In 2015, after the Obama administration adopted the Clean Power Plan (CPP), the Sonoran Institute and the ASU Energy Policy Innovation Council collaborated to evaluate the potential of Arizona to meet the targets of the CPP using a reasonable scenario for renewable energy development. In November, 2015 a study was published titled "Gliding Toward a Clean Energy Future: Arizona Responds to the EPA's Clean Power Plan" which demonstrated that there was significant potential for the state to meet much of its goals by implementing power purchase agreements for the fifteen projects that are already permitted or in process, and to develop a certain amount of energy in the three SEZs and REDA lands. In this scenario, the state would generate an additional 4,312 MW of renewable energy and reduce its reliance on fossil-fuel generation.

While the CPP is likely to be significantly altered or completely repealed by the Trump administration, this study is valuable as it establishes a reasonable scenario for energy supply that can be further leveraged to help regulators understand the potential for scaling up energy development, and for the development of additional transmission capacity moving energy from Arizona to nearby demand centers.

Resources:

1. Restoration Design Energy Project Final EIS and Record of Decision: https://eplanning.blm.gov/epl-front-office/projects/nepa/79922/107093/131007/RDEP-ROD-ARMP.pdf
2. Western Solar Plan Final EIS and Record of Decision: http://solareis.anl.gov/index.cfm
3. Sonoran Institute Build-out Study: https://sonoraninstitute.org/files/pdf/arizona-renewable-energy-build-out-study-11172015.pdf
4. Arizona State Land mapping tool: http://gis.azland.gov/webapps/parcel/

Understanding Regulation

Land use regulation is complicated and has a significant role in determining the feasibility of an energy project on a given parcel. In the following sections, we will provide a general overview of best practices associated with land use regulation that can help inform appropriate site selection.

Federal

The federal government manages a significant portion of Arizona's land portfolio. Overall, 2% of the state is National Wildlife Refuges, 4% National Parks, 4% military lands, 15% National Forests, and 19% Bureau of Land Management. Though Indian tribes occur on 27% of the land, it is not considered federal lands in this document. With so much land managed by the government, it is important to be aware of the general practices that are associated with development of projects on these lands:

1. Energy development is permitted on many federal lands within Arizona. Generally, unless withdrawn from energy development it can be permitted after a successful application approval.
2. Some lands are withdrawn from energy development. Most often these areas have known environmental or cultural value or may be in use by other interests.
3. In general, lands that are special designations are not eligible for energy leasing or rights-of-way. These could include:
    a) Administrative designations including Lands with Wilderness Character, Areas of Critical Environmental Concern, Critical Habitat Areas, Special Resource Management Areas, and others.
    b) Congressionally protected lands which could include some National Monuments, National Conservation Areas, Wilderness areas, and Special Management Areas, among others.
    c) Lands protected under the Antiquities Act by Presidential declaration which include some National Monuments.

4. All federal lands are governed by a management plan. For Bureau of Land Management, these plans are titled Resource Management Plans, for National Forests, these are titled Forest Plans, and for lands in the National Park Service these are known as General Management Plans. National Wildlife Refuges operate under a Comprehensive Conservation Plan.
5. In general, management plans are available on the respective websites of each agency. It is recommended that potential project applicants request a formal meeting with the respective agency to discuss a considered project, and to receive guidance on the location and use of the applicable management plan.
6. Management plans are approved through a formal and complex process that occurs every one or two decades. These plans become the regulatory guidance for how lands will be managed to balance the interests of the public including various user groups. Each plan details in what manner amendments or modifications can be made to permit development or activities that are not currently permitted under the plan. In many cases, development on lands prohibit energy projects, can be allowed but only after an extensive and expensive amendment process.
7. Various stakeholders will have interest in the use and development of public lands. In most cases, these individuals and entities will have previously used the land or benefited from it in some way, which will increase the value of early engagement and an effective dialogue about how to avoid impacts though site selection and design. In general, the federal agency will assist in the development of an effective outreach strategy.

Best practices regarding siting energy development on federal lands in Arizona:

8. Within Arizona, the BLM is generally the land manager with the most available and suitable land for energy development. These lands have recently been evaluated and categorized for suitability for solar development:
    a) Solar Energy Zones: Within Arizona, three Solar Energy Zones (SEZs) were identified—two under the Western Solar Plan (http://blmsolar.anl.gov/) and one under the Restoration Design Energy Project (RDEP) (https://eplanning.blm.gov/epl-front-office/projects/nepa/79922/107093/131007/RDEP-ROD-ARMP.pdf). These solar energy zones are located in the western region of the Sonoran Desert. One each in La Paz, Maricopa, and Yuma Counties.
        i. To view these zones visit: http://blmsolar.anl.gov/sez/
        ii. Development within SEZs is preferred by the BLM and many stakeholders as they were approved for this use through a formal process including amendments to existing RMPs. Also, mitigation (see that section in this document) is defined and

should result in a lower impact on natural and cultural resources and an expedited planning process.

b) Renewable Energy Development Areas (REDA): These areas were defined through the Arizona Restoration Design Energy Project (RDEP) (http://azmemory.azlibrary.gov/cdm/ref/collection/feddocs/id/2545). This process occurred during and just following the Western Solar Plan process and resulted in one additional SEZ and the identification of about 192,000 acres of low conflict and high potential lands for solar energy development. In addition, the screening process also included private and state trust lands, resulting in another 1.6 million acres of land that is likely suitable for projects.

9. Due to the significant involvement and investment in these two federal environmental planning processes, it is expected that most stakeholders will prefer development that considers locating within SEZs and/or REDA lands before evaluating other sites. A project proponent should detail why previously screened lands are not suitable for development while making the case for siting in a different location.

