Pueblo of Laguna Utility Authority

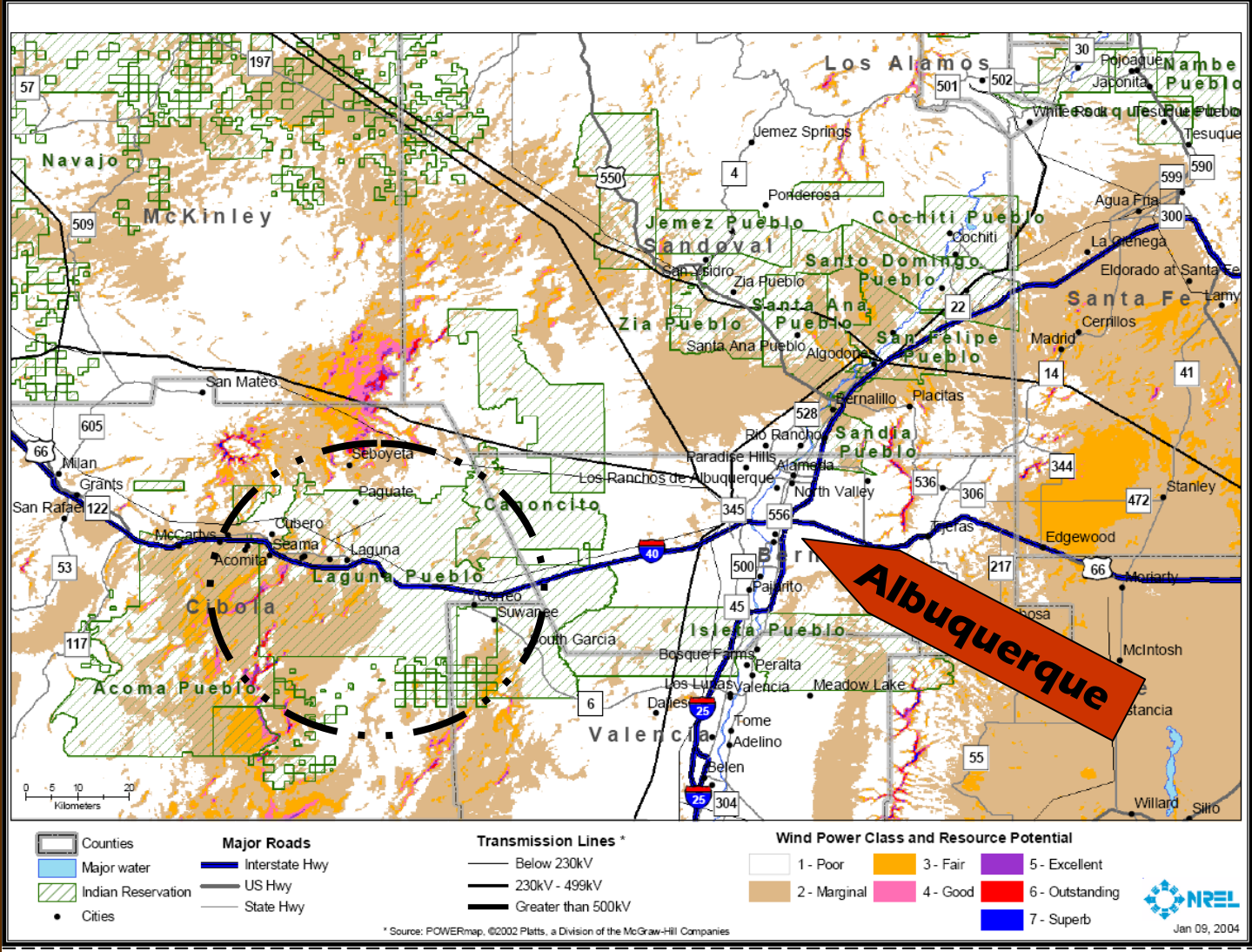
Renewable Energy Feasibility Study

DOE Program Review

October 2006

Project Location: Pueblo of Laguna

Location in New Mexico

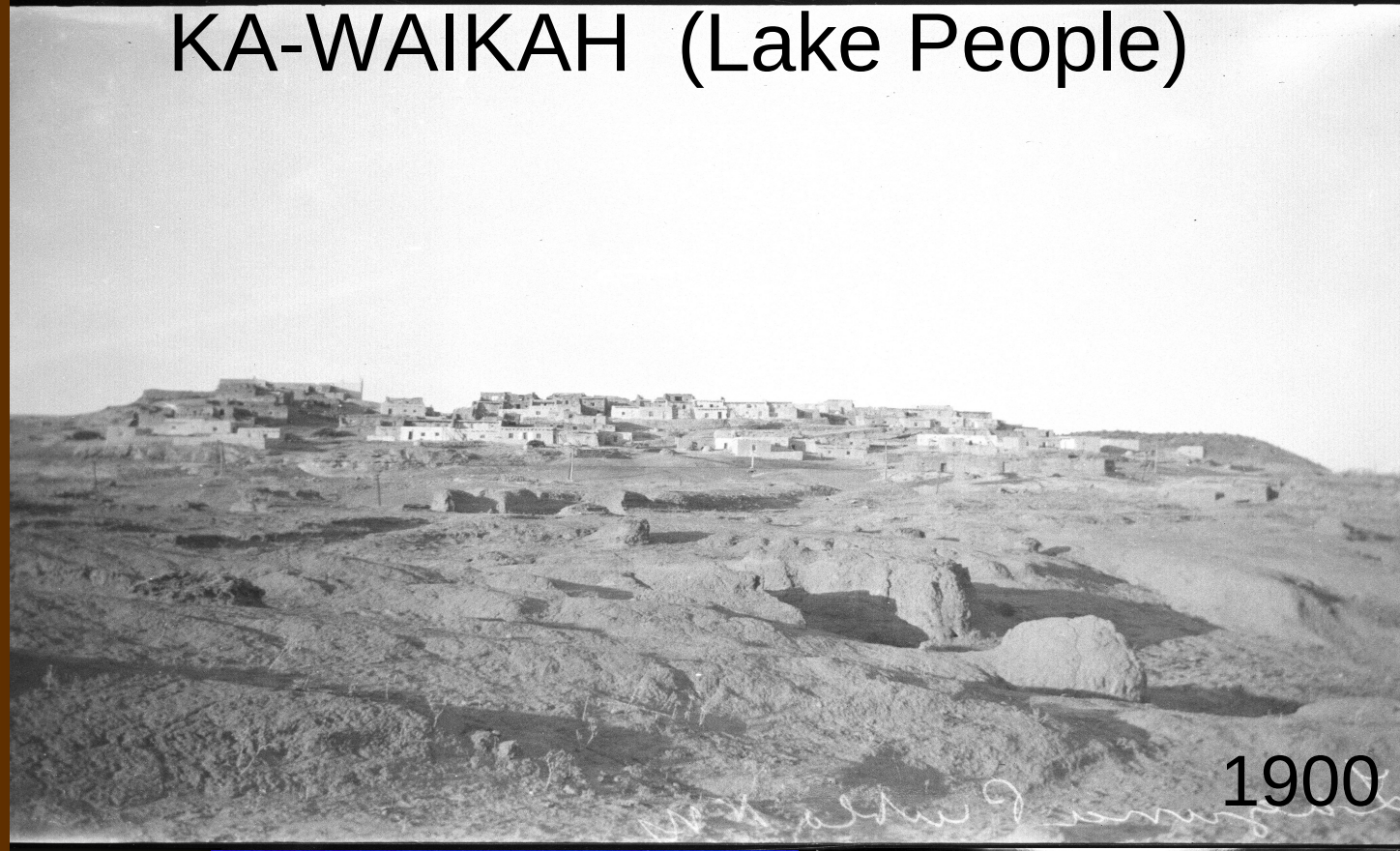


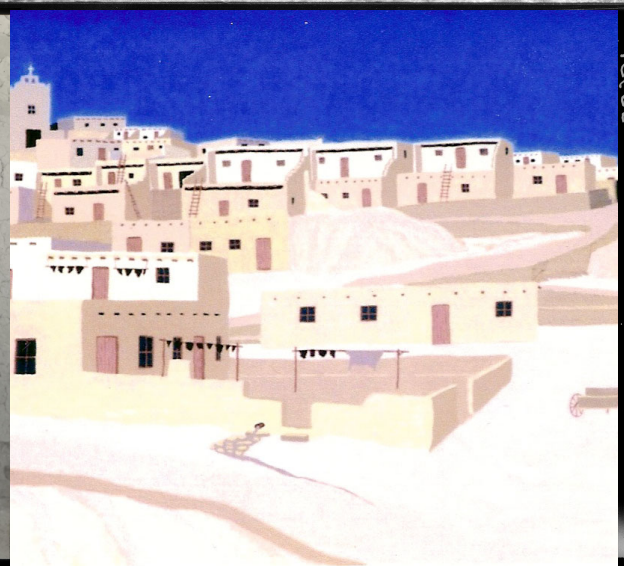
Pueblo of Laguna: 533,000 acres
44 miles west of Albuquerque

