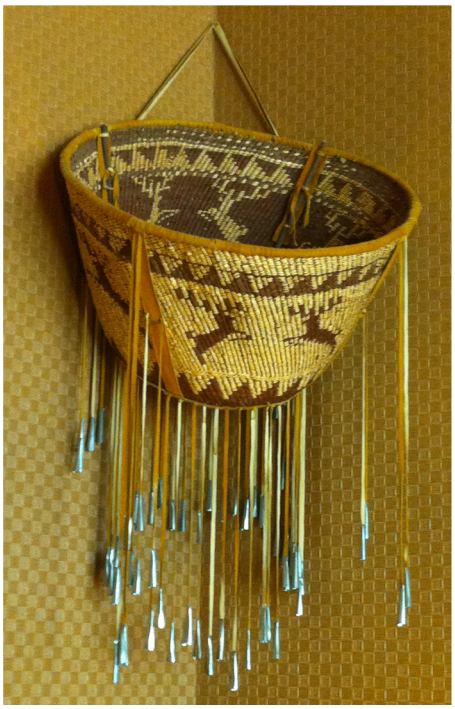
May 2013



San Carlos Apache Tribe
Solar Energy Feasibility Study

Prepared for San Carlos Apache Tribe by **Parametrix**
Funded by U.S. Department of Energy Tribal Energy Program

CITATION

Prepared for
San Carlos Apache Tribe
San Carlos, Arizona

Prepared by
Parametrix. 2013. San Carlos Apache Tribe
Solar Energy Feasibility Study.
Parametrix. Portland, Oregon. May 2013.

Cover Photo: Peridot Mesa, courtesy of Jim Rapp
Cover inset photo: Burden basket, courtesy of Jim Rapp

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EXECUTIVE SUMMARY

Purpose and Goals

The San Carlos Apache Tribe (Tribe) in the interests of strengthening tribal sovereignty, becoming more energy self-sufficient, and providing improved services and economic opportunities to tribal members and San Carlos Apache Reservation (Reservation) residents and businesses, has explored a variety of options for renewable energy development. The development of renewable energy technologies and generation is consistent with the Tribe's 2011 Strategic Plan.

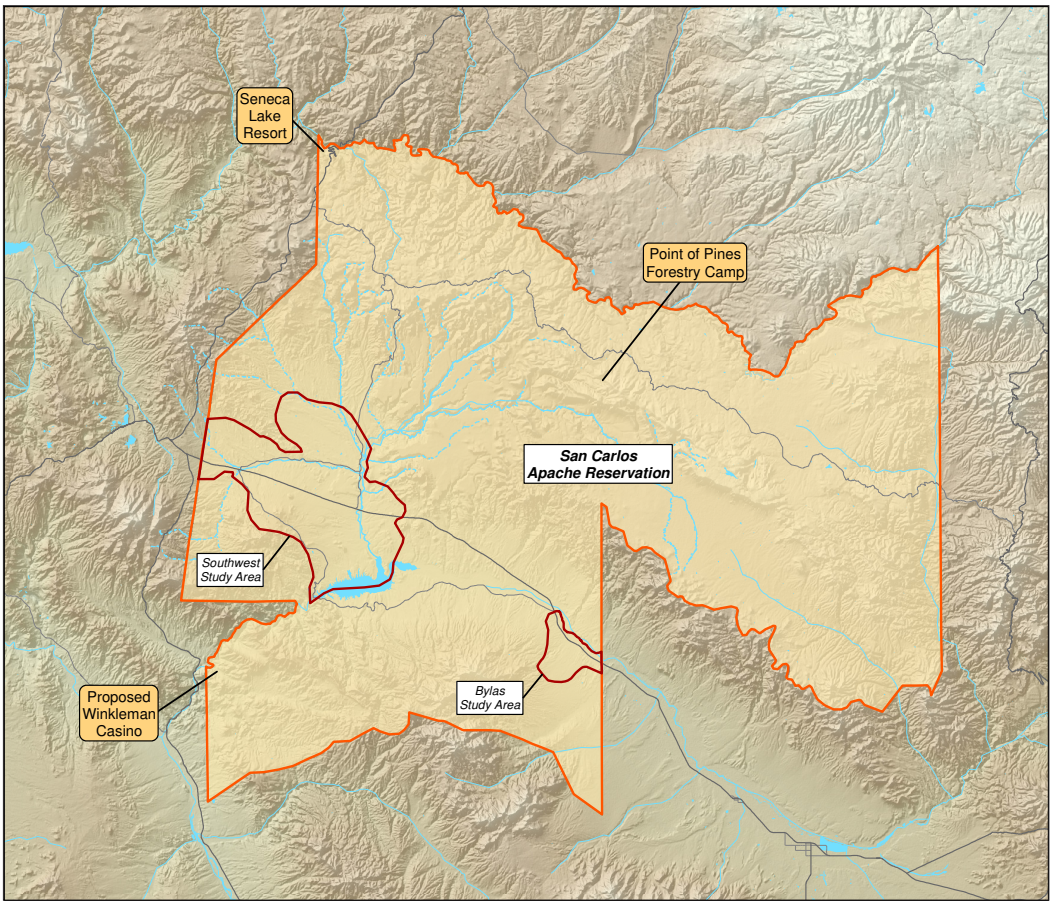
The Tribe wishes to assess the potential development of both commercial-scale and community-scale solar energy generation within the Reservation. The Tribe is frequently approached by private developers and vendors regarding the use of tribally owned property and buildings for renewable energy developments. Proposed projects have ranged from modest, community-scale energy projects serving a single institutional building to commercial-scale projects with energy export potential.

The Tribe will use the objective data and analysis in this Study to make well-informed and technically sound decisions on outside proposals as well as for advancing solar development programs and projects of its own. The Tribe's goals are to:

- Develop renewable energy generation on the Reservation.
- Reduce purchased energy costs by providing power directly to Reservation facilities.
- Develop energy sector skills and experience among tribal members.
- Create employment opportunities in managing, operating and maintaining solar facilities.
- Support tribal sovereignty and the Tribe's energy security and independence.
- Reduce the negative impacts of energy consumption and GHG emissions.

Community Profile

The Reservation is located in east-central Arizona. Total area of the Reservation is 1.834 million acres making it the tenth largest reservation by land area in the United States. The Reservation's northern boundary abuts the southern boundary of the White Mountain Apache Reservation and is delineated by the Salt and Black Rivers. The ridgeline of the Gila Mountains defines the southeast boundary. To the west, the Reservation's boundary abuts the city limits of Globe, Arizona. There are three main populated communities on the Reservation: San Carlos, Peridot, and Bylas. The 2010 US Census determined that the overall resident population on the Reservation was 10,068. Total tribal membership exceeds 15,000.



San Carlos Apache Reservation and Solar Study Boundaries and Areas

On-Reservation employment is predominantly limited to tribal government and tribal enterprises and other government entities such as the school district and federal agencies. Private business and services account for a relatively small number of jobs. Recent Tribal demographic surveys (2010) found that annual median income on the Reservation was $15,600, about half of the annual median income in surrounding counties, and about one-third of the annual median income in Arizona as a whole.

The Reservation is served by three electrical utilities. APS Power is a private electrical utility and provides electrical power to the southwest end of the Reservation in the area along US 70 called Cutter. APS serves the Apache Gold Casino/Resort, the tribal airport

and a tribally owned sawmill. The Graham County Electrical Cooperation (GCEC) serves the Bylas community in the southeastern portion of the Reservation. The San Carlos Irrigation Project (SCIP) is an agency of the Bureau of Indian Affairs and provides electrical power to the communities of San Carlos and Peridot, to the Gilson Wash District along AZ 170, and to recreational developments near the San Carlos Reservoir.

US Department of Energy (DOE) National Renewable Energy Laboratory data indicates that the Reservation has the highest rated level (5.5–6.0 kWh/m^2/day) of solar photovoltaic (PV)-based electric power generation potential. These climatic conditions, combined with significant acreages of relatively flat and south facing vacant land within the more developed portions of the Reservation indicate strong prospects for developing renewable solar power generation.

Study Scope

This Study assessed the possibilities for both commercial-scale and community-scale solar development within the southwestern portions of the Reservation around the communities of San Carlos, Peridot, and Cutter, and in the southeastern Reservation around the community of Bylas. Three smaller sites (Point of Pines, Dudleyville/Winkleman, and Seneca Lake) were also evaluated for community-scale solar potential.

Commercial: **Produces electrical energy for export off the Reservation.**

Community: **Offsets direct electricity usage on the Reservation.**

A wide range of potential sites was assessed. This Study first identified sites with varying degrees of suitability for commercial-scale development. Some of these sites were also assessed for community-scale possibilities. In addition, some larger business and institutional building complexes, and three large residential areas, were analyzed community-scale potential. For both commercial- and community-scale sites, a minimum potential power generation of 1 megawatt (MW) was a baseline minimum requirement, as stipulated by the DOE Tribal Energy Program grant funding this Study.

Phase 2 expanded on information for selected sites from Phase 1, as well as adding general information and recommendations regarding tribal benefits (economic, social, etc.) and business planning. In consultation with the DOE Tribal Energy Program, the scope of Phase 2 was altered from that in the original scope included in the DOE grant agreement underwriting this Study. Based on the lack of adequate commercial-scale electric power transmission on the Reservation, and the high cost of building new commercial-scale power lines, Phase 2 analysis was re-directed towards expanding on community-scale solar development opportunities, as well as the potential for solar development around the community of Bylas.

This Study did not include an assessment of sites or buildings for solar installations under 1 MW, such as individual residential structures or smaller commercial or institutional buildings. Smaller solar installations can and should play an important role in reducing purchased electrical consumption and costs on the Reservation. Small arrays of rooftop or grounded-mounted solar PV flat panels should be considered in all of the Tribe's building development or remodeling projects, particularly until recommended larger community-scale systems come on line.

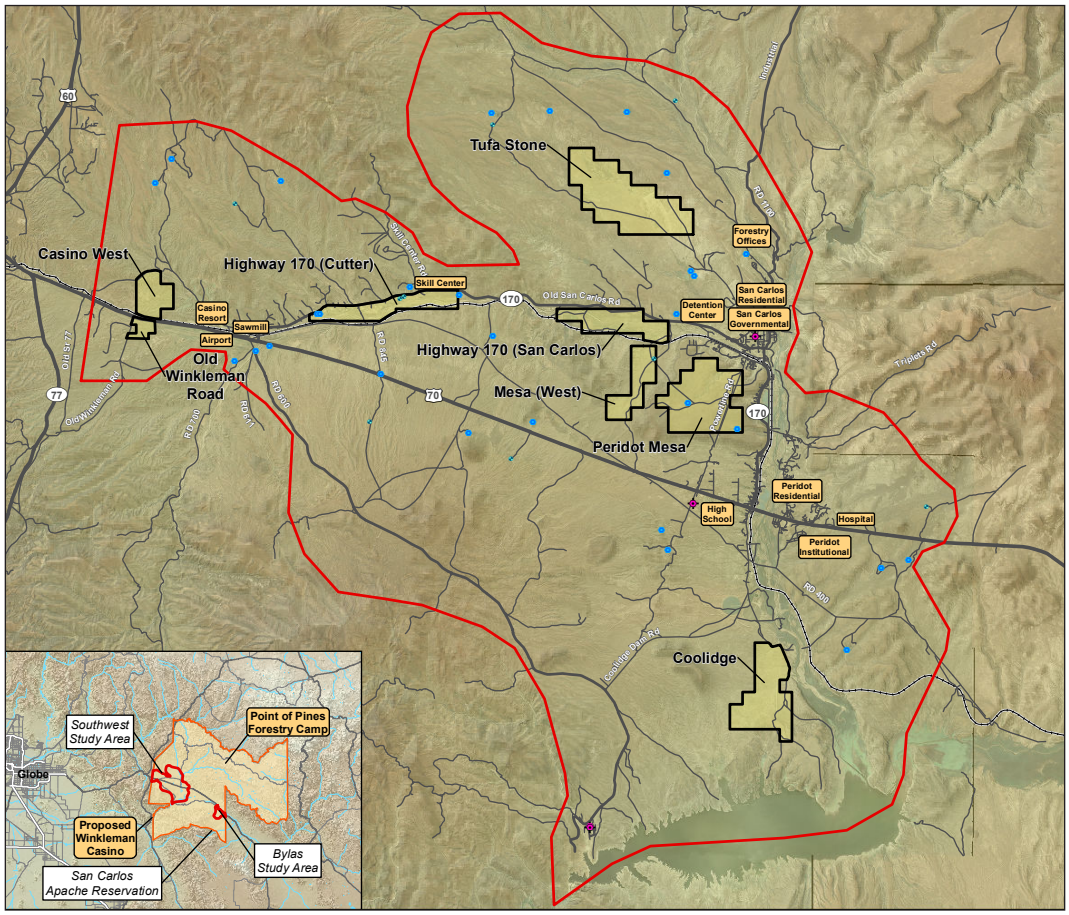
This Study used the conclusions of the Tribe's DOE-funded Energy Organization Analysis (EOA) adopted in 2012, and incorporates additional information on the business and

financial planning that is concurrently underway for a new tribal energy corporation or utility. Many benefits may accrue to the Tribe and Reservation as a result of developing locally generated solar electrical power. These include social and cultural benefits such as consistency with Apache cultural norms and values, tribal sovereignty, and economic stability (capital to support other tribal and Reservation programs and reductions in costs associated with energy purchases, employment and job skill development, etc.). This Study report qualitatively describes possible benefits.

Study Elements

This Study report considers solar power applications and solutions using proven commercially available crystalline silicon, thin film, or concentrating photovoltaic (PV) technologies installed in flat-panel or concentrating solar PV arrays, and to a more limited extent, concentrating solar power (CSP) systems. Factors applied include:

- Proximity to population centers.
- Suitable slope and aspect (less than 4 percent facing south and less than 1 percent facing north).
- Areas of not less than 20 usable contiguous acres.
- Shading and obstruction due to surrounding natural or built features.
- Capacity to generate not less than 1 MW of power.
- Electrical service provider renewable energy programs and policies.



Specific Commercial and Community Solar Sites

- Proximity to electrical power transmission and distribution infrastructure.
- Transmission and distribution infrastructure capacity and interconnections.
- Road and transportation adequacy and accessibility.
- Limitations (or benefits) imposed by existing or planned development and land uses.
- Limitations (or benefits) imposed by environmental conditions and natural resources.
- Benefit/cost ratio between purchased electrical power and locally generated solar power.
- Organizational implications (forms of ownership, operations, and maintenance).

This Study includes site-specific documentation of solar development technical considerations, and transportation, land use, and environmental factors impacting a wide variety of potential commercial and community-scale site and facilities. All potential commercial-scale sites and most community-scale sites generally exhibited similar ecological and topographic characteristics. All are within the Reservation's desert grassland or Sonoran scrub dominated areas. In some cases, sites that otherwise meet preferred slope and aspect and other technical criteria were in environmentally sensitive areas such as flood hazard zones.

Key Challenges

A variety of challenges confront solar power development on the Reservation. Solar irradiance levels, site availability, electrical transmission and distribution capacity, and environmental constraints impact feasibility. The Tribe's status as a sovereign entity with a large undeveloped land base creates other opportunities and challenges, as may the Tribe's limited financial resources and relative lack of energy sector experience. The three key challenges identified by this Study are:

Electrical Transmission Gaps

The Reservation is literally surrounded by a large network of high capacity power transmission lines serving energy-intensive mining industries to the south, west and east. None of this transmission passes through the Reservation. The largest capacity power line on the Reservation is a SCIP-owned and operated 69 kilovolt (kV) line that runs past the San Carlos Reservoir, through the community of Peridot, and terminates in the community of San Carlos. The single greatest challenge for developing commercial-scale renewable power on the Reservation is the lack of adequate transmission-scale electrical power infrastructure on the Reservation.

Capital Financing and Development Incentives

The Tribe may have to identify major development partner(s) in order to obtain necessary financing and construction expertise. Potential partners include utilities seeking to comply with Arizona's Renewable Portfolio Standard, municipalities, other tribes, federal agencies, and large power retailers, as well as private developers/manufacturers. This is a challenge for power development projects in any community. The situation for the Tribe is made more challenging as renewable power development incentives in Arizona are currently retracting rather than expanding. Both APS and GCEC programs are being adversely impacted by the loss of incentive programs.

Operational Management

Outside facility operations and management partners may also be necessary, at least in the near-term. The question of Tribe's capacity to operate and maintain solar power

facilities is crucial, as well as what forms of ownership and management best assure the Tribe's long-term control and benefit. The Tribe's EOA provides direction for future forms of ownership and management of solar facilities. This analysis is the core of the *Business Plan* chapter of this Study report.

Key Findings and Recommendations

Commercial-Scale

Transmission

Viable commercial-scale solar generation is predicated on the availability of transmission-scale power line capacity to export the generated power to external markets for sale. There are no transmission-scale power lines anywhere within the Reservation. The closest point of interconnection to the regional power grid from San Carlos is 18 miles distant in Globe, Arizona (APS service territory). A new 115 kV transmission line would cost in the range of $11 million.

From Peridot, the nearest interconnect through SCIP's service territory is in Coolidge, Arizona some 70 miles distant. The existing SCIP 69 kV power line is not adequate according to SCIP to export power to the regional power grid. Estimated cost of a new 70-mile long 115 kV transmission line is $48 million. A separate study conducted by US DOE on behalf of the Tribe estimates a cost of $15 million to upgrade the existing 69 kV system to export even modest commercial loads of 10 MW. Based on the lack of existing transmission-scale infrastructure, detailed evaluations and costing of commercial-scale solar generation facilities was not conducted as part of this Study. However commercial-scale site feasibility investigations were completed.

> ***Pursuit of commercial-scale solar generation should continue to be a long-term tribal goal but is NOT recommended as a priority until such time as transmission-scale electrical power lines can be brought to or through the Reservation.***

Solar Development Sites

Fifteen sites within the Reservation were initially identified as having some degree of commercial-scale potential. An initial screening based on site size (50 acres minimum) and suitable slope (less than 4 percent) and aspect (predominantly south facing) was conducted. Eight sites were given a full Phase 1 analysis assessing additional factors such as transportation, land use, and natural resources. A commercial-scale assessment was also applied to the area south of the community of Bylas. The lack of any significant south facing slopes or transmission-scale power lines, and prior development plans, make commercial-scale solar around Bylas infeasible.

Three sites with commercial-scale potential were advanced to Phase 2—Tufa Stone, Peridot Mesa, and Coolidge. The Phase 2 analysis screened for additional factors such as shade and obstructions, reduced the minimum site size to 20 acres, and evaluated contiguous north facing areas with less than 1 percent slopes.

Two sites should be reserved through land use designation or some other official tribal process as FUTURE commercial-solar sites. These two areas are:

> ***Peridot Mesa***
> ***Located between the communities of San Carlos and Peridot. Approximately 1,550 acres atop the eastside of the mesa.***

"Coolidge"
West of the San Carlos River and north of the San Carlos Reservoir. Approximately 1,200 acres.

Community-Scale

Based on the lack of any commercial-scale electric power transmission between the Reservation and the regional transmission grid, Phase 2 of this Study greatly expanded consideration of community-scale options. Additional analysis was also applied to community-scale solar power options in Bylas. A wide variety of different sites or facilities were considered for community-scale development including the three Phase 2 commercial-scale sites. Many of the feasibility factors applied to commercial sites were re-applied to community-scale sites. Additional community-scale factors included location and condition of the electrical power distribution network, safety and security issues, and the carrying capacity of the lands or structural condition of the building facilities that might support community-scale solar infrastructure.

Facility Sites

Three building complexes were identified within the Reservation where the development of site-specific facility-scale solar power would be the most beneficial and cost-effective. Other facility and neighborhood sites were analyzed and are described in this Study report, but each had a significant flaw such as environmental or land use constraints, distances from electrical power lines, security challenges, or building structural conditions.

The following facilities are recommended for development or re-development using facility-scale solar:

Apache Gold Casino/Resort
The priority community-scale solar project. The casino/resort is the single largest consumer of purchased electrical power on the Reservation and considerable progress has already been made on an 1.1 MW solar installation on this site.

Tribal College/Skill Center
As the technical training center and tribal college is established at the former San Carlos Junior High School, installation of solar power should be considered as part of any physical remodeling or site conversion. This recommendation is conditioned on the status of a Peridot Mesa phased community-scale site in the SCIP service territory as recommended below.

Dudleyville (Winkleman) Casino
The Tribe is planning a second casino/resort on US 77 on the far southwest side of the Reservation near the towns of Dudleyville and Winkleman. Installation of solar power should be considered as part of the site and building development.

Bylas

The lack of south facing slopes and the recommendations of the Bylas New Community Master Plan suggest a different approach to facility or neighborhood solar for this community.

The most effective strategy for the Bylas community is providing rooftop and close-in ground mounted solar for commercial and instructional buildings on US 70, and the incorporation of clustered or individual solar installations as new subdivisions and buildings (such as the new elementary school) are constructed in the new community.

Phased Sites

SCIP is the electrical power provider to the most populated areas of the Reservation – San Carlos and Peridot. The SCIP power line distribution system is well developed and could serve to distribute power from a phased community-scale solar development that would feed power to the entirety of the uses in the two communities – residential, governmental, institutional, commercial and recreational. Several sites and building complexes considered for facility-based community solar were re-evaluated for suitability for a phased solar facility. The three Phase 2 commercial-scale sites were also re-evaluated for this purpose.

> ***The Peridot Mesa is recommended for development of a 5 MW to 10 MW community-solar facility on one or two specific sites on the eastside of the mesa. The solar facilities would connect to the SCIP distribution power line system at the base of the mesa via extensions of short (less than 1.5 miles) and economic ($250,000/mile) new 12 kV power lines.***

Smaller Solar Installations

Smaller solar installations of less than 1 MW can and should play an important role in reducing purchased electrical consumption and costs on the Reservation. Small arrays of rooftop or grounded-mounted solar PV flat panels should be considered in all of the Tribe's building development or remodeling projects, particularly until larger community-scale phased systems can be developed.

Energy Efficiency Improvements

All community-scale solar installations should be associated with comprehensive energy audits for the buildings involved and energy conservation improvements (insulation, lighting, windows, etc.). Energy conservation building retrofits are the most cost-effective means to reduce energy consumption and will reduce the scale of the solar installations needed to meet remaining demand.

Business Planning

The Tribe has been considering a variety of approaches to energy organizational structures best fitting current and planned tribal energy programs and projects. One structure has been selected as the near-term approach, and a second as a long term approach.

Energy Corporation/Joint Venture

This form is being considered to support initial efforts with private solar developers for solar installations at the casino/resort and potentially other facility sites.

Energy Utility

This form may be necessary in the long term to build and operate phased solar installations connecting directly to distribution or transmission lines.

BACKGROUND

The San Carlos Apache Tribe (Tribe) in the interests of strengthening tribal sovereignty, becoming more energy self-sufficient, and providing improved services and economic opportunities to tribal members and San Carlos Apache Reservation (Reservation) residents and businesses, is exploring a variety of options for renewable energy development. The development of renewable energy technologies and generation is consistent with the Tribe's 2011 *Strategic Plan*, which states in part:

> ***The Apache People will live a balanced life in harmony with spirituality, culture, language, and family unity in an ever-changing world.***
>
> ***The Apache People shall create a strategic framework for our tribe to grow and prosper.***

The Tribe's *Strategic Plan* addresses energy policies and programs including solar and biomass renewable energy projects, hydropower generation, and electrical power transmission upgrades. In November 2011, the Tribe adopted an *Energy Strategy and Program* developed with US Department of Energy (DOE) funding. The *Energy Strategy and Program* identifies solar energy as the Tribe's primary renewable energy initiative, and the most practical and achievable near-term option for implementing the Tribe's overall plans with respect to energy self-sufficiency. The preamble to the Tribe's *Energy Strategy and Program* states:

> *The overarching purpose of this energy strategy is to provide a framework for the Tribe's future energy security and independence, and to reduce the negative impacts of energy consumption and GHG emissions on the Tribe's people and land. The Tribe has always been committed to adopting best ecological practices and policies in government services, infrastructure development, and for the natural environment. Development of a comprehensive set of energy efficiency and conservation programs, plans, and projects is of increasing importance due to rising energy costs and the impacts of energy use on the climate. The Tribe also plans to diversify its economy through "green" jobs creation and the retention of local earnings.*

PURPOSE, GOALS, AND OBJECTIVES

Purpose

This Solar Feasibility Study (Study) explores the potential development of both commercial-scale and community-scale solar energy generation within the Reservation. The Tribe is frequently approached by private developers and vendors regarding the use of tribally owned property and buildings for renewable energy development. Proposed projects have ranged in scope from modest, community-scale energy projects serving a single institutional building to commercial-scale projects with energy export potential. This Study provides the objective data and analysis for the Tribe to make well-informed and technically sound decisions on such proposals, as well as for advancing solar development programs and projects of its own.

Courtesy of DOE

This Study is funded by a grant from the DOE Tribal Energy Program. It identifies potential solar power generation sites on the Reservation, and assesses issues such as power transmission and transportation access, power generation potential, benefit/cost ratios, and environmental and other site features that may impact feasibility.

Goals

The Tribe's goals for future solar power generating facilities are to:

- Develop renewable energy generation on the Reservation.
- Reduce purchased energy costs by providing power directly to Reservation facilities.
- Develop energy sector skills and experience among tribal members.
- Create tribal employment opportunities in managing, operating and maintaining solar facilities.
- Support tribal sovereignty and the Tribe's energy security and independence.
- Reduce the negative impacts of energy consumption and greenhouse gas (GHG) emissions.

Objectives

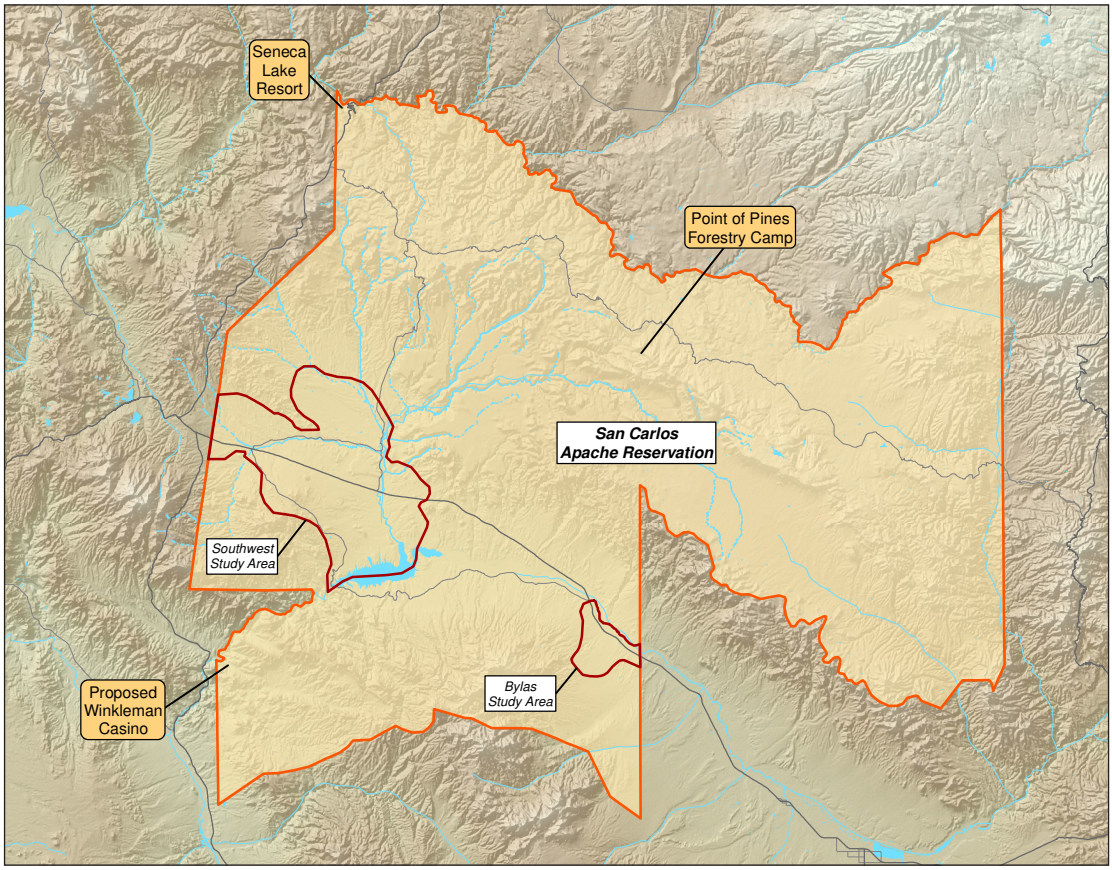
The central objective of this Study was to develop data and provide analysis that informs sound decision-making regarding solar power projects within the Reservation. This Study report provides the Tribe with the following key decision-making tools:

- Site-specific renewable resource assessments and preliminary site planning.
- Transmission and distribution interconnection considerations.
- Analysis of appropriate and effective technologies and design.
- Preliminary system costing and phasing plans.
- Economic, environmental, and social cost/benefit information.
- Preliminary business planning.

STUDY AREAS

This Study did not assess areas within the Reservation distant from population centers, far from transportation and power line infrastructure, and/or in steep or remote terrain. These attributes are not consistent with cost-effective solar resource development. This Study assessed the possibilities for both commercial-scale and community-scale (see page 7 for definitions) solar development within the southwestern portions of the Reservation around the communities of San Carlos, Peridot, and Cutter, and in the southeastern Reservation around the community of Bylas, as well as community-scale opportunities in other specific locations within the Reservation.

Figure 1: Solar Feasibilty Study Areas



Southwestern Study Area

The original southwestern Study area included:

- Population centers (and thus energy demand centers) around San Carlos, Peridot, and Cutter.
- Concentrations of contiguous south-facing lands with predominantly 4 percent or less slopes.
- Lands with built electric power lines operated by the San Carlos Irrigation Project (SCIP) and APS Power.
- Lands with adequate built transportation access.

Based on tribal reviews in June and October 2012, the original southwestern Study area boundary was revised to:

- Add lands to the west of San Carlos Reservoir and south of Route 3 and in the vicinity of Coolidge Dam. These lands were preliminarily found to have suitable slope, aspect, and access for solar development.
- Remove lands in the upper reaches of the Tufa Stone Dam area that are remote from power lines and have very poor access, and lands south of US 70 and east of the San Carlos River that are planned for other developments under the Tribe's Peridot master plan.

Bylas Study Area

This Study included a second large area consisting of lands around the community of Bylas. This community is served by the Graham County Electric Cooperative (GCEC). The Tribe's recently adopted Bylas master plan contemplates significant changes to the location, size and character of the community (see Figure 2). The present community is located in the southeastern portion of the Reservation along both sides of US 70. The Gila River and its floodplain bound the northeast side of Bylas. There are extensive tribal agricultural operations along the Gila River floodplain. The Eastern Arizona Railroad parallels the highway on the south side. A roadside rest park, private school, recreation center, grocery store, post office, gas station, and a tribal enterprise-owned business incubator building anchor a small business and institutional district along the north side of US 70. A small number of other tribal government and enterprise offices (housing authority, health center) and institutions (churches, school) are located at various points on or near to the highway.

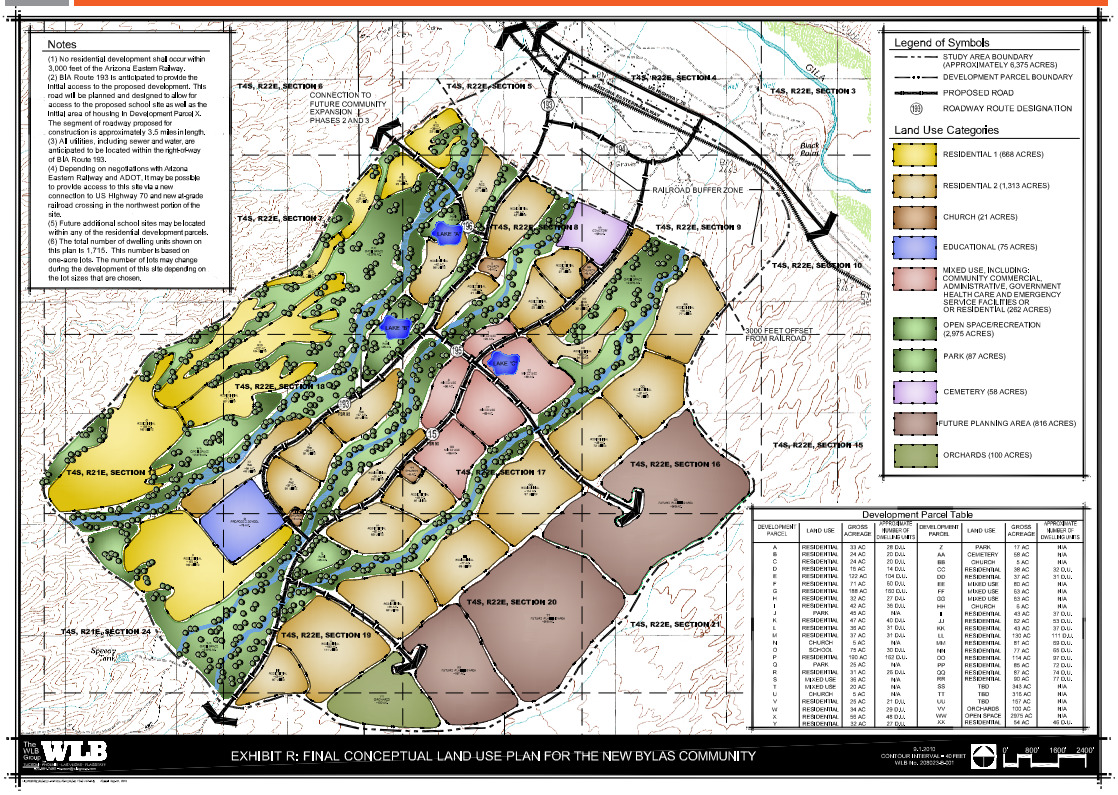
Bylas Business Incubator. Courtesy of Tribe

According to the 2010 US Census, approximately 445 homes are in Bylas, located on both sides of US 70. About half of these dwelling units are owned by the Tribe's housing authority. Some of this housing is located in or very near the floodplain or in areas more suitable for agricultural operations. Soils underlying much of the Bylas residential community north of the highway are unsuitable for development resulting in chronic problems with building foundation cracking and failing. Seventy or so additional homes were classified in the 2010 US Census as vacant/abandoned.

The existing Bylas community is slated for eventual relocation to a 6,375-acre site uphill and southwest of the current town site (see Figure 2). The Bylas *New Community Master Plan* designates approximately 45 percent of the Bylas solar feasibility study area as Phase 1 for the relocated community, including residences, parks and open spaces, commercial and institutional development, agriculture, and a 3,000-foot-deep railroad buffer zone. A total of 1,715 housing units are projected. Two additional phases totaling 4,000 more acres northwest of Phase 1 are designated but not detailed in the master plan. When the new plan is fully realized, only existing business facilities, the post office, other institutional buildings, and perhaps a few homes will remain along the north side of US 70.

The new Bylas elementary school opening in summer 2013 is approximately 3.5 miles southwest of the current town center. This school anchors the proposed new Bylas community. The school is designed to accommodate south-facing rooftop solar panels. To the northeast of the school, the Tribe's housing authority has near-term prospective plans to build approximately 110 new residential housing units. These will be offered to residents that occupy deteriorated housing in the older community north of US 70. This new neighborhood is planned to include solar power. The scheduling of this development is unknown.

Figure 2: Bylas New Community Plan



Map Courtesy of Tribe

Other Sites

Three smaller sites (Point of Pines, Dudleyville/Winkleman, and Seneca Lake) outside of the two primary study areas were also evaluated for community-scale solar potential.

STUDY PARAMETERS

This Study focuses on two levels of solar power generation feasibility: commercial-scale and community-scale. The definitions of commercial- and community-scale vary. Commercial-scale is sometimes called utility-scale. Community-scale is variously termed distributed power or local or facility-scale. For the purposes of this Study, the two levels of solar asset development were defined as:

- Commercial: Produces electrical energy for export off the Reservation.
- Community: Offsets direct electricity usage on the Reservation.

A wide range of potential sites were assessed with varying degrees of suitability for commercial-scale development. Some of these sites were also assessed for community-scale possibilities. In addition, some larger commercial and institutional building complexes and three residential areas were analyzed for community-scale potential. For both commercial- and community-scale sites, a minimum potential power generation of 1 Megawatt (MW) was a baseline requirement.

This Study did not include an assessment of sites or buildings for solar installations under 1 MW, such as individual residential structures or smaller business or institutional buildings. *Smaller solar installations can and should play an important role in reducing purchased electrical consumption and costs on the Reservation. Small arrays of rooftop or ground-mounted solar PV flat panels should be considered in all of the Tribe's building development or remodeling projects.*

Key Challenges

A variety of challenges confront any solar power development. Solar irradiance levels, site availability, electrical transmission and distribution capacity, and environmental constraints impact project feasibility. The Tribe's status as a sovereign entity with a large undeveloped land base creates other opportunities and challenges, as do the Tribe's limited financial resources and relative lack of energy sector experience.

Transmission

The Reservation is literally surrounded by a large network of high-capacity power transmission lines serving energy-intensive mining industries to the south, west and east. None of this transmission passes through the Reservation. The largest capacity power line on the Reservation is a 69 kilovolt (kV) line owned and operated by the San Carlos Irrigation Project (SCIP). This line runs past the San Carlos Reservoir, through the community of Peridot, and terminates in the community of San Carlos.

With the possible exception of financing, the single greatest challenge for developing commercial-scale renewable power is the lack of adequate transmission-scale electrical power infrastructure on the Reservation. This challenge is discussed in detail elsewhere in this Study report.

Capital Costs and Financing

The Tribe may have to identify major development partner(s) in order to obtain necessary financing and construction expertise. Potential partners include utilities seeking to comply with Arizona's Renewable Portfolio Standard, municipalities, other tribes, federal agencies, and large power retailers, as well as private developers/manufacturers. Action at the beginning of 2013 by the Arizona Corporation Commission (ACC) to eliminate all funding for renewable energy credits (REC) for renewable power developments makes financing even more of a challenge. Appendix A summarizes current incentives available for renewable power development, and Appendix B addresses potential capital financing approaches and structures.

Facility Operation and Management

Outside facility operations and management partners may be necessary, at least in the near-term. The question of the Tribe's capacity to operate and maintain solar power facilities is crucial, as well as what forms of ownership and management best assure the Tribe's long-term control and benefit. The Tribe adopted an Energy Organization Analysis (EOA) in 2012 that provides direction for future forms of ownership and management of solar facilities. This analysis is the core of the *Business Plan* chapter of this Study report.

Site Baselines and Identification (Phase 1)

Specific baseline characteristics for commercial-scale feasibility were used to preliminarily identify and screen a wide range of potential sites. This preliminary analysis was subject to two rounds of Tribal review.

Commercial-scale Sites

A range of potential commercial-scale sites within the two primary study areas were examined based on:

- Proximity to population centers and electrical power service.
- Suitable slopes (less than 4 percent).
- Suitable aspect (predominantly southern).
- Areas of not less than 50 usable contiguous acres.
- The nominal capacity to generate not less than 1 MW of power.

The sites best meeting initial screening criteria were then further evaluated as to:

- Electrical service provider, proximity to transmission infrastructure, and transmission capacity.
- Shading and obstruction due to surrounding natural or built features.
- Road and transportation adequacy and accessibility.
- Limitations (or benefits) imposed by existing or planned development and land uses.
- Limitations (or benefits) imposed by environmental conditions, natural resources, and sensitive sites.