State Trust Lands

Arizona State Lands comprise approximately 12% or 9 million acres of the state. Most of these lands are under some form of resource use including ranching, mining, timber sales, or other consumptive uses. Other lands are planned and entitled for development of various forms including renewable energy projects. The Arizona State Land Department (ASLD) has embraced the development of renewable energy and has a number of projects that are currently finished or under development throughout the state.

1. Not all ASLD parcels are available for solar development. Properties that can be leased for solar are listed on their website at https://land.az.gov/commercial-sales-leasing/available-properties.
2. ASLD lands are mapped for easy viewing at http://gis.azland.gov/webapps/parcel/. Lands with solar potential are highlighted once the "Solar Scores" layer is turned on.
3. It is recommended that a potential developer contact the ASLD to discuss the potential for a project early in the siting process.

County and City Permitting

Projects on state and private lands will require permitting and approval through a local jurisdiction which will be either a county or city. Unincorporated lands will be permitted through the relevant

county process, while projects that are annexed into an incorporate city or town will fall under their authority.

1. To determine the jurisdiction of a parcel, contact the city or county planning department that is closest to the property. County mapping resources can be found on the internet which will also provide some information.
2. Various counties within Arizona have embraced solar energy development by analyzing the solar potential of various parcels and developing application processes that suit the rapid permitting of suitable projects.
3. A pre-application meeting is recommended for all project proponents in order to determine process expectations and timelines.
4. Some cities and counties have special processes for renewable energy projects. A request should be made to the appropriate planning department for more information.

Environmental Impacts

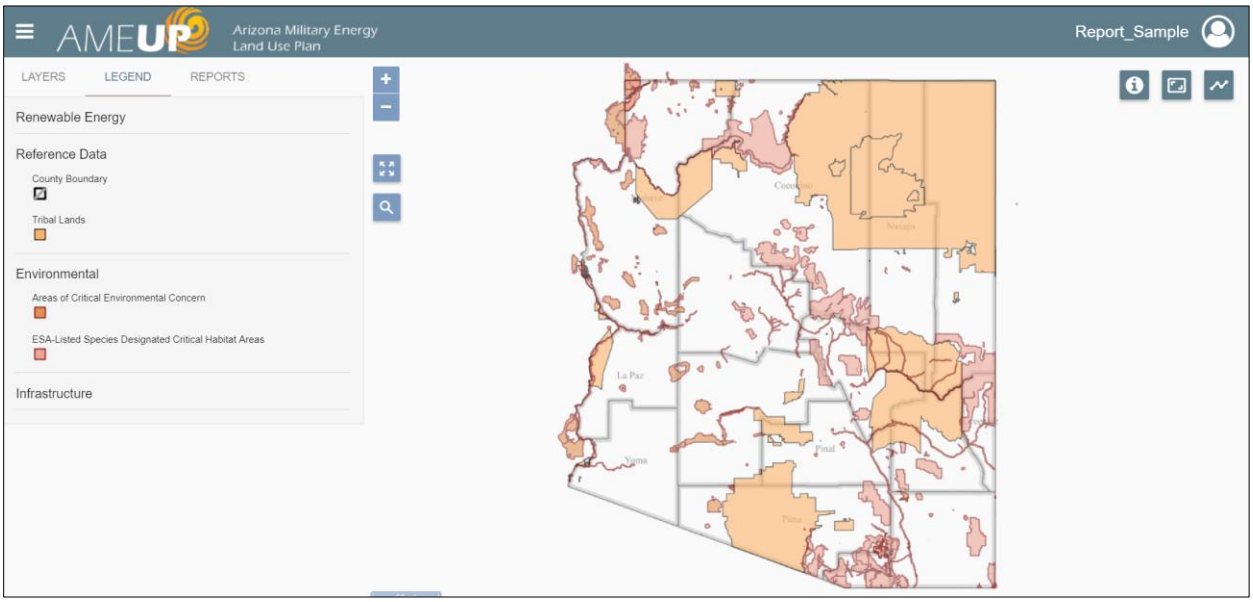
The southwest desert is a landscape that is easily disturbed and hard to restore. The development of utility scale solar projects can have a sizeable footprint in terms of land area and water use, and result in many possible effects on a desert environment. These can include habitat loss and fragmentation; alteration of water sources; disruption of wildlife movement; increases in wildlife mortality; promotion of invasive species and impacts to cultural and historic resources.

To anticipate the potential environmental impacts that a solar project may incur it is recommended that the project developers conduct a pre-NEPA preliminary environmental screening analysis. This should occur during the pre-application phase as project developers meet with nearby landowners, tribes, environmental groups and other potentially affected interests. This pre-NEPA analysis will allow the project developers (and potential investors) to evaluate the feasibility and risks associated with a proposed project. The analysis should look at both project-level and cumulative effects of the proposed project.

Determining the resource concerns and issues through a preliminary analysis will allow for development of alternative design and/or site selection and mitigation measures. This section will identify the most common biophysical and socioeconomic impacts associated with large scale utility projects, and provide resources that either identify best management practices (BMPs) or encouragement the development of project specific BMPs for solar energy development.

Habitat Fragmentation

Habitat fragmentation is the process through which previously intact areas of habitat are divided into smaller disconnected areas by roads, urbanization, infrastructure and other barriers. This decreases the degree of habitat connectivity of the landscape for wildlife. The disruption of animal movement by habitat fragmentation presents problems for wildlife, ranging from direct mortality on roadways to the genetic isolation of fragmented populations. However, the effects of habitat fragmentation can often be mitigated by identifying and protecting areas that wildlife use for movement, known as wildlife linkages or wildlife corridors. Identification of areas where solar development is incompatible with wildlife conservation should be assessed as part of the preliminary environmental screening analysis. Habitat fragmentation can be prevented or at least reduced by appropriate site selection and the incorporation of wildlife-friendly guidelines.