Laguna Pueblo

Enrollment 8,000

Six Villages



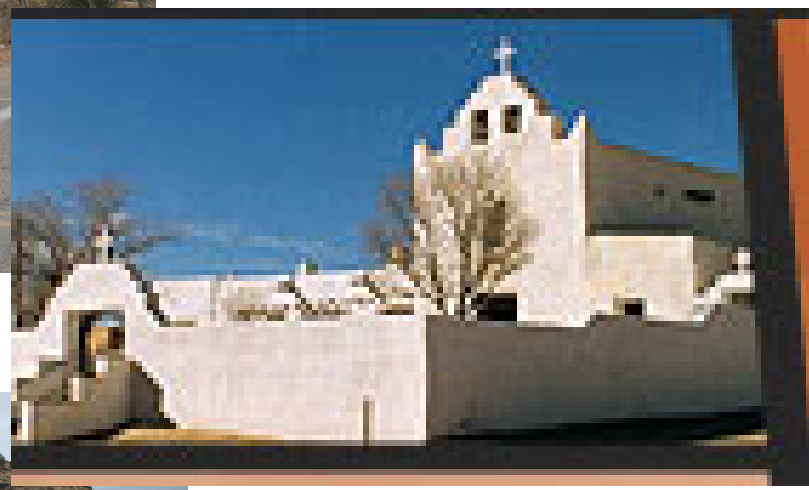


Laguna: Main Village

Sept. 19 - St. Joseph Feast Day

Traditional Home

San Jose Mission



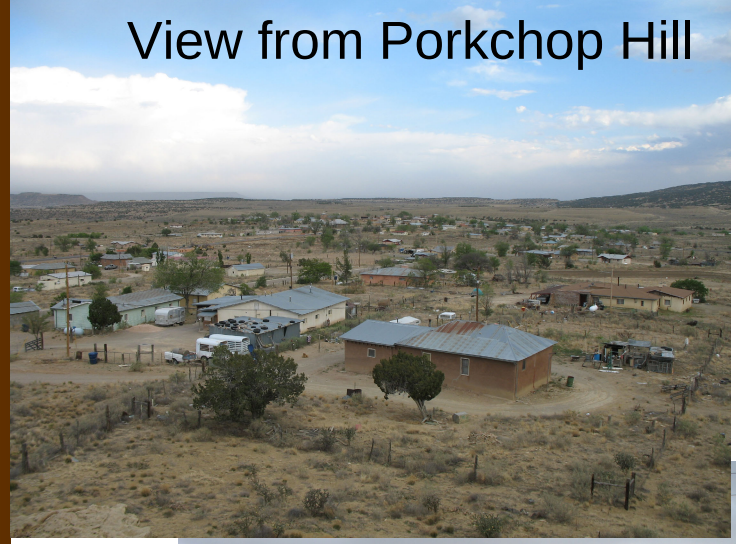
Old IHS Clinic

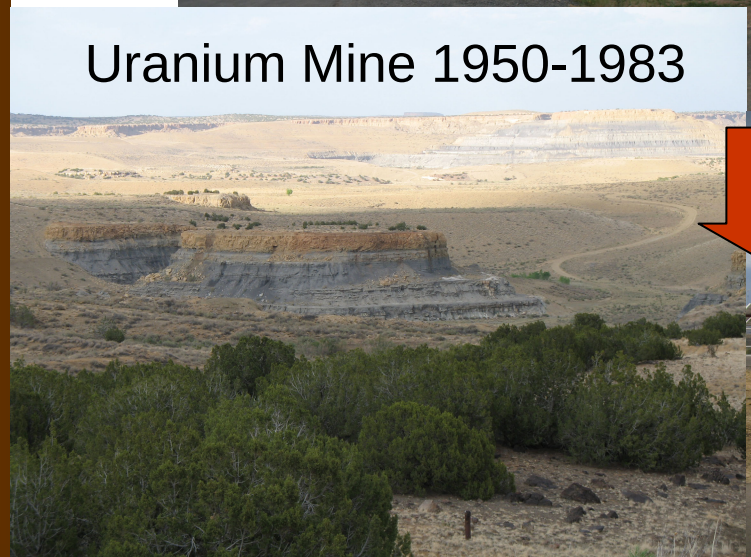
Tribal Administration Building

Paguate: Northern Village

(Propane only)