Community-Scale Sites

Buildings or building complexes and sites with sufficient roof area or surrounding vacant lands to generate 1 MW of solar power were identified. Baseline characteristics for community-scale solar feasibility mirror commercial-scale criteria in many respects. The basic unit of analysis (acres of flat and south facing land) is somewhat different as community-scale installations can accommodate a wider range of variables through rooftop systems or more extensive ground alteration within smaller areas.

Refined Site Analysis (Phase 2)

Phase 2 expanded on information for selected sites from Phase 1 as well as added general information and recommendations regarding tribal benefits (economic, social, etc.) and business planning. In consultation with the DOE Tribal Energy Program in December 2012, the scope of Phase 2 was altered. Based on the lack of adequate commercial-scale electric power transmission on the Reservation and the high cost of building new commercial-scale power lines, a higher-level analysis than originally contemplated was applied to commercial-scale sites in Phase 2. Phase 2 was redirected towards expanding on community-scale solar development opportunities as well as the potential for solar development around the community of Bylas. The scope of the business plan element of this Study was also reconsidered based on the Tribe's separate efforts to incorporate an energy organization or utility.

Commercial-Scale Sites

Phase 2 addressed potential commercial-scale sites in the southwestern study area. No commercial-scale sites were identified in the Bylas study area. Phase 1 baseline factors were expanded to include:

- Slopes of less than 1 percent and north facing.
- Areas of not less than 20 usable contiguous acres.

Community-Scale Sites

For Phase 2, factors influencing community-scale sites were similar but not identical to those used for the assessment of commercial-scale solar feasibility. External power markets and many environmental conditions (given that existing built sites were considered) did not apply to community-scale generation. Transmission issues were also not considered, although the proximity and capacity of distribution power lines is important. Assessments were made as to the potential for centralized community-scale generation serving multiple sites and neighborhoods. Three additional community-scale sites outside of the two primary study areas are also described.

Common Factors

As applicable and appropriate, the following evaluation factors were used in examining Phase 2 sites and options. All factors do not apply to all options.

System Elements and Configuration

This Study considered proven commercially available crystalline silicon, thin film, and concentrating PV technologies configured as flat panel or concentrating PV. Factors include, as applicable:

- Insolation levels
- Shade and obstructions
- Structural or land conditions
- Electrical interconnection
- Power generation potential
- Conceptual system costs

Local Power Loads and Transmission Interconnections

Reducing electrical power purchases is the crucial factor in recouping capital investment and underwriting operations of community-scale solar installations. Another essential component is an understanding of the Reservation's power providers'—APS, SCIP, GCEC—renewable energy development support programs, net metering policies, and related policies. See Appendix A for further information.

Power transmission capability is the single most important constraint to commercial-scale power generation on the Reservation. There is no power transmission infrastructure within the two primary study areas with the capacity to export power into the regional power grid, and the cost of building new transmission capability is extremely high. Some of the community-scale options described later in this Study report may, however, require extending local distribution lines or interconnecting with the 69 kV line operated by SCIP.

The DOE Tribal Energy Technical Assistance Program is providing a separate evaluation to determine regional transmission capacity, power purchase agreements, and other particulars with respect to SCIP electrical power service. Draft outcomes from this DOE report are reflected in some sections of this Study report. The complete final report can be obtained from the Tribe. The DOE report is formally titled "Pre-Feasibility Transmission Interconnection Study for Solar Generation Facility" and is hereafter referred to as "SCIP Interconnection Transmission Study" in the body of this Study.

As Phase 1 of this Study concluded that commercial-scale solar development was dependent on new transmission capacity and that such capacity would, for the foreseeable future, be prohibitively expensive and complex, no analysis was undertaken with respect to power export markets.

Environmental

Field investigations were conducted for all sites to identify any environmental factors not documented through GIS analysis and tribal records. All potential commercial-scale sites generally exhibited similar ecological and topographic characteristics. All are within the Reservation's desert grassland or Sonoran scrub dominated areas. In some cases, sites that otherwise met solar siting criteria, such as preferred slope and aspect, were in environmentally sensitive areas such as flood hazard zones. Field notes are included as Appendix C.

Business Planning

This Study used the conclusions of the Tribe's DOE-funded EOA adopted in 2012 and incorporated additional information on the business and financial planning that is

concurrently underway for a new tribal energy corporation or utility. A separate discussion highlighting sources of development funding and financing structures is attached as Appendix B.

Tribal Benefits

Many benefits may accrue to the Tribe and Reservation as a result of developing locally generated solar electrical power. These include social and cultural benefits such as consistency with Apache cultural norms and values, tribal sovereignty, and economic stability (e.g., capital to support other tribal and Reservation programs and reductions in costs associated with energy purchases, employment and job skill development). This Study report qualitatively describes possible benefits.

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TRIBAL AND RESERVATION COMMUNITY PROFILE

Reservation Location and Size

The Reservation is located in east-central Arizona. Total area of the Reservation is 1.834 million acres making it the tenth largest reservation by land area in the United States. The Reservation's northern boundary abuts the southern boundary of the White Mountain Apache Reservation and is delineated by the Salt and Black Rivers. The ridgeline of the Gila Mountains defines the southeast boundary. To the west, the Reservation's boundary abuts the city limits of Globe, Arizona.

Figure 3. San Carlos Apache Reservation

Natural Features

Elevations within the Reservation range from 2,400 feet to above 8,000 feet. The Gila and San Carlos Rivers bisect the Reservation, and the Gila, Black, Salt and San Pedro Rivers define the Reservation's perimeters. The San Carlos River feeds into the San Carlos Reservoir and the Gila River. In the Bylas study area the Gila River also runs along the north side of the community of Bylas. A large number of Bylas homes are located north of US 70 and within the Gila River's 100-year floodplain. Approximately one-third of the Reservation is forested. Natural habitats within the two study areas are primarily desert grasslands and Sonoran desert scrub.

The riparian corridor of the San Carlos River running between San Carlos and Peridot is extensively used for agriculture. Most streams (washes) within the two study areas only have intermittent flows but can fill quickly to high velocity floods during summer monsoon rainstorms and at other times. The Gilson Wash is the most prominent wash in the southwestern study area. The Gilson Wash runs along the south side of AZ 170, crosses US 70, and then turns west behind the tribal airport to the western Reservation boundary.

San Carlos River
Courtesy of Jim Rapp

San Carlos Reservoir
Courtesy of Jim Rapp

Two major water impoundments are within the southwestern study area: the San Carlos Reservoir and the Tufa Stone Reservoir. The San Carlos Reservoir is an impoundment of the Gila River created by the Coolidge Dam. When full, the reservoir covers 19,500 acre-feet and when full is one of the largest bodies of water in Arizona. Tufa Stone Reservoir is a much smaller (50 acre-feet) flood control impoundment above and to the northwest of residential neighborhoods in the community of San Carlos. The Reservation is in the third year of a major drought. In mid-2012, water levels at the San Carlos Reservoir were at record lows and Tufa Stone Reservoir was completely dry.

Future plans call for the Tufa Stone Dam to be renovated to reduce water losses from seepage. An impoundment of the San Carlos River—Talkalai Lake—is northeast of the community of San Carlos but outside of the southwestern study area. Tribal plans call for a second impoundment of the San Carlos River near US 70.

Transportation

US 70 runs through the southerly sections of the Reservation and the communities of Peridot and Bylas as well as through the Cutter area. AZ 170 (also called Old San Carlos Road or Route 6) connects Cutter with the community of San Carlos. After passing through San Carlos, AZ 170 (also called Route 3 at this point) turns south along the west side of the San Carlos River and intersects with US 70 in Peridot, then continues southward as Coolidge Dam Road. The Bureau of Indian Affairs (BIA) maintains approximately 640 miles of paved and unpaved roads within the Reservation.

The southern portion of the Reservation is also crossed west to east by the Eastern Arizona Railroad. The railroad parallels US 70 to Cutter, then follows the south side of AZ 170 to San Carlos where it turns south along the San Carlos River, crosses to the east side of the river south of US 70, and continues southeast through the community of Bylas. The railroad only carries freight, although a seasonal excursion train from Globe to the casino/resort has operated in past years.

Various maps in this Study report illustrate transportation features.

Communities and Population

The 2010 US Census determined that the overall resident population on the Reservation was 10,068. Total tribal membership exceeds 15,000. There are three main populated communities on the Reservation: San Carlos, Peridot, and Bylas.

- San Carlos (including the Seven Mile District to the northeast and the Gilson Wash District to the west along AZ 170) has the largest concentration of population with 4,745 residents. The majority of tribal government buildings are within the community of San Carlos and the Gilson Wash District.
- Peridot is south of San Carlos. The two communities are separated by the Peridot Mesa. Peridot has a population of 1,350. Peridot includes the largest concentration of businesses on the Reservation, as well as the high school and junior high school, telecommunications offices, some other government offices, rodeo grounds, and a new hospital.
- Bylas (southeast of Peridot) has 1,962 residents, including a small business and institutional district, and some government offices.
- The Tribe's Apache Gold Casino/Resort, airport, rodeo pavilion, sawmill, and sand and gravel enterprises are located at the west end of the Reservation in an area referred to as Cutter. According to the 2010 US Census there are approximately 77 residents in this area.
- The balance of the Reservation's population lives on home sites outside of these four communities.

Governance

The San Carlos Apache Tribe is a federally recognized Indian tribe. The Tribal Constitution was adopted in 1936 and last revised in 1984. The Tribal Charter was ratified in 1955. The Tribe is governed by an elected council representing four districts, with the tribal chairman and vice-chairman elected by the full tribal membership. The four election districts are Gilson Wash, and Seven Mile (which combine to encompass the community of San Carlos), Peridot,

and Bylas. These four districts exercise some independent authorities and enterprises. Government offices and facilities are primarily concentrated in and around the community of San Carlos, although there are some government offices in Peridot and Bylas.

Services

Government administration is headed by a tribal council-appointed general manager. Tribal government services include planning and economic development, forestry, cultural resources, agriculture and livestock, public safety and corrections, fish and wildlife, social and health services, natural resources, an airport, and transportation. Tribal enterprises operate the casino/resort complex, recreation facilities at San Carlos Reservoir, telecommunications, housing, water supply/waste water, and solid waste collection.

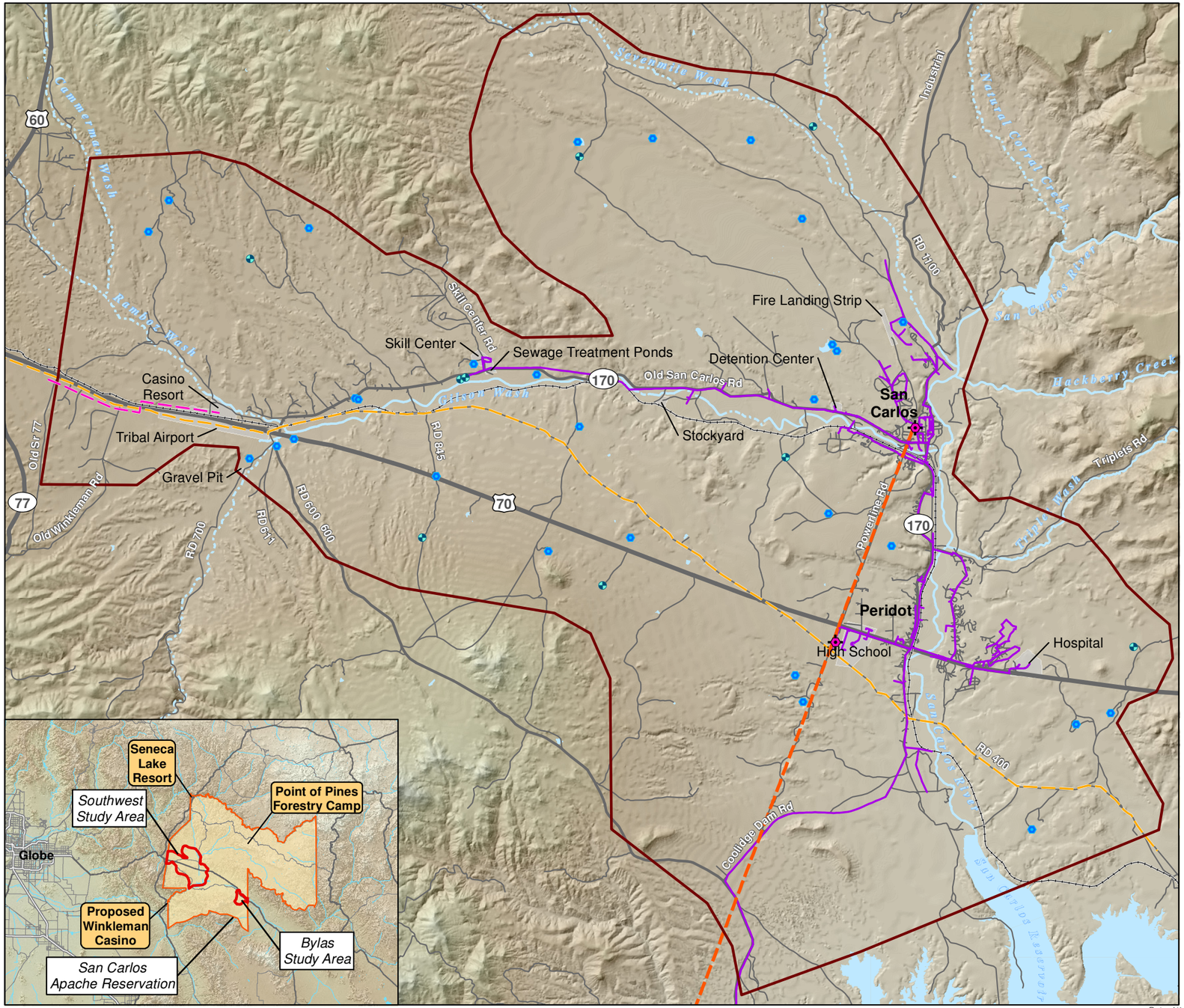
Tribal energy services and programs are presently provided primarily through the Planning and Economic Development Department. Staff consists of an energy program coordinator and energy auditors. The Tribe has recently adopted a DOE-funded Energy Organization Analysis (EOA) which calls for the creation of a tribal energy utility. As of mid-2013, the Tribal Council was considering forming an energy enterprise corporation as a vehicle for furthering renewable energy development initiatives.

The US Postal Service, BIA, USDA Natural Resource Conservation Service, Indian Health Services, the San Carlos Unified School District, Gila Community College, and churches and private K-12 schools provide facility-based services within the Reservation and the two study areas.

APS, SCIP, and GCEC (for Bylas only) provide electrical power services. See the Energy Profile chapter of this Study report for more information. Southwest Gas provides natural gas services to the Reservation. A natural gas pipeline owned by El Paso Gas crosses the Reservation, but no retail service is provided.

Economy and Employment

On-Reservation employment is predominantly limited to tribal government and tribal enterprises and other government entities such as the school district and federal agencies. Private businesses and services account for a relatively small number of jobs. Recent Tribal demographic surveys (2010) found that the annual median income on the Reservation was $15,600, about half of the annual median income in surrounding counties, and about one-third of the annual median income in Arizona as a whole. Nearly every measure of income places most of the Reservation's residents below the poverty line.



Southwestern Study Area
Utility and Road Infrastructure

Legend

- Study Area
- SCIP 69kV Transmission Line
- SCIP 3 Phase Distribution Lines
- APS Distribution Line
- Natural Gas Pipeline
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River
- Waterbody
- Electrical Substation
- Water Tank
- Water Well

N

0 1 2 3 4 5

Miles

San Carlos Apache Tribe

Parametrix

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Figure 4. Southwestern Study Area Utility and Road Infrastructure

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ENERGY PROFILE

Prior Energy Initiatives

Since 2008, the Tribe has undertaken or supported a variety of progressive and forward-thinking energy initiatives including planning, conservation, and renewable energy. These initiatives include:

2008	Defined energy goals in Tribal Strategic Plan (revised and re-included in 2011 plan)
2009	Received $317,000 DOE Energy Efficiency and Conservation Block Grant (EECBG)
2010–2012	Initiated EECBG-funded energy programs and projects
2010	Hired and trained tribal energy auditors
2010–2012	Conducted building energy audits
2010–2012	Conducted three San Carlos Apache Tribal Energy Summits
2011	Received $171,000 DOE-funded energy organization analysis and staff capacity grant
2011	Adopted Tribal Energy Strategy and Program
2012	Adopted Tribal Energy Organization Analysis
2012	Received $221,000 DOE-funded solar feasibility study grant
2012	Hired tribal energy program coordinator
2013	Completed a new tribal radio station and transmission tower that includes solar power (funded by EECBG)
2013	Completed a new 15 home solar powered subdivision in San Carlos
2012-2013	Planning for joint venture-funded casino/resort community-scale solar power facility

Electrical Energy Service Providers

Virtually all electrical power on the Reservation is purchased from three providers: SCIP, APS, and GCEC. SCIP is the largest provider, and APS provides power to the largest single consumer: the casino/resort complex. The new tribal radio station and a small new single family subdivision is solar powered. Planned community-scale solar installations at the casino/resort, the new IHS hospital east of Peridot, and the new Bylas elementary school will begin to reduce dependence on purchased electric power. There may also be some residential solar installations within the Reservation that were not documented during this Study.

Coolidge Dam
Courtesy of Jim Rapp

The Coolidge Dam, which was commissioned in 1930, was primarily intended to impound irrigation water from the Gila River, but included turbines, transmission lines, and other systems to generate and deliver hydroelectric power. The dam and its impoundment, San Carlos Reservoir, is located within the south-central Reservation. According to SCIP officials, area rainfall and river flows proved too low and variable to generate commercially competitive hydroelectric power. The dam only intermittently produced power until the 1980s. After years of virtual shutdown as a hydropower facility and deteriorating power infrastructure, and damaging floods in the early 1980s, the remaining hydroelectric equipment was removed or abandoned.

San Carlos Irrigation Project

SCIP is an agency of BIA. As a public agency, SCIP does not have a regulatory obligation to subsidize renewable energy development. SCIP officials report that the utility does not presently have a residential net metering policy supporting individual home-site solar installations, nor any incentive programs supporting larger community-scale or commercial-scale renewable development. This lack of incentive programs is a significant barrier to the development of viable solar power projects of any size, all the more so in that SCIP is the largest electrical power provider on the Reservation and serves two of the three most populated areas—San Carlos and Peridot.

SCIP owns and operates a 69 kV power transmission line that originates in Oracle, Arizona, and enters the Reservation from the southwest. This line was constructed in the late 1920's and many transmission towers and lines have never been replaced. The most significant physical or infrastructure impediment for the development of commercial-scale solar power generation on the Reservation is this 69 kV line, or, rather, the lack of any larger transmission line. The 69 kV line is the largest capacity electrical power line within the entire Reservation. SCIP has indicated that the line is nonetheless designed for the purposes of delivering power to the Reservation and does not have sufficient capacity to export power back into the regional power grid. The recent SCIP Interconnection Transmission Study indicates that this 69 kV line could "accommodate a reverse flow over the local load up to about 10 MW." Recent discussions between the Tribe and SCIP indicated that the 69 kV line is scheduled for major capital maintenance in 2013. This project will not, however, upgrade the line to sufficient capacity to carry export power loads.

San Carlos Substation
Courtesy of Jim Rapp

SCIP Service Territory

SCIP provides electrical power to the communities of San Carlos and Peridot. The SCIP service territory

extends west down AZ 170 almost to the Cutter area (but excludes the casino/resort, sawmill and tribal airport) and east along US 70 to the new IHS hospital. SCIP power is also provided to recreational developments around the San Carlos Reservoir. The power mix in the SCIP system is similar to that of APS Power (see next section).

SCIP 69 kV line - Peridot Mesa
Courtesy of Jim Rapp

SCIP Transmission and Distribution System

At Coolidge, Arizona, the SCIP 69 kV line connects into the regional power grid and higher capacity power transmission lines. This 69 kV line continues farther south from Coolidge to Oracle, Arizona, just north of Tucson. The 69 kV line's northward route from Coolidge to the Reservation is via a switching station in Hayden, Arizona. The line then passes through the remote Needles Eye Wilderness and through a small switching station below the Coolidge Dam and is routed straight north to SCIP's Peridot substation on the south side of US 70 near San Carlos High School.

The distance between the Coolidge Dam and the Peridot substation is approximately 10 miles. The distance from the Coolidge Dam to Coolidge, Arizona (via SCIP's Hayden switching yard) is approximately another 60 miles. Within the Reservation the 69 kV power line continues north from the Peridot substation over US 70 and Peridot Mesa and terminates at a second SCIP substation in the center of the community of San Carlos.

The 69 kV line is not interconnected to any other transmission lines between Hayden, Arizona, and the community of San Carlos. *This lack of capacity and connectivity, combined with the absence of SCIP renewable power incentive programs, and probable system costs and financing challenges, are the major impediments to commercial-scale solar power development on the Reservation.*

Three-phase SCIP power distribution lines with a 12 kV capacity feed out from the San Carlos substation to serve the San Carlos government and institutional center, areas to the west along AZ 170 in the Gilson Wash District, and residential neighborhoods to the north. Distribution lines also feed out of the Peridot substation to serve commercial and institutional uses in Peridot. These lines also serve residential and institutional uses east along both sides of US 70 to the new IHS hospital.

Another set of three-phase lines originates at the Coolidge Dam switching station, swing east and north along Coolidge Dam Road, and connect into the three-phase lines in Peridot. This section of SCIP's three-phase system was, in part, constructed to provide system redundancy protecting against outages caused by localized line failures. Numerous local power lines feed out of all sections of the three-phase system.

The overall 69 kV and three-phase SCIP system within the Reservation is shown on Figure 5. The SCIP Interconnection Transmission Study suggests that the capacity of the 69 kV system could be upgraded in several ways to allow for smaller commercial export loads up to 10 MW. Costs of such an upgrade is around $15 million plus cost of the solar power generation facility.

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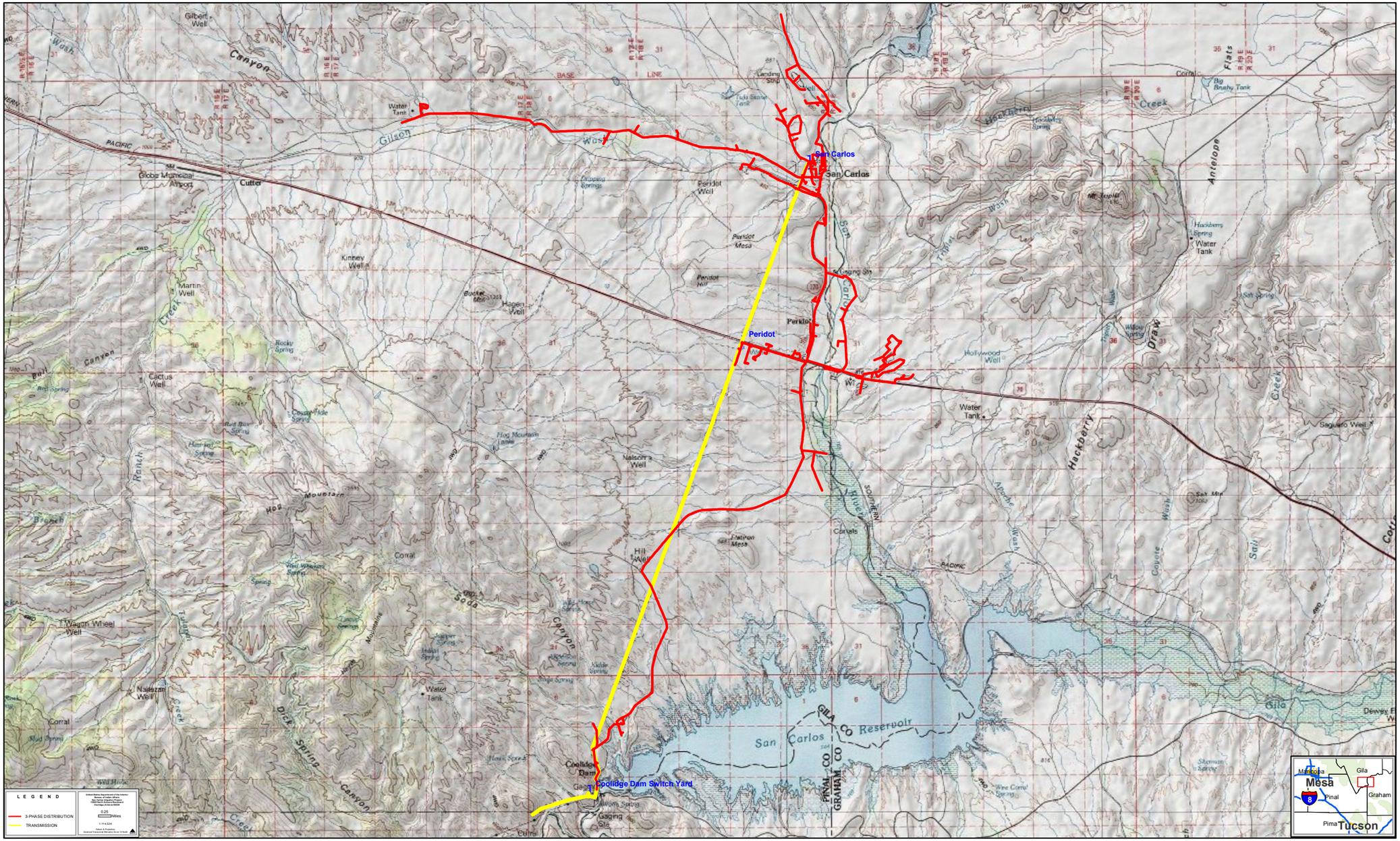

Figure 5. SCIP 69 kV and Three-Phase Distribution System

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APS Power

APS is an investor-owned private utility subject to regulatory and renewable energy generation requirements. APS offers a range of renewable energy development subsidies, funding, and renewable power purchase programs. The 2009 mix of power sources in the APS system is listed in Table 1.[1]

Table 1. APS Power Sources

Coal	38%
Natural Gas	31%
Nuclear	27%
Renewables	2%
Energy Efficiency	2%

A renewable energy credit (REC) issued by APS in 2012 in the amount of $3 million was a significant factor in the economic feasibility of a 2.75 MW community-scale solar facility then being planned for the casino/resort. Due to a change in the Tribe's solar power development partner, this REC subsequently expired, but the Tribe and a new private energy services partner have obtained a replacement REC for a 1.1 MW project. This smaller facility is based on a more complete assessment of power demands and planned energy efficiency upgrades at the casino/resort and will meet approximately one-third of the casino/resort's electrical power demand (after energy efficiency improvements).

Appendix A details the various programs, incentives, and other considerations for solar power development within APS and SCIP service territories. In January 2013, however, the Arizona Corporation Commission (ACC) effectively eliminated all support for the REC program. Although the Tribe's 2012 REC award is secure, no incentives will be available in 2013, and the availability of future incentives is highly problematic, at least until ACC policy changes.

APS Service Territory

APS presently serves the Apache Gold Casino/Resort complex (casino, rodeo grounds and pavilion, golf course, hotel, market/gas station, administrative offices, and RV park), the San Carlos Apache Airport, and a tribally owned sawmill, plus approximately 45 scattered residences along and near US 70 in areas west of the US 70/AZ 170 intersection in Cutter. APS does not provide service east of this intersection.

Irrespective of current power line capacity or location, APS officials have indicated that APS may not be permitted by federal regulation to participate in developing or operating new power lines through the SCIP service territory or in projects involving the use of SCIP power infrastructure, such as the San Carlos or Peridot substations.

APS Transmission and Distribution System

APS supplied power is delivered to the western portions of the Reservation via a distribution power line originating at an APS substation in the adjoining city of Globe, Arizona. This substation is approximately 2 miles west of the Reservation boundary and is interconnected with the regional power grid and higher capacity transmission lines. The APS distribution line enters the Reservation at a small switching station on the Reservation's west edge, approximately 2.5 miles from the casino/resort and 16 miles from the center of the community of San Carlos. The distribution line parallels the south side of US 70 until reaching the west end of the tribal airport, where it crosses to the north side of the highway, enters the casino/resort property, and then terminates on the east side of the casino. The main APS distribution line is shown schematically on Figure 4. APS local service lines feed off this distribution line.

1 Similar information was not available for SCIP or GCEC but can be assumed to be reasonably consistent to APS.

There are no APS transmission-grade power lines within the Reservation. Information on the capacity of the APS power distribution system was not provided. The APS Globe substation is the closest APS facility where a new transmission line exporting solar electric power generated on-Reservation could interconnect with the regional power grid. The distance from the SCIP San Carlos substation to the APS Globe substation is approximately 18 miles. APS officials have indicated informally that a new 69 kV transmission line used solely for power export may be adequate for such purposes.

Graham County Electrical Cooperative

Note: Public information on GCEC is extremely limited. The cooperative does not appear to have website. The information that follows was derived partly from a website called ArizonaGoesSolar.org and from limited field observations. Although focused on solar development, this website includes some general information about the cooperative. This information could not be verified for completeness or accuracy.

The following quote is from the Tribe's 2012 EOA and generally describes the purpose and structure of rural electric cooperatives.

> *Cooperatives are membership organizations, usually formed to deliver services to rural areas and remote customers where other options are not available. In terms of electrical power services, the best examples are the electric cooperatives that were first formed in the 1930s and 1940s in the rural western U.S. to bring electrical power to isolated farms. These cooperatives still form an important part of local power supply in many rural areas, and, as such areas have grown in population, "co-ops" now often serve urban and suburban communities. Electric cooperatives are seldom in the power generation business. Cooperatives usually buy from other power companies and utilities, and distribute "retail" power to members. Cooperatives do, however, usually own and operate the infrastructure that delivers the power to members (transmission lines and substations).*

The ArizonaGoesSolar website indicates that "GCEC offers a variety of up-front incentives (UFI) to members for the purchase and installation of several renewable energy solutions, including technologies such as solar PV systems, solar water heating, residential wind, and solar daylighting. Up front incentives are paid to members after the project has been completed and all payment requirements have been met."

GCEC also offers performance-based incentives (PBI) for solar and wind systems larger than 10 kilowatts (kW). PBIs are incentives that are paid based on the actual metered production of the system being installed. Production is tracked and incentives are paid out on a quarterly or semiannual basis for a period up to 20 years. Incentive payments cannot exceed 50 percent of system costs, and projects are selected based on a competitive selection process.

The ArizonaGoesSolar website also includes a table documenting the solar installations that GCEC has supported. Most system sizes are small and in the range of 5 kW to 15 kW, with a few in the range of a few hundred or a few thousand kilowatts. Two systems have reported sizes of around 25,000 kW. The website provides no information as to the kind of facilities or sites served by these solar installations. The website also indicates that this program is a collaborative effort with the ACC. As reported in the *APS Power* section of this Study report, ACC effectively terminated some key renewable power support programs in early 2013, so the status of the GCEC program is uncertain.

GCEC Service Territory

GCEC serves the electric power generation, transmission and delivery needs of Safford, Arizona and surrounding areas, including the Reservation's Bylas area. GCEC directly serves more than 9,000 cooperative members and also provides electrical power to Thatcher and Safford municipal power utilities, with a combined customer base of about 5,500. Within the Reservation, GCEC serves businesses and homes from the southeastern Reservation boundary to a line roughly at the point US 70 crosses the Gila River west of the community of Bylas. *Note: The Bylas service area has not been confirmed by direct information from GCEC, and additional local service lines may not have been identified during Study field observations.*

GCEC Transmission and Distribution System

GCEC operates and maintains more than 1,200 miles of electric power lines. In 2009 GCEC constructed a 14-mile 69 kV power line from northeast of the City of Safford to the City of Thatcher. The ArizonaGoesSolar website states that the "Safford-Thatcher line doubles capacity and reliability." Although not within the Reservation, this improvement to GCEC's system would presumably be a benefit to Bylas customers.

GCEC does not interconnect with the SCIP 69 kV transmission system or SCIP distribution or local service lines within the Reservation. The distance along US 70 from the most easterly SCIP power distribution line at the new IHS hospital to the point at which US 70 crosses the Gila River is approximately 20 miles.

Morenci Mine

The Morenci Mine is the one of the largest open pit mines in the world and has massive power demands. The mine is located just outside of the eastern boundary of the Reservation. Morenci is owned and operated by Freeport-McMoRan which has offices in Globe, Arizona, as well as other mining operations in the region. Freeport-McMoRan opened an apprentice technical training program in October 2012 at the Tribe's Skill Center/Tribal College (the former San Carlos Junior High School) on AZ 170 west of the community of San Carlos.

Morenci owns and operates an electrical power line that supplies a water pumping station on the Black River within the Reservation. This line is approximately 40 miles long. Water is pumped uphill and then gravity-fed eastward back to the Morenci Mine and used in open pit mining processes. Power service is provided at no cost to the Tribe's Forestry Services Camp and other Tribal facilities sited adjacent to this power line in the Point of Pines area under an access agreement with the mining company.

Electrical Energy Demand

Extensive data on overall Reservation electrical loads or costs has never been formally collected and analyzed. Some data on annual electrical energy consumption was obtained in 2010 for select facilities near the Reservation's western boundary (see page 29) and for a very limited number of individual tribal buildings in San Carlos. A preliminary assessment of power costs conducted in 2010 by the Tribe's building energy auditor for a potential energy efficiency grant through USDA's High Energy Cost Grant Program showed retail electric power rates charged on the Reservation to be in excess of 200 percent of the national average.

Power utility bills are, for the most part, delivered to, processed, and paid by individual tribal government departments and enterprises. Nontribal government and institutional

operations on the Reservation also pay their own bills, as do private business enterprises and residents. An inventory of annual purchased power consumption based on actual power bills was initially attempted as part of the Tribe's 2011 *Energy Strategy and Program*. However, the number of accounts spread over tribal government and enterprise operations, other government agencies, the school district, and private uses proved too complex to cost-effectively complete as part of the *Energy Strategy*, even when scaled down to just tribal operations. Many billing records are only available in paper form, further complicating efforts to compile these records. These same challenges were faced in developing this Study. Consumption models were developed as a substitute for actual records of consumption.

Peak Load Demand

The draft SCIP Interconnection Transmission Study (mid-2013) provided the following information on SCIP substation capacity and loads.

Table 2. SCIP Peak Demand

SCIP Substation	MVA	MW
Peridot	7.7	5
San Carlos	10	4.5

Annual Consumption Projections

Estimates of current electrical power consumption are needed to cost-effectively size solar development alternatives. In light of the difficulty in obtaining actual records, current Reservation electricity consumption was modeled. Data on the average annual electricity consumption by building type in the region was obtained from the Energy Information Administration (EIA). EIA regional estimates are based on the GCEC service territory and consumption records. GCEC serves communities just east of Peridot and San Carlos including the community of Bylas within the Reservation, so this "regional" average is actually relatively specific to Reservation power demand. The EIA indicates an average consumption of 13.8 kWh per square foot of building space for GCEC customers.

San Carlos and Peridot

Consumption models were produced for all commercial, institutional and residential buildings in San Carlos and Peridot based on estimates of total building areas in square feet. The building footprints of commercial and institutional buildings in Peridot and San Carlos were measured using high-resolution aerial photographs. GIS shapefiles were created to delineate commercial, institutional, governmental and residential buildings. These measurements and averages were multiplied by the number of GIS-coded building types in San Carlos and Peridot. Estimates of square footage based on aerial and GIS interpretation were validated using some limited actual square footage information provided by the Tribe's Housing Authority and Planning and Economic Development Department.

Unless building-specific variations were known, all buildings were assumed to be one story for the purposes of calculating building size (most commercial and institutional buildings in San Carlos and Peridot are one story in height). In consultation with tribal staff, an average residential dwelling unit size of 1,800 square feet was selected.

Based on this modeling effort, the communities of San Carlos and Peridot are estimated to consume 61,595 megawatt-hours (MWh) of electricity annually.

Bylas

The same approach was used as for Bylas as with Peridot and San Carlos, except the 2010 US Census count of 445 dwelling units in Bylas was used as the residential unit multiplier rather than a residential building count generated by aerial photography and GIS measurements.

For Bylas, the electricity consumed annually is estimated at 12,580 MWh.

Cutter

For the Cutter area, modeled residential consumption was based on 1,800 square feet multiplied by the 45 residential dwelling served by APS. Commercial electricity consumption was based on actual consumption records for 2010 obtained from the casino/resort, airport, and sawmill operators (see Table 3). Annual consumption of electricity in Cutter including modeled projections for residential dwellings and actual figures for commercial and industrial uses as shown in Table 3 is estimated to total 9,905 MWh.

Table 3. Cutter Annual Commercial Energy Usage

Casino/Resort	7,463 MWh
Sawmill	1,300 MWh
Airport	23,599 kWh

Greenhouse Gas (GHG) Projections

Two methods were used to estimate GHG emissions generated to produce the electricity consumed in San Carlos/Peridot, Bylas, and Cutter. Based on EPA estimates of GHG emission intensity by utility, the average national emission factor for electricity production[2] was used to estimate total GHG emissions. This calculation methodology yielded an estimate of 33,275 $MtCO_2$ due to electricity consumption in San Carlos and Peridot; 6,840 $MtCO_2$ due to electricity consumption in Bylas; and 5,385 $MtCO_2$ due to electricity consumption in Cutter.

Using a different methodology, emission factors specific to electricity produced by GCEC were used to estimate total GHG emissions in all three areas. This GCEC-specific methodology produced an estimate of 43,458 metric tons of carbon dioxide equivalent ($MtCO_2e$) based on electricity consumption in San Carlos and Peridot, 8,876 $MtCO_2e$ based on electricity consumption in Bylas, and 6,199 $MtCO_2e$ based on electricity consumption in Cutter.