The map above is taken directly from the AMEUP web tool, and showcases just a few of the many data layers included in the tool to aid developers with assessing environmental impact before a proposal is drafted.

Resources:

1. Central Arizona Conservation Alliance "GreenPrint": Web-based viewer to identify areas of rural and urban habitat blocks and natural heritage species. Available in January 2018 by contacting Sonoran Institute at (602) 393-4310.
2. Arizona Game and Fish Department- Web-based viewer for wildlife data http://www.habimap.org/
3. Renewable Energy Development Areas file: https://www.blm.gov/az/st/en/prog/energy/arra_solar.print.html
4. Guidelines for Solar Development in Arizona -Arizona Game and Fish Department:

5. http://www.azgfd.gov/hgis/documents/FinalSolarGuidelines03122010.pdf
6. Sonoran Desert Conservation Plan- Pima County: http://www.pima.gov/CMO/SDCP/intro.htm
7. Oracle Road Wildlife Crossing: http://www.sonorandesert.org/learning-more/wildlife-linkages-2/oracle-road-wildlife-crossings-2/

Wildlife Connectivity

Connectivity refers to the degree to which the landscape facilitates or impedes movement. Wildlife corridors and linkages are a distinct component of the landscape and both provide connectivity. Wildlife corridors specifically facilitate the movement of animals, while other types of corridors may support connectivity for plants or ecological processes. Although the term is frequently used synonymously with corridor, linkages refer to broader regions of connectivity important to maintain ecological processes and facilitate the movement of multiple species.

1. New roads, communities, and energy corridors impact wildlife connectivity by forcing wildlife to find ways around or through new structures. Extreme examples of habitat fragmentation have demonstrated a significant loss of biodiversity, especially larger mammals who rely on broader spaces for migration.
2. In 2006, the Arizona's Wildlife Linkages Assessment was published, representing the results of a stakeholder workshop in which important potential wildlife linkage zones were identified. The report is one tool to identify areas where solar project could be located without posing a problem to large scale landscapes and wildlife connectivity. This report, background information, and associated GIS datasets provide important wildlife linkage information and offers a starting point for detailed consultation and coordination among the organizations and agencies that have a major role to play in maintaining habitat connectivity.

Resources:

1. Central Arizona Conservation Alliance “GreenPrint”: Web-based viewer to identify ecological linkages and corridors. Available in January 2018 by contacting Sonoran Institute at (602) 393-4310.
2. Arizona Wildlife Linkages Assessment https://www.azdot.gov/docs/planning/arizona_wildlife_linkages_assessment.pdf?sfvrsn=7
3. Smart Lines: Transmission for the Renewable Energy Economy (Resource Media and WRA 2008), the Western Electric Coordinating Council’s Environmental Data Task Force’s Preliminary Environmental Recommendations for the Transmission Planning Process (WECC 2011)

4. Sonoran Desert Conservation Plan- Pima County: http://www.pima.gov/CMO/SDCP/intro.htm
5. Oracle Road Wildlife Crossing: http://www.sonorandesert.org/learning-more/wildlife-linkages-2/oracle-road-wildlife-crossings-2/

Avian Concerns

In the past, issues with birds and wind energy turbines has been the most commonly voiced avian concern in the development of energy facilities. However, with the proliferation of solar arrays, it is now being reported that certain avian species seem to crash into large solar power arrays (i.e. lake effect) or get burned by the concentrated rays. Noise, lighting and vegetation clearing could impact migratory birds. As solar energy farms increase there is a concern that these clean energy facilities can cause harm to certain bird species.

1. Avoidance of locations with known high value bird habitat and/or migratory patterns can reduce or eliminate the potential for avian concerns. Alternatively, if the proposed site is unavoidable, monitoring requirements (preconstruction surveys to assess baseline avian and abundance) and mitigation measures (design and environmental) are typically required of proponents/operators.
2. The problem of bird deaths is complex and needs to be tailored to the species, the environment and the facility. Since this phenomenon was first documented, biologists and conservationists have developed a list of recommendations for directly reducing avian mortality including clearing vegetation around solar towers to make the area less attractive to birds, retrofitting panels and mirrors with designs that help birds realize the solar arrays are not water, suspending operations at key migration times, restoring bird habitat elsewhere to draw birds away from the solar facilities and preventing birds and bats from roosting and perching at the facilities.

Resources:

1. Avian Power Line Interaction Committee's Suggested Practices for Avian Protection on Power Lines (APLIC 2006).
2. A Review of Avian Monitoring and Mitigation Information at Existing Utility-Scale Solar facilities
3. http://www.evs.anl.gov/downloads/ANL-EVS_15-2.pdf
4. Multiagency Avian-Solar Collaborative Working Group Avian-Solar Science Coordination Plan http://blmsolar.anl.gov/program/avian-solar/docs/Final_Avian-Solar_Science_Coordination_Plan.pdf

Riparian Areas

Riparian areas are ecosystems that occur along watercourses or water bodies such as floodplains, streambanks and lake shores. They can be found where water flows or collects when it rains and are at every elevation from mountain top to desert floor. Riparian areas are important for ecosystem services (filtering pollutants, stabilizing bank streams, providing biodiversity) and providing wildlife habitat. Typical in the arid western United States, riparian areas are estimated to be less than 2% of the total land area. In Arizona that number is .04%.