September 25 - St. Elizabeth Feast Day



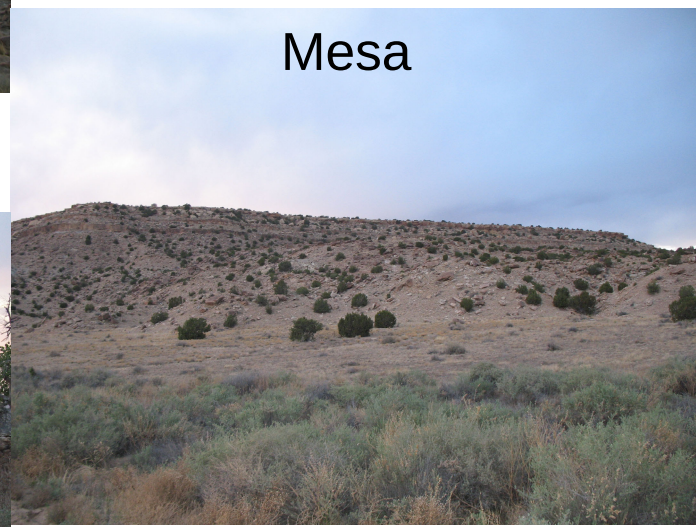


Paraje: Near West Village

October 17 Feast Day

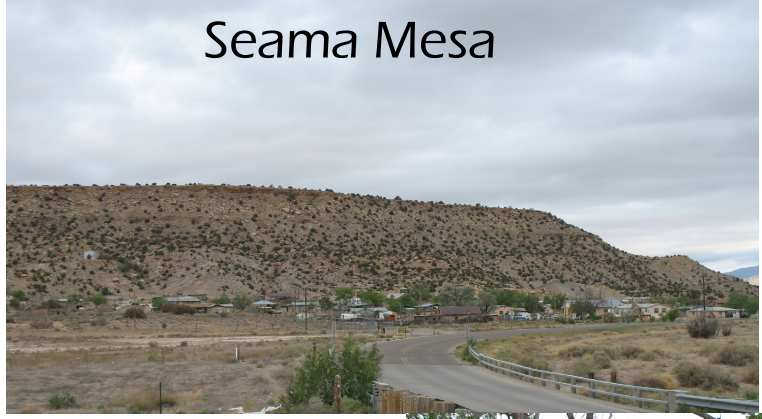

View looking south


Village


Mesa

Seama: Near West Village

July 26: St. Anne Feast Day



1926

Encinal: Smallest Village (Propane only)

September 8 Feast Day

Encinal Springs

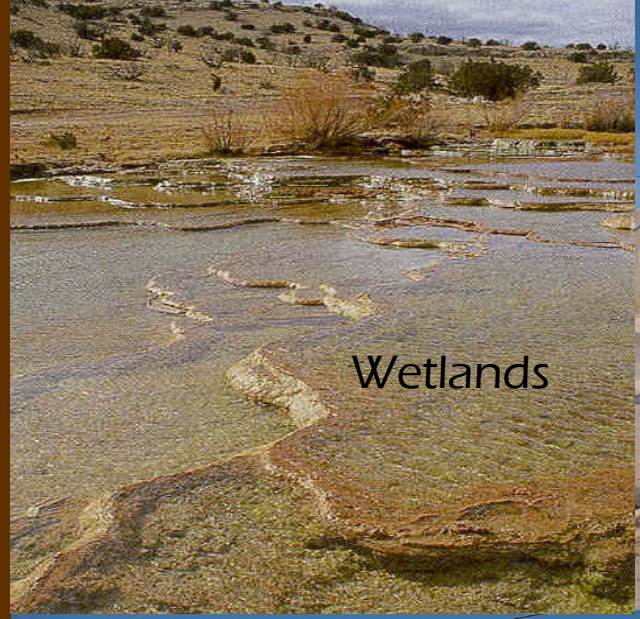
White Springs

Water Canyon

Water Shed

Mesita: East Village

August 15th - St. Augustine Feast Day



Project focuses on community involvement in addition to technical studies

Project Objectives

- Assess feasibility of renewable energy generation projects
- Build on Pueblo interest in renewable energy focused on wind, solar and biomass resources
  - Prior projects included solar facilities at Majors Ranch and Laguna Industries
- Consider options to leverage nearby gas pipelines to develop a "hybrid" project, providing "firm" power
- Encourage community involvement and participation through education
- Expand on previously completed work
  - Utility formation and development
  - Energy self-sufficiency options
  - Integration of energy management with economic development
- Support energy capacity building

Project is being led by Utility Authority personnel

Project Participants

Tribal and Staff Participants:

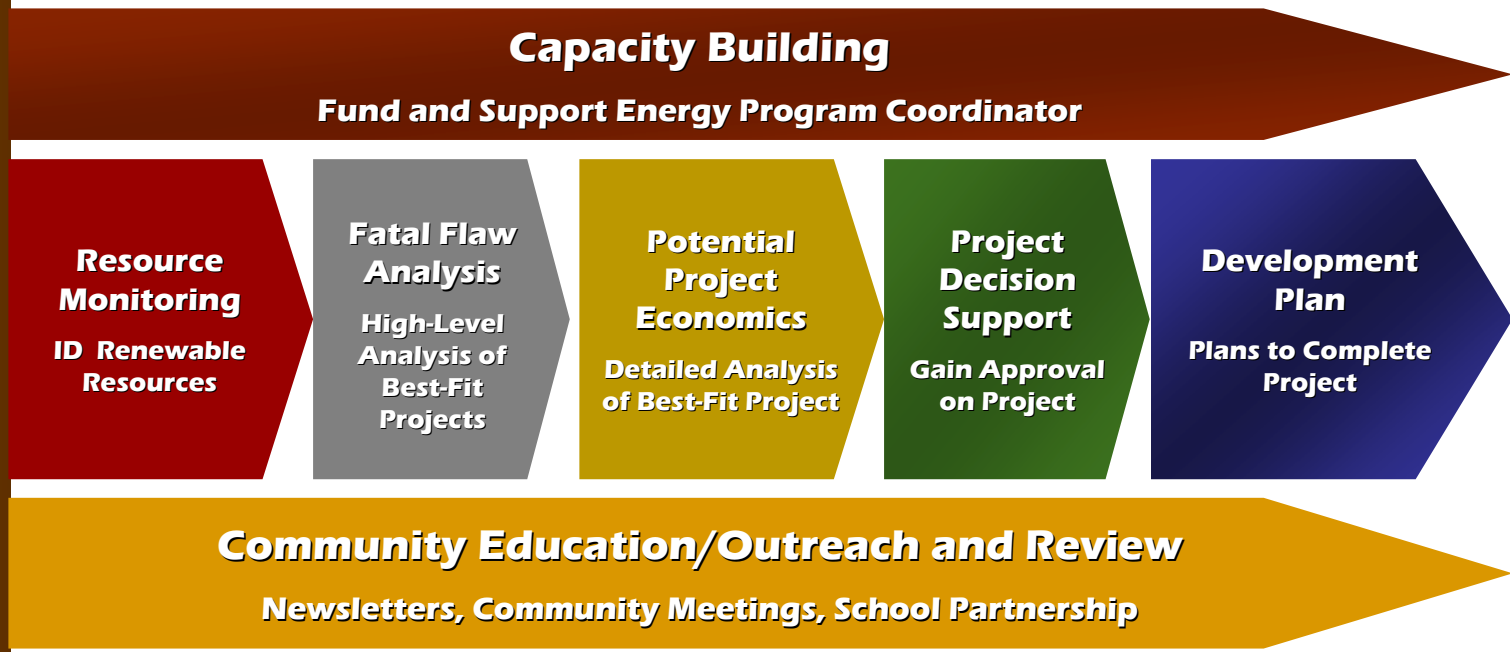
- Pueblo of Laguna Utility Authority and Board of Directors
- Pueblo of Laguna Tribal Council and Staff Officers
- Pueblo of Laguna Villages
- Pueblo of Laguna Entities/Facility Managers