2 7.0555×10^{-4} metric tons of carbon dioxide ($MtCO_2$)/kWh

Table 4. San Carlos/Peridot and Bylas Electricity Consumption/GHG Emissions

	Total Building Footprint (Square Feet)	Average Electricity Consumption (kWh/square foot)[a]	Total Electricity Consumption (kWh)	Total Electricity Consumption (MWh)	Average MtCO2e Based on EPA Carbon Calculator[b]	Average MtCO2e Based on National Emission Factor[c]
San Carlos/ Peridot (service provider: SCIP)	4,463,396	13.8	61,594,862	**61,595**	33,275	43,458
Bylas (service provider: GCEC)	911,602	13.8	12,580,109	**12,580**	6,840	8,876

Table 5. Cutter Electricity Consumption/GHG Emissions (electrical service provider: APS)

Total Residential Footprint (Square Feet)	Average Electricity Consumption (kWh/square foot)[a]	Total Residential Electricity Consumption (kWh)	Actual Commercial Building Consumption (kWh)	Total Electricity Consumption (MWh)	Average MtCO2e Based on EPA Carbon Calculator[b]	Average MtCO2e Based on National Emission Factor[c]
81,000	13.8	1,117,800	8,786,920	**9,904**	5,385	6,199

a. Based on 2003 EIA data reported in 2006. Accessed online at http://www.eia.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html on March 1, 2013. Graham County Electric Cooperative (GCEC) is the only local electricity producer registered with the EPA's GHG emission calculator, and thus, while not the true service area provider this data provided an estimate consistent with local conditions.

b. Based on the EPA's How clean is the electricity I use? - Power Profiler for zip code 85550. Accessed online at http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html on March 2, 2013. Different GHG emissions associated with electricity production have varying heat trapping capacities; emissions are often normalized to allow comparison of true warming impact and reported in MtCO2e.

c. Based on EPA's reported National Emission Factor of 7.0555 x 10^-4 metric tons CO2/kWh. Accessed online at http://www.epa.gov/cleanenergy/energy-resources/refs.html

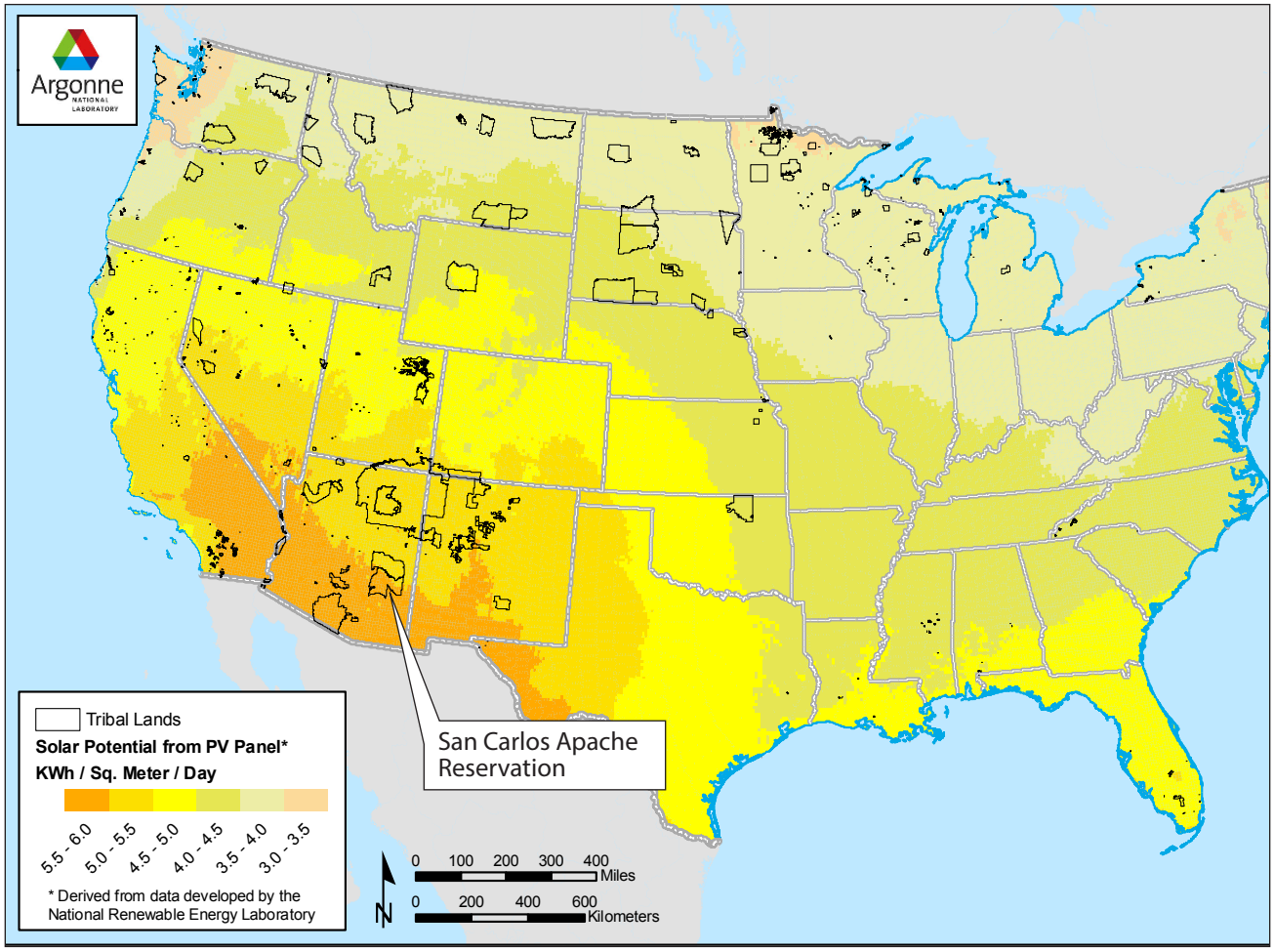
Electrical Power Costs

Retail power rates charged by SCIP are summarized in Appendix F. Data on actual power bills in the SCIP service territory was not available. An analysis of Reservation power rates in 2010 indicated that costs were over 200 percent in excess of the national average as determined by the US Department of Agriculture. The recent SCIP Interconnection Transmission Study does project some retail costs but does not provide any attribution or references explaining these projections.

Solar Energy Resources and Generation

DOE National Renewable Energy Laboratory (NREL) data for solar photovoltaic (PV) applications indicates that the Reservation has the highest rated level (5.5–6.0 kWh/m^2/day) of solar resource potential (see Figure 7). These climatic conditions, combined with

Figure 7: Solar PV Potential on Tribal Lands



Courtesy of Argonne National Laboratory

significant acreages of relatively flat and south facing vacant land on the Reservation, particularly within the southwestern study area, indicate strong prospects for developing renewable solar power generation.

Additional documentation and comparisons with respect to solar and other renewable energy prospects on the Reservation are included in the Tribe's 2011 *Energy Strategy and Program*. There is presently no developed and operating commercial-scale solar generation on the Reservation. There are six community-scale solar facilities at differing stages of planning or development:

Radio Station Solar Panels
Courtesy of Tribe

Tribal Radio Station and Transmission Tower

A new tribal radio station located in San Carlos, near the government center, and an off-site radio transmission tower came online in April 2013. DOE funding provided for the installation of solar PV power panels at the radio station and transmission tower. The station's system is rated at 7.1 kW and the tower at 3.1 kW.

Apache Gold Casino/Resort

A 1.1 MW community-scale solar facility is being developed as a joint venture between the Tribe and a private solar developer and includes support from a 2012 REC issued by APS. Present plans will meet approximately one-third of the casino/resort's electrical demands using small ground-mounted arrays distributed throughout the casino/resort property.

Between 2010 and 2013 the Tribe considered three community-scale proposals for ground-mounted solar power at or near the casino/resort complex. All proposals were for flat-panel solar PV systems and were turn-key. None of these proposals were based on a formal tribal request for proposals that specified minimum generation requirements, system configurations, and other particulars. Therefore, direct comparisons between the proposals should be approached with caution. The Tribe reports the per watt construction cost of the three proposals for the casino/resort as follows:

Table 6. Casino Solar PV Proposals

Vendor	System	Generation	Overall Cost	Per Watt
Ameresco	Ground mounted	1.095 MW	$3.6 M	$3.30
Solaire	Ground mounted	2.75 MW	$6.32 M	$2.30
EcoDistributing	Ground mounted	1.1 MW	$2.42 M	$2.20

The Solaire proposal was originally based on the installation of solar panels atop parking lot shade cabanas on the south side of the casino/resort facing US 70. Based on casino management concerns about security and appearance issues and the cost of the proposed mounting system (e.g., shade cabanas), this concept was dropped. Development of a 12-acre abandoned ballfield abutting the east end of the casino/resort complex was the basis for the Solaire estimate cited above.

Casino Entrance
Courtesy of Jim Rapp

The Ameresco proposal was based on smaller clusters of ground-mounted solar PV panels distributed across vacant lands abutting the casino and hotel. Ameresco also proposed significant energy efficiency upgrades to the casino and hotel. The cost of energy efficiency upgrades are not in the per watt estimate cited above. EcoDistributing did not provide a formal proposal or quote, only indicating they could build the equivalent to the Ameresco proposal at considerably less expense.

IHS Hospital

A new hospital operated by the Indian Health Science (IHS) is currently under construction on US 70 just east of Peridot and the San Carlos River. The hospital is designed to include rooftop solar panels.

IHS Hospital
Courtesy of Steve Albert

Bylas Elementary School

This new school is located approximately 3.5 miles southeast of the present center of the community of Bylas. The school was designed and built to accommodate rooftop solar panels. The main school buildings have all been completed. As of October 2012, funding for solar panels as well as other school infrastructure was still being secured. The school will open in the summer of 2013.

Bylas Elementary School
Courtesy of Jim Rapp

Bylas "Solar" Subdivision

Lands to the immediate west and north of the new Bylas Elementary School are planned for a new 100- to 110-unit residential subdivision to be developed by the San Carlos Apache Housing Authority. This housing will replace homes in the center of Bylas that are in the floodplain of the Gila River. Conceptual plans call for solar infrastructure sufficient to meet most residential electrical power needs. The housing authority does not have a firm development timeline for this project.

San Carlos "Solar" Subdivision

A 15 home subdivision is under construction just off AZ 170, northwest of the center of San Carlos. The subdivision will be ready for occupancy before the end of 2013. All homes included rooftop solar panels.

San Carlos Subdivision
Courtesy of Steve Albert

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SOLAR POWER INFRASTRUCTURE BASICS

Generation

Solar photovoltaic (PV) systems use solar cells made of layers of semiconducting materials. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic effect. Solar PV cells are normally combined into modules of about 40 cells; the modules are in turn assembled into PV arrays. PV arrays can also be used for large electric utility or industrial applications. Hundreds of arrays can be interconnected to form a single, large PV system.

Concentrating solar power (CSP) *linear* systems are also given some consideration in this Study, although factors on the Reservation related to transmission, system size, and water supply limit CSP feasibility. Other CSP-type systems in addition to CSP linear systems are also available. The two primary alternatives are termed "power tower" and "dish engine." These alternatives were *not* evaluated as part of this Study.

Excellent tribally oriented guides to renewable power infrastructure and other considerations for renewable power development are available online through the US Department of the Interior's Office of Indian Energy and Economic Development and DOE.

- Tribal Energy and Environmental Information Clearinghouse[1]
- DOE Weatherization and Intergovernmental Program[2]
- DOE Tribal Energy Program[3]

1 http://teeic.anl.gov/er/solar/index.cfm
2 http://www1.eere.energy.gov/wip/information.html
3 http://apps1.eere.energy.gov/tribalenergy/

Solar PV systems

PV systems are highly reliable. The panels can be fixed in place facing south or fitted with manual or automated systems that track the movements of the sun across the day or seasons. Flat-panel PV arrays without tracking have no moving parts, and even two-axis sun-tracking systems require only a relatively small number of low-speed moving parts. This tends to keep operation and maintenance costs down. The required equipment is also flexible with respect to slope changes and can be engineered to accommodate variations across a site. Construction is more complex on slopes greater than 4 percent to 5 percent. This Study used slopes of 4 percent or less as a basic measure of feasibility.

There are two variants of solar PV available. The most common form is flat-panel PV designed to allow sunlight to strike solar cells directly without the benefit of light-concentrating or focusing devices. Solar cells convert sunlight directly into electricity and are made of semiconducting materials similar to those used in computer chips.

A second solar PV form is referred to as concentrating PV. Specialized PV cells are designed to convert a high percentage of sunlight into electricity when they are exposed to concentrated sunlight. These cells are typically mounted in a "concentrator" that uses inexpensive plastic lenses or reflective surfaces to focus sunlight onto a cell at up to 1000 times the normal strength of sunlight. Concentrating PV systems benefit from the cost savings of using less solar cell material per kilowatt, since each solar cell produces much more power than in flat-panel PV systems. However, concentrating PV requires sophisticated tracking systems to keep them pointed at the sun. Because of the sophistication of the tracking system, concentrating PV systems are usually used in large commercial or industrial settings, although they could provide power to a local community or small town.

Concentrating Solar Power Linear Systems

CSP can produce as much as 30 percent more power than a flat-panel PV system having the same total solar cell area. A general rule of thumb published by the DOE Office of Indian Energy is that a CSP system needs to generate a minimum of 50 MW to be economic. Parabolic mirrors or Fresnel lenses used in CSP systems require flat terrain with less than 2 percent slopes. One percent is considered ideal. CSP systems may also require a power station where solar energy is used to convert water to steam which drives turbines that produce electricity.

A challenge to CSP system feasibility on the Reservation is that reliable sources of large volumes of water are needed for system cooling towers. Another drawback is that more expensive high-performance solar cells and precise dual-axis tracking are needed for CSP, as compared to flat-panel. Also, both mirrors and concentrating lenses must be kept clean to perform optimally. Finally a 50 MW system would have no place to export and sell commercial power due to the lack of transmission on the Reservation.

Given that the lack of adequate electrical transmission on the Reservation significantly limits near or mid-term possibilities for commercial-scale solar power generation, CSP systems are not recommended.

Common features

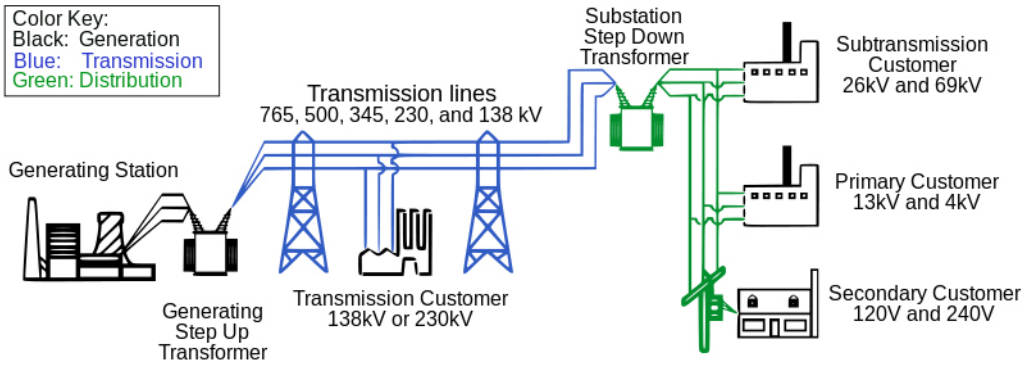
Whether the generation method is PV or CSP, additional infrastructure is required in order to connect to the local distribution or transmission grid. For PV systems, each block of PV panels requires inverters to convert the power from direct current (DC) to alternating current (AC), so the power can be stepped up in voltage through power transformers to connect to the distribution or transmission grid. If CSP systems using heat to make steam for a turbine are used, inverters are not required, but power transformers are also needed to step up the voltage and connect to the grid.

Transmission

To allow for the export of power generated on-Reservation, new or upgraded transmission infrastructure is needed. Electrical power transmission-level voltages are typically a minimum of 115 kV. Voltages above 230 kV are considered extra high voltage, have different design requirements and are much more costly to build and maintain. Voltages lower than 115 kV are usually considered subtransmission scale but are occasionally used on long transmission lines with light loads. The SCIP 69 kV line through Peridot and San Carlos can be characterized as a "long line-light load subtransmission line." Voltages less than 26 kV are

typically used for distribution. Figure 8 illustrates a typical system from generation to delivery to the customer. In the case of this Study, the "generating station" would be a commercial-scale solar array and the probable transmission would be 115 kV to 138 kV.

Figure 8: Generation and Transmission System



Courtesy of Wikimedia Commons

One or two new transmission-level power lines would have to be constructed partly or substantially off-Reservation to accommodate commercial-scale export loads. Approximately 2 miles of a new 18-mile-long line to Globe, Arizona, would be off-Reservation. A new 70-mile-long line from Peridot to Coolidge, Arizona, may include at least 60 miles off-Reservation. The Tribe would not control much of the land through which these new lines would pass. Land acquisition greatly complicates and increases the costs of an already complex and costly undertaking.

Using the high-level unit cost variables (see page 38), two examples of possible transmission lines costs follow. The SCIP Interconnection Transmission Study reports a cost of approximately $68 million for a new transmission line to Oracle, Arizona. This estimate is however based on using a 230 kV line, and Oracle is more distant than Coolidge.

115 kV line San Carlos to Globe, AZ	
$400K x 1.3 (permit/acquire)	$520K/mile
$520K x 18 miles	$9.36M
$520K x 1.2 x 2.5 m (urban)	$1.56M
TOTAL	**$10.92 Million**

115 kV line Peridot to Coolidge, AZ	
$400K x 1.5 (permit/acquire)	$600K/mile
$600K x 1.3 x 35 m (mountain)	$27.3M
$600K x 35 miles (rural)	$21M
TOTAL	**$48.3 Million**

The following factors and variables should only be used as general guidelines for making order of magnitude conceptual cost estimates for transmission infrastructure. Field surveys, preliminary and final design and engineering, an assessment of local construction market conditions, and a thorough evaluation of land acquisition and permitting costs, should be undertaken in all cases.

Base Transmission Line Variables

Total installed costs for electric transmission are highly variable based on several factors including terrain, type of construction, material availability, environmental factors, and cost of land acquisition. In the southwestern US, costs for a typical 115 kV wood pole transmission line built to Rural Utility Service standards would have a total installed cost (including engineering, materials and construction) of between $300,000/mile and $500,000/mile.[3]

Land Acquisition and Permitting Variables

Assuming no land acquisition costs within the Reservation and expedited permitting based on tribal sovereign authority, a factor of 1.2X for permitting and environmental compliance costs should be applied to the above base ranges *within* the Reservation. A factor of 1.3X (for shorter distances and less acquisition) to 1.5X (for longer distances and more acquisition) should be applied to account for *off-Reservation* land acquisition, permitting and environmental costs.

Topographic Variables

The base should also factor in another 1.2X for crossing hilly topography, which would apply for many routes through the Reservation. A factor of 1.3X is applied for mountainous and remote areas, which describes the topography of some of the conceptual route of a new transmission line from Peridot to Coolidge, Arizona.

Urban Area Variables

Most of the land that would be crossed by a new transmission line from San Carlos south towards Coolidge and Hayden or west towards Globe, would be characterized as rural. The last two or so miles from the western Reservation boundary to the regional grid interconnection in Globe, Arizona, is characterized as urban. A factor of 1.2X is applied for crossing urbanized lands, such as a route through Globe.

Other Electrical Power Infrastructure Variables

Besides the actual solar panels and transmission infrastructure previously discussed, additional equipment is required to complete a fully functioning commercial-scale PV installation, including power inverters to convert the DC voltages generated by the solar cell modules, power transformers to step up the voltage generated (typically 480 V) to the appropriate voltage to be fed into the power system, plus protective equipment and controls to ensure safe and efficient operation of the overall interconnect. Costs of additional commercial-scale interconnect and controls equipment could be in the range of $4.0 million to $8.0 million, depending on size, capacity, voltage level and applied standards.

3 These particular ranges include construction and engineering costs, but NOT land acquisition, environmental compliance, or permitting costs.

SITE EVALUATION CRITERIA

The site inventory and feasibility analysis within the primary two study areas was conducted using GIS information and site visits. For preliminary calculations it was assumed that 1 MW of electrical power can be generated with flat-panel solar PV systems for every 5 acres of land. Other published information suggests up to 9 acres per MW based on climatic conditions, system type and size, shade and obstructions, and other factors. The SCIP Interconnection Transmission Study suggest 6 acres per MW as a "rule of thumb". In the southwestern US, acreage per megawatt can potentially be reduced (i.e., improved) based on the year-round consistency and the higher number of sunny days, by using solar power systems that track the sun across the seasons, and/or by using concentrating PV systems.

In addition, commercial-scale solar facilities usually require an on-site electrical substation or extensive interconnection infrastructure and equipment to directly convert the electrical power produced for transfer into the power grid. Substations can require between 10 to 15 acres of land or more. In some cases nearby existing substations can be used. Within the southwestern study area, SCIP substations are not close enough to any of the possible commercial-scale sites to replace an on-site substation.

Internal access roads and support facilities, distances from other land uses and features, and protection of cultural, environmental and natural resource features can also reduce the effective size of any given site. Full design and engineering of selected sites will be necessary to make final determinations as to preferable systems, costs, site boundaries, power generation potential, and other factors.

> *Note: All site areas and boundaries illustrated in this Study report are subject to adjustment based on future field investigations and surveys and the outcomes of design and engineering associated with actual facility development. This Study assumed that the existing electrical distribution system was at least adequate to carry community-scale loads at present levels of demand. Nonetheless, the condition and capacity of the transmission and distribution lines to which a generation facility interconnects should be specifically assessed. The amount of developable land may also vary based on the level of investment in site grading and other alterations.*

Slope and Aspect

Solar PV flat-panel ground-mounted arrays require flat or gently sloping areas, usually of less than 4 percent to 5 percent. CSP systems require even flatter sites, slopes usually less than 1 percent to 2 percent. Some areas with intermittent south-facing slopes exceeding these percentages are interspersed on some potential solar sites. These sites may, in some cases, be developable with grading and other site alterations. Predominately south-facing slopes are also required, although this can be partly mitigated by systems that rotate manually or automatically with the season.

- Figure 9 shows lands within the southwestern study area that have slopes of 4 percent or less.
- Figure 10 shows predominantly south facing slopes.
- A third map (Figure 11) illustrates those areas of at least 50 contiguous acres with the overlapping combination of preferred slope and aspect.

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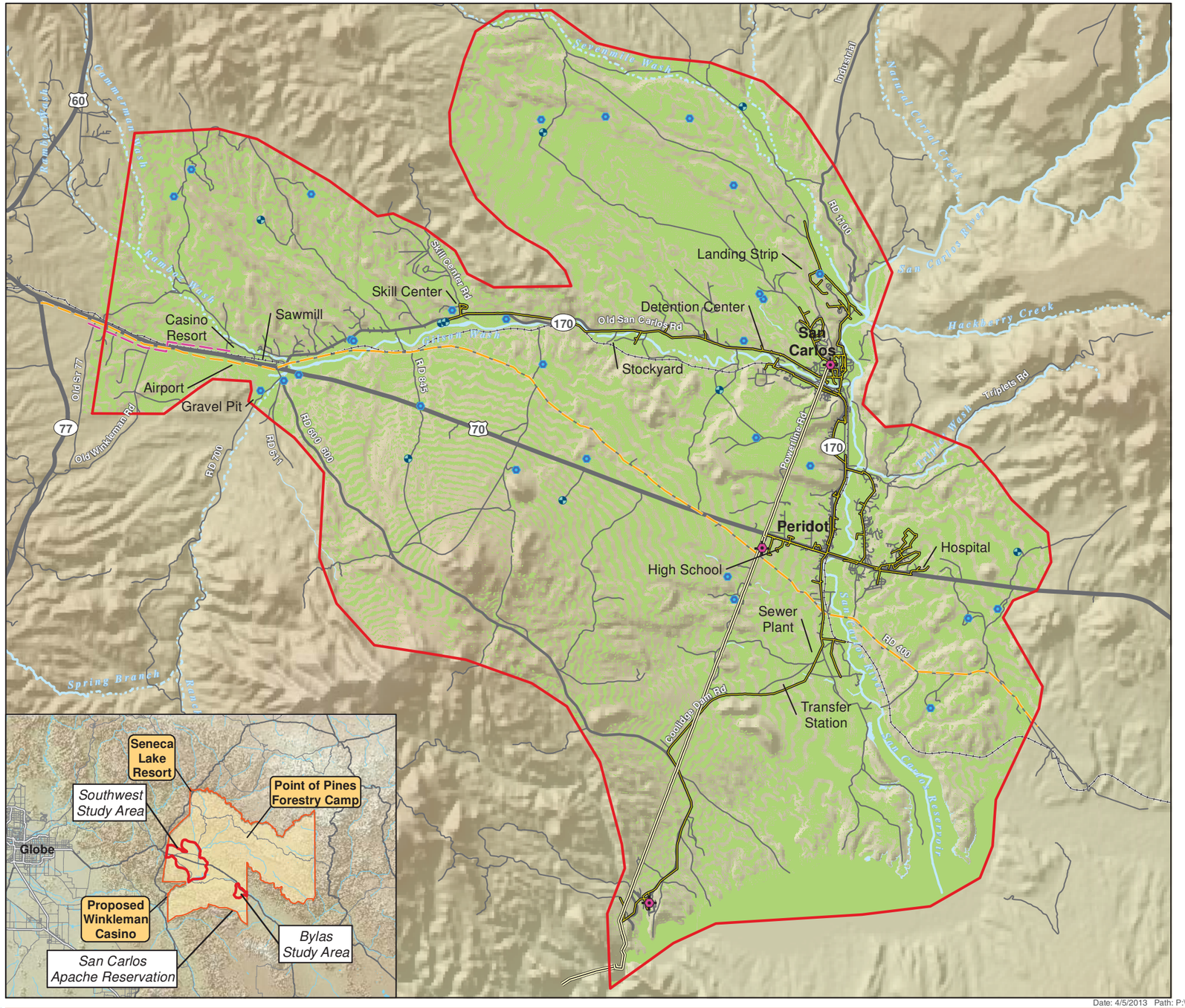

Figure 9. Preferable Slopes

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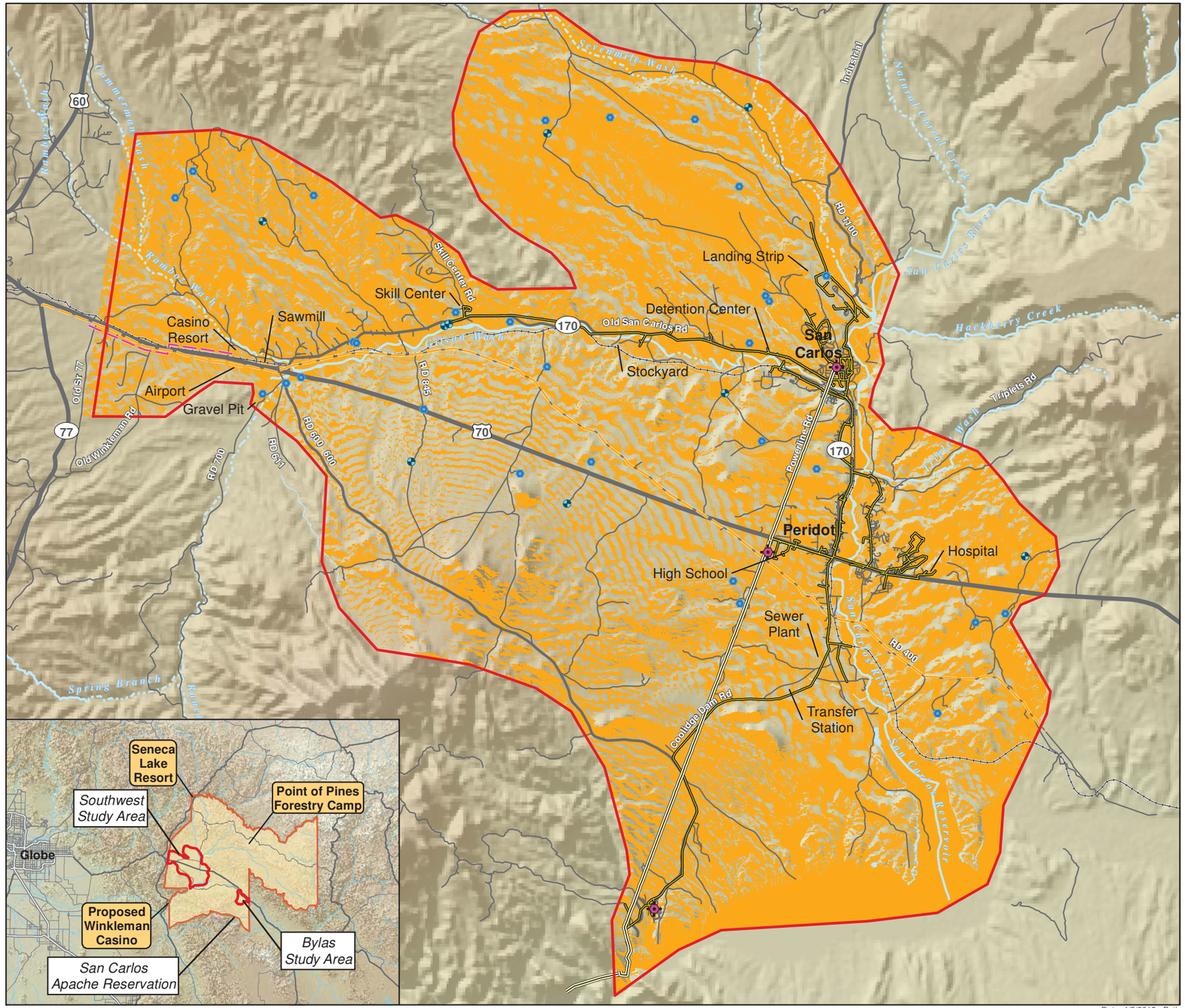

Figure 10. Preferable South facing Aspect

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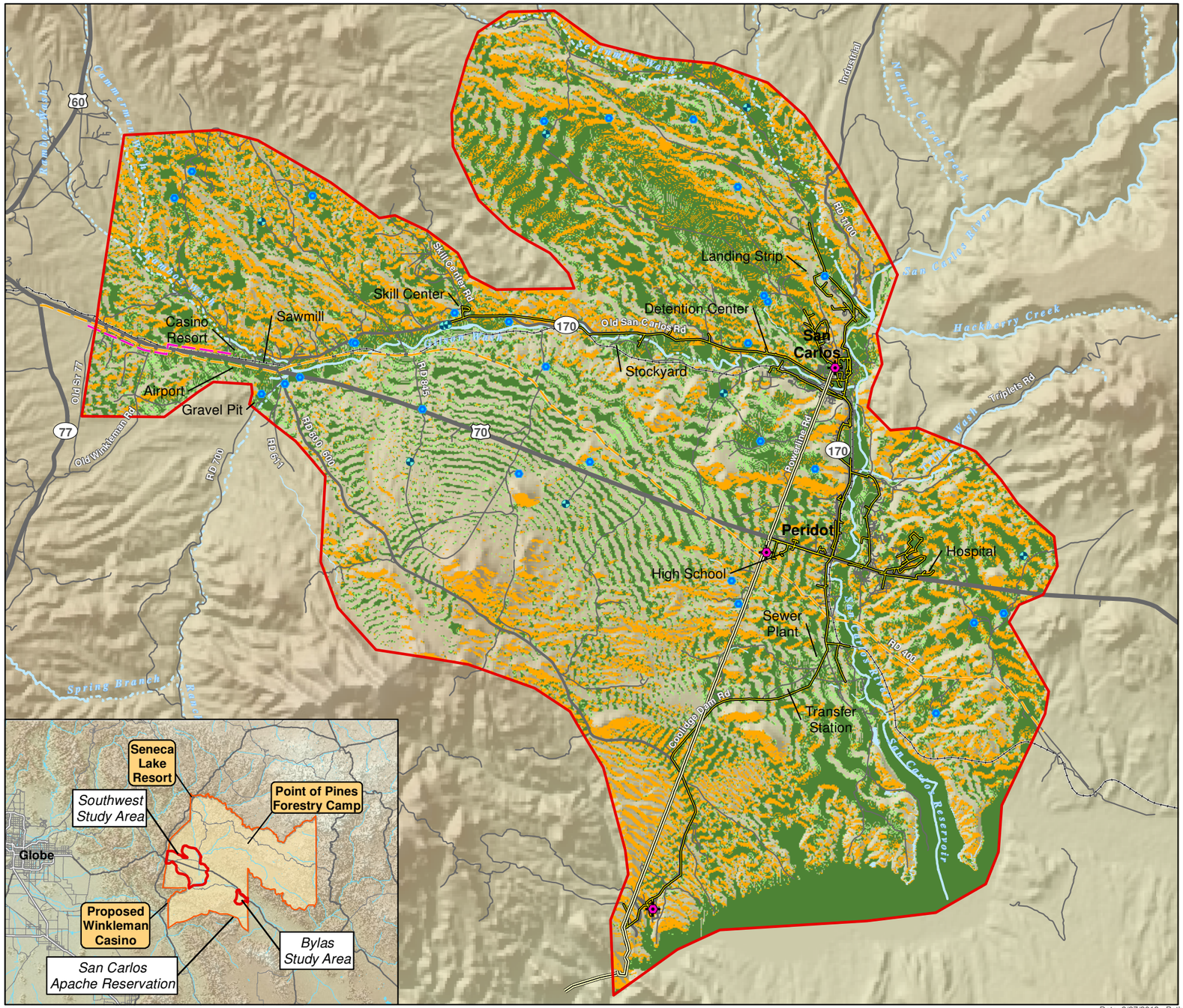

Southwest Study Area
Preferred Slope and Aspect

Legend

- Study Area
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River
- Waterbody
- Pipeline
- SCIP 3 Phase Distribution Lines
- SCIP 69kV Transmission Line
- APS Distribution Lines
- Electrical Substation
- Water Tank
- Water Well
- Preferable Aspect
- Preferable Slope
- Preferable Slope and Aspect

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San Carlos Apache Tribe

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Figure 11. Preferred Slope and Aspect

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Shading and Obstructions

Shading or obstructions of solar panels can greatly reduce power generation capacity. As the sun rises or sets, nearby buildings, hills, trees, and other tall vegetation can keep sunlight from striking the surface of PV panels even with the addition of manual or automated sun tracking systems. Without battery storage, solar facilities also do not provide power once the sun sets. This Study considered shading impacts on those sites which otherwise exhibited the most potential for solar generation.

Afternoon shading at west side of Peridot Mesa Courtesy of Jim Rapp

Electrical Service and Transmission

Much of the Reservation is without any electrical power service. Even within the two primary study areas, which encompass the majority of the population within the Reservation, electrical power lines are absent in many areas. As noted earlier, three electrical power utilities serve the Reservation: APS, SCIP, and GCEC. These three utilities are not interconnected, although APS and SCIP do have side-by-side customers in the Cutter area east of the casino/resort. The current local distribution and transmission power line grids within the southwestern study area are illustrated on Figure 4 (page 17).

The key issues to be evaluated with respect to electrical service are:

- What power transmission or distribution lines are available in given area? What is the capacity of the transmission or distribution line? If not present, or of insufficient capacity, what would be the distance/costs of extending an adequate capacity distribution or transmission line?
- What programs and policies does the electrical power provider have with respect to renewable energy generation and export?

Transportation Infrastructure

Adequate and fully maintained all-weather roads are needed to access solar power facilities during both construction and operational phases. Many roads within the Reservation and the two primary study areas are not paved. Tribal staff have indicated that some mapped roads accessing lands meeting preferred slope and aspect parameters are not maintained or have been closed. Others are poorly surfaced, eroded, and/or narrow. This will be a concern in construction phases where trucks and heavy equipment may have to make regular trips to the development site over an extended period. There are three key questions evaluated with respect to transportation access:

- Are there existing roads?
- If so, are the roads open and regularly maintained?
- Is the road(s) adequately constructed and sufficiently wide to safely support both construction and operational phase traffic?

Existing and Planned Land Uses

Most of the lands considered during this Study are surrounded by developed uses or slated for future development. The Tribe has recently adopted conceptual land use plans

for the Peridot (US 70), Gilson Wash (AZ 170), Seven Mile (including much of San Carlos), and Bylas Districts that identify areas reserved for future residential, commercial, public service, cultural, and agricultural uses.

In addition, the Tribe has a long-standing policy of deeding 4-acre home sites within the Reservation to tribal members. Many of these home sites are developed but at least an equal number are vacant. Tribal officials have indicated that there have been discussions about establishing a program to provide alternative building sites to current owners of the vacant home sites. These vacant home sites impact the feasibility of some solar sites described in this Study report. Records provided by the Tribe's Planning and Economic Development Department indicate that most of these deeded home sites are between the western Reservation boundary and Cutter and along the flatter lands on both sides of AZ 170 to the vicinity of the Tribal Detention Center on the edge of San Carlos.

Figure 12 illustrates the opportunities and constraints created by developed and planned land uses within the southwest study area.

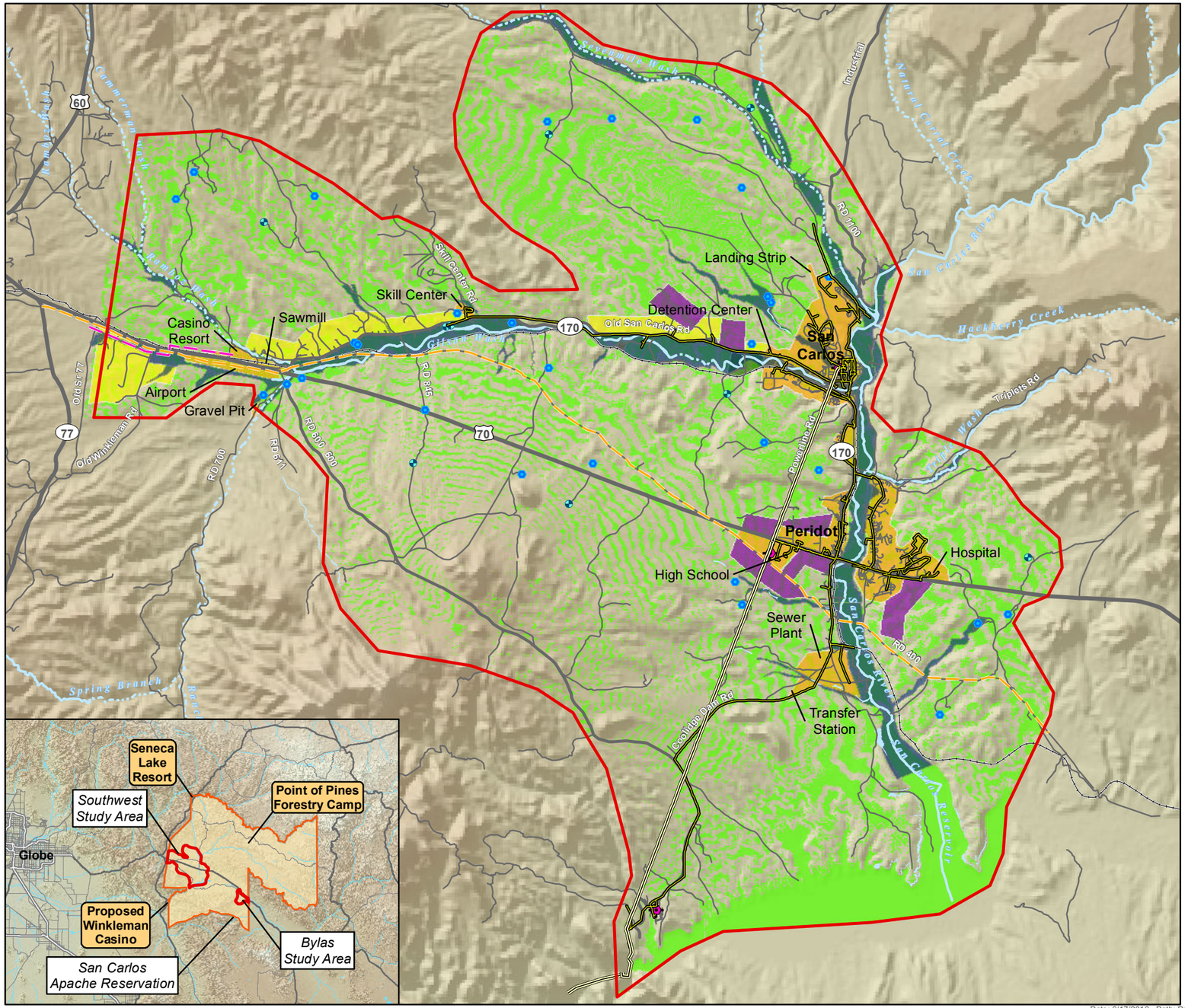
Environmental and Natural Resource Features

The Tribe owns and manages extensive ranchlands and forest lands, but these do not have any significant overlap with the two study areas. Big game hunting is also important to the Reservation's economy. No significant hunting areas were identified within the two study areas. Except for soils along rivers, streams, and washes subject to inundation, none of the soils create any significant limitations to solar development. A variety of other natural features and environmental conditions may, however, alter the suitably of sites that are otherwise feasible for solar development with respect to slope, aspect, land use, and transportation.

The Tribe has published a Multi-Hazard Mitigation Plan (2005) that identifies areas subject to flooding and other hazards. The hazard areas documented in the 2005 Mitigation Plan are illustrated on Figure 12. A complete set of environmental checklists from field visits conducted in October 2012 is attached as Appendix C. The desert grassland and Sonoran desert scrub that dominates the two study areas are crossed by perennial streams and intermittent washes that occasionally flood. Some areas along US 70 west of the casino/resort were not included in the 2005 Multi-Hazard Mitigation Plan. Flood hazard boundaries illustrated on Figure 12 were developed by extending the flood boundary into these areas based on FEMA standards.