1. An evaluation of the project area for riparian areas will allow for the development of mitigation measures to minimize disturbance to sensitive areas. In general, projects should avoid disturbing riparian areas including desert washes.
2. Water flows should pass out of the site at the same locations and with the same amount as before the project occurred. This will minimize the amount of impact to off-site resources.
3. Riparian areas convey wildlife passage in addition to water flows. Large sites should accommodate wildlife connectivity through the site by leaving large riparian and xeroriparian areas (desert washes) undisturbed through the project.

Resources:

1. Central Arizona Conservation Alliance “GreenPrint”: Web-based viewer to identify riparian and wetland areas and corridors. Available in January 2018 by contacting Sonoran Institute at (602) 393-4310.
2. Sonoran Desert Conservation Plan: http://www.pima.gov/CMO/SDCP/Riparian.htm
3. Riparian Habitat Management in Arizona. Arizona Audubon: http://www.tucsonaudubon.org/~tucsonau/images/stories/IBA/BMP%20070306%20v.5%20web.pdf

Ground Disturbance

Large scale solar utility developments create large areas of disturbance and soil, groundwater, and surface water resources can be impacted. In particular, the large, cleared, impervious surface areas created can block or reroute surface flows. Soil erosion at a site can be particularly problematic as it can remove soil, decrease its productivity and damage biological resources. Further, if uncontrolled runoff from construction sites causes short-term increases in turbidity in nearby watercourses, this can exacerbate flooding and also lead to increases in sedimentation and siltation which degrades water quality.

1. Use of appropriate buffers between disturbed and undisturbed areas is important.
2. Engineering controls can be determined through agency consultation.
3. Minimizing the impact to large undisturbed areas of desert pavement is important as restoration of this surface is virtually impossible.

Resources:

1. Desert Pavement Protection Plan. San Diego Gas and Electric Company: http://www.cpuc.ca.gov/Environment/info/aspen/sunrise/otherdocs/Desert_Pavement_Protection_Plan_070110.pdf
2. Desert Soils. Joseph R. McAuliffe. https://www.desertmuseum.org/books/nhsd_desert_soils.php

Site Design to Avoid Impacts

Solar development has the potential to directly and indirectly affect many different biophysical and socioeconomic resources. Avoidance criteria are best applied during pre-construction site selection (macrositing) and during the final adjustment of the project footprint (micrositing). Good macrositing decisions are essential for choosing an acceptable site or portion of a site. Once a site is selected, micrositing efforts, such as appropriate placement of roads, power lines, and other infrastructure can avoid or reduce potential impacts to wildlife and other biological resources.

1. Conceptual designs can address anticipated stakeholder concerns even during macro siting decisions. During the due diligence phase and site selection, a concept plan should be shared with key stakeholders to gather whether concerns can be addressed through design adjustments.
2. Similar projects in similar ecosystems should be researched in order to determine the types of issues that were raised and addressed through site design. In some cases, poorly designed

projects have generated a lot of input that can be integrated into a contemporary, more appropriate project.

Environmental Mitigation

General and resource-specific mitigation measures can be applied to avoid or minimize impacts from solar energy development. In order to identify and implement appropriate mitigation measures, the potential impacts of a project on a specific resource must first be assessed. Then, project- and site-specific factors must be evaluated to determine whether the impact can be avoided or mitigated, what action can be taken, how effective the mitigation measure will be, and the cost-effectiveness of the measure. Each solar project is unique, and no one recommendation will apply to all pre-construction site selection and layout planning. However, consideration of the following elements in site selection and development of infrastructure for the facility can be helpful to avoid and minimize impacts.

Air Quality

Solar energy development projects tend to cause large-scale disturbances which can result in wind-borne dust during the various stages of activity (site preparation, construction, and operation). Many projects located in the southwestern desert occur in air basins with federal designations of "nonattainment" for federal particulate matter (PM2.5 and PM10), and state-level ozone nonattainment. Without adequate fugitive dust mitigation, projects have the potential to exceed the PM10 threshold during construction and operation, and could cause localized exceedances during construction. Typically, air quality impacts are low during site characterization activities. Construction activities have the greatest potential for air emissions and adverse air quality impacts (soil disturbance, fugitive dust, and large equipment exhaust emissions). It is generally appreciated that air emissions associated with operations (generating electricity form solar technologies) are negligible. Just as important as managing the air quality impacts of the project is understanding how they relate to the air quality standards of the region. Under the Clean Air Act, area's (county's) are required to meet air quality standards. Permitting of construction and operation of the plant need to be reviewed by county and state air quality departments. While air quality particulates are considered to be of most concern, nitrogen oxides (NOx) and volatile organic compounds (VOCs) can mix with to form ground-level ozone. Each of these pollutants are products of utility scale solar projects and need to be analyzed for their impacts to the environment. To determine if a solar project requires an air permit contact the county where the project is located or the Arizona Department of Environmental Quality

Resources:

1. Maricopa County Air Quality https://www.maricopa.gov/2686/Planning-Area-Maps
2. Arizona Department of Environmental Quality http://legacy.azdeq.gov/function/permits/renew.html
3. Best Management Practices and Guidance Manual for Desert Renewable Energy Projects: http://www.energy.ca.gov/2010publications/REAT-1000-2010-009/REAT-1000-2010-009-REV1.PDF

Social Impact

Social impacts associated with solar projects are not easy to define and they are often given less attention than environmental impacts. Most important social impacts of solar projects are public acceptance, job creation, and social benefits (i.e. progress of the region, income, health benefits of improved air quality, etc.). Visual impacts are dependent on the type of surroundings and landscape where the solar system is installed. As with the environmental impacts, the amount of social impact depends on the location. Near natural beauty and cultural heritage areas, solar installations usually have a strong negative impact. With the help of the visual landscape planning, cultural heritance and aesthetics can be protected.