Project Consultant:

- Red Mountain Energy Partners

Project Scope

Study includes seven phases – two continual and five in sequence



Utility Authority Newsletter established to provide community education

Laguna Utility Service News

Volume 1, Issue 4
October 2006

Inside this issue:

Funding for Utility Authority newsletters and customer education and outreach programs planned for 2006 is provided through a grant awarded by the Department of Energy Tribal Energy Program

What is Renewable Energy?

"**Renewable Energy**", the new buzz word of our day, has actually been around for more than 20 years. Technology has come a long way and systems have improved to maximize the output and storage.

What is Renewable Energy? It is an energy source that can be renewed by nature and can provide clean sources of electricity generation.

Do you know where your electricity comes from? Most likely it comes from a coal burning generation station which uses a large quantity of water, produces CO^2 (carbon dioxide), pollutes the air and disturbs the earth to remove the coal mined. Power generated in the plant is transferred into large transmission lines, then to distribution lines that deliver power to homes and businesses.

Solar Energy. Energy from the sun generates power either by using photovoltaic (PV) cells to directly convert light to electricity, or by collecting the sun's heat to create steam to drive a conventional thermal power plant.

Wind Power. As the wind blows, it drives a generator. The electricity produced by the generator is transferred by underground cables to the power "grid", or can be used to supply pumps, motors, or other local devices.

Geothermal. Geo = Earth, Thermal = Heat. Thermal energy from underground "hot springs" can supply steam turbines to generate electricity, or, at lower temperatures, can be used directly for heating.

Biomass. Waste from forest areas, yards, farming, and construction can be used as fuel to generate electricity.

Hydro. Power created from moving water, streams and rivers that turns turbines.

Methane Gas. Methane can also be used to generate electricity. Because methane is produced from waste streams such as landfills, animal waste and wastewater treatment plants, it is a renewable resource.

Intermittent Resources. Can only produce energy when certain conditions are met. These conditions include: when the sun is shining, when the wind is blowing, or when the stream is moving.

Solar Power: Photovoltaics (PV)

Photo = Light, Voltaics = Electrical Power.

What is PV made of? A solar panel is made up of many smaller photovoltaic cells. An array consists of many solar panels (shown below).

How does it work? Cells collect the sun's light and the energy is converted to Direct Current that travels through wires to power homes, buildings, pumps, motors, or other needs. Excess power generated during sunny periods can either be delivered back to the power grid, or be used to charge batteries to supply needs at night or during cloudy periods.

System Sizes. Different types and sizes of systems are used for different types of loads. A stand-alone off-grid system typically serves one household or building and can be powered by fairly small PV arrays with battery storage. A midsize array can supplement a commercial building or school, and can be mounted on the ground, rooftops, or on carports that provide shade as well. Large concentrating PV systems intensify the sun's light to produce electricity, and are typically used for large centralized power stations.

Environmental Impacts. None. No carbon dioxide emitted into the air. Little or no water is used. No threat to wildlife. No noise is emitted. Low maintenance and improved technology makes it environmental friendly.

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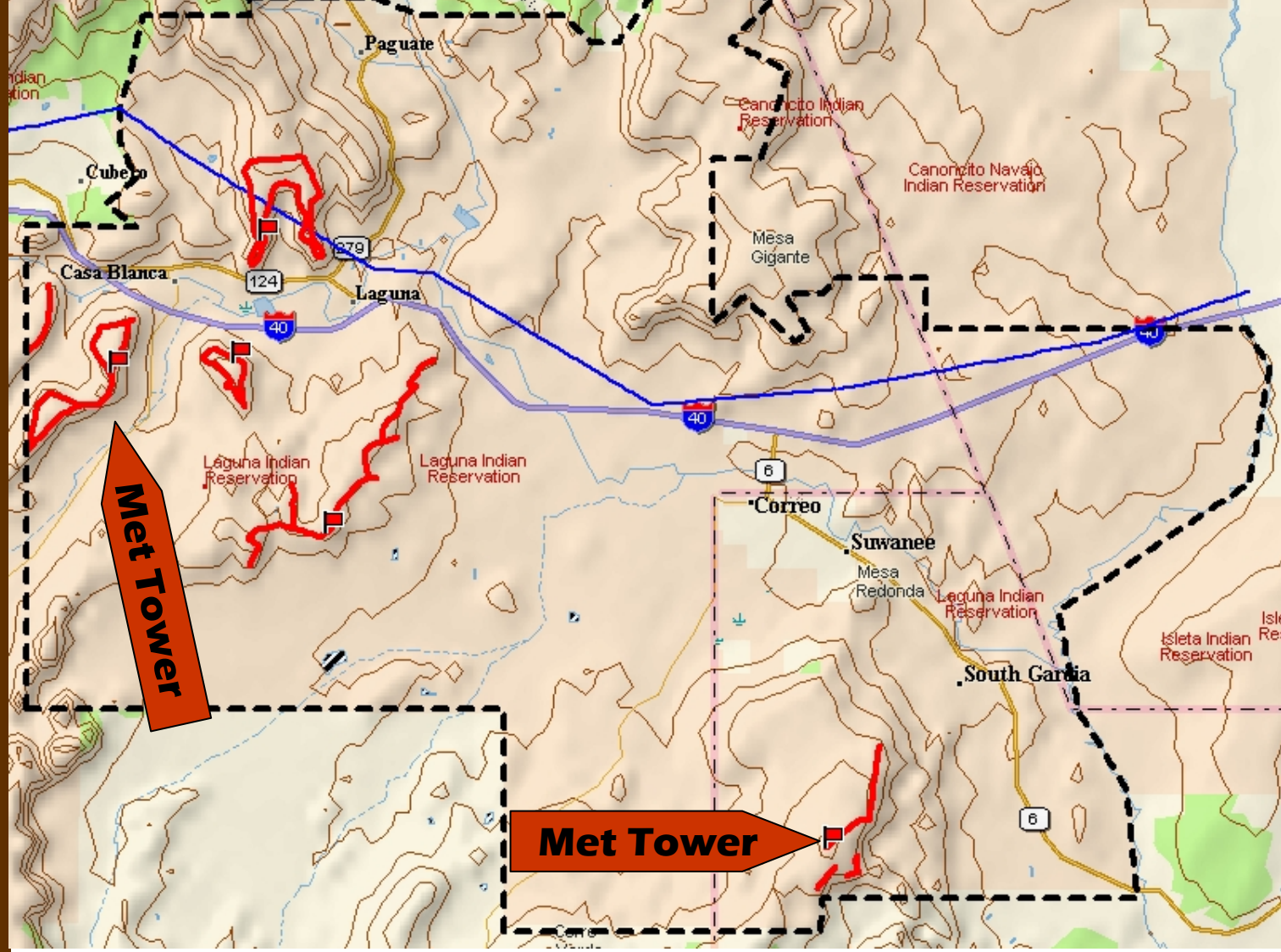
Middle School and Utility Authority Partnership:

Mentorship
RE Curriculum
Science Fair
Campus Project

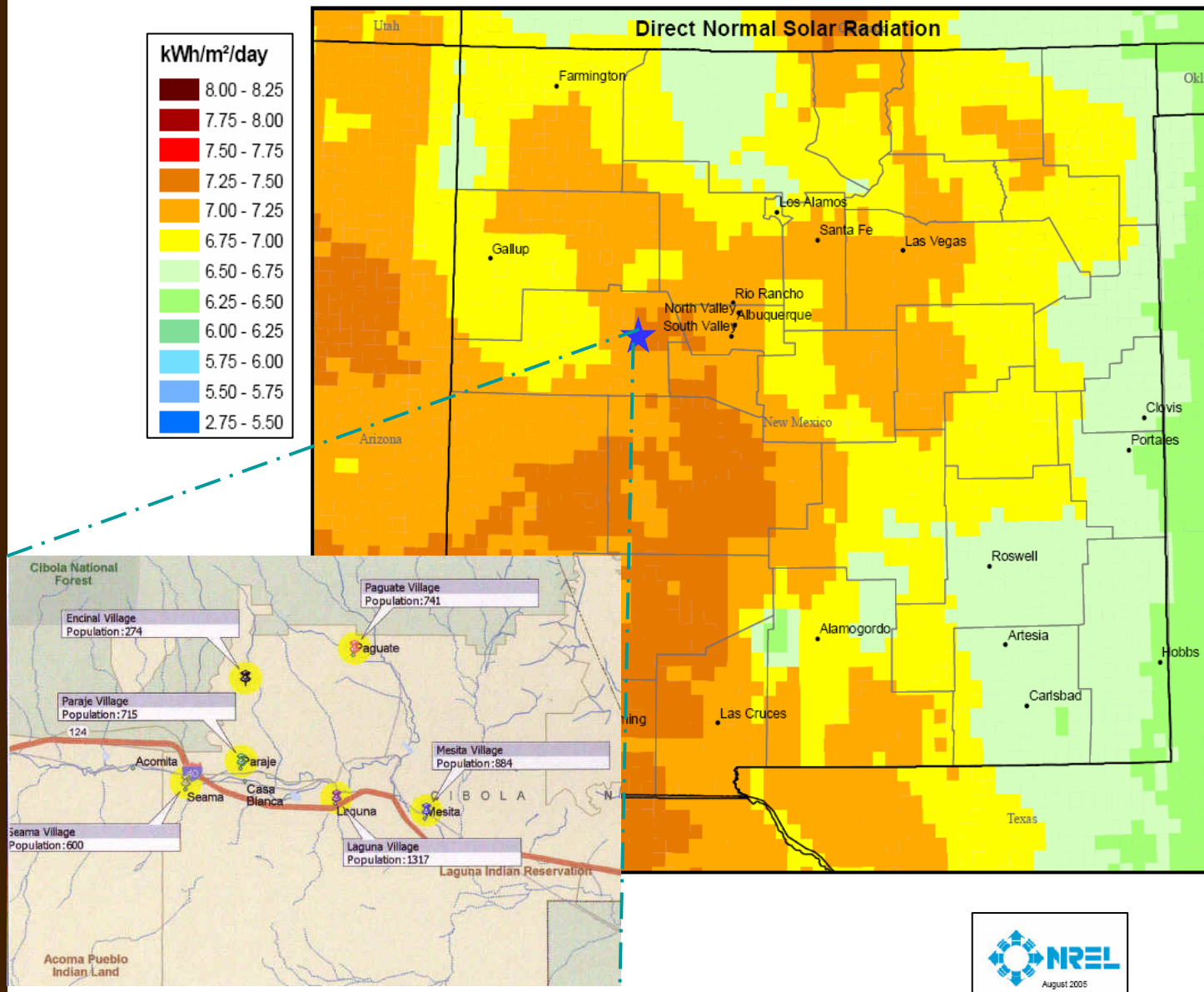
Laguna Middle School selected Energy as the theme for 2006/2007 Science Fair