Sensitive Sites

Specific sensitive site field investigations were outside of the scope of this Study. Detailed investigations should be conducted before any solar developments are undertaken.



Southwest Study Area Constraints and Opportunities

Legend

- Study Area
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River
- Waterbody
- Pipeline
- SCIP 3 Phase Distribution Lines
- SCIP 69kV Transmission Line
- APS Distribution Lines
- Electrical Substation
- Water Tank
- Water Well
- Agricultural
- Deeded Homesites
- Developed Areas
- Future Development
- Flood Hazard Areas
- Preferable Slope and Aspect

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San Carlos Apache Tribe

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Figure 12. Constraints and Opportunities

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COMMERCIAL-SCALE SITES

Phase 1 of this Study initially identified 15 sites in the southwestern study area with commercial-scale potential based on basic slope/aspect and transportation parameters. Seven of these sites were eliminated for a variety of reasons: proximity with other sites with overall significantly better solar development potential, conflicts with other uses, extremely high development or operational costs, smaller size, poor access or location, and/or greater variability in slope and aspect.

The remaining eight commercial-scale sites shown on Figure 13 were given a full Phase 1 evaluation. Five of the sites described were found to have one or more significant constraints or limitations that, at least in contrast to other sites, made solar facility development less practical. Results for these five eliminated sites are documented in site-by-site summaries included as Appendix D.

Three of the sites identified in Phase 1—Tufa Stone, Coolidge, and Peridot Mesa—were deemed most feasible for commercial-scale development. These sites had more attributes and fewer constraints than other sites. Site-by-site summaries for these finalist sites, enhanced by the Phase 2 analysis, follow. The comparative outcomes and findings are summarized in Table 7. The commercial feasibility of all sites is, however, significantly limited by the lack of transmission-scale infrastructure to export electrical loads off-Reservation.

Table 7. Preferred Commercial-Scale Sites

	Tufa Stone	Peridot Mesa	Coolidge	Bylas
Net site area	1,500 acres	700 acres	800 acres	N/A
Power generating capacity	300 MW	140 MW	160 MW	N/A
Slope	<4%	<4%	<4%	<4%
Aspect	South	South	South	North
Shade and obstruction	No issue	No issue	No issue	No issue
Power transmission	None	69 kV	None	None
Power distribution	None	Nearby	Nearby	Nearby
Transportation infrastructure	Poor	Acceptable	Acceptable	Subject to development
Existing and planned land uses	Agricultural (south end)	No issue	No issue	Planned new community
Environmental and natural resources	High erosion evidence, landfill	Peridot resources	Proximity to river and reservoir	No issue

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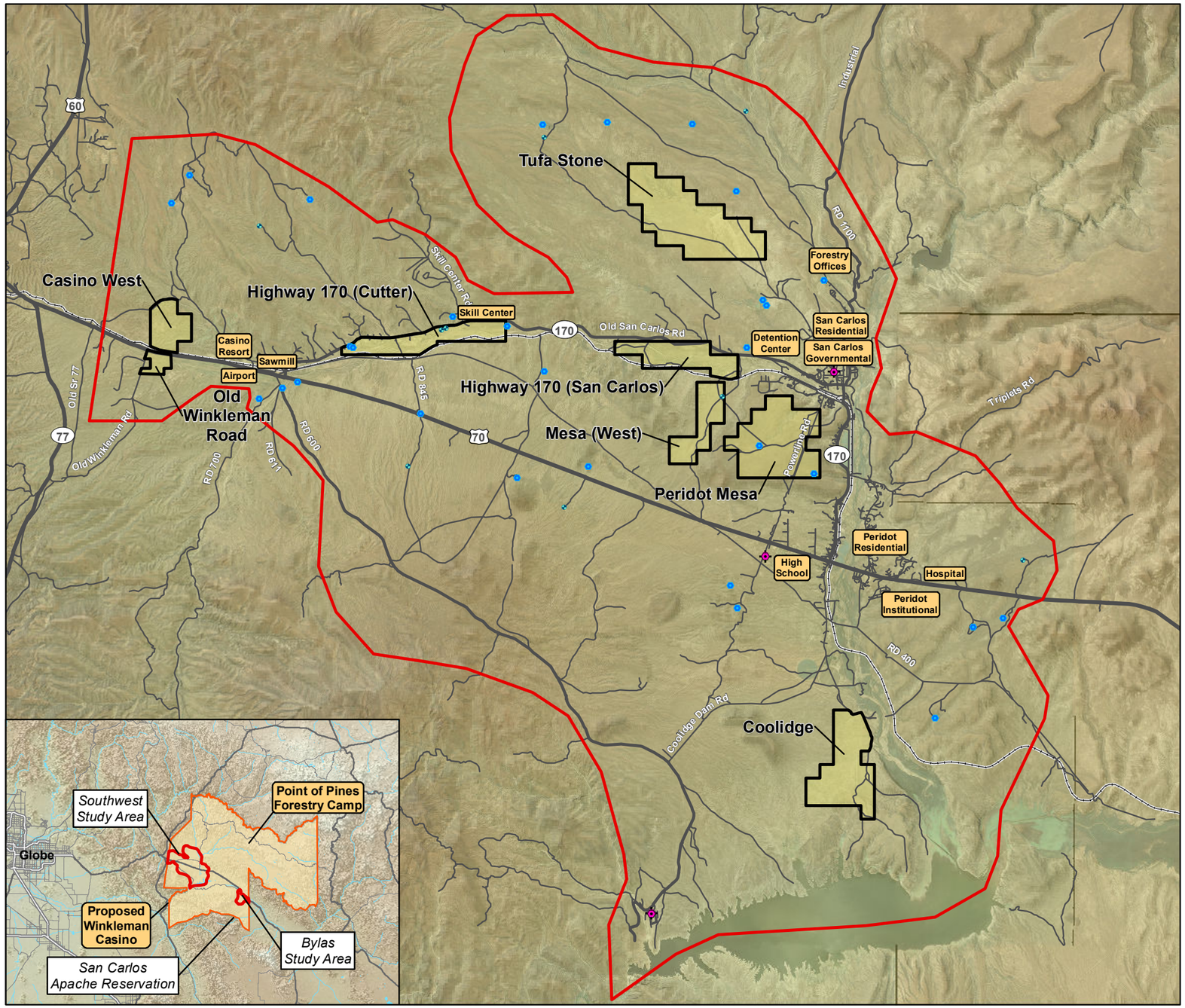

Southwest Study Area Potential Commercial and Community-Scale Solar Sites

Legend

- Study Area
- Potential Commercial-Scale Solar Site
- Potential Community-Scale Solar Site (High School)
- Highway
- Major Road
- Local Road
- Railroad
- Electrical Substation
- Water Tank
- Water Well
- Preferable Slope and Aspect

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San Carlos Apache Tribe

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Figure 13. Southwest Study Area Solar Sites

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Tufa Stone

Immediately northwest of the community of San Carlos is a large open area above the Tufa Stone Reservoir. This area is termed Dourine Pasture on USGS mapping, a place name not used by the Tribe. Approximately 8,000 to 9,000 acres of this overall area has some degree of suitability for solar development based on preferred slope and aspect criteria. Most of the area is, however, very poorly accessed and without any power service, and slopes become increasingly variable approaching the upper northwest end of the area.

Some of these more remote upper areas were afforded an initial evaluation but were dropped from more detailed consideration given the large area of suitable lands in the Tufa Stone area closer to the community of San Carlos. The parts of Tufa Stone that are most suitable for solar development are immediately northwest from the center of the community of San Carlos (see Figure 13). The site is reached off the paved end of Road 903 beyond the White Rock and Indian Hills subdivisions. From the Tufa Stone Dam northwest there are approximately 4 miles of lands on either side of an unpaved portion of Road 903 with consistently suitable slope and aspect characteristics.

Tufa Stone above Tufa Stone Reservoir Courtesy of Jim Rapp

Size and Capacity

This is the single largest site identified within the southwest study area. The delineated area is approximately 1,950 acres. Taking into account topographical and physical variations (north-facing slopes, ridges, washes, ravines, water bodies, etc.) within this boundary, approximately 1,500 net acres would be suitable for solar development. This net area is essentially contiguous (see Figure 14). Nominal solar power generating capacity based on the presumed net area of the site and the 5 acres per MW guideline is approximately 300 MW.

Slope and Aspect

This site is essentially flat. Moreover, the terrain is flat enough to meet the more restrictive slope criteria for CSP facilities. Slope and aspect at this site impose no constraints to solar facility development.

Shade and Obstruction

Tufa Stone is a predominantly flat and very large plateau that sits higher than the community of San Carlos to the southeast. The predominant vegetation on the Tufa Stone site is grasslands with few trees or tall vegetation. Surrounding mountains rise to 6,000- to 8,000-foot elevations but are considerably distant. Some low ridges bisect the site but shading impacts are localized and limited as these ridges predominantly run east-west.

Electrical Power Transmission

SCIP is the electrical power service provider. For the foreseeable future, SCIP participation in realizing the Tribe's solar energy generation ambitions will probably have to be on a case-by-case or government-to-government basis. SCIP has no customer programs for

renewable energy development, although a net metering policy is under development. Recent discussions with SCIP have indicated a willingness to discuss issues such as co-investment in power infrastructure improvements and transfer of assets. SCIP was very cooperative in providing information for this Study.

SCIP operates and maintains a three-phase distribution line that runs from SCIP's substation in San Carlos to the Tufa Stone, White Rock and Indian Hills subdivisions southeast of the possible solar site. The SCIP substation is near the center of San Carlos. At the nearest boundary of the area in Tufa Stone judged suitable for solar development to the San Carlos substation is approximately 2.5 miles distant. A new substation on the Tufa Stone solar site would probably be required. There are no power distribution lines to the area north of the Tufa Stone Reservoir.

The San Carlos substation is the terminus of a 69 kV line that originates in Coolidge, Arizona. SCIP is planning significant repairs to this 69 kV line between Hayden, Arizona, and the Coolidge Dam switching station, but this project will restore reliability, not increase capacity. SCIP has indicated that the 69 kV line terminating at the San Carlos substation is not adequate to transmit solar generated power for export and sale off-Reservation.

None of the SCIP power lines within the area are designed to carry the commercial solar power loads that could be generated on the Tufa Stone solar site. A new 2.5 to 3 mile-long transmission-grade power line from north of the Tufa Stone Dam to the San Carlos substation would alone cost on the order of $1 million.

Transportation Infrastructure

The site is bisected by the gravel Road 902 and a few gravel or dirt side routes. Even the graveled lower section of Road 902 closest to paved roads and residential subdivisions in San Carlos is meandering and in less than perfect condition. Between field visits in June 2012 and October 2012, extensive new damage and erosion to the upper portions of Road 902 was noted within the area of a possible commercial-scale solar site, despite a summer 2012 monsoon rain season that was relatively mild. Transportation infrastructure is inadequate for both construction and operational phases. Restoration and rebuilding would be required.

Existing and Planned Land Uses

The Tufa Stone solar site is vacant except for the Tufa Stone Dam and Reservoir and a decommissioned solid waste landfill. Tribal agriculture department officials have indicated there are plans that contemplate expanding farming operations into the first mile or so of this site. The areas of the site closest to the Tufa Stone Dam should probably be reserved for agricultural operations based on these long-range plans and observed site conditions that could be adverse to solar facility maintenance and operations. This site has no other documented existing or planned land use constraints.

Environmental and Natural Resource Features

The most significant feature is the Tufa Stone Dam and Reservoir. Plans are underway to repair the dam to reduce infiltration and leakage. Recent drought conditions had left this reservoir dry in June 2012. Field observation in October 2012 indicated that significant surface water flow impacts the lower 1 to 1.5 miles of this site. Soil types, vegetation types, meander channels, and the observed erosion that occurred between June and October 2012 lead to the conclusion that solar facility infrastructure could be adversely impacted

by surface water flows on a fairly regular basis. These conditions change significantly beyond the 1.5-mile point.

If considered for a solar facility, the former solid waste landfill would have to be evaluated for pollution and stability issues. The availability of adequate water to use for a CSP facility would also have to be further evaluated. The development of commercial-scale solar facilities within this site has no other identified significant or unusual environmental or natural resource constraints.

Tufa Stone Reservoir
Courtesy of
Jim Rapp

SUMMARY

A flat-panel solar PV, concentrating PV, or CSP facility of considerable size could be sited within the Tufa Stone site. Site development factors such as operational buildings, power plants and/or substations, and internal access roads can all be accommodated given the acreage available. The possible scale of a solar power generating facility on this large site may potentially justify at least the cost of a 3-mile-long transmission line extension to the San Carlos substation.

The overriding constraint, which is the same constraint that applies to every commercial-scale site on the Reservation, is the lack of any power transmission facilities connecting to the San Carlos or Peridot substations with the capacity to export power into the regional power grid. A new 3-mile line would have no transmission-scale export facility to connect into.

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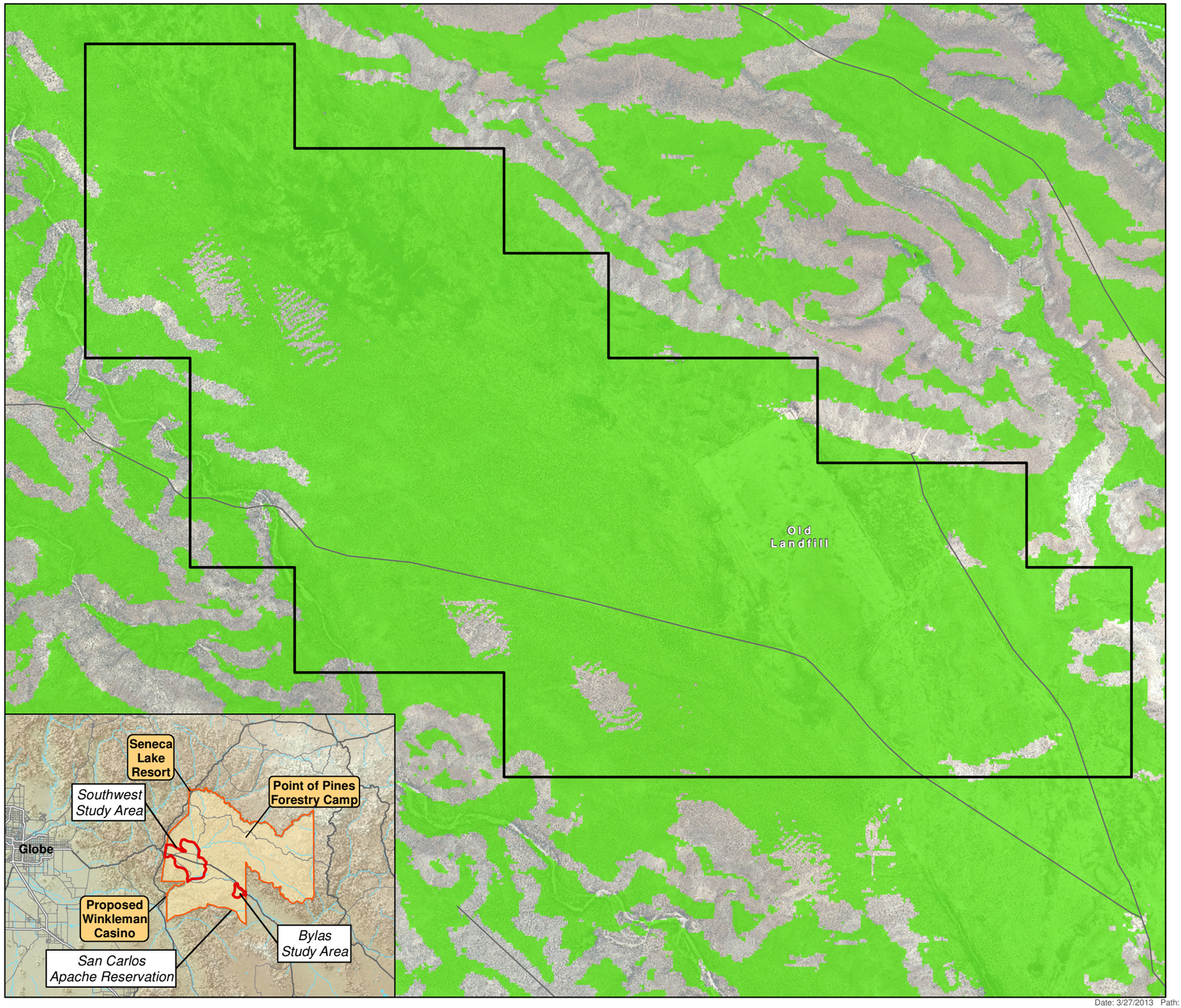

Solar Sites
Tufa Stone
1,950 Acres

Legend

- Potential Solar Site
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River
- Preferable Slope and Aspect

N

0 500 1,000 1,500
Feet

San Carlos Apache Tribe

Parametrix

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Figure 14. Tufa Stone Solar Site

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Peridot Mesa

To the immediate southwest of the center of the community of San Carlos is the Peridot Mesa (see Figure 13). This mesa is approximately 2 miles across north to south and 2 miles east to west. The top of the mesa is flat and affords a high degree of suitability for solar development. Well-maintained gravel roads cross the Peridot Mesa between the community of San Carlos and the community of Peridot, including the aptly named Powerline Road along which SCIP's 69 kV power line runs. From the approximate center of the Peridot Mesa to the San Carlos substation is 1.75 miles, and south to the Peridot substation is another 2.5 miles.

Peridot Mesa Courtesy of Jim Rapp

Size and Capacity

The delineated area is approximately 1,550 gross acres (see Figure 15). Taking into account topographical and physical variations (north-facing slopes, ridges, etc.), and particularly the several ravines that cut into the mesa top within this boundary, approximately 700 net acres would be suitable for solar development. This net area could be expanded with site grading as slopes in all directions are relatively gentle, except along the ravines. The site divides in about five zones of the most suitable lands, as can be readily seen on Figure 15. Nominal solar power generating capacity based on the presumed net area of the site and the 5 acres per MW guideline is approximately 140 MW.

Slope and Aspect

This site area is predominantly flat except for two or three deep ravines that cut into the mesa. Even most of areas on the Peridot Mesa away from the mesa edge with slopes facing north have slopes of approximately 1 or 2 percent or less. This maximizes the total land area that could be developed for solar power generation with minimal necessary site alterations. The terrain is also flat enough to meet more restrictive slope criteria for CSP facilities. Slopes and aspect at this site impose no constraints to solar facility development, except for the deep ravines.

Shade and Obstruction

Peridot Mesa is a predominantly flat plateau with an elevation of approximately 3,000 feet. San Carlos and Peridot are at 2,600-foot elevations. The mesa is capped by a layer of volcanic basalts originating from an extinct volcanic cone on the southwest corner of the mesa. The mesa is devoid of trees or tall vegetation. Habitat is almost entirely low Sonoran desert scrub. Surrounding mountains rise to 6,000- to 8,000-foot elevation but are a considerable distance from the mesa. An extinct volcanic cone is the only significantly higher elevation above the mesa cap (3,200 feet) but it lies on the opposite (west) side of the mesa from the 69 kV power line. Shading and obstruction is a negligible issue assuming that solar facilities will be located on the east side of the mesa.

Electrical Power Transmission

SCIP is the electrical power service provider. For the foreseeable future, SCIP participation in realizing the Tribe's solar energy generation ambitions will probably have to be on a case-by-case or government-to-government basis. SCIP has no customer programs for renewable energy development, although a net metering policy is under development.

Peridot Mesa
Courtesy of
Jim Rapp

Recent discussions with SCIP have indicated a willingness to discuss issues such as co-investment in power infrastructure improvements and transfer of assets. SCIP was very cooperative in providing information for this Study.

SCIP operates and maintains a 69 kV power line that runs straight across the Peridot Mesa slightly towards its east side. This line passes through SCIP's Peridot substation and terminates at the San Carlos substation. SCIP is planning significant repairs to this 69 kV line between Hayden, Arizona, and the Coolidge Dam switching station, but this project will restore reliability not increase capacity. SCIP has indicated that the 69 kV line is not adequate to transmit solar generated power for export and sale off-Reservation. An on-site substation would also probably be required even if transmission capacity was adequate. There are no power distribution lines on top of the mesa, although SCIP's power distribution infrastructure follows the base of the mesa to the north, south and east.

Transportation Infrastructure

The site is bisected by several good quality gravel and dirt roadways, although the primary access up the north side of the mesa from Aravaipa Road in San Carlos is narrow and steep. Transportation infrastructure is nonetheless inadequate for both construction and operational phases. Restoration and rebuilding would be required. Access routes from the community of Peridot are longer but may be more practical as these approaches avoid any developed residential neighborhoods such as are found on the north side, and they also directly intersect with US 70.

Peridot Deposit
Courtesy of
Jim Rapp

Existing and Planned Land Uses

The top of the Peridot Mesa is vacant. The mesa is, however, the center of the Tribe's economically and culturally significant gemstone mining industry. Operations tend to be small family-run businesses with only intermittent activity. The mining is primarily confined to blasting along the edges of the mesa in ravines where gemstone ore deposits are shallow and exposed. There is sufficient territory on the top of the Peridot Mesa to stay well clear of mining areas, although any solar development should be preceded by an assessment of mining claims.

Environmental and Natural Resource Features

The most significant natural features are peridot and other gemstone ore deposits. The availability of adequate water to use for a CSP facility would also have to be further evaluated. Observed soil and vegetation types, the general lack of evidence of water caused erosion, and road conditions indicate that there would be few concerns for adverse impacts from surface water flow, but water supply may also be very limited. The development of commercial-scale solar facilities within this site has no other identified significant or unusual environmental or natural resource constraints, subject to a determination of mining claims.

SUMMARY

A solar flat-panel or concentrating PV array of considerable size could be sited on the Peridot Mesa. Site development factors such as operational buildings or substations and internal access roads can be accommodated. Some roadway improvements may be required for both construction and operations phases. Care would need to be taken to protect the integrity of peridot mining along the mesa's edges.

The overriding constraint, which is the same constraint that applies to every commercial-scale site within the Reservation, is the lack of any power transmission facilities with the capacity to export power into the regional power grid.

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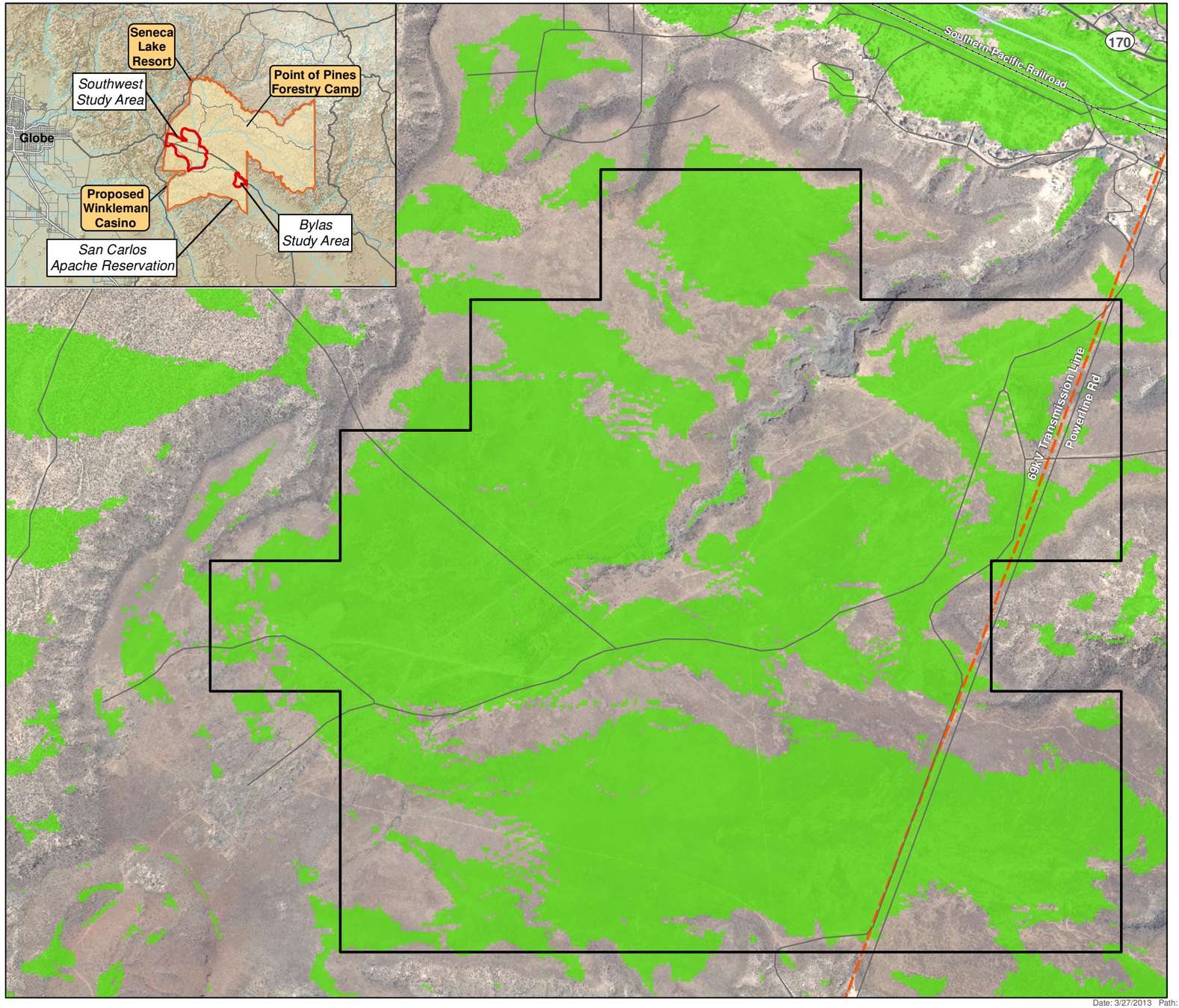

Solar Sites
Peridot Mesa
1,550 Acres

Legend

- Potential Solar Site
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River
- Preferable Slope and Aspect

N

0 500 1,000 1,500
Feet

San Carlos Apache Tribe

Parametrix

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Figure 15. Peridot Mesa Solar Site

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Coolidge

This site is on the west side of the San Carlos River approaching the San Carlos Reservoir and due south of Coolidge Dam Road and the Reservation's sewage ponds and solid waste transfer station (see Figure 13). The Peridot District *Conceptual Land Use Plan* indicates that both the sewage ponds and solid waste transfer station are planned for expansion. Several gravel and dirt roadways cross this site in the direction of the north shore of the San Carlos Reservoir and converge and intersect with the paved Coolidge Dam Road in the vicinity of the solid waste transfer station and sewer ponds. The site is approximately 1.75 miles long and 1.25 miles wide.

Size and Capacity

The gross area of the delineated Coolidge site is approximately 1,218 acres (see Figure 16). Overall, the site is nets out to approximately 800 acres that exhibit the highest suitability after northerly facing slopes, local topographical variations, washes, and the like are accounted for. This net area is in two "zones" as can be seen on Figure 16, with the easterly zone being the larger and better accessed. The nominal generating capacity based on the net area of the site divided by the 5 acres per MW guideline is approximately 160 MW.

Slope and Aspect

This site is variable and broken up into two zones that exhibit the Study's preferred slope and aspect characteristics. Steeper areas are interspersed. The largest concentration of uninterrupted preferred slope and aspect is along the east side and south end of the site (approximately half of the total area). Most of the northerly facing slopes on the Coolidge site are relatively flat, potentially creating more acreage within the site suitable for solar development with only minimal site alterations. A deep and wide wash does cross the site diagonally. Development of the flatter land west of this wash is in any event less feasible due to a lack of road access. Field investigations conducted in October 2012 revealed additional suitable areas for solar development along the south end of the originally mapped site.

Shade and Obstruction

Coolidge is a predominantly flat, except for two desert washes that bisect the site, one being relatively deep. The predominant vegetation is grasslands and Sonoran desert scrub. Surrounding mountains rise to 6,000- to 8,000-foot elevations but are a considerable distance from the area. The east side of the site slopes downward toward the San Carlos River and the south side of the site is near the San Carlos Reservoir. Shading and obstruction is a negligible issue.

Coolidge Site
Courtesy of
Jim Rapp

Electrical power transmission

SCIP is the electrical power service provider. For the foreseeable future, SCIP participation in realizing the Tribe's solar energy generation ambitions will probably have to be on a case-by-case or government-to-government basis. SCIP has no customer programs for renewable energy development, although a

net metering policy is under development. Recent discussions with SCIP have indicated a willingness to discuss issues such as co-investment in power infrastructure improvements and transfer of assets. SCIP was very cooperative in providing information for this Study.

The SCIP 69 kV line is about 2.5 miles to the west of this site, and the Coolidge Dam switching station is 6 miles southwest "as the crow flies." SCIP three-phase distribution lines originating at the Coolidge Dam switching station (separate from the 69 kV line) follow Coolidge Dam Road close to the north side of this site. These three-phase lines serve and pass the solid waste transfer station and the sewage ponds. There are no power distribution lines crossing the actual site.

SCIP is planning significant repairs to the 69 kV transmission line between Hayden, Arizona, and the Coolidge Dam, but this work will only restore reliability not increase capacity. SCIP has indicated that the 69 kV is not adequate to transmit solar generated power for export off-Reservation. An on-site substation would also probably be required even if transmission capacity was adequate.

The overriding constraint, which is the same constraint that applies to every commercial-scale site within the study area, is the lack of any power transmission facilities with the capacity to export power into the regional power grid.

Transportation infrastructure

Several gravel and dirt access roads enter the Coolidge site from Coolidge Dam Road. The roads are in reasonably good condition and as of October 2102 did not show much evidence of recent erosion from summer monsoon rainfall and flooding (in sharp contrast to the roads accessing the Tufa Stone site). Nonetheless transportation infrastructure is probably inadequate for both construction and operational phases. Restoration and rebuilding would be required, including potentially sections of the paved Coolidge Dam Road.

Existing and planned land uses

The site is vacant. Solar development would not be constrained by existing or planned uses on this site.

Environmental and natural resource features

The proximity to the San Carlos River and the San Carlos Reservoir are the most significant potential natural resource concerns. The site is also crossed roughly on the diagonal by a large wash with intermittent seasonal flows. Nonetheless soils types and the lack of evidence any major seasonal erosion on the site indicate that solar facilities could be developed without significant site alterations.

The wetlands and riparian areas surrounding San Carlos River contain one of the largest known populations of southwestern willow flycatcher. This flycatcher subspecies is listed as threatened under the federal Endangered Species Act (ESA). The Coolidge site boundary was drawn to avoid obvious conflicts with the river and reservoir, and surrounding wetlands and riparian areas. Nevertheless any development of this site for solar generation should be preceded by an assessment of possible impacts both at constructions and operational phases.

The development of commercial-scale solar facilities within this site has no other identified significant or unusual environmental or natural resource constraints.

SUMMARY

Most of the interspersed areas on the Coolidge site that have northerly facing slopes are relatively flat, although the deeper wash cutting through the site diagonally isolates the westerly 300 acres of the area. Some more lands to the south as observed during an October 2012 site visit could be added to the site for consideration. Overall, the Coolidge site merits further analysis along with the Tufa Stone and Peridot Mesa sites.

The overriding constraint, which is the same constraint that applies to every commercial-scale site within the Reservation, is the lack of any power transmission facilities with the capacity to export power into the regional power grid.

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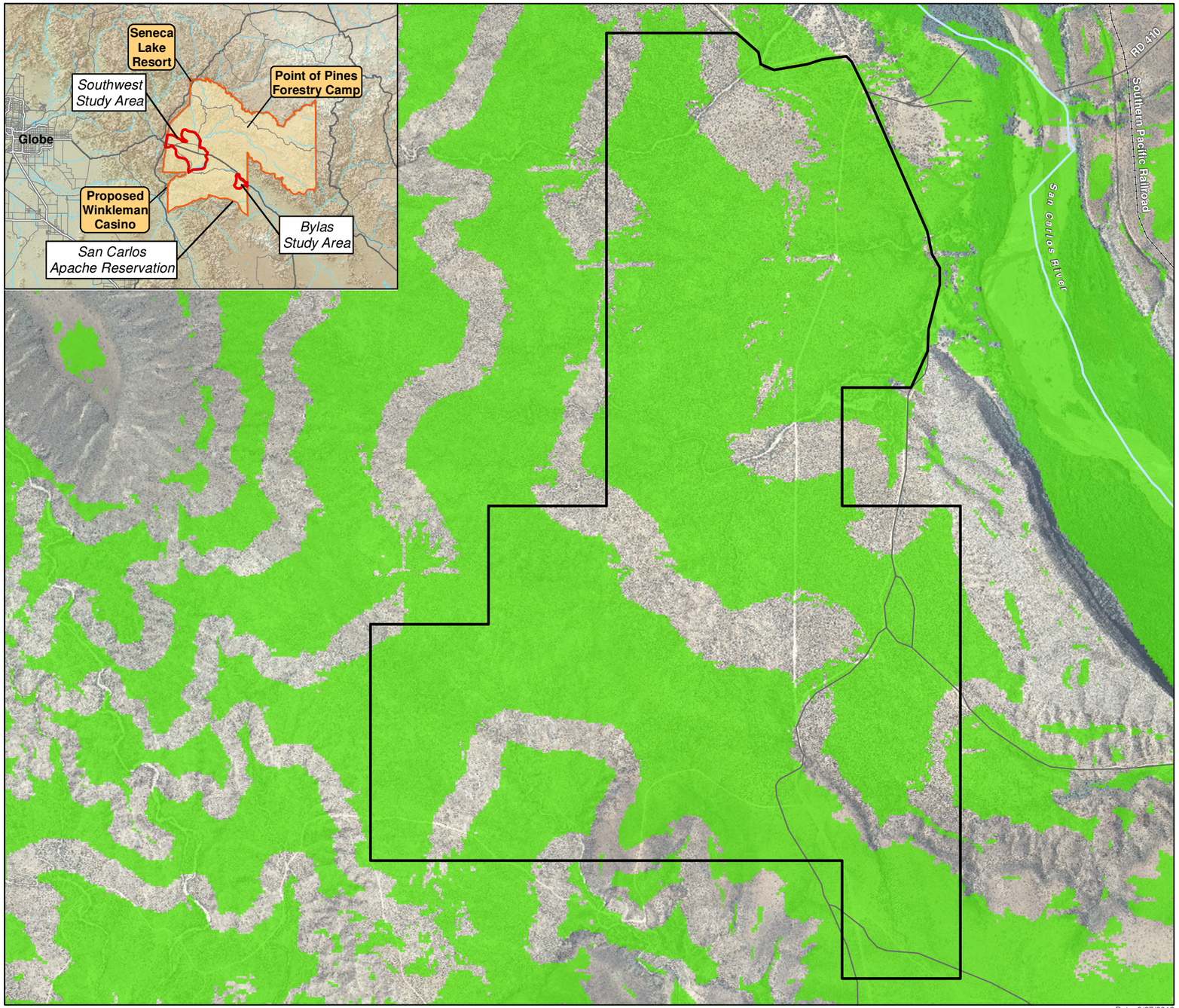

Solar Sites
Coolidge
1,218 Acres

Legend

- Potential Solar Site
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River
- Preferable Slope and Aspect

N

0 500 1,000 1,500
Feet

San Carlos Apache Tribe

Parametrix

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Figure 16. Coolidge Solar Site

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COMMUNITY-SCALE SITES

The development of community-scale generation within the populated areas of the Reservation could utilize a phased approach on one (or more) of the three sites – Tufa Stone, Peridot Mesa, and Coolidge - initially identified for future commercial-scale development. Solar installations and supporting infrastructure consolidated on one of these sites could be initially sized to serve local demand and then expanded gradually, eventually building out to export power levels as and if new commercial-scale transmission infrastructure comes on-line.

Nearly all of the Reservation's tribal government offices and other institutional uses and commercial uses are within the two study areas. These uses and many nearby residential neighborhoods could benefit from clusters of rooftop or ground-mounted solar flat-panel PV installations to reduce or offset purchased power consumption. The power needs of these facilities and the potential for smaller on-site clusters of solar arrays could provide an economy of scale that reduces unit costs (both construction and maintenance) over building-by-building solar installations. Community-scale sites also do not typically require substations, extensive access roads, and support buildings. As a result, solar power may have a higher per-acre net generation than with commercial-scale facilities.

The potential facility and neighborhood community-scale sites that were initially considered are shown on Figure 13 (see page 51). Several of these sites had limited solar feasibility attributes and/or were under 1 MW of potential solar generation. These sites may still benefit from building-specific solar installations, and, in fact, one such site—the new IHS hospital on US 70 in Peridot—includes provisions for rooftop solar. The remaining seven facility- or neighborhood-scale sites were given an additional evaluation for community-scale solar potential. Each of the three highest priority commercial-scale sites was also given further evaluation for phased community-scale development potential. The outcomes and findings are summarized in Table 8.

All community-scale solar installations should be associated with comprehensive energy audits for the buildings involved and energy conservation improvements (insulation, lighting, windows, etc.). Energy conservation building retrofits are the most cost-effective means to reduce energy consumption and will reduce the scale of the solar installations needed to meet remaining demand.

Table 8 Community-Scale Sites

	Distribution Lines	Customer Proximity	Road Access	Security	Available Area	Building Condition
Casino/Resort/ Rodeo Complex	On-site	On-site	Paved	Good	Very good	Good
Skill Center/ Tribal College	On-site	On-site	Paved	Good	Very good	Good
San Carlos Government Center	On-site	On-site	Paved	Good	Limited	Variable
San Carlos residential neighborhoods	On-site	On-site	Paved	Average	Limited	Variable
Peridot residential neighborhoods	On-site	On-site	Paved	Average	Limited by current and future development	Variable
Peridot institutional uses	On-site	On-site	Paved	Good	Good	Good
Bylas	Future development	Future development	Future development	Unknown	Highly limited by future development	N/A
Tufa Stone	None	Distant	Poor–unpaved	Poor	Excellent	N/A
Coolidge	Nearby	Distant	Acceptable–unpaved	Good	Excellent	N/A
Peridot Mesa	Nearby	Nearby	Acceptable–unpaved	Good	Excellent	N/A

Individual Facility-Scale or Neighborhood Sites

Casino/Resort/Rodeo Complex

The casino/resort complex is on the north side of US 70 in an area called Cutter approximately 2.5 miles east of the Reservation's western boundary. APS is the electrical power provider. The Tribe's general aviation airport is on the south side of the highway directly across from the casino/resort.

The casino/resort complex is the single most intense user of electrical power on the Reservation, but is not interconnected with the three primary Reservation communities (San Carlos, Peridot, and Bylas) that create the most overall power demand. APS has obligations to support renewable power generation under the State of Arizona's renewable power portfolio standards, although recent actions by the ACC at least temporarily eliminate one important mechanism to foster solar power generation.

Plans are in advanced stages to install a 1.1 MW community-scale solar system to meet about one-third of the casino/resort's power needs after energy efficiency improvements are made. Small ground-mounted clusters of solar PV arrays would be sited in close proximity to the building(s) be served. APS awarded approximately $1 million in renewable energy credits in 2012 to support this effort.

Vacant lands within the casino/resort complex are sufficient to accommodate additional solar installations to meet the remaining power needs of the complex. Ground-mounted flat-panel PV systems could be installed to the rear of the casino and hotel buildings, along highway frontage near the gas station/convenience store, at the west end of the rodeo grounds, and on an abandoned ballfield east of the resort's RV Park.

Casino/Resort Complex (Google Maps)

Given the high site-specific power demands at the casino/resort, access to a power provider (APS) with renewable power portfolio programs, and lack of electric power interconnections to other developed portions of the Reservation, *it is recommended that the Tribe make near-term facility-scale solar development at the casino/resort complex a priority solar development effort*. Solar power on the casino/resort site could also be fed into the APS distribution network or through new distribution lines to power the tribal airport, the nearby sawmill, and the approximately 45 homes served by APS in the area.