1. **Cultural and Historic Resources**

The potential for impacts on cultural resources from solar energy development, including ancillary facilities, such as access roads, is directly related to the amount of land disturbance and the location of the project. Indirect effects, such as impacts on the cultural landscape resulting from the erosion of disturbed land surfaces and from increased accessibility to possible site locations, are also considered.

1. Many impacts can be reduced or avoided when considered during the preliminary siting phase.
2. Conducting an informal consultation with the state agency early in the project development process and preferably prior to final project siting and design will allow for the preliminary identification of cultural and historically sensitive areas.

Resources

1. Arizona State Historic Preservation Office: https://azstateparks.com/shpo1
2. National Register of Historic Places: https://azstateparks.com/national-register
3. National Historic Preservation Act: https://azstateparks.com/national-register

4. Best Management Practices and Guidance Manual for Desert Energy Projects: http://www.energy.ca.gov/2010publications/REAT-1000-2010-009/REAT-1000-2010-009-REV1.PDF

Viewsheds

In the simplest of terms, the visual impacts associated with a solar energy plant depend primarily on its size, and the topography of its surroundings. However, it is important to recognize the viewshed impacts associated with the facility. The construction and operation of a solar energy plant creates a visual contrast with the surrounding landscape, primarily because of the introduction of complex and visually distinctive man-made structures on a large scale into the existing landscape. In the southwestern states where most U.S. utility-scale solar facilities are in operation or planned, solar facility sites are relatively flat, open spaces, typically located in visually simple and uncluttered valley landscapes that often lack screening vegetation or structures. Because of the lack of screening elements, the open sightlines, and relatively clean air typical of the western U.S., solar facilities may be visible for long distances, and their large size and distinctive visual qualities can give rise to strong visual contrasts in some circumstances. The visual contrasts caused by the addition of solar facilities to the landscape give rise to visual impacts from the facilities. Visual impacts include both the changes to the visual qualities and character of the landscape resulting from the visual contrasts created by the facilities.

Visual impact varies also according to the hours of visibility to an observer. Visual impacts have become an increasingly important concern not just for individuals but for organizations such as tribes, local governments, environmental groups, and the National Park Service (NPS). Concerns over potential negative visual impacts of solar facilities are routinely expressed by stakeholders during the environmental impact assessment processes that are typically required for these types of facilities.

The Best Management Practices publication listed below, includes BMPs for avoiding and reducing visual impacts associated with the energy generation components of a facility, such as wind turbines or solar energy collectors, and includes many BMPs for reducing visual impacts associated with ancillary components, such as electric transmission, roads, and structures. However, visual impact mitigation is only partly addressed by considering what is built; mitigation must also address where a facility is built, and how it is built, operated, and decommissioned. The publications and links below provide proven, effective and vetted BMPs to address a wide range of potential visual impacts from renewable energy facilities throughout the project lifecycle.

Resources:

1. Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities. Cheyenne, Wyoming. 342 pp. April. http://blmwyomingvisual.anl.gov/docs/BLM_RenewableEnergyVisualBMPs_LowRes.pdf
2. Utility -Scale Solar Energy Facility Visual Impact Characterization and Mitigation: http://blmwyomingvisual.anl.gov/docs/SolarVisualCharacteristicsMitigation_Final.pdf

Noise

Noise impacts from utility scale solar projects are two-fold; during construction and during operations. Construction noise can be limited with construction noise BMPs (i.e., use of noise barriers, sound control devices, limit noisy construction activities). Noise generated by solar farms is generally not audible above ambient noise outside of project facility fence. Noise generation can come from the converters which generate a low buzzing sound as they convert electricity from the direct current (DC) generated by photovoltaic modules to alternating current (AC) used by the electric grid. Other components which can generate noise are tracking equipment that allows photovoltaic modules to face the sun over the course of the day. Central inverters are another source of noise and are usually surrounded on all sides by the vast solar panel arrays whose electricity they manage. This can also to create a distance from anyone who might happen to be nearby. Typically, large utility scale solar projects are not generally constructed directly adjacent to residences, and predictably there are no noise recipients. To preemptively mitigate noise and

visual interference, solar plants are generally required to be hedged to some degree by either walls or greenery. This has the effect of acting as a buffer for any noise that might make it past the panel arrays themselves.

Resources:

1. Best Management Practices and Guidance Manual for Desert Energy Projects: http://www.energy.ca.gov/2010publications/REAT-1000-2010-009/REAT-1000-2010-009-REV1.PDF

Environmental Justice Issues

Solar energy development could raise environmental justice concerns in the affected area around the development if minority or low-income populations are present. Adverse impacts that might disproportionately affect minority and low-income populations include reduced water quality, health or environmental hazards exposure, loss of lands for livestock grazing, and social and economic proposed project related impacts. The U.S. Census Bureau data will determine whether the facility would be located near a minority population or a population where 50 percent or more of the residents have an income below the poverty level. Because such impacts are location dependent, a detailed analysis should be a part of the pre-NEPA analysis.

Resource:

1. Best Management Practices and Guidance Manual for Desert Energy Projects: http://www.energy.ca.gov/2010publications/REAT-1000-2010-009/REAT-1000-2010-009-REV1.PDF

Jobs and Workforce

Job creation is often dependent on several facility characteristics, including project scale and technology. While the local labor pool may be qualified for less-skilled jobs, often local hiring will not satisfy the demand in professional, technical, and supervisory areas. While local laborers may be hired, local unemployment levels may not necessarily decrease, especially when the unemployed do not have the skills required for the new positions. Just as the quality of local labor plays a part in employment impacts, so does the quantity of available labor. A town will likely experience greater employment effects if its job applicants do not have to compete with the job applicants in other nearby towns. A concerted effort by the project developer to employee local workforce for construction and operation can produce a positive impact on a regions workforce pool.