Maps indicated potential wind resource at Laguna



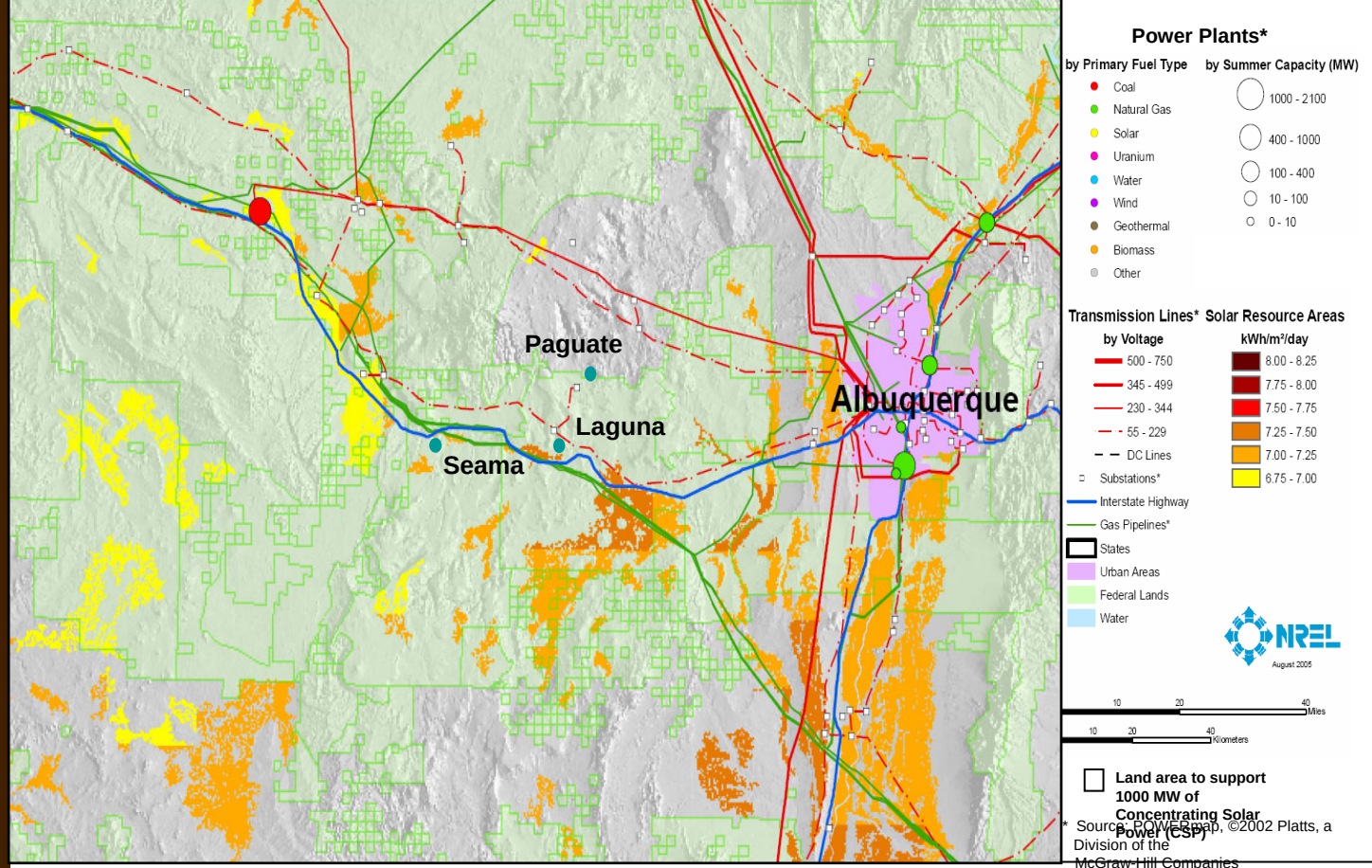
One year of data has not confirmed the anticipated resource at selected sites to support large-scale wind development

Solar resource at Laguna appears adequate to support PV



Laguna average annual insolation falls in the range of 7.25 – 7.5 kWh/m²/day

Solar resource at Laguna appears adequate to support Concentrating Solar Power



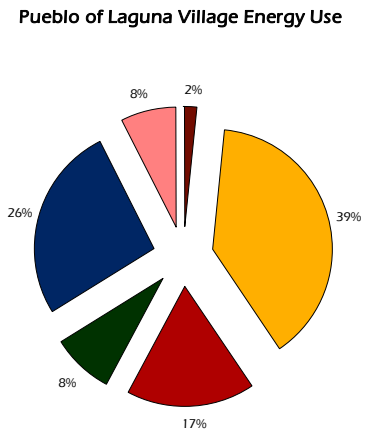
Portions of the reservation have concentrator insolation levels in the range of 7.25 – 7.5 kWh/m²/day, well within the range suitable for large-scale solar projects