Skill Center/Tribal College

The Skill Center/Tribal College is located off of AZ 170 at the former site of San Carlos Junior High School. The Tribe is currently pursuing initiatives to re-use these buildings to establish a tribal college and technical training center. Freeport McMoRan technical apprentice training programs opened at the Skill Center in October 2012. Tribal college programming is schedule to start in 2013. There is also housing to the rear of the site that was previously used for teacher quarters. This housing is for the most part highly deteriorated.

Assuming that the establishment of a Tribal College would entail building renovations and upgrades, and perhaps even new facilities, solar retrofits could be included. Additionally, there are areas exhibiting preferable slope and aspect characteristics along the access road to the site around the former teacher housing, and at two level sports fields between the

Tribal college/skill center ballfields
Courtesy of Jim Rapp

main school buildings and AZ 170. These sports fields are however preliminary slated for tribal college building expansion.

This site is served by SCIP which has no established programs supporting solar power development. Nonetheless, the site is at the end of the SCIP power distribution system and sits apart from other development along AZ 170. This factor, combined with the planned tribal college, the partnership with Freeport McMoRan, and the ballfield in front of the school, makes this *a second priority for a facility-specific solar development.*

San Carlos Government Center

The Tribe's main government office center is in the community of San Carlos along San Carlos Avenue between AZ 170 and Yavapai Street. Many of these buildings date to the 1930s and 1940s and would greatly benefit from energy efficiency retrofits. Other institutional buildings, including non-tribal agencies and schools, are on streets on either side of San Carlos Avenue, approximately bounded by Apache Avenue and Mohave Avenue. There are approximately 80 buildings categorized as governmental, institutional, or commercial in the government center area. Extending west from San Carlos along AZ 170 there are a few additional government and institutional buildings – churches, tribal public safety offices, and the tribal detention center.

Although the government center area is relatively flat, it is the most densely developed on the Reservation. There is only limited unused vacant land to accommodate anything beyond small ground-mounted arrays. There may also be structural issues with roof-mounted solar panel arrays for many older buildings. Solar installations would therefore probably have to proceed building-by-building in the core of San Carlos. There is a small mesa just north of the government center. This area could be used for a larger community-scale solar facility. Road access to the top of this mesa is, however, extremely steep and in very poor condition. Significant improvements with road surface and grades would be required to provide safe all-weather access. New power distribution lines would also have to be extended to the government center.

San Carlos Government Center
Courtesy of Jim Rapp

The government center is served by SCIP which has no established programs supporting solar power installations. Although small individual solar installations (such as the tribal radio station in San Carlos) should be encouraged, *solar power serving the government center area should concentrate on the community-scale option recommended by this Study—a phased development atop Peridot Mesa*.

San Carlos Residential Neighborhoods

There are three major residential neighborhoods northwest of the government center—White Rock, Indian Hills, and Tufa Stone. These neighborhoods

were developed by the San Carlos Apache Housing Authority. Single-family homes are substantially identical within each neighborhood. Residential neighborhoods are also to the northeast and east of the government center, and south of the center along the base of Peridot Mesa.

San Carlos Residential Neighborhoods
Courtesy of Jim Rapp

There is a new 15 home subdivision being constructed by the Housing Authority southwest of the town center on the northwest side of Peridot Mesa. There are also scattered residential buildings along the 8 to 10 miles of AZ 170 out to the Cutter area. There are approximately 1,150 residential buildings in total. *Note: the number of dwelling units may be significantly higher. Building counts were conducted for estimating electrical energy consumption. Building square footage was the relevant factor. The number of dwelling units within a given residential building was not a factor.*

Individual house-by-house rooftop or ground-mounted solar systems could be used. Alternatively, neighborhood-by-neighborhood consolidated sets of ground-mounted arrays could be a solution. The Housing Authority could be responsible for maintenance of such consolidated solar systems. In addition, a solar power system atop the small mesa described under the preceding section could serve these neighborhoods, particularly the Tufa Stone subdivision which is directly at the base of the mesa. New power distribution lines would have to be extended to the neighborhoods from the mesa.

This site is served by SCIP which has no established programs supporting solar power installations. Although small individual solar installations should be encouraged, *solar power serving San Carlos residential neighborhoods should concentrate on the community-scale option recommended by this Study—a phased development atop Peridot Mesa*.

Peridot Residential Neighborhoods

There are three major residential neighborhoods along both sides of US 70 east of the San Carlos River and Peridot commercial centers – Moonbase, La Bamba City, and Hallelujah Square. These neighborhoods were developed by the San Carlos Housing Authority. There is also a residential subdivision near the high school and other scattered residences. Rooftop solar is not recommended for most existing residences given the age and condition of many of the buildings. There are approximately 740 residential buildings in total. *Note: the number of dwelling units may be significantly higher. Building counts were conducted for estimating electrical energy consumption. Building square footage was the relevant factor. The number of dwelling units within a given residential building was not a factor.*

The Peridot District Conceptual Land Use Plan identifies 177 acres of future residential land primarily east of the San Carlos River. Given the level of existing and planned development, there are no large continuous acreages of vacant, flat, and south-facing lands remaining within this area. There are, however, many smaller areas interspersed between existing and planned uses within which a considerable amount of solar power

generation could be achieved with small ground-mounted arrays built close to clusters of residential uses, or individual rooftop or ground mounted solar systems. Solar installations could be included in all future residential development in these areas.

These sites are served by SCIP which has no established programs supporting solar power installations. Although small individual solar installations should be encouraged, *solar power serving Peridot residential neighborhoods should concentrate on the community-scale option recommended by this Study—a phased development atop Peridot Mesa*.

Peridot Institutional Uses

The Tribal Cultural Center and Museum, Peridot Rodeo Grounds, tribal Fish and Game offices, and other institutional uses are located along US 70 east of the San Carlos River. West of the river are commercial and retail uses on the north side of the highway with the high school/junior high school complex on the south side. In total there are approximately 22 commercial and institutional buildings in Peridot. Individual rooftop or ground-mounted solar systems could be retrofitted to provide renewable electrical energy to existing facilities. The Peridot District Conceptual Land Use Plan also identifies 156 acres of future industrial land primarily east of the river. Solar installations could be included in all future commercial and industrial development in Peridot.

These sites are served by SCIP which has no established programs supporting solar power installations. Although small individual solar installations should be encouraged, *solar power development serving Peridot institutional uses should concentrate on the community-scale option recommended by this Study—a phased development atop Peridot Mesa*.

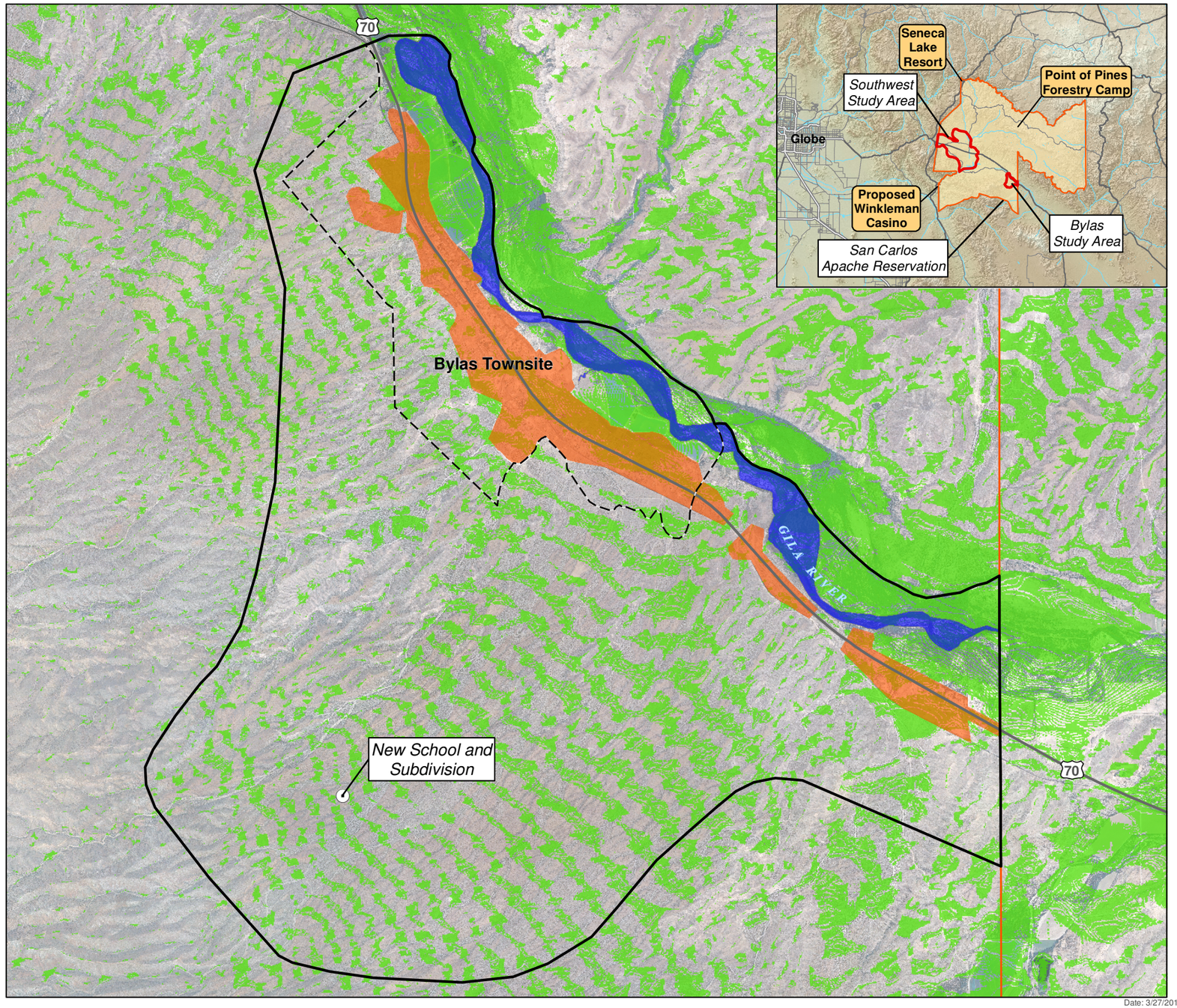
Bylas

Background information on current development in Bylas and future plans for this community can be found in the earlier *Study Areas* chapter of this Study report. No viable commercial-scale solar sites were identified in the Bylas study area. Vacant lands within this area are southwest of the existing town site and US 70. Slopes almost exclusively face north (see Figure 17). In addition the 6,300-acre new community development plan overlays nearly half of the study area.

Bylas presents a different scenario for community-scale solar development than in the southwestern study area. Due to structural conditions and the planned relocation of residential Bylas, solar installations in existing residential neighborhoods would generally not be cost-effective. The GCEC program for individual solar installations may be used for selected existing dwellings, particularly those south of the highway that may not be relocated as part of the Bylas master plan.

The most effective strategy for the Bylas community is providing rooftop and close-in ground mounted solar for commercial and instructional buildings on US 70, and the incorporation of clustered or individual solar installations as new subdivisions and buildings (such as the new elementary school) are constructed in the new community.

Phased Community-Scale Solar



Solar Sites
Bylas
14,139 Acres

Legend

- Potential Solar Site
- Bylas Town Site
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River
- Reservation Boundary
- Developed Areas
- Potential Flood Areas
- Preferable Slope and Aspect

N

0 0.5 1 1.5
Miles

San Carlos Apache Tribe

Parametrix

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Figure 17. Bylas Constraints and Opportunities

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Opportunities and Constraints

Beyond the obvious financing challenges with building a phased community-scale system on a single site, the biggest constraint for the Tribe may be in using SCIP's existing power infrastructure to distribute the solar generated electrical energy into the community. Factors to consider are:

- SCIP may not be willing to lose one of its biggest retail power customers—the Reservation and its residents, businesses, and institutions. Upwards of approximately 40 percent of SCIP's customer base is located on the Reservation.
- SCIP does not have policies and programs in place such as net metering or renewable energy credits that would support the development of locally generated renewable power or help roll the savings from reduced power purchases back into local power bills.
- Transfer of ownership of the SCIP power distribution system and assumption of operations and maintenance by the Tribe may be necessary. This would trigger the need to form a tribal energy utility, and probably require some form of government-to-government negotiations and federal agency approvals (BIA and/or the Department of the Interior).

Focusing community-scale solar development on a single site and feeding into the current SCIP power distribution system has many distinct advantages:

- The electrical power distribution network is already in place, and is already sized to accommodate the power demands of the entire SCIP service territory.
- Generated renewable power would be distributed to the entire SCIP customer base within the Reservation – commercial, residential, institutional, tribal, non-tribal. All would benefit at some level from reduced purchased power costs and reduced fossil fuel consumption impacts.
- The symbolic importance of the Tribe operating its own community-wide "power plant," even if actual electrical generation was initially modest, would be considerable.
- By using the existing SCIP distribution infrastructure, start-up capital costs for power distribution would be significantly reduced.
- Economies of scale would probably mean that the construction cost per acre or per MW of electric energy would be less than the equivalent power production spread across a variety of sites and system sizes and demands.
- Operations and maintenance would be more efficient and cost effective.
- Challenges with installations on individual buildings and smaller sites—equipment maintenance, building structural issues, facility and equipment security, etc.—would be mitigated.

Overall Considerations

The three potential commercial-scale sites identified by this Study—Tufa Stone, Peridot Mesa, and Coolidge—are all within the SCIP service territory. Challenges with respect to commercial-scale and even community-scale solar developments on these sites within the SCIP power distribution service area are detailed elsewhere in this Study report. In summary these challenges are:

- Lack of any transmission infrastructure with adequate capacity to export commercial electrical power loads off-Reservation. SCIP's 69 kV line cannot carry any significant commercial export loads.

- High cost of building new transmission-scale infrastructure given the distance (up to 70 miles) and terrain between the Reservation and SCIP's interconnection to the regional power grid.
- There is no direct government-to-government relationship between SCIP, an agency of BIA, and the tribal government as an entity. SCIP acts a retail supplier of electrical energy to the Reservation. SCIP simply sells power to individual tribal and Reservation ratepayers.
- SCIP has no incentive programs supporting renewable energy generation, not even at the individual residential home level.
- The decline or outright loss of the Reservation as a residential power consumer may be a strong financial disincentive for SCIP to cooperate in the development of tribally owned and operated solar power.

Site-Specific Considerations

The following criteria were applied to phased community-scale development on the three commercial-scale sites previously identified near San Carlos and Peridot. A preferred site must have sufficient attributes to make a community-scale development as small as 1 MW both economically and practically feasible. Adequate land base to generate a minimum 1 MW of electrical energy and the absence of any significant land use, or environmental constraints on these three sites was determined as part of the commercial-scale assessment. Additional factors influencing feasibility for community-scale generation include:

- Adequate electrical power distribution infrastructure.
- Absent adequate distribution infrastructure, relative proximity to potential electrical power customers.
- Adequate transportation access that would not have to be significantly upgraded or restored to accommodate construction or operational traffic.
- Relative challenges in keeping solar facilities safe and secure.

Potential Community-Scale Phased Sites

Tufa Stone

There no power lines of any capacity - transmission, distribution or local service - crossing the portions of the Tufa Stone site identified for community-scale potential. Residential subdivisions and the San Carlos government center are 1 to 3 miles distant. New community-scale power distribution lines would have to be extended at least a minimum of 1 to 2 miles from the south edge of the proposed Tufa Stone solar development area to connect to the nearest existing three-phase SCIP line. The terminus of SCIP's 69 kV line at the San Carlos substation is another 1.5 miles distant.

The Tufa Stone site is bisected by the gravel-covered Road 902 and many gravel or dirt side routes. Even the graveled lower section of Road 902 closest to paved roads and residential subdivisions in San Carlos is meandering and in less than perfect condition. Between field visits in June 2012 and October 2012, extensive new damage and erosion to the lower portions of Road 902 were noted, despite a summer 2012 monsoon rain season that was relatively mild.

The Tufa Stone area is heavily used and vandalized with considerable trash dumping along Road 902 and side roads, presumably originating from nearby residential neighborhoods. This would suggest that keeping any solar facilities on this site free from vandalism and interference may be a challenge.

Tufa Stone is NOT recommended for further consideration as either a community or commercial-scale solar site.

Coolidge

No power lines of any capacity – transmission, distribution or local service - cross the portions of the Coolidge site identified for community-scale potential. The closest SCIP three-phase line runs along Coolidge Dam Road about 0.5 mile from the north end of this site. The overall area is 4 to 5 miles south of US 70, remote from residential neighborhoods and businesses in Peridot. The only nearby destinations are recreational facilities to the southwest long the shore of the San Carlos Reservoir. The only other proximate developments are the sewage ponds and a waste transfer station on the north side of Coolidge Dam Road.

Existing SCIP power distribution lines on Coolidge Dam Road are distant 1 mile along a dirt access road or 0.5 mile across country. This distance is measured from the north end of the site identified by this Study. Distance from the site's north end to the SCIP's Peridot substation is approximately 6 miles by following Coolidge Dam Road west and then the SCIP 69 kV power line north. The largest areas of contiguous suitable lands for solar development are actually to the southeast end of the site at least an additional mile further from Coolidge Dam Road.

Several gravel and dirt access roads enter the Coolidge site from Coolidge Dam Road. The roads are in reasonably good condition and as of October 2102 did not show much evidence of recent erosion from summer monsoon rainfall and flooding (in sharp contrast to the roads accessing the Tufa Stone site).

In contrast to Tufa Stone, there was little evidence of dumping and other vandalism within the Coolidge site. The roads through this site end at the San Carlos Reservoir shoreline but do not directly access any developed recreational facilities. This probably limits drive-through traffic. These factors, relative remoteness from residential neighborhoods, and the intervening waste transfer station probably accounts for the lack of dumping in the area.

Coolidge would be a second priority site, behind Peridot Mesa, for phased community-scale development.

Peridot Mesa

The Peridot Mesa is surrounded by most of the residential, commercial, institutional, and agricultural uses on the Reservation. The Peridot Mesa is crossed north to south by the largest capacity power line on the Reservation – SCIP's 69 kV which links to and feeds the nearby communities of San Carlos and Peridot. The 69 kV line runs directly through or is near to the flat areas on top of the mesa best suited for solar development. A phased community-scale solar facility on the Peridot Mesa could step up electrical power to the voltage of the 69 kV line through new switching infrastructure and send that power down to the San Carlos and Peridot substations. Alternatively,

SCIP Peridot Substation
Courtesy of Jim Rapp

a new power line could be extended approximately 1.5 miles to connect the San Carlos or Peridot power subdivisions. A set of decommissioned power poles parallels the 69 kV and could presumably be reused for a new line.

Peridot Mesa is bisected by several gravel and dirt roadways. The roads are generally in good condition although the primary access road up the north side of the Peridot Mesa from Aravaipa Road in San Carlos is narrow and steep. Access routes from the community of Peridot are longer but may be more practical for regular access to any solar facilities. These south approaches avoid any developed residential neighborhoods, such as are found on the north side of the mesa, and also directly intersect with US 70.

Although close to the developed areas of San Carlos and Peridot, the Peridot Mesa does not show much if any evidence of misuse or dumping. The proximity to law enforcement and other tribal government activities centered on the north side of the mesa, the economically and culturally significant gemstone mining around the perimeter of the Peridot Mesa, and the physical separation created by the mesa's elevation may make the area more secure.

Recommended Phased Site Approach

The high cost to construct a solar generating system large enough for power export, combined with the complete lack of transmission infrastructure to export commercial loads, effectively makes a commercial-scale solar facility on the Reservation infeasible for the foreseeable future. A variety of issues also makes development of multiple community-scale solar sites dispersed throughout the SCIP service territory both less practical and less cost-efficient in terms of effectively advancing the Tribe's goal of electrical energy independence.

In light of these factors, it is recommended that the Tribe build toward energy independence, and preserve the potential for long-term expansion to commercial energy generation, by developing a phased community-scale solar PV facility on the Peridot Mesa. Close proximity to the SCIP 69 kV line that the crosses the mesa and two nearby power substations, as well as the lack of significant environmental or security issues, make this site highly preferable over the Tufa Stone and Coolidge sites. A solar facility sized to meet the current electrical demands of the communities of Peridot and San Carlos could tie into the existing SCIP power distribution system with a direct connection into the existing 69 kV line or by short line extensions to the existing San Carlos or Peridot substations.

The development of phased community-scale solar power generation on the Peridot Mesa could begin with as small as a 1 MW block of solar PV panels. An immediate corresponding reduction in the consumption of purchased SCIP electrical power would accrue to the entire San Carlos and Peridot customer base once the initial installation was operational. Additional blocks of PV panels and inverters could be added gradually up to the capacity of the existing distribution system and corresponding peak load demands.

A full technical and engineering analysis of the condition and capacity of the existing SCIP transmission, substation, and distribution system should be conducted prior to proceeding with any development. The reasonable assumption is that the existing SCIP system is adequate to deliver purchased power and that replacement with locally generated renewable electrical power would not create any overall capacity issues. The system would need to be analyzed for any localized distribution line or infrastructure

limitations. As noted elsewhere in this Study report, some form of partnership(s) with SCIP involving "net metering", operational contracts, and/or outright tribal assumption of the system, would almost certainly be required.

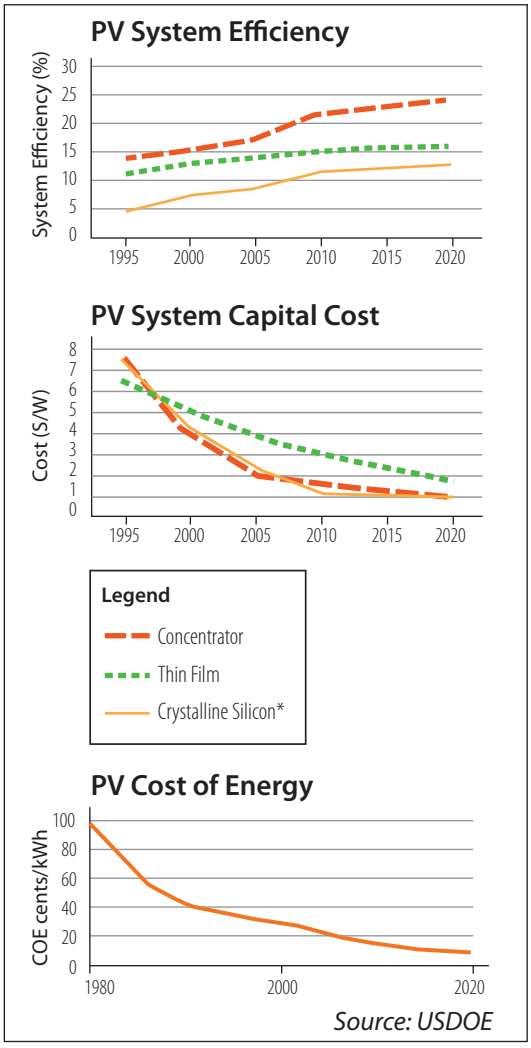
Conceptual Systems

Two conceptual layouts for 5 MW fixed flat-panel solar PV systems atop Peridot Mesa are included as Figure 18. This size of system could meet a substantial percentage of the load demand (as documented by SCIP) for San Carlos and Peridot (see page 28 of this Study). One concept assumes direction connection into the existing 69 kV line, the second assumes a substation connection. The two locations are for illustration purposes only. Numerous locations are possible atop the Mesa with costs varying primarily based on the length of the new connecting electrical lines. System size and configurations are also illustrative. Solutions are scalable and the initial solar array could be as small as 1 MW, and expanded as additional development funding is secured. The configuration of the solar blocks can also be varied to match site conditions.

Power Lines Below Peridot Mesa
Courtesy of Jim Rapp

Flat solar PV panels rated at 295 watts were used for the conceptual specification. Systems were assumed to be ground mounted at a fixed 10 degree angle with 65 percent site coverage. Inverters, transformers, and other connection infrastructure are included. These specifications could be varied. Manually or automatically sun-tracking rotating systems could be used (which would, however, impact site coverage), as could concentrating PV systems.

Each change would have cost implications. Solar PV technology is rapidly advancing with new materials, increased efficiency, and changing costs, as illustrated by the graphs to the right. All these factors may impact actual system design, location, generation capacity, and cost.



Source: USDOE

Estimated Costs

The installed construction cost for these conceptual systems is estimated to be approximately $3.00 per watt, plus the cost of new connecting line extensions. This per watt construction cost is consistent with current benchmark pricing for larger scale solar PV, but towards the high-end of the bids that the Tribe has previously received for the proposed casino/resort solar installation (see Page 32 of this Study report for this information). Cost of new 69 kV lines connecting to the existing SCIP system is estimated at $350,000/mile. The site locations illustrated on Figure 18 would require 69 kV line extensions of approximately one-third of a mile for the north site and 1.5 miles for the

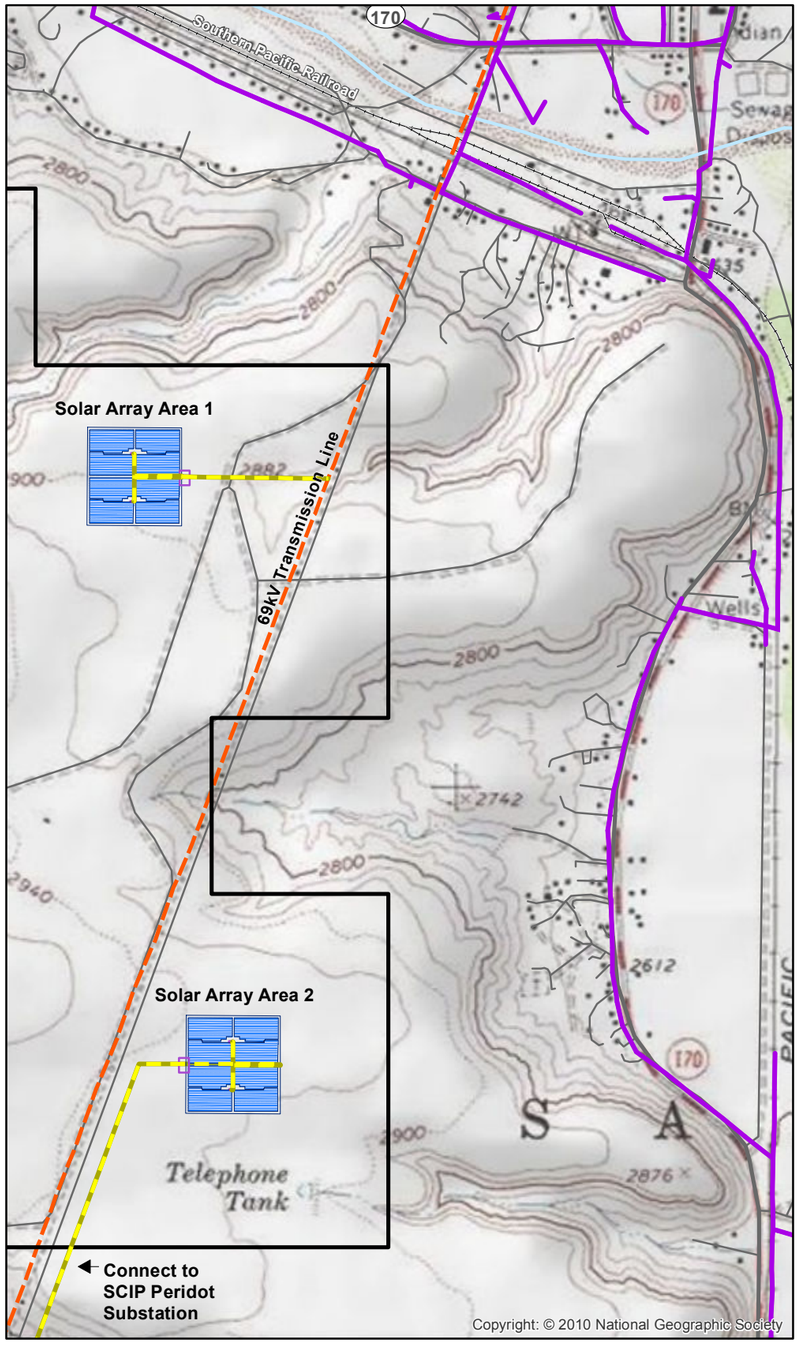
south site. Overall cost would be in the range of $17.2 million to $19.5 million for each location. Information provided in the SCIP Interconnection Transmission Study suggests that the existing 69 kV connection option would include new transformers and other equipment on the order of $2 million. This same report suggests a $2 million upgrade to the Peridot substation for the substation connection option. Total cost of the two options vary by the length of new connecting 69 kV power lines. (See Table 9 below.)

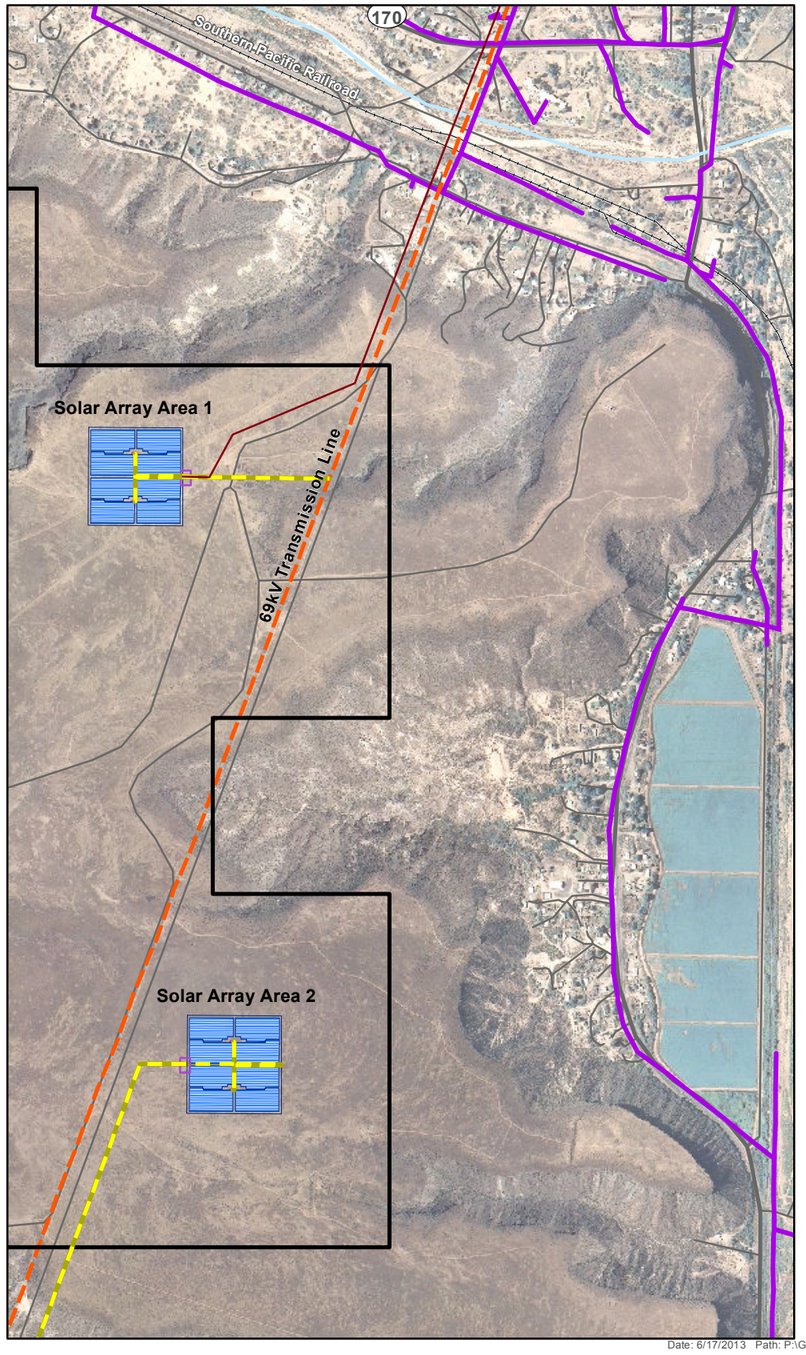
Table 9. Community-Scale System

Mesa Site	System Size	Connecting Line	Interconnection	Cost
North	5 MW	0.3 mile	69 kV line	$17.2 M
South	5 MW	1.5 miles	Substation	$19.5 M

Benefit/Cost Comparison

A benefit-cost comparison between a 5 MW community-scale solar facility that effectively replaces purchased power from SCIP for the San Carlos and Peridot communities could not be conducted. Actual power consumption and billing records could not be obtained. Overall power consumption was modeled based on regional averages (see Page 30) but could not be integrated with SCIP's tiered retail power rate system. A very preliminary cost assessment conducted in 2010 with very partial records indicated retail power costs were over 200 percent of a national average published by USDA. The few individual billing records obtained in the course of the Study were consistent with the 2010 assessment. This would indicate that an initial $17 to $20 million capital investment amortized over 20 years and including system maintenance and capital replacement could be cost effective. Much would depend on the agreements that would have to be negotiated with SCIP and the relative cost of producing renewable power versus purchasing power over 20 years.

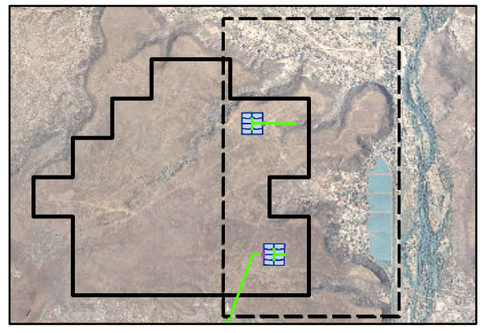




Peridot Mesa

Conceptual Community-Scale Solar Sites

- Solar Site Study Area
- Proposed Distribution Line
- Proposed Solar Site Location
- SCIP 69kV Transmission Line
- SCIP 3 Phase Distribution Lines
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River



N

0 500 1,000 1,500
Feet

San Carlos Apache Tribe

Parametrix

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Figure 18. Peridot Mesa Conceptual Solar Sites

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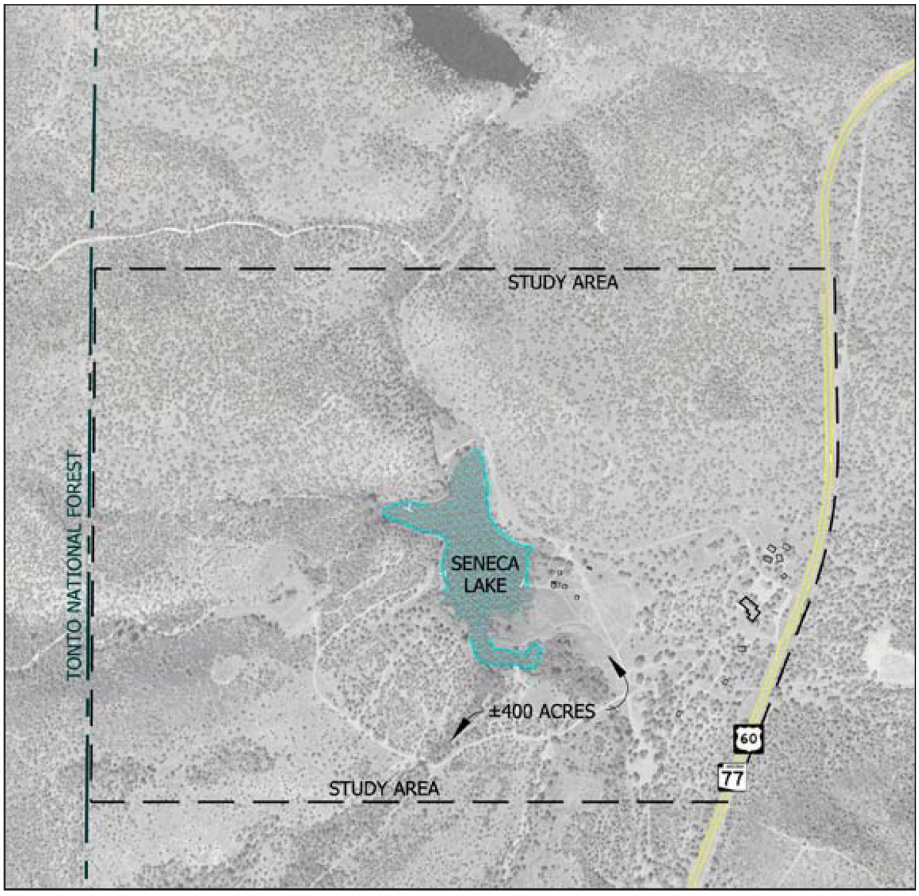
Community-Scale Sites Outside of Study Areas

Seneca Lake Resort

This 400-acre site is 30 miles north of Globe, Arizona, within a small portion of the Reservation on the west side of US 60 near the scenic Salt River Canyon (see Figure 13). An abandoned resort occupies much of the site. The Tribe's 2009 *Seven Mile Wash District Master Plan* includes an appendix that evaluates Seneca Lake site conditions and recommends renovation and restoration of recreational and lodging facilities. *Solar PV systems could easily be incorporated into any restoration plans.*

Seneca Lake
Source: Seven Mile Master Plan



Source: Seven Mile Master Plan

Point of Pines Forestry Camp
Courtesy of Steve Albert

Morenci Power Lines
Courtesy of Jim Rapp

Point of Pines Forestry Services Camp

The Tribe's Point of Pines Forestry Services Camp, Ranger Station, and Education Camp are all located in close proximity to one another in the high elevation Point of Pines area (see Figure 13). Point of Pines is crossed by a 40+ mile long power line owned and operated by the Morenci Mine. This power transmission line powers a major water pump station on the Black River (and also provides power to these tribal facilities).

Point of Pines is accessed via the paved Route 8, which traverses major pasturelands and ranchlands along much of its length. The Forestry Services Camp complex consists of a ranger station, residential cabins for forestry staff and firefighters, helicopter landing pad, and associated buildings such as a mess hall and storage facilities. At some distance east of this cluster of buildings is a second set of buildings used to house education camps and academic research staff. These facilities are approximately 50 road miles from Route 8's intersection with US 70, 2 miles east of Peridot. The relatively flat pastureland surrounding the area is actively ranched.

There is more than sufficient flat vacant land around this site to accommodate ground-mounted solar PV arrays. Roof-mounted is also possible. However, since power to this facility is provided from the Morenci Mine power line free of charge in exchange for the right to cross Reservation lands, the capital investment required for a community-scale solar installation may make little or no economic sense. The expansive flat pasture lands, paved roadway access, and the Morenci power transmission line also make the Point of Pines area a nominally feasible candidate for commercial-scale solar development. There would, however, be only one potential customer—the Morenci Mine. There would also be challenges in maintaining a commercial-scale solar facility in this remote high elevation area.

This Study was not scoped to consider on-Reservation solar developments serving a specific off-Reservation customer. Nonetheless, the Morenci Mine arrangement suggests that one long-range possibility for the Tribe to develop commercial-scale power generation and surmount the obstacles presented by the lack of transmission-scale power lines passing through the Reservation may be to partner with nearby high energy demand industries.

Dudleyville (Winkleman) Tribal Casino (proposed)

The Tribal Council has approved plans for a second casino within the Reservation just east of US 77 between the towns of Mammoth and Dudleyville in the Aravaipa area (see Figure 13). The Tribe plans to have a temporary facility open by the first half of 2014 with up to 400 slot machines, 10 to 12 table games, and a small lounge and restaurant. Depending on market conditions, eventual plans are for a $26 million permanent facility which will include a destination hotel, convention center, and a 500- to 1,000-seat concert venue. Incorporating solar energy to offset purchased electrical energy consumption has been discussed.

BUSINESS PLANNING

This chapter refines and updates the conclusions of the Tribe's DOE Tribal Energy Program-funded Energy Organization Analysis (EOA) adopted in 2012, and incorporates the business and financial planning that is concurrently underway for a new Tribal energy corporation and/or utility, as well elements of the Tribe's 2011 *Energy Strategy and Program*.