In the case of renewable energy development, many rural communities have voiced opposition to claims of project proponents who assert that jobs will be created. Rural communities have asserted that their lack of skilled and technically competent workers will result in few jobs for local residents and that new projects are more likely to import jobs and result in additional demand for public services without adequate employment or tax revenue to offset the impacts. Project proponents should be prepared to demonstrate that projects will actually benefit the communities in which they are located.

Resources:

Research on the impacts of utility-scale solar on local social and economics are scarce, an abundance of research exists on the impacts of oil and gas and wind energy development. By considering the effects and similarities that oil, gas, and wind energy share with the solar industry, a generalization can be made about the possible effects of solar facilities on jobs and workforce creation. Evaluation of the BMPs for the socioeconomic impacts of oil, gas and wind energy development may inform BMPs for utility scale-solar projects.

1. Energy-Sector Workforce Development in Southwestern Pennsylvania. Rand Corporation. https://www.rand.org/content/dam/rand/pubs/research_reports/RR800/RR807/RAND_RR807.pdf
2. Power Initiative. U.S. Economic Development Administration: https://www.eda.gov/archives/2016/power/

Decommissioning and Restoration

Decommissioning would include the dismantling of solar facilities and support facilities, such as buildings/structures and mechanical/electrical installations; disposal of debris; grading; and revegetation as needed. Activities for decommissioning would be similar to those for construction but on a more limited scale. Potential impacts on ambient air quality would be correspondingly less than those for construction activities. The area disturbed during decommissioning/reclamation could be exposed to wind erosion. Stabilizing disturbed soils would reduce these emissions. However, given that stabilization is never fully effective and disturbed soils sometimes cannot be stabilized, wind erosion from disturbed areas could continue after decommissioning/reclamation, particularly in case of the highly erodible soils.

A decommissioning plan is usually required as a component of the permitting process. It should be thoroughly examined to determine what impacts are not likely to be recovered within a reasonable period after the project site is abandoned. These impacts should be characterized as irrecoverable and an appropriate mitigation plan put into place.

Resources

1. Belectric Decommissioning Plan: https://planningdocuments.saccounty.net/DocOpen.aspx?PDCID=13854
2. Barlow Solar Energy Centre Decommissioning Plan Report: https://www.edf-en.ca/wp-content/uploads/barlow_Draft-Decommissioning-Report.pdf

Mitigation Activities

The overall framework for mitigation of impacts is based upon three general steps: 1. Avoid impacts as much is possible; 2. Minimize impacts to natural, social, and cultural resources through careful design; and 3. Mitigate impacts that could not be avoided or minimized. The best approach for successful mitigation is to consider not only the direct unavoidable impacts associated with a project while it is under construction and operation, but also to examine those that cannot be restored after the project is decommissioned and to consider the connected impacts from associated actions.

Often mitigation actions are prioritized to occur on the same site as the impacts, however research demonstrates that these are regularly ineffective at maintaining or improving the conditions of the impacted targets. A more successful approach is by assessing the conditions and overall trajectory of the impacted target across a region, and determine what activities can be performed that will meet regional goals. The following best practices should be considered:

1. First, avoid impacts to known sensitive resources. A site selection process should examine sensitive resources that are known to occur in the region and avoid them.
2. Secondly, if avoidance is not practical, minimize the impact to the resource target by careful project design.
3. After designs are solidified, an honest assessment of impacts should occur that considers the impacts to all targets during construction, operation, and those that will remain after the project is decommissioned.
4. A regional assessment should occur to each known target that considers the trajectory of the species and an evaluation of long-term goals for each. For example, if desert tortoise is impacted, a regional goal might be to maintain a viable population of tortoise, resulting in mitigation actions that are designed around the regional goal, rather than one narrowly-crafted to simply recover incidental take that occurs in project construction and/or operation.
5. Mitigation actions should be designed in consultation with government and relevant stakeholders in order to ensure that they result in actual recovery or improvement of the impacted resource.

Resources:

1. Regional Mitigation Strategy for Arizona Solar Energy Zones. Bureau of Land Management: https://www.blm.gov/documents/arizona/public-room/report/regional-mitigation-strategy-arizona-solar-energy-zones-final
2. General Mitigation Measures (Best Practices) for Solar Energy Projects. Tribal Energy and Environmental Information Clearinghouse: https://teeic.indianaffairs.gov/er/solar/mitigation/index.htm
3. Building a Roadmap for Successful Regional Mitigation. Defenders of Wildlife, Sonoran Institute: https://drive.google.com/open?id=0B67e770Rmq-ZSWZ3YVRFR195TDQ

Military Encroachment

Development actions can bring surprising and unpredictable impacts to military facilities. This situation is broadly referred to as encroachment and can be learned about in recent reports by the Sonoran Institute, made available in the resources section below. The following excerpt from the report "Mutual Benefit; Preserving Arizona's Military Missions and the Value of Publicly-owned Lands" provides more context:

> "The DOD defines encroachment as "the cumulative result of any and all outside influences that inhibit normal military training, testing and operations" (Ripley 2008, 1). The concept is so important to the military that in fiscal year 2013 alone, DOD spent over $80 million on encroachment mitigation programs (Hagel 2014). A military facility is defined as an area owned or managed by any entity of the Department of Defense for the use or purpose of military training or readiness. For the purposes of this analysis, Sonoran Institute suggests three over-arching categories of encroachment to military facilities.
>
> 1. Direct Encroachment: A condition whereby an action, proposed action or an action's direct impacts will impair a military facility or its mission by interfering with operations.
>
> 2. Indirect Encroachment: A condition whereby an action, proposed action, or the likely results from an action or proposed action will cause impairment or impose a greater burden on a military facility through increased oversight, regulation and/or cost.
>
> 3. Perceived Encroachment: A condition whereby it possible that an action or proposed action may trigger an increased level of scrutiny or the perception of impairment to a military facility even if there is no evidence of direct or indirect encroachment.
>
> This structure is important as it allows decision-makers to better determine the appropriate actions or proactive measures that would best address the concern. Direct and indirect

forms of encroachment have been recognized by the military community in the past, although little attention has been given to the threats of perceived encroachment.