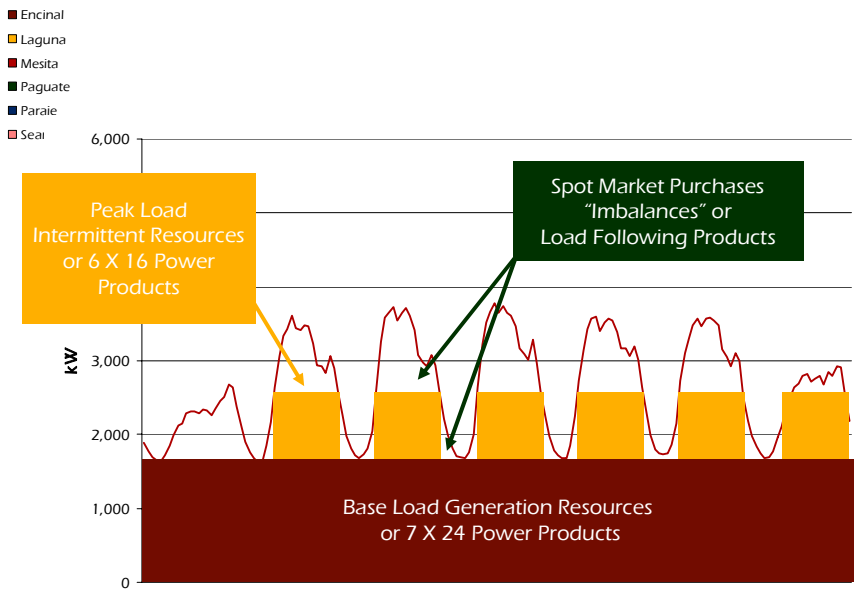
Preliminary Load Study Results

Electric usage requirements were forecasted by village and reservation

Majority of energy demand is nonresidential; 66% in Laguna and Paraje

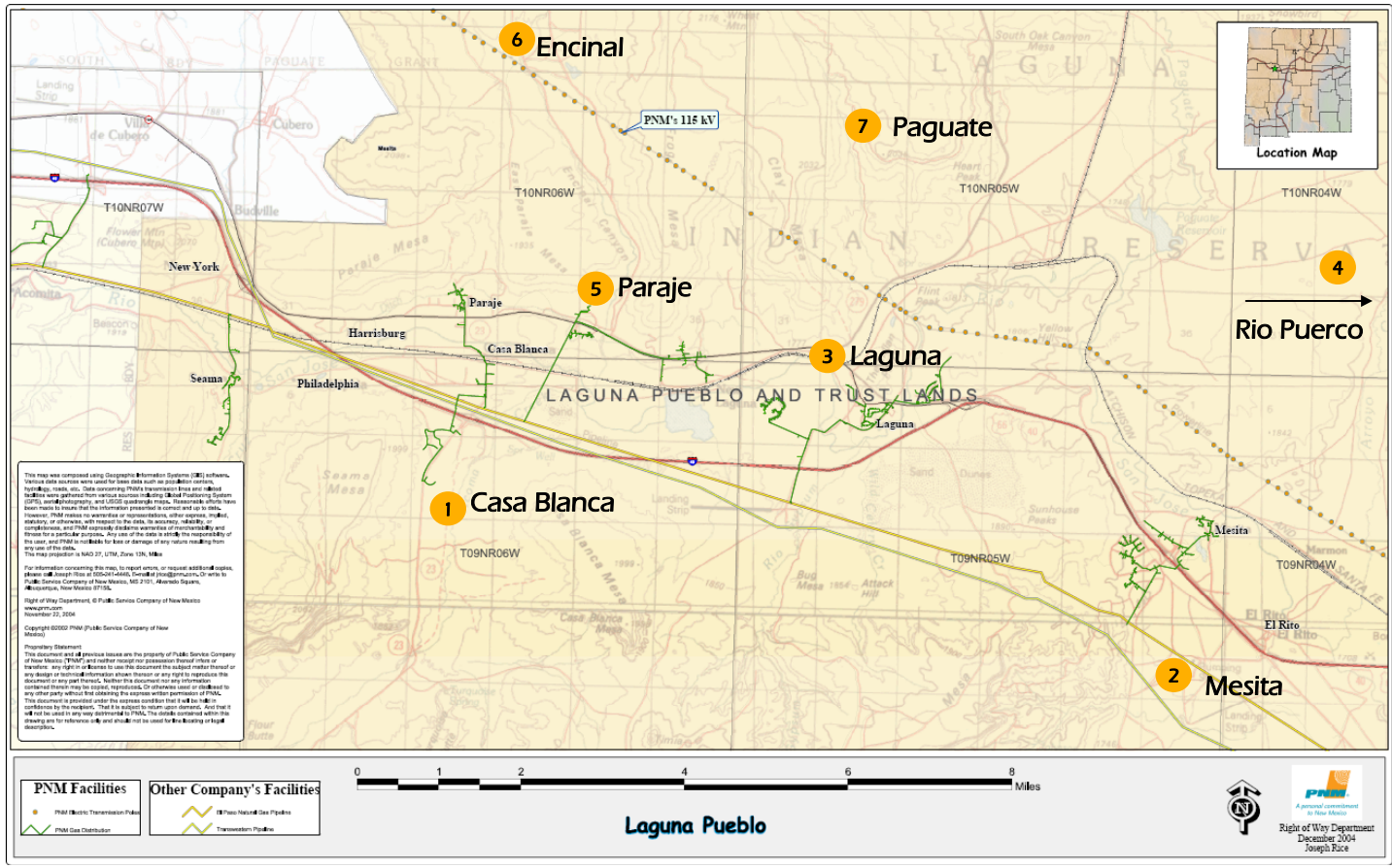
- Peak demand approximately 5 MW; varies up to 3.2 MW in a day
- Resources required to serve the total reservation electric demand:
  - 1.6 MW base load supply (7 X 24) (57%)
  - 1.9 MW intermediate (6 X 16) (28% includes solar/wind)
  - 1.6 MW load following (spot market purchases)





Initial Project Sites Identified

Seven potential project sites were identified to meet a range of village and reservation needs



Initial Wind Project Configurations

Multiple wind project options were considered at identified sites

Village or Reservation Application	Peak Demand (kW)	Annual Usage (kWh)	Load Factor	Possible Project Configurations (All Grid-Supplemented)	Peak Power (kW)	Projected Capacity Factor	Projected Annual kWh	Initial Capital Cost [1]
Laguna Industries Generation	544	1,620,000	34.0%	Two Fuhrlander 250 kW Turbines [2]	500	21.14%	871,507	$1.25M - $1.75M
Encinal Village-Scale Generation	102	393,023	44.0%	One Fuhrlander 100 kW Turbine	100	24.2%	225,223	$250k - $300k
Laguna Village-Scale Generation	2,083	9,207,437	50.5%	One GE 1.5 MW Turbine	1,500	20.6%	3,059,491	$2.0M - $2.25M
Mesita Village-Scale Generation	949	4,073,652	49.0%	One Fuhrlander 600 kW Turbine [2]	600		1,000,000	$950k - $1M
Paguate Village-Scale Generation	472	1,953,873	47.3%	Two Fuhrlander 250 kW Turbines [2]	500	21.14%	871,507	$1.25M - $1.75M
Paraje Village-Scale Generation	1,392	6,206,168	50.9%	One GE 1.5 MW Turbine	1,500	20.6%	3,059,491	$2.0M - $2.25M
Seama Village-Scale Generation	427	1,783,999	47.7%	Two Fuhrlander 250 kW Turbines [2]	500	21.14%	871,507	$1.25M - $1.75M
Laguna Reservation-Scale Generation	5,426	23,618,151	49.7%	Four GE 1.5 MW Turbines	6,000	20.6%	12,237,964	$8M - $9M
Power Export to Grid	6MW	N/A	N/A	Forty GE 1.5 MW Turbines	6MW	120.6%	122,379,640	$75M - $85M

Initial wind project capital costs identified ranged from $250,000 to $85 million

Initial Solar Project Configurations

Multiple solar project options were considered at identified sites

Village or Reservation Application	Peak Demand (kW)	Annual Usage (kWh)	Load Factor	Possible Project Configurations (All Grid-Supplemented)	Peak Power (kW)	Expected Capacity Factor	Projected Annual kWh	Initial Capital Cost [1]
Laguna Industries Generation	544	1,620,000	34.0%	Twenty 25 kW Dish-Engine Modules	500kW	25%	1.1 GWh	$2.5M
Encinal Village-Scale Generation	102	393,023	44.0%	Four 25 kW Amonix HCPV [2] arrays	100kW	23%	203,000	$600k
Laguna Village-Scale Generation	2,083	9,207,437	50.5%	Parabolic Trough	2MW	25%	4.4 GWh	$8M
Mesita Village-Scale Generation	949	4,073,652	49.0%	Parabolic Trough	1MW	25%	2.2 GWh	$4M
Paguate Village-Scale Generation	472	1,953,873	47.3%	Twenty 25 kW Dish-Engine Modules	500kW	25%	1.1 GWh	$2.5M
Paraje Village-Scale Generation	1,392	6,206,168	50.9%	Parabolic Trough	1MW	25%	2.2 GWh	$4M
Seama Village-Scale Generation	427	1,783,999	47.7%	Sixteen 25 kW Amonix HCPV [2] arrays	400kW	23%	812,000	$2.4M
Laguna Reservation-Scale Generation	5,426	23,618,151	49.7%	Parabolic Trough	5MW	25%	10.9 GWh	$20M
Power Export to Grid	60 MW	N/A	N/A	Parabolic Trough	Sized to project need	25%	132 GWh	$240M

Initial solar project capital costs identified ranged from $600,000 to $240 million

Initial Gas Project Configurations

Multiple gas-fired project options were considered at identified sites

Village or Reservation Application	Peak Demand (kW)	Annual Usage (kWh)	Load Factor	Possible Project Configurations	Installed Capacity	Heat Rate	Installed Cost per kW
Laguna Industries Generation	544	1,620,000	34.0%	Caterpillar G3512 90 TA	570kW	13,040	$1263
Encinal Village-Scale Generation	102	393,023	44.0%	Olympian G125G1	114kW	14,000	$1300
Laguna Village-Scale Generation	2,083	9,207,437	50.5%	Caterpillar G3612 TA 90 LE	2.3MW	11,384	$1231
Mesita Village-Scale Generation	949	4,073,652	49.0%	Caterpillar G3606 TA 130 LE	1MW	11,652	$1348
Paguate Village-Scale Generation	472	1,953,873	47.3%	Caterpillar G3512 90 TA	570kW	13,040	$1263
Paraje Village-Scale Generation	1,392	6,206,168	50.9%	Caterpillar G3612 TA 90 LE	1.5MW	11,594	$1245
Seama Village-Scale Generation	427	1,783,999	47.7%	Caterpillar G3512 90 TA	570kW	13,040	$1263
Laguna Reservation-Scale Generation	5,426	23,618,151	49.7%	Caterpillar GCM34	5.9MW	9,724	$1200
Power Export to Grid	60 MW	N/A	N/A	GE MS6001 FA	75.9MW	9,760	n/a