Six forms of energy organization options were evaluated in the EOA—ad-hoc, tribal office/department, corporation/joint venture, utility authority, energy service company (ESCO), and cooperative. Five key goals were assessed for each organization type, and a series of objectives for each goal were considered (See Table 10). Additional information can be found in Appendix B.

Table 10. Business Planning Goals and Objectives

Goals	Goals	
Supports Tribal Sovereignty and Self-sufficiency	• Preserves/increases tribal authority and control over its resources and lands. • Protects tribal assets, legal immunities, and privileges. • Preserves tribal tax exemptions. • Preserves/assures tribal ownership of energy assets (power plants, transmission). • Allows for appropriate and orderly transitions to tribal management and ownership.	• Provides for tribal and Reservation energy independence. • Compatible with tribal institutional capacity. • Builds tribal management, institutional and technical expertise for the long-term.
Supports Economic Development and Financial Stability	• Creates new tribal revenue sources (for both energy sector investments and general operations). • Creates near- and long-term tribal energy sector employment. • Develops tribal energy sector skills and expertise (at both management and technical levels). • Supports or helps to expand existing tribal and Reservation business enterprises. • Allows for government, private, foundation, and/or non-tribal sector investments/ loans/grants, and necessary development/ management roles assistance.	• Can be implemented by following existing or permissible tribal codes, standards, and contracts. • "Start-up" tribal institutional and management capacity is sufficient. • "Start-up" financial investment is within the capacity of the tribe. • Allows for issuance of tax-exempt bonds. • Allows for debt financing from commercial lenders.
Protects Cultural and Social Values	• Exhibits a high degree of political and community acceptability. • Creates social and economic resources supporting the preservation of social and cultural values.	• Enhances long-term tribal capacity through education and training. • Allows for necessary partnerships with external partners without comprising tribal cultural and social values.
Preserves Environmental Resources	• Supports the sustainable use of local and renewable energy resources. • Can develop a broad range of programs and projects supporting energy efficiency and renewable energy, thus displacing non-renewable resource development and consumption.	• Facilitates a broad range of energy programs and projects, thus reducing reliance on any one resource. • Does not require the depletion of other resources to achieve energy goals and objectives.
Energy Strategy and Program Consistency	• Satisfies the overall goals and objectives of the 2011 Energy Strategy and Program. • Is effective for implementing energy efficiency and conservation strategies. • Is effective for implementing commercial-scale renewable energy development.	• Is effective for implementing commercial-scale renewable energy development. • Supports greenhouse gas reduction strategies.

Business Organization Forms

Ad-Hoc

An "ad-hoc" approach to energy programs and projects has few advantages other than expediency once beyond the phase where projects or programs are funded and implemented on a case-by-case basis. The Tribe is well past this point with the completion of the 2011 *Energy Strategy and Program*, the energy conservation audit program, hiring of an energy coordinator, and consideration of solar power development proposals**.** The ad-hoc approach has little ongoing value and may actually inhibit the orderly and effective implementation of the 2011 *Energy Strategy and Program* and contribute to uncoordinated actions and decision making, missed opportunities, and duplication of effort.

Table 10. Ad-Hoc

Goals	Performance	
Supports Tribal Sovereignty and Self-sufficiency	• At best, ad-hoc is neutral with respect to desired outcome. There is nothing intrinsic with an ad-hoc approach to successfully managing energy programs and projects with respect to the desired outcomes.	• The potential for lack of coordination and consistency may actually slow or work against building energy expertise and capacity, advancing sovereignty, etc.
Supports Economic Development and Financial Stability	• At best, ad-hoc is neutral with respect to desired outcome. There is nothing intrinsic with an ad-hoc approach to successfully managing energy programs and projects with respect to the desired outcomes.	• With respect to financial matters, there are few if any advantages with respect to outside partners or financing, protection of tribal assets and immunities, etc.
Consistent with *Energy Strategy*	• Not adequate for consistent and cost-efficient delivery and management of multiple conservation and energy efficiency programs.	• Major limitations in delivering and managing both community and commercial-scale energy generation and transmission projects.

Government Office or Department

The formation of a tribal energy office or department would be a viable platform for many of the energy programs that the Tribe is currently delivering or contemplating. Formation of an office or department would allow energy program managers and staff to focus exclusively on energy issues, and provide a central clearinghouse for tribal energy programs. However, at such point as Tribe begin to consider capital-intensive energy infrastructure projects, the office or department form has distinct limitations, particularly with respect to financing options and tribal immunities. These constraints have already been experienced by the Tribe in attempting to form private partnerships and joint ventures for the casino/resort solar project.

Table 11. Government Office or Department

Goals	Performance	
Supports Tribal Sovereignty and Self-sufficiency	• May not be able to efficiently manage and/or operate complex energy infrastructure projects.	• Would not shield tribal government assets or immunities from commitments and liabilities arising from major renewable energy infrastructure development.
Supports Economic Development and Financial Stability	• Would not accommodate some forms of financing for major renewable energy infrastructure development.	
Consistent with *Energy Strategy*	• Good vehicle for delivering consistent conservation and energy efficiency programs.	• If the office or department were properly chartered, could provide for better coordination of energy projects undertaken by other tribal departments and authorities.

Utility Authority

A tribal enterprise utility authority would effectively encompass nearly all the future energy initiatives articulated in the 2011 *Energy Strategy* and Program (with the exceptions of elements addressing transportation and materials conservation). In addition, the original charter of the existing tribal telecommunications utility (SCATUI) may allow for the future incorporation of an energy utility function (this information provided by SCATUI management in December 2011). The long-developed managerial and administrative capacity of SCATUI, as well as broad similarities in physical infrastructure and operation and maintenance equipment and some staff skills, may help fast-track some elements of an energy utility enterprise.

Table 12. Utility Authority

Goals	Performance	
Supports Tribal Sovereignty and Self-sufficiency	• Energy utility clearly best meets sovereignty and self-sufficiency goals and objectives	
Supports Economic Development and Financial Stability	• Energy utility clearly best meets sovereignty and self-sufficiency goals and objectives.	• One weakness may be the start-up capacity of the Tribe. A phased approach and/or the adding energy program/project functions to the telecommunications utility may resolve some capacity issues.
Consistent with *Energy Strategy*	• A tribal enterprise energy utility authority can effectively encompass nearly all the future energy initiatives in the 2011 *Energy Strategy*.	

Corporation/Joint Venture

The Tribe could also consider forming an energy corporation for the sole purpose of joint ventures or other forms of contracting or partnering with outside entities. Joint ventures can be entered into and managed by many forms of incorporated tribal organizations. The joint venture option works best, however, as a TOOL rather than as the sole form of tribal

organization used to advance energy initiatives. The corporation/joint venture form would NOT be a very effective device for managing the full range of energy programs identified in the 2011 *Energy Strategy*.

Should the Tribe engage in the development of capital-intensive commercial-scale renewable energy projects (or even larger community-scale projects), joint ventures or outside contracts may be necessary to secure necessary financial, construction, and management resources, especially for design/construction and early phases of management. The Tribe began the process of forming an energy corporation for joint venture purposes in late 2012.

Energy Service Company (ESCO)

Formation of, or contracting with, an ESCO could speed the completion of energy efficiency and weatherization improvements to tribal buildings and facilities. Financing energy efficiency programs under ESCO's can also be attractive to tribes with more limited resources. These advantages notwithstanding, given the relatively small number and size of tribal institutional and commercial buildings, the Reservation would probably not be especially attractive to an "outside" ESCO partner. Nor does the ESCO form have the best potential for broad-based implementation of the 2011 *Energy Strategy and Program*. The formation of a local ESCO would also require an investment of out-front funding and training very similar to an energy utility. Energy utilities are simply more flexible mechanisms for implementation of a broad range of energy programs and projects.

Cooperative

There is limited need on the Reservation for many of the services that electrical cooperatives typically excel at, for example extending service to multiple remote sites. Other energy organization forms, such as energy utility authorities, are also equally effective vehicles for the types of retail power services cooperatives provide. The cooperative option does not appear to offer any unique advantages relative to the specifics of the Tribe and Reservation. This does not exclude partnering with GCEC in the Bylas area.

Business Organization Phasing

For three business options – ad-hoc, ESCO, and cooperative - the weaknesses with respect to one or more desired outcomes are significant enough to suggest no further consideration. *The remaining options – tribal office/department, operating utility, and corporation/joint venture - are recommended as part of a phased or multi-dimensional approach to tribal energy program and project management and development.* Nonetheless, given the significant weaknesses of a tribal energy office or department with respect to tribal immunities and finances, especially in the development and management of energy infrastructure, the office/department option is suggested only as an first and interim step in the evolution of the Tribe's energy business.

Phase 1: Energy Program Administration

In the near-term, Tribal energy programs and projects should continue to be housed in the Tribe's Planning and Economic Development Department, and supported by current Planning management and administrative staff. The Tribe should also consider formation of a separate energy office.

To the extent that tribal programs or projects with significant energy components are being developed by other tribal departments and enterprises (such as the Housing Authority "solar community" being planned for Bylas), the Tribe should define internal systems and agreements to better integrate and coordinate such efforts.

As current DOE energy program funding awarded to the Tribe in 2000–2012 is fully expended in late 2013, and the grant-funded energy coordinator and energy auditor positions have to transition to replacement grant funding or direct tribal support, the Tribe may consider establishing a tribal energy office, managed and funded separately from the Planning Department. The Tribal Council resolution or other actions forming this energy office should specify its authority, including the degree of responsibility for coordinating and advising on all tribal programs and projects involving energy conservation, transmission, and generation.

The terms of formation of a tribal energy office would not preclude energy actions and developments by other tribal departments and enterprises but should assure that the energy office acts as a clearinghouse. This will help to avoid duplication and cost inefficiencies, better assure that emerging energy expertise and information is shared across all tribal initiatives, and make the best use of limited tribal resources. The tribal energy office would also promote the 2011 *Energy Strategy and Program* as the benchmark policy for authorizing and developing all tribal energy initiatives.

The Tribe's initiatives in 2012-2013 towards the formation of an energy corporation may render the need for a tribal energy office moot.

Phase 2: Energy Corporation Formation

In 2014, establish a separate (from the main tribal government) entity for the purposes of engaging in joint ventures and other contracts for energy facility capital development. This is a crucial action given the Tribe's prior and current experience in forming partnerships to develop solar power generation at the casino/resort and for the effective near-term implementation of many of the recommendations in this Study report. Formation of an operating enterprise (energy utility, see Phase 3 below) can evolve easily out of the energy corporation.

The form of this tribal energy entity may vary. The Tribe's attorney and other legal advisors may consider a wide range of possible options:

"Government": Separate tribal government entity or political subdivision.

Such entities are easy to form, enjoy sovereign immunity, and are exempt from federal income tax. Such entities are still essentially units of tribal government, however, and may not be able to secure certain types of financing, which may be important where capital-intensive energy projects are involved. Tribal government assets may also not be as well protected from liabilities arising from the actions or policies of the separate entity, as would be the case with corporate forms of tribal enterprise (see below).

The government form is NOT recommended.

Corporate: Incorporated enterprise distinctly separate from main tribal government

There are several iterations of possible corporate enterprise structures. The Tribe should consider its prior experience with other tribal enterprises (such as the SCATUI) and the many short- and long-term implications for an energy enterprise (management

obligations, revenue generation, need for contracting and/or joint ventures, capital development/replacement and financing, power purchases and sales, utility infrastructure operation and maintenance, ratemaking and collection, etc.).

For more information see the 2012 San Carlos Apache *Energy Organization Analysis* and DOE's publication *Renewable Energy Development in Indian Country: A Handbook for Tribes*. This publication is available online from the DOE Tribal Energy Program website through a link entitled *Indian Energy Legal Handbook*.

Phase 3: Energy Utility Formation

Within the next 1 to 2 years, subject to the pace of development of capital-intensive energy generation projects and outcomes of the energy transmission and delivery initiatives in this Study, the Tribe should incorporate an energy utility enterprise or establish a distinct energy utility function within the existing tribal telecommunications utility (SCATUI). Formation of an energy utility should be preceded by a detailed legal review, development of a specific business and finance plan, and articulation of a set of near- and long-term goals and objectives.

The Tribe's 2011 *Energy Strategy and Program*, accomplishments between 2011 and 2013 with energy audits and program management, this Study, and other initiatives suggest that a broad range of energy programs and projects are possible on the Reservation. These could include additional energy audit programs, energy efficiency and conservation building improvements, community-scale (and one day commercial-scale) renewable energy generation, ownership and operation of the SCIP power distribution system, and even re-commissioning the Coolidge Dam as a hydroelectric facility.

A tribal energy utility is the best long-term option for managing the full range of the Tribe's current and long-term energy initiatives. Similar considerations as described in this Study report for solar facility development should be followed in incorporating an energy utility. These include the many short- and long-term implications for management obligations, revenue generation, need for contracting and/or joint ventures, capital development/replacement and financing, power purchases and sales, infrastructure operation and maintenance, ratemaking and collection, etc.

In particular, a rigorous analysis should be undertaken as to how the energy utility will maintain and operate electrical generation and distribution infrastructure and how the utility will be managed and administered. An energy utility represents a significant opportunity to build expertise and provide employment to tribal members in a wide variety of fields: management, finance, engineering, construction, and highly specialized infrastructure maintenance. As these skills may not be currently available in great quantity among Reservation residents, utility formation should include provisions for the initial contracting out for these services and a training plan to eventually transition to staffing drawn from tribal members and Reservation residents to the greatest extent possible.

TRIBAL BENEFITS

Many benefits will accrue to the Tribe and Reservation as a result of a given site development or solar alternative approach, combined with the Tribe's decisions on the form of energy organization to manage energy programs and projects, and the degree to which the Tribe partners with and compensates outside project development partners.

These benefits may include social benefits such as tribal sovereignty, employment and job skill development, the generation of capital to support other tribal and Reservation programs, reductions in costs associated with energy purchases (or if a commercial-scale development is possible, revenue from energy sales), and consistency with Apache cultural norms and values. The business planning goals and objectives for selection of appropriate form(s) of tribal energy organization reported in the *Business Planning* chapter of this Study report also provide context and direction for probable tribal benefits. Finally, it is also important to consider the Tribe's overall energy goals as defined in the 2011 San Carlos Apache *Energy Strategy and Program*:

The San Carlos Apache Energy Strategy and Program provides a framework for future energy initiatives that support the Tribe's energy security and independence, and that will reduce the negative impacts of energy consumption and greenhouse gas emissions on the Tribe's people and Reservation.

- *Providing for the Tribe's energy security and independence by developing and utilizing renewable energy generation resources and technologies.*
- *Decreasing the Tribe's overall consumption of non-renewable energy and non-recyclable materials.*
- *Enhancing the Tribe's natural and built environments through reducing greenhouse gas (GHG) emissions.*
- *Reducing per-capita and overall energy costs, and saving money for the Tribe's institutions and members.*
- *Promoting sustainable, energy efficient practices and systems in the Tribe's homes, businesses, and institutions.*
- *Building and maintaining sustainable and energy efficient tribal infrastructure and facilities.*
- *Diversifying the Tribe's economy by supporting new renewable energy jobs and skills.*
- *Establishing an integrated program of energy efficiency and conservation projects and activities.*

Descriptions of various tribal benefits follow. The benefits are based on the recommendations of this Study which focus on major community-scale solar developments in two or three areas (casino/resort and Peridot Mesa, and perhaps the

tribal college/training center). As this Study does not recommend any near-term or mid-term initiatives to develop commercial-scale solar power due to the lack of adequate transmission, the benefits of power sales revenue are not included below.

Economic Development

Employment and Job Skills Development

The development and operation of solar energy facilities on the Reservation will provide for three kinds of employment: construction, direct, and secondary. The scale of the employment provided will vary based on the scale of the solar facility being installed, and by the form of ownership and management that is used. The development of solar energy projects will probably initially require the Tribe to partner with outside developers and manufacturers. However, these partnerships are structured, the Tribe should always negotiate to retain ultimate ownership of the facilities being developed and for guaranteed employment for tribal members at management, technical and support levels to the extent such skills are present, and job training and skill development where expertise is presently lacking.

Associated with new energy sector employment on the Reservation will be job skill development that tribal members can transfer to other employment and employers both on and off-Reservation. The Tribe should always negotiate to guarantee management, technical and support staff job training and skills development. The scope of possible skill development will vary based on the solar projects undertaken by the Tribe and the forms of managing and delivering the energy services or projects that the Tribe undertakes.

Increased Tribal Revenues

If long-term prospects for commercial-scale solar can be realized, substantial revenues can be generated for the Tribe with respect to renewable energy export sales and the sale of green energy certificates. Commercial development is, however, not likely in the foreseeable future due to the lengthy and costly transmission infrastructure that would have to be constructed to interconnect with the regional power grid.

The prospects for revenues from community-scale solar are more limited. One model that has been discussed for the solar development at the casino/resort is that the casino/resort tribal enterprise would pass through some purchased energy savings to support the Tribe's energy programs or the operational costs of an energy corporation or utility. This is an approach that could be applied to other tribal enterprises benefitting from reduced purchased power costs – water authority, San Carlos Lake recreational enterprise - although none would have the power consumption or operational revenue streams that would make the potential pass-through as significant as with the casino operation.

Another possibility is development of solar power generation that exceeds local demand. Even though the centralized and phased community-scale solar facility recommended by this Study is not intended for commercial export. If and when the facility grows to a size that exceeds local demand, the excess power could be sold back into the regional grid.

Through formation of an energy utility, which would in any event probably be a prerequisite to a community-scale solar facility the size of what could be built atop Peridot Mesa, the Tribe could generate revenues through local energy sales. This may not as matter of policy be an approach the Tribe would wish to follow; however, given that the origin of the revenue would be directly from Reservation ratepayers, including of course

the tribal government itself. There would also be no practical mechanism to recover the costs of building and operating a tribal solar facility from individual ratepayers if SCIP remained as the local electrical service provider.

Reduced Power Costs

Reductions in the amount of purchased power needed to meet overall electrical power needs on the Reservation MAY have a positive impact on individual, business and government pocketbooks. This factor will greatly depend on how the Tribe decides to manage the operation and maintenance of community-scale solar facilities.

For solar installations on individual buildings, the direct ratepayer enjoys reduced power purchases and a lower bill from the utility provider. Any such savings can be used to pay off the cost of the solar installation or for other purposes that the home or business owner deems appropriate. The situation changes when a true community solar facility is developed that serves multiple rate payers, or in the case of the Peridot Mesa site, potentially benefits all San Carlos and Peridot ratepayers. This would be the case whether the Tribe assumes an operating utility authority or that SCIP remains the provider. As a matter of policy the cost savings could be considered a social benefit to individual Reservation residents, government operations and businesses, in other words a free program of the Tribe's government that results in reduced power bills. This would, however, leave the capital costs, ongoing operations, and future replacement of the solar facility unfunded.

Environmental Stewardship and Greenhouse Gas Reduction

The most direct and quantifiable environmental benefits of solar facility development on the Reservation will primarily be for reduced greenhouse gas emissions. Purchased electricity consumed on the Reservation is almost entirely derived from non-renewable sources, primarily coal and natural gas (approximately 69 percent), with a sizable percentage generated by nuclear (27 percent). Renewables, at least in recent published information on the regional power "mix," accounted for only 2 percent GHG emissions from the projected 61,595 MWh of purchased electricity consumed in San Carlos and Peridot likely falls between 33,275 and 43,458 $MtCO_2e$. The range of GHG emission from the 12,580 MWh of electricity consumed in Bylas is likely between 6,840 and 8,876 $MtCO_2e$. The range of GHG emission from the 9,904 MWh of electricity consumed in Cutter is likely between 5,385 and 6,199 $MtCO_2e$. Replacing purchased carbon-based power with renewable solar energy will greatly reduce and could theoretically fully eliminate the Reservation's "carbon footprint" resulting from electrical consumption.

Social and Cultural Benefits

The Tribe's 2011 Strategic Plan states:

- *The Apache People will live a balanced life in harmony with spirituality, culture, language, and family unity in an ever-changing world.*
- *The Apache People shall create a strategic framework for our tribe to grow and prosper*.

The key term in this tribal mission statement is "The Apache People will live a balanced life in harmony…" The utilization of renewable resources to meet the Tribe's energy needs is highly consistent with traditional Apache cultural and social practices including care for the environment, conservative use of land and water, and sustaining natural resources

for current and future generations. This has been the Apache way of life for centuries. The development of locally generated solar energy and associated San Carlos Apache initiatives such as formation of an energy corporation or utility will also be important milestones in meeting the Tribe's goals of energy independence and sovereignty.

APPENDIX A
Incentives

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TECHNICAL MEMORANDUM

Date:	June 28, 2012
To:	Gail Haozous, Kenneth Duncan Jr., Nate Nash, San Carlos Apache Tribe
From:	Ann Radil, Jim Rapp, Parametrix
Subject:	San Carlos Apache Tribe Solar Feasibility Assessment: Relevant Financial Incentives and Policies
Project Number:	283-2818-002
Project Name:	San Carlos Apache Tribe Solar Feasibility Assessment

INTRODUCTION

There are numerous local, utility, state, and federal incentives and policies designed to promote renewable energy and energy efficiency by making project development and conservation measures more affordable. For the vast majority of renewable energy sources, subsidies and affordable project financing terms are critical to delivering a levelized cost of energy, or grid parity, with traditional sources of energy such as coal or natural gas. The purpose of this Technical Memorandum is to document incentives and debt forgiveness programs relevant to both commercial-scale and community-scale solar energy developments at the San Carlos Apache Reservation (Reservation).

This Technical Memorandum is the deliverable associated with Phase 1: Identification and Preliminary Assessment of Sites in Southwestern Reservation, Activity 1: Study Baselines, Task C: Review Arizona Corporation Commission (ACC), state and federal renewable incentives and related laws as pertaining to the San Carlos Apache Tribe Solar Feasibility Assessment.

APPROACH

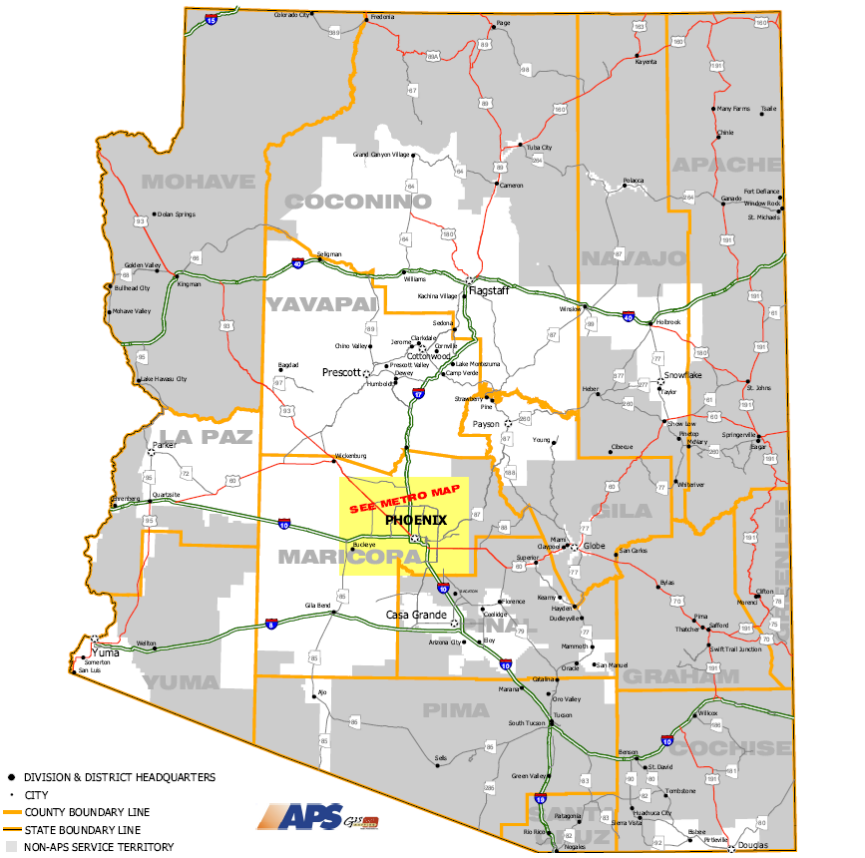
Leveraging expertise in environmental solutions and asset development, Parametrix has derived the most pertinent factors affecting financial performance and consequently project viability of both residential- and commercial-scale solar installations at the Reservation. Ultimately, this information will be synthesized and presented in a final report, which will provide a comprehensive “blueprint” for renewable energy development.

More specifically, Parametrix has identified the prevalent financial incentives and regulatory policies, and has screened these funding mechanisms to identify those relevant to commercial- and/or residential-scale solar photovoltaic (PV) or concentrated solar power (CSP) project development at the Reservation. Solar PV technologies comprise an array of cells containing a material, such as silicon, that converts solar radiation into electricity. A PV array is a linked collection of PV modules, which are in turn made of multiple interconnected solar cells. By their modularity, they are able to be configured to supply most loads. Concentrated solar power (CSP) systems use lenses or mirrors to focus a large area of sunlight onto a small area. Electrical power is produced when the concentrated light is directed onto PV surfaces or used to heat a transfer fluid for a conventional power plant.

Incentives are offered in various forms, including on a per kilowatt hour (kWh) or per kW generated bases, or as a percentage of the project's total installed costs. Some incentives are limited at a certain dollar threshold, or are paid over a period of years. It should be noted that while researchers have made every effort to provide up-to-date information, incentives are typically offered within a certain period and are thus subject to change and should not be seen as a guaranteed source of funding. Thus, the San Carlos Apache Tribe (SCAT) should confirm all incentives prior to finalizing solar energy system development plans.

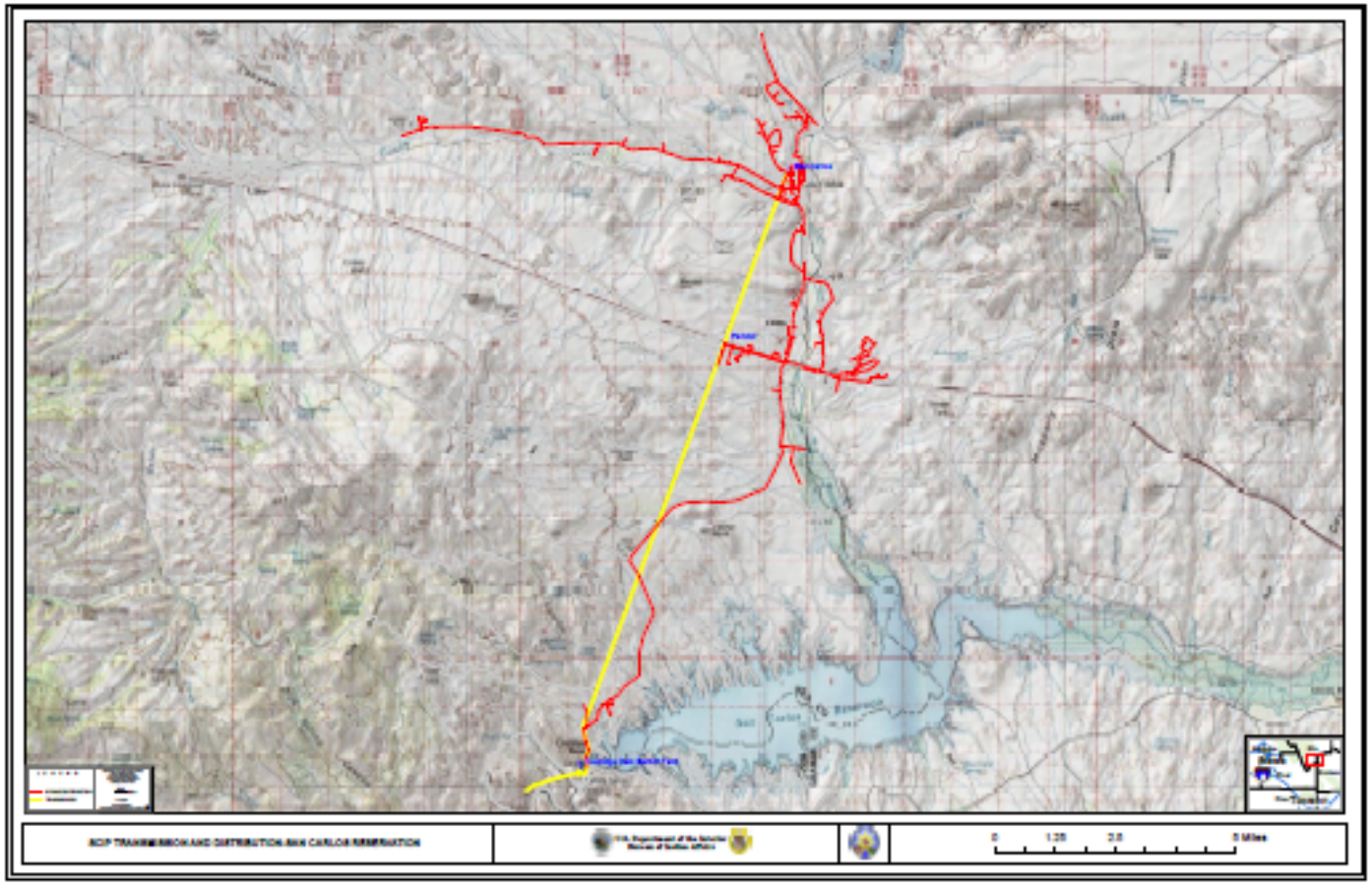
The descriptions of various funding mechanisms are organized by source: federal, state and utility. SCAT staff have reported that the Reservation receives power from four utilities: Arizona Public Service (APS), the San Carlos Irrigation Project (SCIP), the Graham County Electrical Cooperative, and power provided to the SCAT's Point of Pines Forestry Camp by the Morenci Mines. The Graham County Electrical Cooperative service area and the Point of Pines service area are outside of the study area. As a result, the descriptions of utility support programs are limited to and organized by APS- and SCIP-sponsored programs.

Figure 1. Map of APS Service Territory



Source: Accessed online at http://www.aps.com/images/pdf/AZ_Map.pdf on 8/13/2012

FIGURE 2. MAP OF SCIP TRANSMISSION AND DISTRIBUTION AT THE SAN CARLOS RESERVATION



RESULTS

The following section summarizes the renewable energy subsidies relevant to the SCAT. To make sense of these findings, it is necessary to first understand the relationship between incentives and tax credits and energy organization, or the renewable energy project's sponsor.

Relationship between Project Sponsor and Available Renewable Energy Incentives

In general, solar system development occurs in three phases: (1) pre-construction development, (2) construction, and (3) operation. During the pre-construction phase, it is common that a Tribal sponsor commits resources for an initial assessment, as is the case with the Department of Energy (DOE) funding the SCAT Solar Feasibility Assessment. After this initial assessment, it is common for a Tribal project sponsor to take the lead in continuing to evaluate the technical, social, environmental and financial feasibility of developing a renewable energy project. There are various forms that this project sponsor may take; each form comes with unique tax liabilities and consequently, alternative avenues for securing debt and equity sources of funding, as well as eligibility for federal, utility, state or local incentives.

The *Energy Organization Analysis Report* (Report) documents alternative forms of project sponsorship relevant to the SCAT Solar Feasibility Assessment. This Report is included as Appendix A to this Technical Memorandum. It should be noted that the form of development entity may limit or expand the financial incentives available to the SCAT. It is recommended that SCAT staff consider the trade-offs between various forms prior to committing to a single project development strategy. In other words, it is important for the SCAT to decide early in the process what role they want in the long-term management, operation and/or ownership of an energy project. Some projects may only be economically viable if they are owned by a non-tribal entity that can take full advantage of existing tax credits and accelerated depreciation.[i]

Federal Incentives

Congress has enacted various incentives to encourage the development of renewable energy projects, such as tax credits, grants in lieu of tax credits, accelerated depreciation of project costs, loan guarantees, and subsidies for debt financing. Each incentive is subject to certain requirements and limitations, and many incentives are limited or unavailable to tax-exempt entities including Indian tribal government. The following federal incentives are relevant should the SCAT seek to act as a project developer. For a detailed description of tax credits, which reduce tax liability therefore encouraging additional investment in renewable energy development, please see Douglas MacCourt's 2005 report titled, *Renewable Energy Development in Indian Country: A Handbook for Tribes*, which can be accessed online at: http://www.nrel.gov/docs/fy10osti/48078.pdf.

Tribal Energy Program Grant

The DOE Tribal Energy Program promotes tribal energy sufficiency, economic growth and employment on tribal lands through the development of renewable energy and energy efficiency technologies. The program provides financial assistance, technical assistance, education and training to tribes for the evaluation and development of renewable energy resources and energy efficiency measures.

DOE's Tribal Energy Program consists of program management through DOE headquarters, program implementation and project management through DOE's field offices, and technical support through DOE laboratories. Program management for the Tribal Energy Program is carried out by DOE's Weatherization and Intergovernmental Program, which provides programmatic direction and funding to DOE field offices for

program implementation. DOE's field offices, specifically the Golden Field Office, issue solicitations and manage resulting projects.

Program funding is awarded through a competitive process. There are currently no open solicitations for renewable energy and energy efficiency projects. However, it is recommended that SCAT staff and consultants intermittently check the Tribal Energy Program for open solicitations: http://apps1.eere.energy.gov/tribalenergy/.

State and Utility Incentives

Each of the state and utility financial incentives and regulatory policies relevant to solar (both PV and CSP) system development on the Reservation are identified in Table 1 and summarized in greater detail in the following sections.

Table 1. Prevalent and Relevant State and Utility Financial Incentives and Regulatory Policies

Renewable Financial Incentives and Regulatory Policies	Available in Arizona	Available to Offset the Cost of SCAT-Owned or -Managed Solar PV Systems	Available to Offset the Cost of SCAT-Owned or -Managed Solar CSP Systems
3rd Party Solar Power Purchase Agreements (PPAs)	Yes		
Federal and/or State Grant Programs for Renewables	No		
Favorable Interconnection Policies	No. In 2007 the Arizona Corporation Commission (ACC) initiated a rulemaking process to establish statewide interconnection standards for distributed generation. This proceeding is still in progress. Until the new official rules go into effect, the commission has recommended that the utilities use the *Interconnection Document* as a guide. This document applies to systems up to 10 megawatts (MW) in capacity and only applies to interconnection within the APS service territory.		
Loan Programs for Utilities	Yes	No	No
Net Metering Policies	Yes	Yes	Yes, but only in APS Service Territory. Loan programs for CSP are not available in the Salt River Project territory.
PACE Financing Policies	No		
Property Tax Incentives for Renewables	Yes	No	No
Public Benefits Funds for Renewables	No		
Rebate Programs for Renewables	Yes, but only for APS programs		
Renewable Portfolio Standard (RPS) Policies	Yes, but only for APS programs		
RPS Policies with Solar Distributed Generation Provisions	Yes, but only for APS programs		
Sales Tax Incentives for Renewables	Yes		
Tax Credits for Renewables	Yes		

3rd Party Solar Power Purchase Agreements (PPAs)

Many electricity consumers would like to generate renewable energy on-site from solar power to reduce utility bill volatility and climate change impacts while simultaneously improving air quality. However, solar systems have high initial costs and they must be properly designed, operated and maintained to deliver anticipated benefits.

A Solar PPA is a financial arrangement in which a third-party developer owns, operates and maintains the PV or CSP system, and a host customer agrees to site the system on its roof or elsewhere on its property and purchases the system's electric output from the solar services provider for a pre-determined period. This financial arrangement allows the host customer to receive stable, and sometimes lower cost electricity, while the solar services provider or another party acquires valuable financial benefits such as tax credits and income generated from the sale of electricity to the host customer.[ii]

Authorization for 3rd party solar PV and CSP PPAs usually lies in the definition of a "utility" in state statutes, regulations or case law, in state regulatory commission decisions or orders, and/or in rules and guidelines for state incentive programs. While a state may have authorized the use of 3rd party solar PV and/or CSP PPAs, it does not mean that these arrangements are allowed statewide in every jurisdiction. For example, municipal utilities may not allow 3rd party solar PV PPAs in their territories even though they are allowed/in use in that particular state's investor-owned utility (IOU) territories.

In the State of Arizona, the authority to establish 3rd party solar PPAs is granted in ACC Decision 7175, Docket E-20690A-09-034.[iii] Based on recent reports, APS would prefer to work with 3rd parties to obtain competitive bids for developing renewable energy assets that are ultimately owned by APS, since this approach has been shown to be more cost-effective than establishing 3rd party PPAs with developers who both own and manage the asset. Further, this approach ensures that APS has the opportunity to develop renewable energy credits (RECs) to satisfy requirements established by the state's Renewable Energy Standard (RES).[iv] The RPS is described in greater detail in the "APS Renewable Energy Incentive Program" section below.

Net Metering Policies

Net metering is an electricity policy for consumers who own renewable energy facilities. "Net" refers to the deduction of energy outflows from metered energy inflows, or in this case, the net or exported energy will be the difference between energy produced by the solar system and energy consumed within the boundaries of the Reservation. Under the State of Arizona's rules, net metering is available to customers who generate electricity using solar, wind, hydroelectric, geothermal, biomass, biogas, combined heat and power (CHP), or fuel cell technologies. The ACC did not set a firm kWh limit on system size capacity, as is found in most other states' net metering policies. Instead, systems must be sized to meet all or part of a customer's electric load in that the system and may not exceed 125% of the customer's total connected load.

If there is no available load data for the customer, the generating system may not exceed the customer's electric service drop capacity. In electric power distribution, a service drop is an overhead electrical line running from a utility pole, to a customer's building or other premises. It is the point where electric utilities provide power to their customers. The customer connection to an underground distribution system is usually called a "service lateral". Conductors of a service drop or lateral are owned and maintained by the utility company. Additionally, the ACC does not set an aggregate capacity limit for all net-metered systems in a utility's territory. The utility must instead demonstrate to the ACC why such a cap should be allowed.

Net metering is accomplished using a single bi-directional meter. Any customer net excess generation (NEG) will be carried over to the customer's next bill at the utility's retail rate, as a kWh credit. Any NEG remaining at the customer's last monthly bill in a calendar year will be paid to the customer via check or billing credit as the utilities avoided cost payment. Therefore, based on the ACC's rules, the Tribe's solar system could earn additional revenue, reconciled annually at an avoided-cost rate by the utility.

APS Renewable Energy Incentive Program

Through the Renewable Incentive Program, APS offers customers who install various renewable energy sources the opportunity to sell the credits associated with the energy generated to APS. Previously, APS only provided incentives for solar technologies, but they expanded the list of qualified renewables in 2008 to include all technologies eligible for Arizona's Renewable Energy Standard (RES). The solar technologies eligible for a rebate include PV, solar hot water, solar HVAC and solar daylighting systems. Up-front incentives for PV may be de-rated based on expected performance. According to the Database of State Incentives for Renewables and Efficiency, potential renewable energy systems are eligible for the following credit amounts:

- Grid-tied PV (residential): $0.50/watt DC, adjusted based on expected performance. See note above about incentive availability.
- Grid-tied PV (non-residential): $0.60/watt DC; or commercial customers may opt for a production-based incentive (PBI) on a 10-, 15- or 20-year contract.
- Off-grid PV (residential): $1.50/watt DC; System must be less than 5 kW.
- Off-grid PV (non-residential): $1.35/W or PBI
- Solar hot water systems (residential): $0.50/kWh estimated first-year energy savings based on OG-300 ratings, up to 50% of the system's cost.
- Solar hot water systems (commercial): Up to $0.68/kWh estimated first-year energy savings based on OG-300 ratings for small systems. For large SWH systems, customers can receive $0.41/kWh estimated first year energy savings, or may choose a 10, 15 or 20 year PBI. Incentives are limited to 50% of total system cost.
- Solar Daylighting (non-residential only): $0.20/kWh anticipated first year savings.
- Other solar technologies (non-residential only): PBI amount varies by contract length and technology.