In its various forms, encroachments can limit military activities or operations that may be performed on a military base. Many factors related to land-use and natural resource management around military installations can detract from the military mission. Some examples include direct impacts from urban development adjacent to or surrounding military bases; and indirect impacts due to airspace restrictions, land use restrictions, scheduling changes, and financial constraints (Elwood 2008). In extreme cases, cumulative impacts can compromise the integrity of the military mission on that base."

The above-cited report also provides a helpful table that outlines potential encroachment impacts that could result from renewable energy development. The following is stated in the report:

"***Renewable Energy Development***

Over the past decade, renewable energy projects have become a large component of federal land management. In response to hundreds of thousands of acres proposed for large-scale solar projects, the BLM developed the Western Solar Program in 2012 covering six southwestern states including Arizona. Additionally, the Arizona BLM office implemented the Restoration Design Energy Project in 2013 that provided further direction on which lands were deemed appropriate for solar development across BLM, state, and private lands. These two projects established the solar energy program on BLM lands in Arizona by identifying three solar energy zones and over 1.8 million acres combined that is likely suitable for solar development across the state on federal, state, and private lands.

Recently, solar projects near Quartzite, Arizona have been the subject of controversy regarding the impact of the vertical towers on military operations. Two projects have been proposed in the area including the Solar Reserve project featuring a 653-foot tower on BLM lands and the "Enviromission" project that could be as tall as 2,500 feet on State Trust Lands. The military community has raised concerns about the possible impacts both projects could have on the military mission.

Renewable Energy Development Encroachments		
Direct	Indirect	Perceived
Solar towers located in flight corridors or military airspace can pose a vertical obstruction. Both solar and wind projects may cause interference with electromagnetic equipment and testing operations. Wind energy towers located in flight corridors or military airspace can pose a vertical obstruction.	Large developments of renewable energy can disturb habitat thereby encouraging wildlife to live on nearby military lands. Solar arrays can cause a "lake effect" and attract large birds to military operating areas thereby increasing the risk for bird strikes. Water intensive solar projects could impact military installations in areas where water is constrained or subject to management scrutiny.	On occasion, the development of renewable energy projects may pose no real encroachment pressure but may increase the amount of scrutiny of the viability of military installations and operations.

Benefit: Conditional

Renewable energy development can be an encroachment pressure if it is poorly sited. On the other hand, it can be hugely beneficial when used as buffer for a military installation in the right location. Solar projects that are low-lying and well sited can fill lands that would otherwise be left vacant, thereby bringing value to the community and the landowner. Renewable energy projects should be in the toolbox as opportunities for beneficial use of buffer lands."

The following best practices should be observed in locating and designing a renewable energy project relevant to military interests:

1. Project proponents should use the AME-UP tool to assess site candidates to determine which are anticipated to have overlap with areas of military interest including SUAs.
2. Candidate sites are not necessarily in conflict with military interests if there is overlap with SUA, however a consultation with the relevant agency is essential to reducing the likelihood of opposition to the project.
3. A thorough review of potential encroachment concerns associated with renewable energy projects should occur with the relevant military agency including those of physical obstruction, environmental impacts including habitat fragmentation, air quality, loss of naturalness, and other issues.

Resources:

1. "Mutual Benefit: Protecting Arizona's Military Mission and the Value of Publicly-owned Lands." Sonoran Institute: http://www.tiny.cc/AZMilitary
2. "Evaluating Encroachment Pressures on the Military Mission in the California Desert Region." Sonoran Institute: http://www.tiny.cc/CalDesertMilitary

3. "Working with the Department of Defense: Siting Renewable Energy Development." Natural Resources Defense Council and Department of Defense: https://www.nrdc.org/sites/default/files/nuc_13112001a.pdf

Recommendations

1) Proposed Phase II Tasks

To operate, maintain, sustain, and promote the web-based tool, the following tasks are needed:

Task 1: Operation and Maintenance – The AME-UP web tool needs ongoing operation and maintenance (O&M) to ensure both its short and long-term viability. Some of these O&M activities include maintenance of internet browser compatibility, data security, server/software updates, data layer(s) update, user acceptance, and other tasks associated with web tool maintenance.

Beyond ensuring internet browser compatibility, data security, server/software updates, updating the stakeholder contact database is a top priority. This database includes primary and secondary contact information for nearly 500 individuals/organizations from each military branch; federal, state, and local planners; electric utility companies; tribes; and other key stakeholders and decision makers in Arizona. Stagnation of this database as contacts change over time will significantly impact the long term utility this database.

Likewise, updating the data layers and feature attributes will be an ongoing task. While the web tool currently contains dozens of essential data layers, stakeholders requested that additional data layers be added. Some of these layers include utility corridors traversing U.S. Forest Service lands; right-of-way (ROW) easements managed by Western Area Power Administration (WAPA); electric utility infrastructure from Trico Electric Cooperative; federal, state, and local exclusion areas; and other data layers related to long term regional planning.