Initial Community Input

Findings From Community Meetings

- Visual impacts may not be acceptable for village-specific projects
- Better support for facility or reservation-wide projects in areas with limited visibility
- Improved likelihood of success if projects were located in existing industrial or commercial areas
- Best wind resources, and minimal visual impacts will be off mesas currently being monitored
- Further input needed from community
- Suggest multiple venues (Laguna newspaper, UA newsletter, additional village/reservation-wide meetings) to provide education, seek input

Preliminary environmental findings did not eliminate any sites

Preliminary Findings

- Sites under consideration adjacent to properties previously impacted by some activity (i.e. development, grazing, agriculture, access roads, etc.)
- All sites appear clear of any immediate cultural or historical fatal flaws
- Washes present at sites #1 and #5, but sites flexible re: mitigation
  - Dry washes; no apparent endangered species issues
- Multiple sites available allow for protection of "view sheds"
- Additional transmission/distribution ROWs yet to be reviewed
- Alternative sites must be identified under any Environmental Assessment
- FONSI (finding of no significant impact) may not be considered, since proposed projects are a "change in use"

Preliminary cost estimates utilized "HOMER" modeling approach

Modeling Considerations

- 2-3 potential configurations from each proposed project site
- Cost analysis utilized:
  - Load profiles, escalated through 2027
  - Solar and wind resource for Laguna
    - Wind data derived from preliminary anemometry results
    - Solar data extracted from National Solar Radiation Database for Albuquerque Region, 1961-1990
- A minimum renewable generating component was required
- HOMER optimizes project design and seeks least cost on the basis of:
  - Overall Net Present Value for the life of the project
  - Levelized Cost Of Energy ("LCOE")
  - Optimal contributions of grid-supplied energy and renewable and/or fossil generating resources
- *No incentives are factored in fatal flaw analysis; LCOE results expected to improve once incentives are considered*

Summary of Initial Project Sites and Configurations

Initial Levelized Cost of Energy (LCOE) estimates ranged from 9.7 to 16.7 cents per kWh without incentives or alternate funding

Case #	Site Description	Load Served	Proposed Project Scale	Grid-Parallel Project Scenarios				Optimum Sizes			Expected Project Net Present Value	LCOE* per Spec ¢/kWh	Optimized LCOE* ¢/kWh
				Generating Resource #1	Qty	Generating Resource #2	Qty	Grid kW	Gen1 kW	Gen2 kW			
1	Rainbow Center, Casa Blanca (Site 1)	Nursing home, housing complex, junior/senior high school	541.2 kW	500 kW Single Axis Horizontal Tracking System	1	Caterpillar 350kW G3508 engine	1	79.0%	0.0%	21.0%	**$4.03M**	**22.1**	**13.2**
2	Southeast of Mesita Village (site 2)	Village load	1.0 MW	Fuhrlander 250 kW FL 250 Wind Turbine	3	Caterpillar 350kW G3508 engine	2	88.0%	11.0%	1.0%	**$5.42M**	**10.8**	**9.7**
3	Laguna Village, north of Transfer Station (Site 3)	Reservation, partial Reservation load, or power export	2.1 MW	Amonix 25 kW HCPV Array	40	Caterpillar 570kW G3512 90 TA engine	2	56.0%	13.0%	32.0%	**$24.59M**	**21.9**	**15.1**
4			5.1 MW	4 MW Single Axis Horizontal Tracking System	1	Caterpillar 570kW G3512 90 TA engine	2	36.0%	25.0%	39.0%	**$42.2M**	**22.2**	**16.7**
5	Paraje, near old high school (Site 5)	Village or partial village load	1.5 MW	1 MW Single Axis Horizontal Tracking System	1	Caterpillar 570kW G3512 90 TA engine	1	80.0%	20.0%	0.0%	**$11.0M**	**19.4**	**13.1**

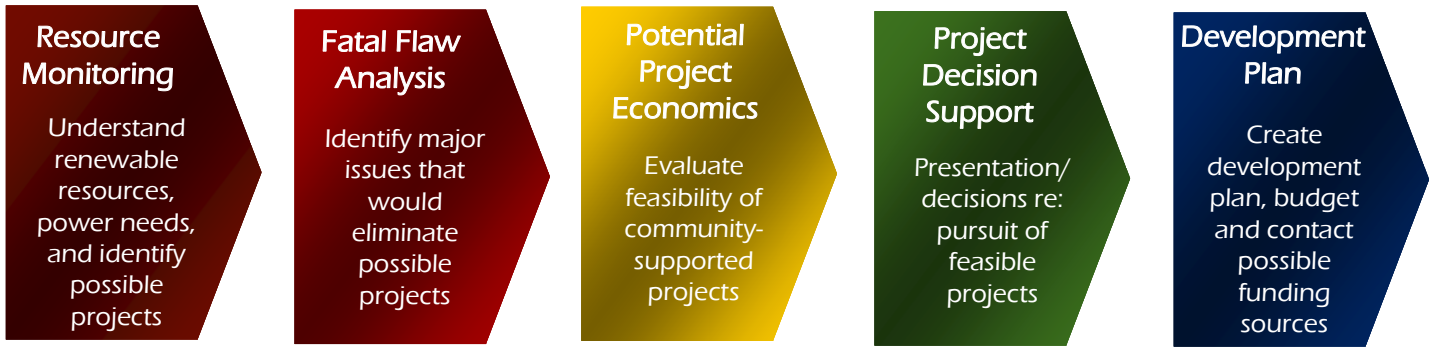
LCOE considerations put initial cost estimates results into perspective

LCOE Considerations

- Incentives will improve project LCOE results
- Large-scale power export projects (e.g. – 50-60MW scale) do not appear to be viable at this time
  - Existing low-cost generating facilities in the region
  - Limited resource needs of potential off-takers
- Reasons for considering renewable energy projects may not be cost-based alone, and may include:
  - Community values
  - Improved power quality/reliability
  - Energy independence
  - Environmental stewardship

Next Steps

Next steps will center around community/ stakeholder involvement, project economics, decision support and preparation of a development plan



- Continue community education activities
- Gather community feedback on preliminary projects identified
- Further define selected projects and determine financial architecture, partnership structures, etc.
- Begin further wind site testing, as appropriate
- Complete detailed economic analyses of accepted projects
- Prepare development plan