APS recently established a net metering pilot program for systems of 100 kW-DC or less. Funds are assigned through a reservation process. All necessary forms can be downloaded from the program website.

APS is also purchasing solar credits and RECs to help the company meet the state's RES. Participating customers receive a one-time rebate or receive an incentive based on system output or kWh savings. APS will have access to the credits for the life of the RES program. A summary of APS' RES program is provided in the following table.

Table 2. Summary of APS Renewable Energy Incentive Program

Incentive Type	Utility Rebate Program
Eligible Renewable/Other Technologies	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Solar HVAC, Solar Pool Heating, Daylighting, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation Technologies
Applicable Sectors	Commercial, Residential
Amount	PV incentives may be de-rated based on expected performance
	Grid-tied residential PV: $0.50/watt; see below for more information
	Off-grid residential PV (less than 5 kW): $1.50/watt DC;
	Grid-tied non-residential PV up to 30 kW: $0.60/W
	Grid-tied non-residential PV over 30 kW: production-based incentive (PBI)
	Off-grid non-residential PV: $1.35/W DC or PBI
	Residential/small solar water heating: $0.50/kWh of estimated first-year savings
	Non-residential solar water heating: up to $0.68/kWh of estimated first-year savings
	Large solar water heating and solar HVAC systems: production based incentive
	Solar Daylighting: $0.20/kWh estimated first year savings
	Grid-tied wind systems (residential and non-residential):$2.25/W
	Off-grid wind systems (residential and non-residential):$1.80/W Other renewables: performance-based incentive
Maximum Incentive	PV: 40% of project costs. Up-front incentive payment is limited to $75,000
	SWH: 50% of system costs
Eligible System Size	Minimum for off-grid systems: 5 kW
	Maximum for large PV: 2 MW
	Under the small SWH system incentive, systems must have OG-300 ratings of 10,000 kWh per year energy savings. "Large" SWH systems have minimum 5,000 kWh/yr. estimated energy savings
Equipment Requirements	SWH systems must be certified to SRCC OG-300 standards
Installation Requirements	PV systems must be installed by a licensed contractor holding one or more of the following certifications with the Arizona Registrar of Contractors: C-11, K-11, L-11.
	SWH systems must be installed by a licensed contractor holding one or more of the following certifications with the Arizona Registrar of Contractors, C-37, C-37R, K-77, K-78, L-77, L-78.
Ownership of RECs	APS
Funding Source	RES Surchage
Web Site	http://www.aps.com/main/green/choice/choice_23.html?source=hme

Source: Database of State Incentives for Renewables and Efficiency. Accessed online at http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=AZ03R&re=0&ee=0 on August 13, 2012.

Sales Tax Incentives for Renewables

Arizona provides a sales tax exemption* for the retail sale of solar energy devices and for the installation of solar energy devices by contractors[v]. The statutory definition of "solar energy device" includes wind electric generators and wind-powered water pumps in addition to daylighting, passive solar heating, active solar space heating, solar water heating, and PV systems. The sales tax exemption does not apply to batteries, controls, etc., that are not part of the system. Note that HB 2429, enacted in June 2006, eliminated the $5,000 limit per device.

To take advantage of these exemptions from tax, a solar energy retailer or a solar energy contractor must register with the Arizona Department of Revenue prior to selling or installing solar energy devices (Arizona Form 6015, Solar Energy Devices – Application for Registration). The Arizona Department of Commerce Energy Office has compiled a guide to the solar energy devices that qualify for exemption under the statutory definition. It is possible to petition the Arizona Department of Commerce to add additional items if they qualify per the statutory definition.

SB 1229 of 2012 extended this exemption to the sale of RECs. As previously described, RECs are typically sold by a renewable energy generator to a utility to company so that company can demonstrate its compliance with the state's renewable energy standard. SB 1229 clarified that sales tax should not be applied to those transactions.

**Technically, the law allows retailers to deduct the amount received from the sale of solar energy devices from their transaction privilege tax base, and similarly, it allows prime contractors to deduct proceeds from a contract to provide and install a device from their transaction privilege tax base.*

Tax Credits for Renewables

There are numerous corporate and residential tax credit programs in Arizona; the relevant corporate tax credit program is described below. It is our current understanding that residential consumers of electricity would not be eligible for personal tax credit due to the absence of residential tax liability.

Corporate Tax Credits

Corporate tax credits may be utilized by tribally-owned enterprises with federal tax liabilities. Specifically, Senate Bill 1254 of 2010 created a tax credit for electricity produced by certain renewable resources. Qualified renewable energy systems installed on or after December 31, 2010, may be eligible for the tax credit based on the amount of electricity produced annually for a 10-year period. The Arizona Department of Revenue (DOR) will accept applications annually between January 2 and January 31 of the year following the year for which the credit is being claimed. The DOR will approve the applications on a first-come, first-served basis until the annual cap of $20 million has been reached. This cap includes both personal and corporate tax credits combined. The DOR will maintain a list of approved applicants. Once a taxpayer is given a position in the list, the taxpayer will remain in that position for the full 10-year period, but the taxpayer must submit a new application every year. If the taxpayer fails to submit a completed application within the one-month window in which the DOR accepts applications, the taxpayer will forfeit the taxpayer's position in the list. If a taxpayer loses position in the list, the taxpayer may apply in the following year for a new position in the list.

The maximum tax credit that can be claimed for a qualified system in any one year is $2 million. The tax credit for wind and biomass* systems equals $0.01 per kilowatt-hour (kWh) for the first 200,000 megawatt-hours (MWh) of electricity produced in a calendar year for a period of ten years. The tax credit for photovoltaics (PV) and solar thermal electric systems varies depending on the year of electricity production according to the following schedule:

- Year 1: $0.04 per kWh

- Year 2: $0.04 per kWh
- Year 3: $0.035 per kWh
- Year 4: $0.035 per kWh
- Year 5: $0.03 per kWh
- Year 6: $0.03 per kWh
- Year 7: $0.02 per kWh
- Year 8: $0.02 per kWh
- Year 9: $0.01 per kWh
- Year 10: $0.01 per kWh

Application materials can be found at the DOR website: http://www.azdor.gov/TaxCredits/RenewableEnergyProductionTaxCredit.aspx.

CONCLUSION

The purpose of this Technical Memorandum is to describe available funding mechanisms and provide access to additional resources that can help the SCAT understand how solar PV and/or solar CSP system development may contribute to the Tribe's long-term goals relating to sovereignty, sustainability, and financial security.

Based on preliminary analysis, the Reservation appears to have significant resources conducive to developing a solar asset. While solar power generally costs more per kWh, there may be tangible social, environmental, and financial benefits that justify the SCAT acting as a project developer or establishing an alternative energy organization structure (e.g. joint ventures, etc.) that would enable the Tribe to develop residential- or commercial-scale solar PV or CSP capacity.

A critical component of the SCAT feasibility assessment involves investigating financial incentives that could defer the increased capital costs of developing a solar asset. There are a number of considerations that determine eligibility for the previously described federal- and utility-sponsored incentives; in many cases tax liability is required to take full advantage of federal- and utility-sponsored funding mechanisms.

Parametrix is in the process of completing Phase 1 of the Solar Feasibility Assessment, as described in the Project Narrative of the project contract. The results described in this Technical Memorandum will be integrated in Phase 2 when the project team completes a detailed assessment of residential- and commercial-scale solar PV and solar CSP development costs and investigates trade-offs between alternative solar asset development scenarios.

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[i] Douglas MacCourt (June 2010). Renewable Energy Development in Indian Country: A Handbook for Tribes. A Project for the National Renewable Energy Laboratory. Subcontract Report NREL/SR-7A4-48078.
[ii] EPA. Green Power Partnership: Solar Power Purchase Agreements. Accessed online at http://www.epa.gov/greenpower/buygp/solarpower.htm on August 13, 2012.
[iii] Arizona Corporation Commission Decision 7175, Docket E-20690A-09-034. Accessed online at http://images.edocket.azcc.gov/docketpdf/0000114068.pdf on June 15, 2012.
[iv] Arizona Public Service Company. 2012 RES Implementation Plan Frequently Asked Questions. August 16, 2011. Accessed online at http://www.aps.com/_files/renewable/2011-RES-FAQ.pdf on August 13, 2012.
[v] Arizona Solar Center. Accessed online at http://www.azsolarcenter.org/economics/tax-breaks.html on June 15, 2012.

APPENDIX B
Development Financing

Introduction

In May 2012, Parametrix began assisting the San Carlos Apache Tribe (Tribe) in assessing the feasibility of developing both commercial- and community-scale solar assets on the Reservation. For the purposes of this investigation, commercial-scale solar development is defined as a solar asset designed to produce sufficient electricity to enable the Tribe to become a net exporter of energy, and a community-scale solar asset is one that is designed to produce sufficient energy to meet all or some of the Tribe's on-Reservation electrical power demand.

The Solar Feasibility Study (Study) scope of work occurred in two phases. Phase 1 generally involved identifying and assessing technology and system design alternatives and identifying a list of sites to be further vetted. Phase 2 involved a more detailed analysis of power load-transmission and other factors, including an assessment of business planning relevant to the recommended alternatives for the Tribe to develop a solar resource or resources.

Building on the Tribe's *Energy Organization Analysis* (EOA) adopted in 2012 and the results of Phase 1 of the Study, this memorandum (Appendix B of the Study report) identifies and evaluates financial considerations relevant to renewable energy development business planning. Specifically, this assessment involved analyzing the preferred business and financial scenarios to identify the financial structures most compatible with community-scale solar asset development. This Appendix B does not consider the business forms best suited to supporting renewable energy and energy efficiency programs, nor for the long-term operation and maintenance of electrical energy infrastructure and retail sales.

This memorandum is associated the *Business Planning* section of the Study report. The *Business Planning* section of the Study report describes and updates the outcomes of the EOA as applied in the last year to formation of an energy corporation and/or energy utility to support the development of a community-scale solar facility at the Tribe's Apache Gold Casino/Resort. This Appendix B memorandum to the Study report includes:

- Background information on solar asset development, including details on typical project development phases and how these relate to financing strategies.
- Key recommendations from the Study to identify relevant project development and financing strategy alternatives based on the initial vetting of site and development alternatives.
- Possible financing strategy and business plan.

The purpose of this analysis and our recommendations is to provide the Tribe with a framework for solar asset development and financing, inform expectations of project development, and recommend an approach that will position the Tribe to realize their goals of energy independence and minimize risk associated with financing development of energy infrastructure.

Solar Asset Development and Financing Strategy

Prior to finalizing planning and development, and while carefully mapping out the interconnection process, it is important for the Tribe and others seeking to develop renewable energy projects to consider the role that the Tribe seeks to have in developing the project. Associated tax, financing and permitting options and compromises should be vetted in the context of the Tribes preferred role(s). As outlined in the following table, there are tradeoffs associated with the various roles that the Tribe may take in developing a community-scale solar asset.

There are several alternatives for the Tribe to consider when evaluating its desired role in solar asset project planning and development relevant to both commercial- and community-scale development, ranging from:

1. Project with no tribal ownership,
2. Planning and development of the community-scale solar asset could be contracted out to a developer to
3. Project can be developed through multiple smaller contracts, where the Tribe acts as the general contractor.
4. A build-own-operate-transfer structure where an outside developer would capitalize the project, operate it for some duration (at least until any tax credits expire that can only be secured by an outside taxable organization), then transfer the project to the Tribe, perhaps retaining a minority interest in the project for a period of time.

The third and fourth options require more internal tribal management capacity and expertise than the first two. The following figure illustrates the typical phases of renewable energy project development.

Figure 1: Project Development Phases

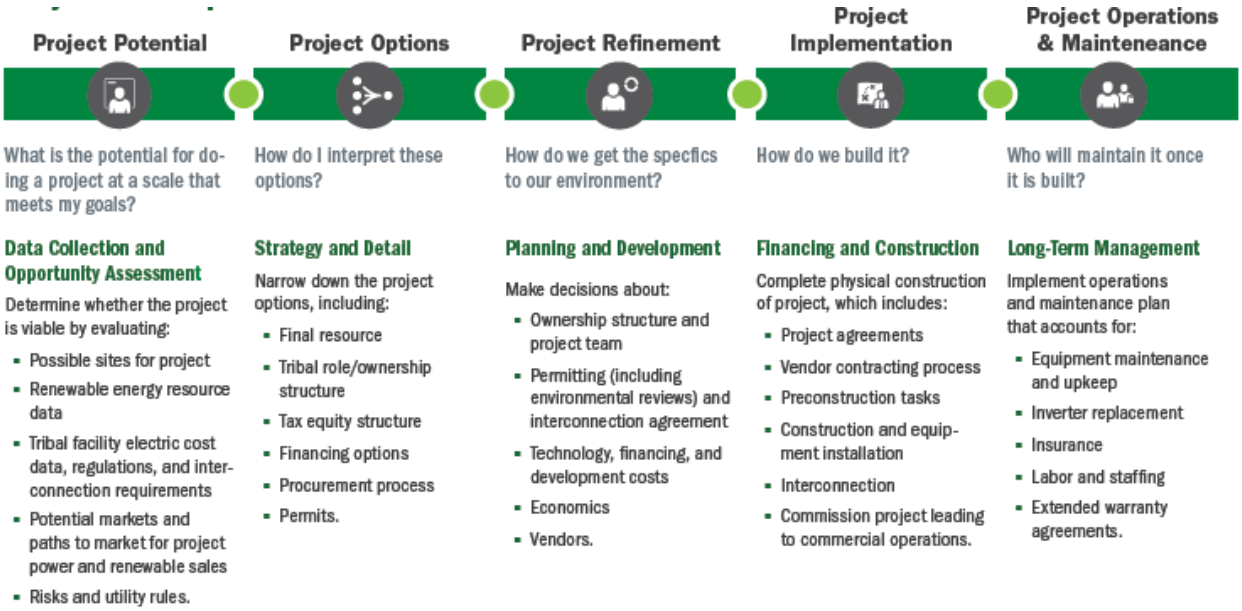

Figure 2: Tribal Roles in Solar Asset Development

Role	Opportunity	Constraints	Comments
Project Developer	Control and self-determination of project; potential for profits	Investors require experience Development risks without portfolio diversification may not make business sense Community investment portfolio may not seek high risk/return investments	Tribal interests may be best served by outsourcing this risk Assembling a portfolio of projects is a typical method to mitigate risk
Lender/Capital Provider	Participate financially in project with lower risk	Requires ready capital May be cost prohibitive to document and manage a single debt transaction	Requires knowledge of lending practices
Investor	Provide cash for project development	Requires ready capital, or unique source of capital that provides market advantage (like NMTC)	Must compete with other investment opportunities Option for Tribes with limited lands
Resource Owner (Lessor)	Low risk, known reward, consistent income	Limited project control	Limited upside, limited risk
Off-Taker	Purchasing clean energy from an "on-site" provider; security	Limited investment, economic development, and capacity-building opportunity	Implies load-serving entity (utility) or some other purchasing demand

Source: U.S. Department of Energy Office of Indian Energy (2012). *Developing Clean Energy Projects on Tribal Lands: Data and Resources for Tribes*. Accessed online at http://www.nrel.gov/docs/fy13osti/57048.pdf on 4/8/2013.

At some point in the development process, project financing and the "deal structure", or the defined role of the Tribe and its partners and/or contractors, becomes inseparable. The financing of tribal renewable energy projects will be challenging and will probably have to be project-specific. Project financing partners will have some say over the management and oversight of the structure; the degree to which Tribe provides financing or takes an active role in contracting with entities to develop the project will determine the degree to which the Tribe has both near-term and ultimate control over the project, as well as the timing of transitions in control.

Parametrix prepared a separate memorandum (Appendix A in this Study report) for the Tribe that identifies relevant federal, state and utility-sponsored incentives, which collectively influence the economic feasibility of solar asset development. As described in that memorandum, tribal tax-exempt status, and the federal tax incentives that are available, will likely require some sort of partnership with a taxable non-tribal organization to take full advantage of available tax credits and certain sources of financing. As discussed in the Study report, early 2013 decisions by the Arizona Corporation Commission to "zero-out" renewable energy credits removed an incentive option that the Tribe had been using with some success in attempting to develop a 1.1 MW solar asset at the casino/resort.

Key Recommendations the Solar Feasibility Study

Phase 1 of the Solar Feasibility Study resulted in a recommendation that the Tribe pursue and further vet opportunities to develop community-scale solar projects using solar photovoltaic (PV) technologies. Commercial-scale projects are NOT recommended as there is no commercial transmission power lines of

115kV or greater anywhere on the Reservation. New and very expensive power transmission would to be extended between 20 to 70 miles to directly interconnect the Reservation into the regional power grid. Community-scale projects will off-set local energy demand and associated retail power costs and achieve energy self-sufficiency but will not require the significant investment (up to an estimated $48 million) needed to build necessary new transmission-scale power lines. Community-scale solar facilities are also less expensive in and of themselves. For example, the feasibility study estimates that a 5MW community-scale facility on the Peridot Mesa would cost approximately $15 million, including the cost of building a new ¾-mile distribution-scale power line to interconnect with the SCIP distribution system at the base of the Mesa. The additional equipment to connect directly to the SCIP 69kV transmission line atop the Mesa would increase the cost by $4 million or more.

In the area of Cutter and the Apache Gold Casino/Resort, served by APS Power, a 1MW to 2MW community-scale ground-mounted solar PV system powering the casino/resort complex is recommended. In Bylas, served by the Graham County Electric Cooperative (GCEC), individual roof-top or ground-mounted solar PV is suggested for the existing commercial district and new school, with solar being included in residential development plans for the planned 6,300-acre Bylas new community. In San Carlos and Peridot, served by the San Carlos Irrigation Project (SCIP), the key recommendation is to build between 5MW and 10MW of solar power generation in phases atop the Peridot Mesa which would off-set up to 100% of the peak and annual power loads within the SCIP service territory (primarily the communities of San Carlos and Peridot).

Recommended Financing and Business Approach

Given the technical and economic resources at the Tribe's disposal, and the tradeoffs associated with the various roles that the Tribe could play in the project development and financing process, it is recommended that the Tribe, at a minimum, take on the roles of "Resource Owner" and "Off-Taker" as described in Table 1 above.

In addition, if the Tribe determines that it has sufficient capital and human resources to invest in the planning and developing the solar asset, the Tribe may also seek to act as an "Investor". If the Tribe chooses to be an active investor in the project, it is recommended that the Tribe form a limited liability corporation (LLC), or use one of the forms of incorporation unique to tribes under federal law, to implement a project development plan and aggregate funds. The tribal corporation would likely seek to partner with an outside investment and/or development entity through a joint venture or some other contractual agreement. Additional information on possible forms of tribal corporations is included in the *Business Planning* chapter of this Study report, and in the Tribe's 2012 *Energy Organization Analysis* (EOA) report.

The Tribe's energy corporation could loan funds to its investment and development partner, which would most likely be a private taxable corporation, to finance community-scale solar installations. The private corporation would invest its own equity, and if necessary, borrow additional funds from a commercial lender. Initially, the private corporation might be the sole owner of the physical solar assets with the Tribe retaining underlying property ownership, and thus would benefit from production tax

credits and depreciation incentives not available to the Tribe. The tribal energy corporation should retain the option to eventually purchase or assume ownership the physical solar assets after a specified period of time, such as ten years.

In this hypothetical development scenario, the Tribe's energy corporation would initially receive interest income from its loan to the private partner. Further, the private corporation would pay only interest on its debt to the Tribe, with the principle of the balance due at the end of a pre-defined timeline, such as ten years. At the end of this period, the Tribe could choose to purchase the physical solar assets from the private partner at a pre-negotiated price equal to the principle amount owed to the tribal energy corporation. At this time, the tribal energy corporation would become the sole owner of the solar asset, which could be profitably operated for its remaining life. [i] The tribal corporation or the Tribe directly could also accrue revenues by sharing energy purchase saving with the direct beneficiaries. The best example is the casino/resort which is operated by an independent tribal enterprise. In developing plans for the initial 1.1MW solar facility at the casino/resort (see various section of this Study report for more information) the Tribe and casino enterprise have conceptually considered that the casino enterprise would share reduced power purchase cost in the form of cash payments to the tribal energy corporation. These payments would be used to underwrite energy corporation operational and administrative expenses.

As noted earlier in this appendix, the development of solar facilities will eventually translate to maintenance and operations (O&M), and capital replacement, responsibilities on the part of the Tribe. APS and GCEC have renewable energy support programs and net metering policies that would potentially simplify the Tribe's eventual O&M role in the sense that the solar plant would just be another piece of tribal infrastructure. Subject to developing the specialized skills requiring in maintaining solar PV arrays and electrical systems, a wide potential wide range of tribal government and enterprise staff could be assigned. A large community-scale solar PV system using the SCIP power distribution network and potentially off-setting 100% of SCIP power purchases would not be as simple. The Tribe should anticipate that SCIP may have very limited ability or economic interest to continue to maintain the current distribution system if power purchases are fully off-set by tribally-owed solar PV. Even the initial connection of a smaller phase of the Peridot Mesa facility may be an issue. The Tribe should anticipate the need to form a tribal energy operating utility as part of any government-to-government negotiations. Several section of the is Study report and the Tribe's 2012 EOA discuss these issues in more detail.

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[i] U.S. Department of Energy: Energy Efficiency and Renewable Energy. Project Financing. Accessed online at http://www1.eere.energy.gov/tribalenergy/guide/financing.html on 4/8/13.

APPENDIX C
Environment Field Notes

Summary of Environmental Considerations
San Carlos Apache Reservation Commercial-scale Solar Sites

Site Name: Casino West

Date Visited: 3 October 2012

Elevation: 3241'

Slope / Aspect / Topography: Generally flat in narrow bands near the highway and on the north end of the site, with extensive hilly terrain in between.

Current Land Use: Unoccupied. Plans for a small (6 acre +) shopping plaza on the SE portion of the site.

Nearest Human Habitation: Several houses and other development (esp. hotel and casino) within one to two miles, mostly along the highway.

Vegetative Cover: Mesquite, acacia, rabbitbrush, yucca, ranging from sparse to moderately dense.

Soils: Soils range from rocky to sandy. Sites on or near the hills would be challenging - likely not feasible.

Evidence of Surface Erosion: On the north end of the site there is an arroyo with evident flow patterns and soil movement. Erosion from the hillslopes is also evident. Some areas on the north end of the site appear more stable.

Visual Resources: If developed on the north side of the hills, site would be visible from the highway, and possibly residences and the hotel.

Water Resources at or Near Site: There is a wash that runs parallel to the highway along the north end of the site.

Threatened or Endangered Species Concerns: None are apparent.

Other Wildlife: cottontails, jackrabbits, and small mammals. There is some habitat for migratory birds, especially in the mesquite along the wash. On the north side (away from the highway) there are likely deer and javelin. Overall wildlife diversity appears to be low to moderate.

Cultural or Historic Resources: None seen during visit. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: None seen during visit. Should be evaluated by further, if appropriate.

Recommendation: Site provides little contiguous area for commercial scale development and challenging conditions with the wash and hillsides. We recommend not pursuing examination of this site further.

Site Name: Old Winkelman Road

Date Visited: 3 October 2012

Elevation: 3324’

Slope / Aspect / Topography: Mostly flat with a few gently rolling hills.

Current Land Use: Open land.

Nearest Human Habitation: There are several scattered homesites on the South side of the site. There are also apparently many undeveloped allotments and homesites within the current boundaries of the proposed site.

Vegetative Cover: Sparse creosote, mesquite, and smaller shrubs.

Soils: Clay to Sandy soils dominate the site.

Evidence of Surface Erosion: There is extensive surface erosion and movement of soil and water in Gilson wash, which bisects the site.

Visual Resources: Any development at the site would be visible from the highway, and from the homes near the site.

Water Resources at or Near Site: Gilson Wash.

Threatened or Endangered Species Concerns: None are apparent.

Other Wildlife: Cottontails, jackrabbits, javelina, songbirds, and small mammals. The mesquite habitat in the wash provides good songbird habitat.

Cultural or Historic Resources: None seen during visit. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: None seen during visit. Should be evaluated by further, if appropriate.

Recommendation: Due to the possibility of frequent flash floods and unstable soils in Gilson Wash, it is recommended that this site be dropped from consideration.

Site Name: Highway 170 - Cutter

Date Visited: 3 October 2012

Elevation: 2801’

Slope / Aspect / Topography: Generally flat, with very mild slope to east, along the gradient of Gilson Wash. Hills on south end of site rise to approximately 40 feet.

Current Land Use: Mostly open land with several residences. Some light grazing, and past agricultural use. Future plans may call for an expansion of agriculture within the site boundary.

Nearest Human Habitation: Several homesites along Cutter Road.

Vegetative Cover: Mesquite, ironwood, creosote, and mixed grasslands.

Soils: Mostly sandy to silty in the lower areas, with gravelly and rocky soils on the hillslopes.

Evidence of Surface Erosion: Though there are extensive areas of open flat terrain with stable soils, much of the site is traversed by Gilson Wash, which is subject to extensive and frequent surface flows, leading to moderate surface soil loss.

Visual Resources: Development at most areas within boundaries of site would be visible from Cutter Road and from some homesites.

Water Resources at or Near Site: Gilson Wash, an ephemeral arroyo.

Threatened or Endangered Species Concerns: None.

Other Wildlife: cottontails, jackrabbits, and small mammals. Mesquite and other riparian vegetation along the wash provides habitat for migratory birds.

Cultural or Historic Resources: None seen during visit other than abandoned house and barn of uncertain age. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: None seen during visit. Should be evaluated by further, if appropriate.

Recommendation: Due to concerns about Gilson Wash and soil stability, site should be eliminated from further consideration.

Site Name: Tufa Stone

Date Visited: 2 October 2012

Elevation: 2825'

Slope / Aspect / Topography: Generally flat with slight variations in topography throughout the site, and a slight (1%) southern slope.

Current Land Use: Appears to be mainly used for grazing. An old landfill is present at the site.

Nearest Human Habitation: Several housing subdivisions are within a mile of the southern end of the site.

Vegetative Cover: Sparse creosote, mesquite, grasses, snakeweed, and other shrubs.

Soils: Sandy to silty soils dominate the site. There is a wash that runs approximately down the middle of the site, with shifting fine-grained soils.

Evidence of Surface Erosion: A wash runs through the middle of site, with mild to moderate erosion and soil movement. Other areas appear stable, especially to the north and west.

Visual Resources: Depending on siting, site would likely not be visible from the housing subdivisions.

Water Resources at or Near Site: Tufa Stone tank is at the southern end of the site.

Threatened or Endangered Species Concerns: None are apparent.

Other Wildlife: Cottontails, jackrabbits, deer, javelina, songbirds, small mammals. Tufa Stone tank provides excellent wildlife habitat and any development should avoid this area.

Cultural or Historic Resources: None seen during visit. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: There is an old landfill near the middle of the site along the eastern boundary. Though this could create concerns, it also provides opportunities, e.g. with EPA's Brownfields to Greenfields program.

Recommendation: The area is large and areas exist for potential development. The best zones are on the far north and west ends of the site, which are the flattest with the most stable soils. Unfortunately, these are also the areas furthest from current development, and would require extensive transmission lines and roads (the current road is in poor condition and would need improvement).

Site Name: Highway 170 – San Carlos

Date Visited: 3 October 2012

Elevation: 3220’

Slope / Aspect / Topography: Generally flat with slight variations in topography throughout the site, and a slight (1%) eastern slope.

Current Land Use: Some private land, houses, and open space.

Nearest Human Habitation: Several houses are interspersed throughout the site.

Vegetative Cover: Mesquite, ironwood, and creosote, with other low shrubs and grasses.

Soils: Sandy to silty soils dominate the site.

Evidence of Surface Erosion: Gilson Wash runs though the site, and has the potential for relatively large flows and considerable movement of surface water and soils. Other areas outside the wash appear stable.

Visual Resources: Depending on siting, development would likely not be visible from the houses and from traffic along either Highway 170 or the Old San Carlos Road.

Water Resources at or Near Site: Site is near city water infrastructure. Gilson Wash traverses much of the site.

Threatened or Endangered Species Concerns: None are apparent.

Other Wildlife: Cottontails, jackrabbits, deer, javelina, songbirds, small mammals. Thick and high mesquite along Gilson Wash provides good songbird habitat.

Cultural or Historic Resources: None seen during visit. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: Scattered household trash is evident throughout much of the site. Should be evaluated further by specialists, if appropriate.

Recommendation: Due to the presence of Gilson Wash, the hilly topography on some portions of the site, and the potential for visual intrusion, we recommend not pursuing this site for further consideration.

Site Name: Mesa West

Date Visited: 2 October 2012

Elevation: 2850'

Slope / Aspect / Topography: Generally flat with slight variations in topography throughout the site, and a slight.

Current Land Use: Open space – appears to be mostly used by wildlife.

Nearest Human Habitation: Several housing subdivisions are within a mile of the southern end of the site.

Vegetative Cover: Sparse creosote, ephedra, mesquite, prickly pear, and grasses. Little interstitial ground cover.

Soils: Sandy to gravelly to rocky.

Evidence of Surface Erosion: Mild evidence of some surface flows, but site soils are generally stable, despite the lack of ground cover.

Visual Resources: Any development at the site would probably be mostly invisible from the Highway and from Old San Carlos Road.

Water Resources at or Near Site: None.

Threatened or Endangered Species Concerns: None are apparent.

Other Wildlife: Cottontails, jackrabbits, deer, javelina, songbirds, small mammals. The area is relatively roadless, and attracts wildlife.

Cultural or Historic Resources: None seen during visit. SCAT staff mentioned artifacts that have been found in the wash at the north end of the site. There are areas that some tribal members may consider "holy ground." This should be evaluated further by CR specialists.

Evidence of Dumping or Environmental Contaminants: No evidence was seen, but an old landfill is apparently present on the site. This should be investigated by specialists, if appropriate.

Recommendation: A relatively low priority site, but no major environmental roadblocks are apparent. If the site does have an old landfill, it opens up Brownfields to Greenfields funding. The cultural areas should be documented.

Site Name: Peridot Mesa

Date Visited: 2 October 2012

Elevation: 2960'

Slope / Aspect / Topography: Generally very flat with slight variations in topography, and a slight (1%) north slope.

Current Land Use: Main use is for Peridot mining, which is conducted in a relatively small area near the center of the mesa. There are no permanent structures on top of the Mesa, but there are houses on the north side of the mesa.

Nearest Human Habitation: Several houses and other development on the north and east sides of the mesa.

Vegetative Cover: Sparse mesquite and other small shrubs, Russian thistle, and sparse grasses.

Soils: Rocky to gravelly volcanic soils appear very stable.

Evidence of Surface Erosion: Little evidence of surface erosion or soil movement due to the rocky nature of the soils and the relatively flat topography.

Visual Resources: Depending on siting, any development might not be visible from the town or from houses around the base of the mesa.

Water Resources at or Near Site: None.

Threatened or Endangered Species Concerns: None are apparent.

Other Wildlife: Cottontails, jackrabbits, and small mammals. Due to the sparse vegetation, there is little wildlife habitat on top of the mesa.

Cultural or Historic Resources: None seen during visit. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: None seen during visit. Should be evaluated by further, if appropriate.

Recommendation: This site is probably the most feasible for any future commercial scale development. It is flat, with stable soils and a very slight north aspect. There would be little concern from shading. Considerations include avoiding and preserving the peridot mining areas, minimizing impacts to the residences on the north and east sides of the mesa.

Site Name: Coolidge

Date Visited: 2 October 2012

Elevation: 2610’

Slope / Aspect / Topography: Ranges from flat to gently rolling hills.

Current Land Use: Open land.

Nearest Human Habitation: Peridot. No human habitation within 5 miles of site.

Vegetative Cover: Sparse creosote in the south of the site, Mesquite in the north; also barrel and prickly pear cactus, ephedra, and other shrubs and grasses.

Soils: Sandy to Rocky soils dominate the site.

Evidence of Surface Erosion: Rocky areas have the most stable soils. Some sandy areas, especially the hills, have evidence of surface flows and unstable soils.

Visual Resources: The nearest well-travelled road or human habitation is quite far, and the potential for conflict over visual resources is low.

Water Resources at or Near Site: San Carlos River (0.5 miles) and San Carlos Reservoir (2 miles).

Threatened or Endangered Species Concerns: None are apparent. The San Carlos River has some Southwestern willow flycatcher habitat.

Other Wildlife: Cottontails, jackrabbits, deer, javelina, songbirds, small mammals. The remoteness of the area likely means that wildlife are relatively undisturbed compared to other sites.

Cultural or Historic Resources: None seen during visit. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: None were noted during the site visit, but it was reported that there is an old dumping ground just north of the site.

Recommendation: The area is large and flat with potential for development, but distant from existing infrastructure (aside from the San Carlos dam and the associated transmission lines). Vandalism at remote sites is a consideration. The largest area of flat undeveloped ground is in the southeastern portion of the site.

Summary of Environmental Considerations
San Carlos Apache Reservation Community-scale Solar Sites

Site Name: Point of Pines

Date Visited: 2 October 2012

Elevation: 5940'

Slope / Aspect / Topography: Mostly flat.

Current Land Use: Open land, wildlife habitat, youth camp, University research, forestry department staging area, ranching, hunting.

Nearest Human Habitation: There are several cabins and homes at Point of Pines, which is largely inhabited during the summer.

Vegetative Cover: Ponderosa pine forests, with expansive meadows.

Soils: Sandy and loamy soils dominate the area.

Evidence of Surface Erosion: Little evidence of surface erosion. The area largely has stable soils and good ground cover.

Visual Resources: Any development at the site would have to be undertaken in relatively open areas, which would likely be visible from activity centers.

Water Resources at or Near Site: A few stock tanks.

Threatened or Endangered Species Concerns: Mexican gray wolves inhabit the area.

Other Wildlife: Elk, deer, and smaller animals and birds are abundant.

Cultural or Historic Resources: None seen during visit. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: There are several old tanks, buildings, and debris scattered over the area.

Recommendation: The Point of Pines area in general is large, flat, and expansive. A community scale solar project is definitely feasible. Currently, however, the area gets its power for free from the Morenci Mine, so there is little incentive to develop the site for solar energy. If this situation changes, the area could be used.

Site Name: Unnamed Mesa Northwest of San Carlos Government Center

Date Visited: 1 October 2012

Elevation: 2840'

Slope / Aspect / Topography: Generally very flat, with very mild (1%) slope to north

Current Land Use: Unoccupied. There is a graveyard on the lower slopes to the west.

Nearest Human Habitation: Many houses within one mile in two subdivisions on E and W sides of Mesa make this a potentially feasible community scale site.

Vegetative Cover: Prickly pear, grasses, snakeweed and other shrubs. Vegetation generally very sparse.

Soils: Rocky volcanic soils appear very stable.

Evidence of Surface Erosion: Very low due to rock soil and low gradient.

Visual Resources: Solar development would likely be visible from many locations in and around San Carlos and the nearby subdivisions, less so from close to the Mesa.

Water Resources at or Near Site: None on the Mesa top.

Threatened or Endangered Species Concerns: None.

Other Wildlife: cottontails, jackrabbits, and small mammals. A few migratory birds. Overall wildlife diversity on the mesa top appears low.

Cultural or Historic Resources: None seen during visit other than abandoned house and barn of uncertain age. Should be evaluated further by CR specialists, if appropriate.

Evidence of Dumping or Environmental Contaminants: None seen during visit. Should be evaluated by further, if appropriate.

Recommendation: A good site to consider for community-scale development, except for the extremely difficult access which would require significant road improvements.

APPENDIX D

Phase 1 Commercial-Scale
Site Descriptions

PHASE 1 COMMERCIAL-SCALE SITE DESCRIPTIONS

Old Winkleman Road

This site was the focus of the original US DOE Tribal Energy Program grant application for this Study. The grant application was broadened to consider a wider Study area and community-scale development prior to award. This site is approximately one mile west of the casino/resort and extends from the west end of the San Carlos Apache Airport buffer zone to Old Winkleman Road. The Gilson Wash meanders across the front of site roughly parallel to the highway. The site also fronts onto Old Winkleman Road to the west. Low hills angle along the east side of the site.

Approximate Size

At up to 140 acres, the site size is adequate for commercial-scale solar PV generation with a nominal capacity based on the gross area of the site of approximately 28 MW.

Slope and Aspect

The site is essentially flat, although crossed by many intermittent stream channels and shallow gullies.

Electrical power transmission

APS is the power service provider. APS has a wide range of incentive and partnership programs available for renewable power, as demonstrated by the preliminary renewable energy credit (REC) that the Tribe received in mid-2012.

A local power distribution line runs down Old Winkleman Road and with feeder lines branching out to serve individual home sites to the west and east. The primary APS local distribution line parallels US 70 across the front of the site, and crosses to the north side of the US 70 just before the airport runway buffer zone. There is an APS switching station at the Reservation boundary west of this site just south of US 70. The nearest substation interconnected to power transmission lines of 115 kV or greater and to the regional power grid is over two miles distant in Globe, Arizona.

None of the power lines crossing or near to this site could export the commercial power loads that could be generated. There is no nearby substation to convert the solar power. An on-site substation would be required even if transmission capacity was adequate.

Transportation infrastructure

US 70 runs across the full north frontage of the site. Old Winkleman Road runs along the full west frontage. Old Winkleman Road is graveled but wide and well maintained. Two narrower gravel roadways cross from Old Winkleman Road to access approximately a dozen homes in the low hills to the east and southeast. The first access crosses the site on the diagonal roughly along the southern edge of the Gilson Wash floodplain described under the *Environmental and Natural Resource Features* section below. This access road would probably have to be relocated as part of any solar site development. The second access road crosses below the south end of the site.

Transportation infrastructure is adequate for both construction and operational phases, although access controls may limit use of the highway in both construction and operational phases. Old Winkleman Road would probably have to be repaired and upgraded at the end of the construction phase.

Existing and planned land uses

In the late 1980's the Tribe designated the 70 to 80 acre highway frontage section of this site for future commercial development. In 2009, the Tribe indicated the site could be used for solar development. This "highway" site was expanded for the purposes of this Study to include additional areas to the south.

There is one home on the west side of the site abutting Old Winkleman Road and a cluster of homes just outside of the site on higher elevations on the east side. The overall site is essentially vacant. Mapping provided by the Tribe indicates that between six to eight deeded but undeveloped home sites overlay the southern portion of the site that is outside of the Gilson Wash floodplain (see discussion re: floodplain below). The status of these vacant deeded home sites is the primary land use constraint impacting solar development.

Environmental and natural resource features

The most significant natural feature on this site is the Gilson Wash. Although flowing only intermittently at this point, the Gilson Wash does flood. While not a frequent occurrence, flooding is regular enough to leave a distinct imprint on the land. The flood hazard area encompasses the majority of the front portion of this site.

Field investigations revealed fine soil deposits and vegetation adapted to intermittently flooded soils, and aerial photography clearly shows the pattern of stream meanders and threads across the landscape. The existing north end gravel access roadway into the site appears to be built along the approximate limit of the historic extent of flooding.