Another important O&M task deals with data security and user acceptance. To ensure data security, including the access and display of "critical infrastructure" layers, e.g., transmission lines, power plants, substations, the latest internet security and user-management protocols will BE maintained. Part of these protocols include requiring users to register and set up an account. Each user will request access to a specific user category, e.g., 1) military, 2) federal, state, or local government, 3) energy development, 4) education, 5) NGO, 6) other, etc. Each request will be reviewed, and either approved or denied by appropriate AME-UP staff. A proper email extension would be required prior to granting access to military or government categories, e.g. @navy.mil or @gilbert.gov.

These protocols represent similar protocols implemented on other recent federal web mapping tools, e.g., Section 368 Energy Corridor Tool (Section 368) and Energy Zones Mapping Tool (EZMT). The benefits of these protocols is that users are vetted and tracked, and that data layers or attributes are adaptable (turned on/off or filtered) should any data security issues arise.

Task 2: Continue Tool Development/Enhancement – Stakeholders requested that additional features or functionality be added to the current web tool. The first feature is a project upload/download tool that allows users to upload the spatial extent (footprint) of a proposed project or area of interest to the web tool, save it, and access it later for further analysis. The ability to upload a project to the web tool is a value-added feature that greatly increases overall user experience and efficiency. The upload feature would accept several common file types such as a shapefile, kml file, or spreadsheet.

Another requested feature discussed with stakeholders is a spatial public commenting tool. This tool would allow individuals/organizations to zoom into a specific location on the map and provide comments on proposed energy projects, issues of concern/support, etc, in a spatial context. These comments could then be collected, analyzed, and addressed by appropriate military personnel, land-use planners, subject matter experts, decision makers, or other appropriate stakeholders.

Task 3: Stakeholder Outreach and Training – The AME-UP web tool is intended for hundreds of potential users throughout Arizona. Because the tool reaches such a large audience, presenting the tool and offering tool training to stakeholders is a logical next step to increase the tool's exposure and utility. These trainings will be realized through small group meetings, webinars, presentations at local, state, or national conferences, etc. Additionally, to further supplement stakeholder training, a series of online instruction materials will be developed and published to the web tool landing page.

Task 4: Policy Recommendations – The AME-UP team will work with key policy makers to develop legislation and ordinances related to permitting in support of compatible siting of energy projects. The objective of the legislation is to ensure military installation commanders and the DOD siting clearinghouse are consulted early in the development process and communities understand the impact of projects on the military missions. We propose working with the Arizona Corporation Commission (ACC); State Legislature; Military Affairs; Arizona State Lands Department; Bureau of Land Management; U.S. Forest Service; and State, county, local entities; etc., to recommend policies that protect military missions and advance proper siting of renewable energy infrastructure.

Task 5: Buffer Program – The Department of Defense (DoD)'s REPI Program is a key tool for combating encroachment that can conflict with, limit or restrict military training, testing, and operations. The REPI Program protects these military missions by helping remove or avoid land-

use conflicts near installations and addressing regulatory restrictions that inhibit military activities. The REPI Program is administered by the Office of the Secretary of Defense (OSD).

A key component of the REPI Program is the use of buffer partnerships among the Military Services, private conservation groups, and state and local governments, authorized by Congress at 10 U.S.C. § 2684a. These win-win partnerships share the cost of acquisition of easements or other interests in land from willing sellers to preserve compatible land uses and natural habitats near installations and ranges that helps sustain critical, at-risk military mission capabilities.

REPI also supports large landscape partnerships that advance cross-boundary solutions and link military readiness, conservation, and communities with federal and state partners through a common, collaborative framework.

Arizona is home to numerous military bases, including eight major installations located across the state: Air Station Yuma (Marines); Barry M. Goldwater Range (Air Force); Camp Navajo (AZ ARNG); Davis-Monthan (Air Force); Fort Huachuca (Army); Luke (Air Force); Naval Observatory Flagstaff (Navy); and Yuma Proving Grounds (Army). Of these eight major military bases, only two are currently protecting their military readiness and addressing encroachment threats via the DoD's REPI program: Fort Huachuca and Naval Observatory Flagstaff.

A DoD encroachment tool – the REPI program, may be a significant opportunity for protecting the operational capabilities of our Arizona military installations while promoting renewable (solar) energy. This proposal would evaluate the requirements, and the benefits, of establishing REPI program partnerships at Arizona's military installations that will protect military readiness, preserve compatible land use around these installations and ranges, and facilitate the development of solar energy systems that benefit Arizona military facilities and local communities.

This task would evaluate the potential for Solar Compatible Use Buffers (SCUBs), under the DoD's REPI program, to protect military readiness at Arizona's military installations while promoting compatible renewable energy (solar) development to provide both the military and local communities their renewable energy needs.

Task 6: Tool Maintenance Plan – The purpose of this task is to identify a state or local government entity who is capable of sustaining the web tool. The task involves conducting research and meeting with various state and local government entities to identify those with compatible missions, sufficient capabilities and resources, staffing, etc. After research activities and meetings are complete, a report will summarize potential state and local entities, along with each entity's capabilities, resources, etc. We anticipate conducting research and holding meetings for several dozen government entities. Additionally, part of this task includes developing a long-term plan to operate, maintain, and sustain the AME-UP tool, including a recommended platform and staffing requirements.

[i] Gray Digital Media. (2015). *New report says turbine light out in Highmore crash.* KSFY. Retrieved from http://www.ksfy.com/home/headlines/New-report-says-wind-turbine-light-out-in-Highmore-crash-300732061.html.

[ii] Watson, J. (2013). *Endangered species thrive on US military ranges.* Military.com. Retrieved from http://www.military.com/daily-news/2013/08/12/endangered-species-thrive-on-us-military-ranges.html.

[iii] U.S. Energy Information Administration, Short-Term Energy Outlook. (2018). *Electricity Renewables Generation and Capacity.* Retrieved from https://www.eia.gov/outlooks/steo/report/renew_co2.php.