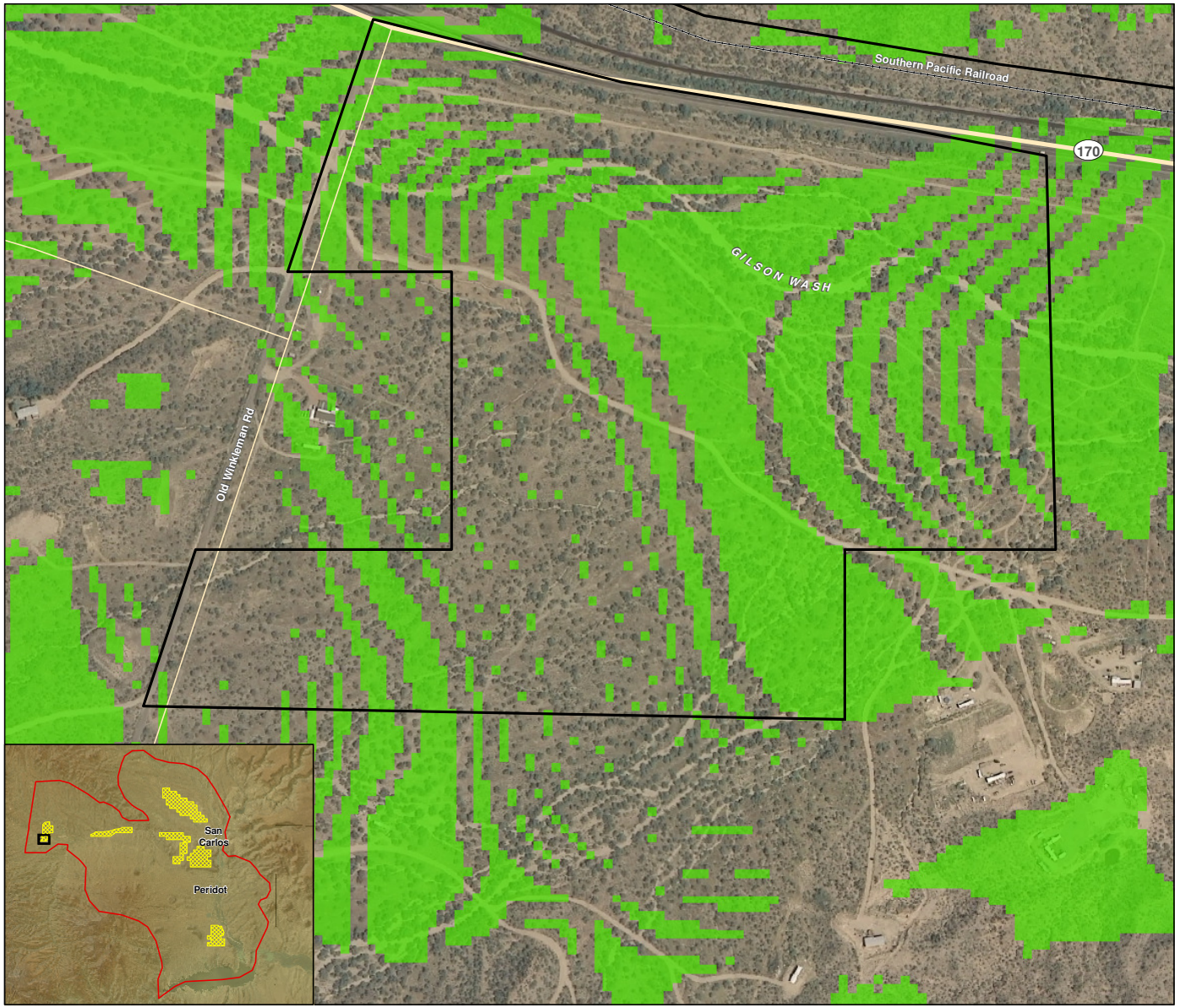
Other factors

A natural gas pipeline crosses the front of the site parallel to US 70. There is a poorly maintained dirt access roadway that follows the pipeline route.

SUMMARY

Irrespective of the availability of adequate transmission, the Old Winkleman Road site is highly constrained by the floodplain of the Gilson Wash along US 70, and by the number of deeded home sites to the rear of the site. Given these floodplain and home site factors, the lack of adequate transmission for commercial-scale power, the relatively small size of the site even before environmental constraints are taken into consideration, and advancing plans for community-scale solar serving the nearby casino/resort complex, the Old Winkleman Road site does not appear to be a key site for either commercial or community-scale solar development.

It is generally recommended that the Tribe focus on developing enough community-scale solar power in and around the casino/resort complex to offset purchased power needs, potentially including the airport and sawmill.



Solar Sites
Old Winkleman Road
132 Acres

Legend

- Study Area
- Potential Solar Site
- Preferable Slope and Aspect
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River

N

0 500 1,000
Feet

San Carlos Apache Tribe

Parametrix
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Figure D-1. Winkleman Site

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Casino/Resort (West)

The center of this site is approximately 0.75 to 1 mile west of the west side of the casino/resort's hotel building. US 70 is along the south side of the site and the Ramboz Wash roughly bounds the north side. The site is crossed by two major ridgelines which eventually converge to the east where three golf course fairways are located. Slopes and aspect are highly variable within this site and in many places fall outside of the Study's baseline parameters for solar development.

Size and Capacity

At up to 460 acres the site size is adequate for commercial-scale solar power generation with a nominal capacity based on the gross area of the site of approximately 92 MW. The most probable location for a solar facility based on the most concentrated area of preferred slope and aspect is the east half of the site, an area of approximately only 100 acres.

Slope and Aspect

Based solely on GIS analysis, this site appeared to have adequate area and enough acceptable slope and aspect factors to merit consideration for commercial-scale solar development. Field investigations revealed that the site has numerous areas with significantly steep slopes. This effectively breaks the overall site into numerous subareas. Site alterations such as grading to combine the various subareas would be extensive.

Electrical power transmission

APS is the power service provider. APS has a wide range of incentive and partnership programs available for renewable power, as demonstrated by the preliminary renewable energy credit (REC) that the Tribe received in mid-2012.

The primary APS distribution line serving the western end of the Reservation parallels the south side of US 70 across the front of this site. Local distribution lines serve two homes at the site's extreme west end of the site. There is an APS switching station at the Reservation boundary west of this site just south of US 70. The nearest substation interconnected to power transmission lines of 115 kV or greater and to the regional power grid is over two miles distant in Globe, Arizona.

None of the power lines crossing or near to this site can carry the commercial power loads that could be generated. There is no nearby substation to convert the solar power. An on-site substation would be required even if transmission capacity was adequate.

Transportation infrastructure

The site overlooks US 70 and the parallel Eastern Arizona Railroad line. A narrow gravel roadway loops outside the northern perimeter of the site starting at US 70 near the Reservation boundary. At its very west end this road provides access to two residential homes. The road crosses Ramboz Wash, eventually passes through the casino/resort golf course, re-crosses Ramboz Wash and enters the developed casino and resort hotel area. The condition and width of the roadway varies and generally deteriorates as it approaches the Ramboz Wash. Transportation infrastructure is not adequate for either construction or operational phases. Road upgrades and extensions would be needed.

Existing and planned land use

Two residential homes are sited on the west side of a gravel roadway that loops around the exterior of the site. Tribal property mapping indicates that there are six other deeded home sites on the immediate east side of this road in the same general vicinity. None of these home sites are located near the most areas with the most concentration of preferred slope and aspect. A small highway commercial development is being planned along the south side of this site fronting on US 70. Other than this planned commercial development there are no apparent constraints based on existing or planned land uses.

Environmental and natural resource features

The most significant nearby natural feature is the Ramboz Wash. A ridge separates the Wash from the potential solar site however so flooding issues are not a concern. The most significant environmental constraint directly impacting the site is the numerous steeper ridges and high points that break up the overall site. The negative cost-benefit ratio in terms of environmental degradation and site development costs would be considerable, if not outright infeasible.

SUMMARY

Given the lack of adequate transmission for commercial-scale power, poor road access, the extreme variability in slope and aspect, and advancing plans for community-scale solar serving the casino/resort complex, the Casino/Resort (West) site is not a key site for solar development. It is generally recommended that the Tribe focus on developing enough community-scale solar power more closely in and around the casino/resort to offset purchased power needs, potentially including the airport and sawmill.

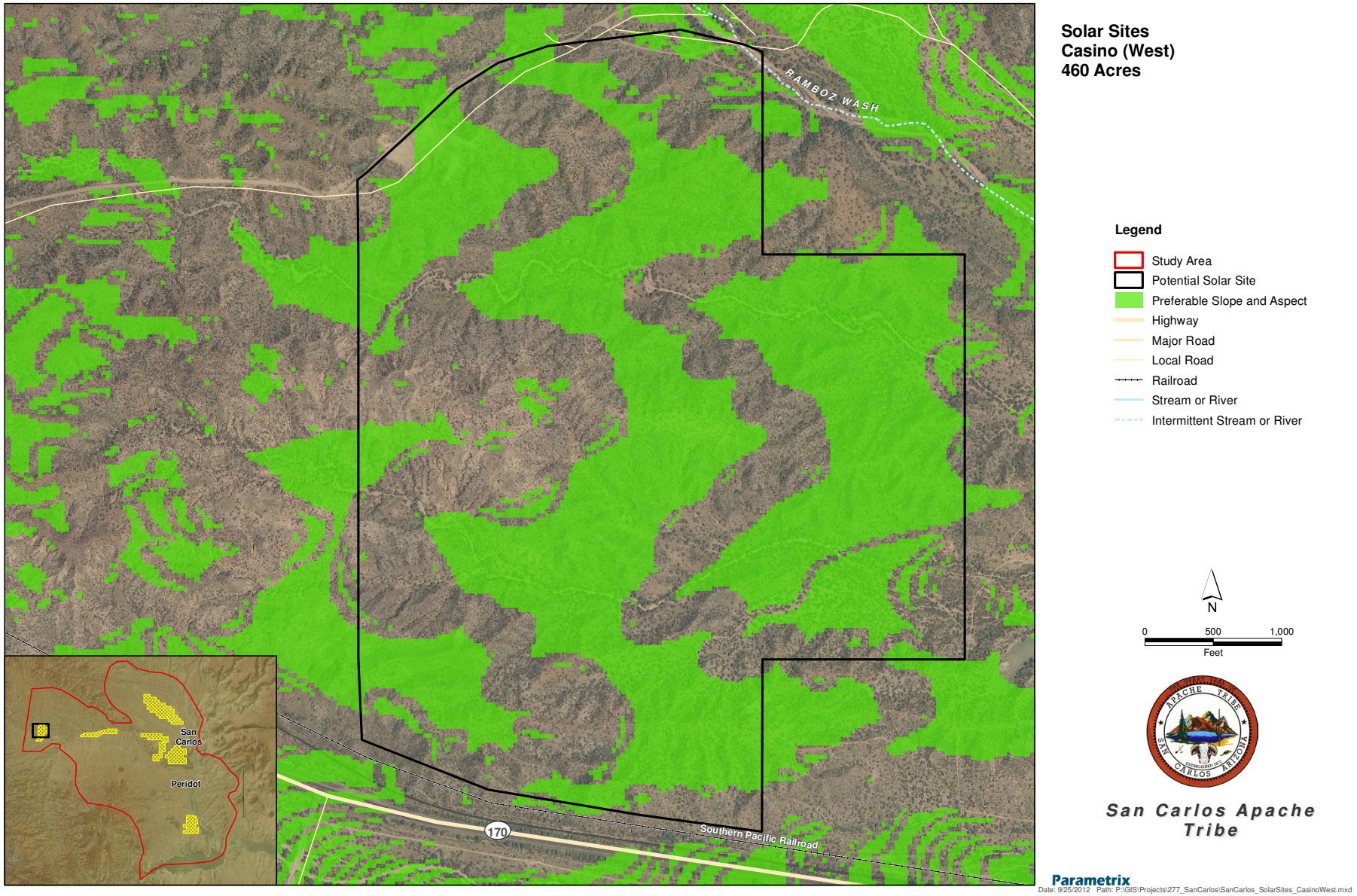

Figure D-2. Casino (West

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Highway AZ 170 (Cutter)

AZ 170 (also referred to as Old San Carlos Road and Route 6) intersects with US 70 in the Cutter area just east of the casino/resort and the Tribal sawmill. AZ 170 approximately parallels the north side of the Gilson Wash and the Eastern Arizona Railroad line for 12 miles before entering San Carlos.

The "Cutter end" of AZ 170 evaluated for this Study extends from the AZ 170/US 70 intersection to the vicinity of the Tribal Skill Center/Tribal College, a distance of approximately 4 miles. The site includes the lands abutting the south side of AZ 170 between the highway and the approximate line of the Eastern Arizona Railroad and Gilson Wash. The deepest parts of this linear site are under 0.5 mile, and mostly are no more than 0.25 mile deep.

Size and Capacity

At up to approximately 775 acres, the site size is adequate for commercial-scale solar power development with a nominal generation capacity based on the gross area of the site of approximately 155 MW. In reality, the linear configuration of a site spanning four miles from west to east and at most a half-mile of depth is a significant constraint to developing an operationally efficient commercial-scale solar power facility.

Slope and Aspect

This site is essentially flat. Slope and aspect impose no constraints to solar facility development.

Electrical power transmission

SCIP is the electrical power service provider. For the foreseeable future, SCIP participation in realizing the Tribe's solar energy generation ambitions will probably have to be on a case-by-case and government-to-government basis. SCIP has no customer programs for renewable energy development, although a net metering policy is under development. Recent Tribal discussions with SCIP have indicated a willingness to discuss issues such as co-investment in power infrastructure improvements and the transfer of assets. SCIP has also been very cooperative in providing information for the Study.

SCIP operates and maintains a three-phase local distribution line that parallels AZ 170 from SCIP's substation in San Carlos to the Skill Center/Tribal College, a distance of approximately eight miles. Local distribution lines serve home sites along and near to the highway from the Skill Center/Tribal College to the AZ 170/US 70 intersection. There is a SCIP substation near the center of San Carlos. This substation is the terminus of a 69 kV line that originates in Coolidge, Arizona. SCIP is planning significant repairs to this 69 kV line between Hayden, Arizona and the Coolidge Dam switching station, but this project will restore reliability not increase capacity.

None of the SCIP power lines within the area are designed to carry the commercial solar power loads that could be generated. An on-site substation would be required even if transmission capacity was adequate.

Transportation infrastructure

This linear site parallels AZ 170 and is crossed by several local public and private gravel or dirt access roads. Transportation infrastructure is adequate for both construction and operational phases, provided that the primary access is off of the highway.

Existing and planned land uses

There are approximately sixteen developed home sites all along the south side of AZ 170 for the first 3 miles of the site east from the AZ 170/US 70 intersection. Most of these homes have direct driveway access to the highway. In addition, a private ranch operates in the triangle of land between AZ 170 and US 70 immediately east of the intersection. One or two vacant deeded home sites are also present. The development of commercial-scale solar facilities within this linear site would be highly constrained by this residential development.

Environmental and natural resource features

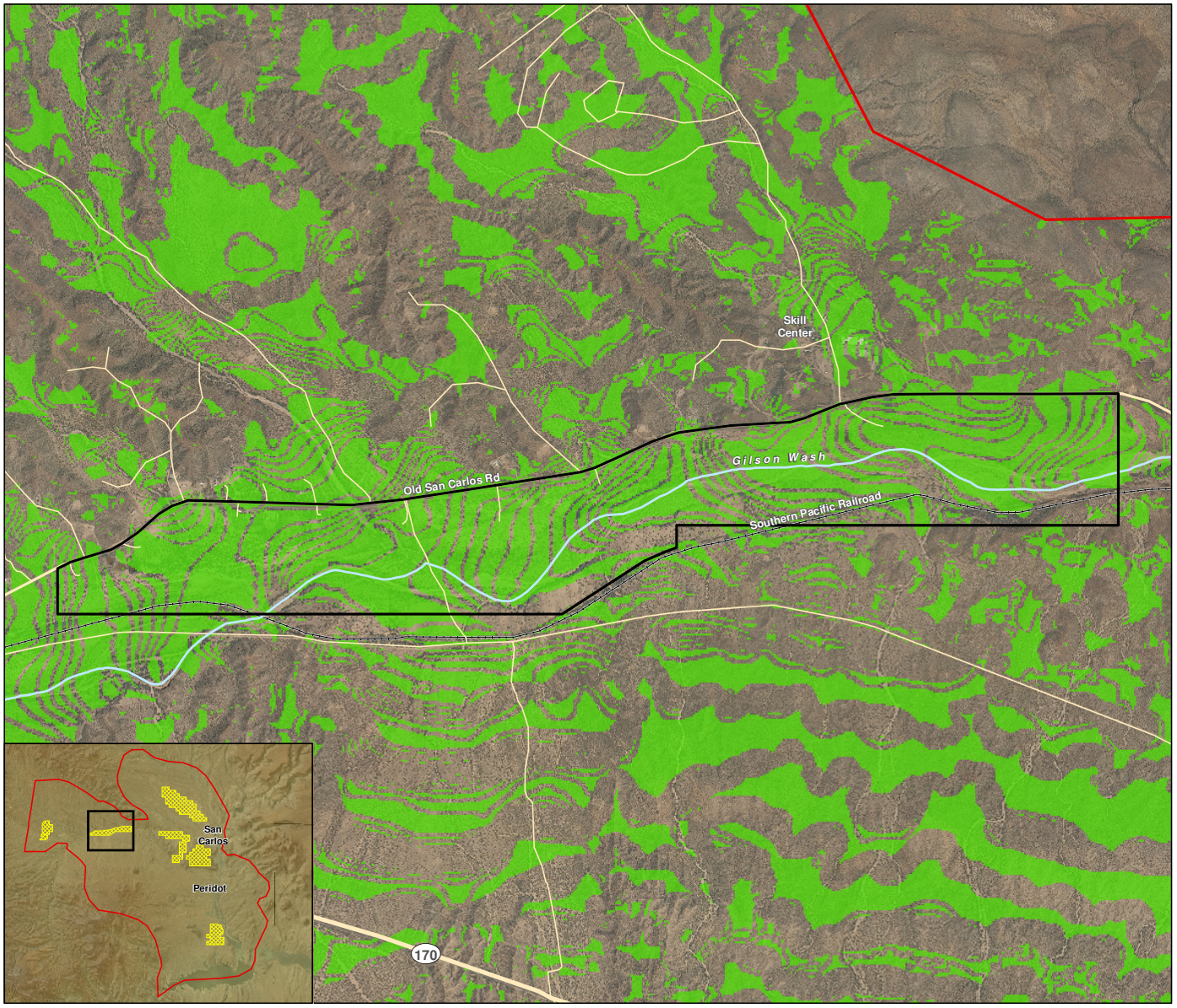
The most significant natural feature is the Gilson Wash. The Wash runs the entire length of the site. Essentially all of the lands with preferred slope and aspect characteristics for solar development are within the hazard zones established by the Tribe's 2005 Multi-Hazard Mitigation Plan. The development of commercial-scale solar facilities within this linear site could not be recommended based on the documented hazard potential.

Other factors

The Eastern Arizona Railroad crosses through the entire site. This railroad and a parallel natural gas pipeline run through the middle of site for a distance of two miles from the AZ 170/US 70 intersection and parallel to the Gilson Wash. The railroad and pipeline both cross to the south side of the Gilson Wash after two miles and then diverge. The railroad continues to closely parallel the Wash while the pipeline turns southeast. The railroad and pipeline crossing of this site, particularly when combined with the constraints of the Gilson Wash floodplain, are significant constraints to development.

SUMMARY

Given the lack of adequate transmission for commercial-scale power, the site's extensive hazard potential, and the site development constraints imposed by the Gilson Wash stream channel and the railroad and natural gas pipeline, this site is not recommended for further consideration.



Solar Sites
Highway 170 (Cutter)
775 Acres

Legend

- Study Area
- Potential Solar Site
- Preferable Slope and Aspect
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River

N

0 500 1,000 1,500
Feet

San Carlos Apache Tribe

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Figure D-3. Highway AZ 170 (Cutter)

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Highway AZ 170 (San Carlos)

AZ 170 (also referred to as Old San Carlos Road and Route 6) intersects with US 70 in the Cutter area just east of the casino/resort and the Tribal sawmill. AZ 170 approximately parallels the north side of the Gilson Wash and Eastern Arizona Railroad line for 12 miles before entering San Carlos.

The "San Carlos end" of AZ 170 that was evaluated for this Study extends from the vicinity of a Tribal stockyard and agricultural operations on the south side of the highway to the Tribal Detention Center, a distance of approximately three miles. The site encompasses lands abutting the south side of AZ 170 between the highway and the approximate line of the railroad. The deepest parts of this linear site are approximately 0.5 to 0.75 mile but are often narrower.

Size and Capacity

At up to approximately 770 acres, the site size is adequate for commercial-scale solar power generation with a nominal capacity based on the gross area of the site of approximately 85 MW. In reality, the linear configuration of a site spanning three miles from west to east and at most three-quarters of a mile in depth is a significant constraint to developing an operationally efficient commercial -scale solar power facility.

Slope and Aspect

This site is essentially flat. Slope and aspect impose no constraints to solar facility development.

Electrical power transmission

SCIP is the electrical power service provider. For the foreseeable future, SCIP participation in realizing the Tribe's solar energy generation ambitions will probably have to be on a case-by-case and government-to-government basis. SCIP has no customer programs for renewable energy development, although a net metering policy is under development. Recent discussions with SCIP have indicated a willingness to discuss issues such as co-investment in power infrastructure improvements and transfer of assets. SCIP has also been very cooperative in providing information for this Study.

SCIP operates and maintains a three-phase local distribution line that parallels AZ 170 from SCIP's substation in San Carlos along the full length of this site, and thereafter to the Skill Center/Tribal College, a distance of approximately eight miles. Local distribution lines serve home sites along and near to the highway. There is a SCIP substation near the center of San Carlos. At the nearest boundary of this site, this San Carlos substation is approximately two miles distant. This substation is the terminus of a 69 kV line that originates in Coolidge, Arizona. SCIP is planning significant repairs to this 69 kV line between Hayden, Arizona and the Coolidge Dam switching station, but this project will restore reliability not increase capacity.

None of the SCIP power lines within the area are designed to carry the commercial solar power loads that could be generated. An on-site substation would be required even if transmission capacity was adequate.

Transportation infrastructure

This linear site parallels AZ 170 and is crossed by several local public and private gravel or dirt access roads. Transportation infrastructure is adequate for both construction and

operational phases, provided that the primary access is off of the highway. Some of the deeper areas of the site, if used for solar development, would require new roadways as existing access roads are dirt surface and narrow.

Existing and planned land uses

The lands between the stockyard and the Detention Center abutting the south side of the highway are vacant. No deeded home sites are recorded on mapping provided by the Tribe, but field investigation did reveal at least one abandoned home. The Gilson Wash District Master Plan identifies 70 acres of land along a bend in the Gilson Wash southwest of the Detention Center for future agricultural development. Except for the current and future agricultural parcels, this site has no identified existing or planned land use constraints.

Environmental and natural resource features

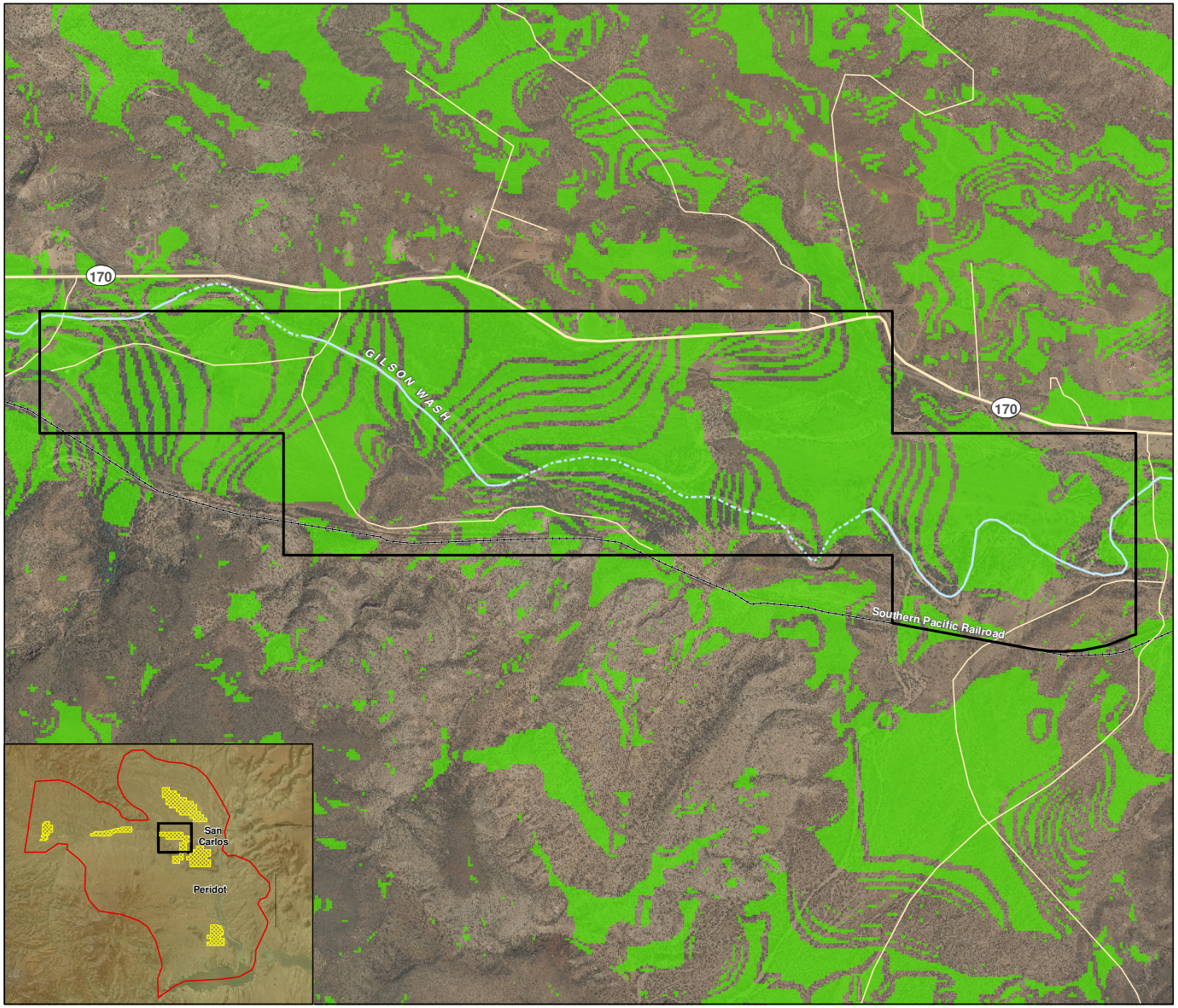
The most significant natural feature is the Gilson Wash which crosses the entire length of the site. Nearly all of the lands with preferred slope and aspect characteristics for solar development are within the hazard zones established by the Tribe's Multi-Hazard Mitigation Plan. Even if not subject to periodic flooding, the main channel of the Wash effectively splits the site lengthwise making solar facility siting even more challenging. The development of commercial-scale solar facilities within this linear site could not be recommended based on flood hazard potential.

Other factors

The Eastern Arizona Railroad runs along the rear of the entire site. The railroad line is not a particular constraint to solar development, as the line is effectively at the south edge of lands with preferred slope and aspect.

SUMMARY

Given the lack of adequate transmission for commercial-scale power and the site's overall hazard potential, this site is not recommended for further consideration.



Solar Sites
Highway 170 (San Carlos)

Legend

- Study Area
- Potential Solar Site
- Preferable Slope and Aspect
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River

N

0 500 1,000
Feet

San Carlos Apache Tribe

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Figure D-4. Highway AZ 170 (San Carlos)

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Mesa (West)

To the immediate southwest of the center of the community of San Carlos is the Peridot Mesa. At the base of the west side of the mesa is a reasonably flat area that could accommodate some solar development. The area is essentially a narrow valley between the mesa and a steep ridgeline further to the west. The site is bisected by a gravel roadway that connects the community of San Carlos to US 70 west of the community of Peridot. This road also intersects with a road that climbs the Peridot Mesa. These roads are not named on available mapping. The site is approximately 1.75 miles long and ranges in width from 0.5 to 0.75 mile.

Size and Capacity

The Mesa (West) site is up to approximately 600 acres. Nominal solar power generating capacity based on the gross area of the site would be approximately 120 MW. The long and narrow site configuration plus a bisecting roadway may make this site somewhat inefficient for commercial-scale solar development.

Slope and Aspect

This site is variable and broken up into a pattern of five subareas with preferred slope and aspect with intervening steeper areas. The intermittent pattern of preferred slope and aspect may make this area inefficient for a commercial-scale solar facility development. The steeper areas have slopes significantly above four percent and would require extensive grading and site alterations to connect the five subareas.

Electrical power transmission

SCIP is the electrical power service provider. For the foreseeable future, SCIP participation in realizing the Tribe's solar energy generation ambitions will probably have to be on a case-by-case and government-to-government basis. SCIP has no customer programs for renewable energy development, although a net metering policy is under development. Recent discussions with SCIP have indicated a willingness to discuss issues such as co-investment in power infrastructure improvements and transfer of assets. SCIP has also been very cooperative in providing information for the Study.

There are three-phase SCIP lines along AZ 170 and Aravaipa Road about one mile from the north end of this site. The San Carlos substation is an additional one mile to the east. The San Carlos substation is the terminus of a 69 kV line that originates in Coolidge, Arizona. SCIP is planning significant repairs to this transmission line between Hayden and the Coolidge Dam, but the work will restore reliability not increase capacity. SCIP has indicated that the 69 kV line terminating at the San Carlos substation is not adequate to transmit solar generated power for export off-Reservation. An on-site substation would also probably be required even if transmission capacity was adequate.

The overriding constraint, which is the same constraint that applies to every commercial-scale site within the Study area, is the lack of any power transmission facilities with the capacity to export power into the regional power grid.

Transportation infrastructure

The site is bisected by a gravel/dirt roadway that runs from San Carlos to an intersection with US 70 west of the community of Peridot. The access road at the north end of the site is subject to flooding by the Gilson Wash and is periodically closed. Access routes from the community of Peridot although longer, may be more practical and avoid any developed

residential neighborhoods such as found on the north side. Although the field visit to this site was conducted during a dry period, soils on the road at the south end would indicate that it is not a reliable all-weather route. Transportation infrastructure is inadequate for both construction and operational phases. Restoration and rebuilding would be required.

Existing and planned land uses

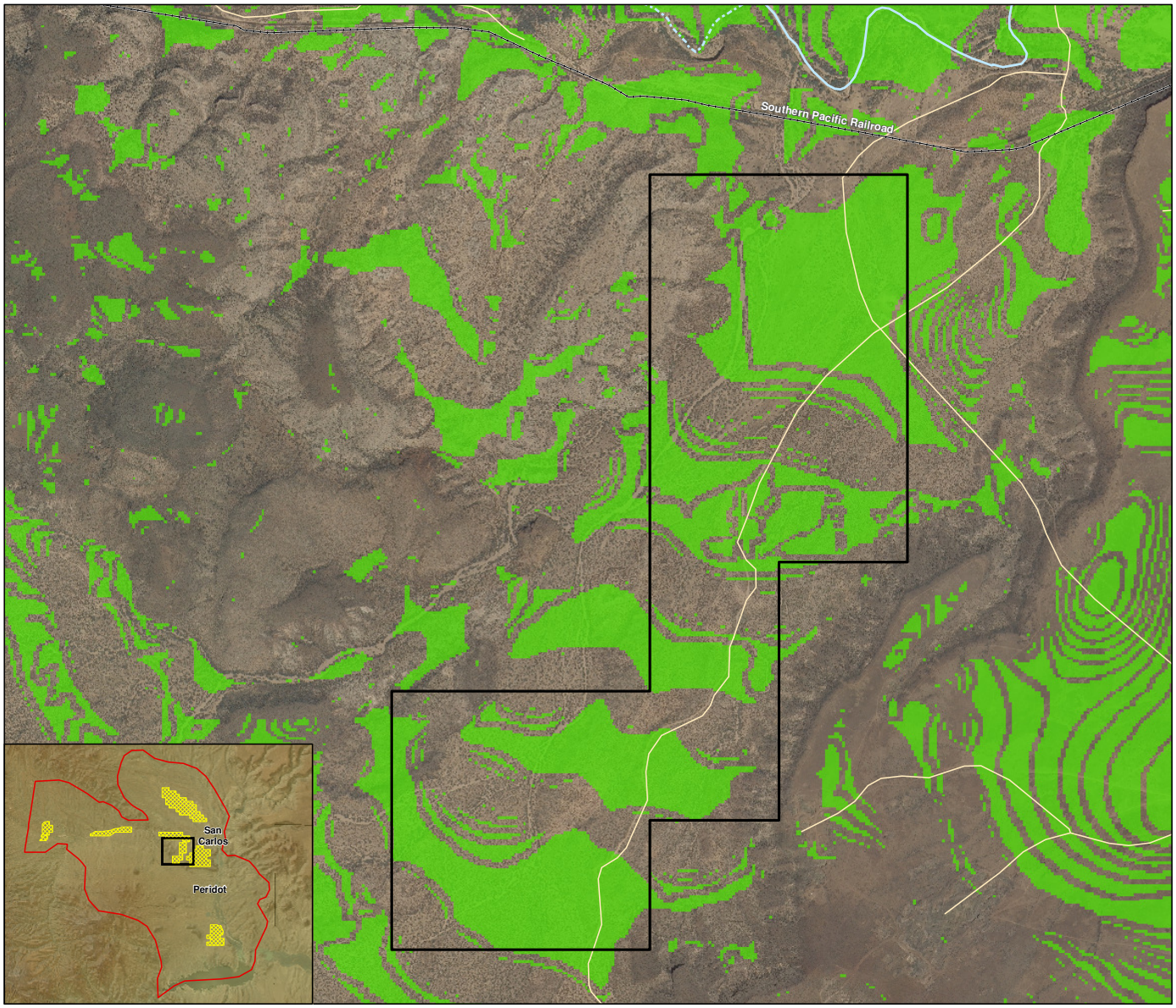
The site is vacant, except for a tribal water well (named the Peridot Well on USGS mapping). The Peridot Mesa is the center of the Tribe's economically and culturally significant gemstone mining industry. The mining is primarily confined to blasting along the edge of the mesa where ore deposits are shallow and exposed. Further investigation is required as to the presence and level of activity of mining, if any, on the west flank of the mesa. Any solar development should be preceded by an assessment of mining claims.

Environmental and natural resource features

The two most potentially significant natural features are potentially peridot and other gemstone deposits and the wide variation in slope and aspect on parts of the site. The development of commercial-scale solar facilities within this site has no other identified significant or unusual environmental or natural resource constraints, subject to a determination of mining claims.

SUMMARY

As compared to the adjacent Peridot Mesa site, the Mesa (West) site preforms poorer with respect to solar development potential in almost all regards – road access, access to the electrical power grid, and net size and shape. The overriding constraint, which is the same constraint that applies to every commercial-scale site within the Study area, is the lack of any power transmission facilities with the capacity to export power into the regional power grid. To the extent the Tribe wishes to reserve sites for long-range solar development prospects, or pursue more immediate commercial-scale solar development plans, the Peridot Mesa site is clearly recommended over the Mesa (West) site.



Solar Sites
Mesa (West)
560 Acres

Legend

- Study Area
- Potential Solar Site
- Preferable Slope and Aspect
- Highway
- Major Road
- Local Road
- Railroad
- Stream or River
- Intermittent Stream or River

N

0 500 1,000 1,500
Feet

San Carlos Apache Tribe

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Figure D-5. Mesa (West)

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APPENDIX E

Phase 1 Community-Scale Site Descriptions

PHASE 1 COMMUNITY-SCALE SITE DESCRIPTIONS

Sawmill and Airport

The tribal sawmill is due east of the casino/resort. When operating, sawmill electrical energy use is only fifteen percent of that at the casino/resort. A solar array on the abandoned ballfield east of the resort's RV Park could possibly be used for sawmill power, as could has could biomass energy conversion. In recent years sawmill operations have been intermittent. The tribal airport is across US 70 from the casino/report. Consumption is less than one-half of one percent of the casino/resort. The small power demand at the airport could be meet with rooftop or ground-mounted standalone solar systems.

Given the relatively low sawmill and airport power consumption, it is recommended that the casino/resort complex receive the priority consideration for expanding community-scale solar facilities in the Cutter area.

Tribal Detention Center

The Tribal Detention Center is seven miles east of the Skill Center and close to the community of San Carlos. Site conditions are not favorable except for very small clusters ground-mounted flat-panel arrays or rooftop retrofits. Slopes are predominantly over four percent except close to the building footprint, and it is probably not desirable to install arrays within the fenced security enclosure. Building retrofits for roof top installations may also raise security concerns.

Tribal Detention Center
Courtesy of Steve Albert

San Carlos Forestry Offices/Fire Management/ Landing Strip

Northwest of the San Carlos Government Center, the Tribe has three buildings housing forestry and fire management offices and operations. An aircraft landing strip utilized by fire suppression crews is also on this site.

There appears to be no significant areas of vacant level land on this site to accommodate any but the smallest sets ground-mounted solar PV arrays. The facility complex sits on top of a ridgelines

San Carlos Forestry Offices/Fire Management/Landing Strip
Courtesy of Jim Rapp

and nearly all the flatter land is taken up by buildings, parking, and the landing strip. Roof-mounted is probably more practical, subject to an assessment of structure feasibility. Building placement and aircraft safety may impact feasibility and generation potential.

High School/Junior High School

San Carlos High School is a newer facility and the Junior High School was relocated to this site in 2009. The site includes facilities such as parking lots, sports fields and maintenance buildings. Within the fenced school site there does not appear to be sufficient level land to accommodate any significant ground-mounted solar PV arrays. Roof-mounted solar may be a practical solution, although a structural assessment of the school building would be needed to make a final determination. Another possibility is installing shade cabanas over parking areas. Solar panels could be installed atop the cabanas (this solution was once proposed at the casino/resort).

High School/Junior High School
Courtesy of Steve Albert

It might be possible to find some abutting flat lands just outside the school site boundary for community-scale ground-mounted solar panels but the terrain immediately surrounding the school to the south and east is characterized by variable slopes.

IHS Hospital

A new Indian Health Service hospital is currently under construction on the north side of US 70 approximately 2 miles east of the community of Peridot. Rooftop solar has been included in the hospital design. There appears to be sufficient level land on this site to accommodate ground-mounted solar PV arrays. Roof-mounted is also possible. In fact, there is approximately 100 acres due east of the hospital site with the preferred slope and aspect characteristics used in this Study to identify commercial-scale sites. Additional solar improvements on the hospital site could also be located and engineered in concert with any solar facilities developed for Peridot residential neighborhoods and institutional buildings.

APPENDIX F

SCIP Retail Power Rates

Provided by SCIP April 2013

SCIP Retail Power Rates
Provided by SCIP April 2013

PURCHASED POWER ADJUSTMENT $.0218 PER kWh

RESIDENTIAL

$10.00 Minimum + first 50 kwh
$.12 per kwh for next 500 kwh
$.09 per kwh for all additional kwh

SMALL COMMERCIAL-≤249 KW One Point Delivery and Measured through One Meter

$20.00 Minimum + first 50 kwh
$.13 per kwh for next 950 kwh
$.08 per kwh for next 9,000 kwh
$.06 per kwh for all additional kwh

DEMAND = $2.00/PER KW

LARGE COMMERCIAL-≥250 KW One Point Delivery and Measured through One Meter

$50.00 Minimum + first 500 kwh
$.095 per kwh for next 10,000 kwh
$.065 per kwh for all additional kwh

DEMAND = $3.00/PER KW

INDUSTRIAL-≥1,000 KW One Point Delivery and Measured through One Meter

$250.00 Minimum
$.05 per kwh

DEMAND = $7.00/PER KW

COMMERCIAL PUMPS

$25.00 Minimum
$.039 per kwh

DEMAND = $2.40/PER KW

STREET & AREA LIGHTING

		2-5	5 +
150 Watts	$17.00	$15.40	$13.75
250 Watts	$20.85	$19.00	$16.35
400 Watts	$27.72	$24.27	$20.85