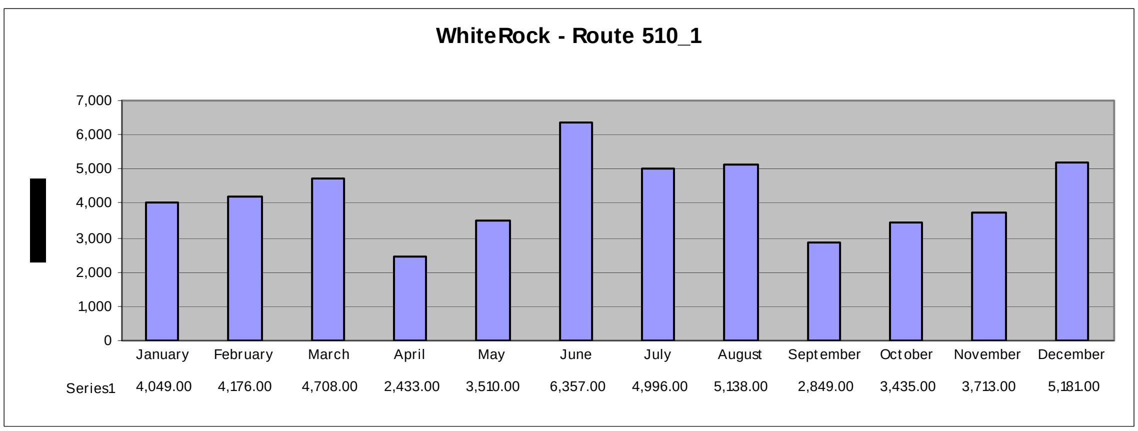
WHITE ROCK

White Rock, New Mexico is a small community that is at the end of a distribution line. This distribution line is not interconnected with the rest of the NTUA's system. The power for this community is purchased by the NTUA from another utility. NTUA would not be the owner of any upgrades to the distribution line serving this community.

LOADS

The community of White Rock has 17 customers, 6 Residential, 3 Public Street, Highway, and Private Area Lighting, and 8 Commercial accounts. The total monthly consumption in White Rock for 2004 is shown in Table 1.



	January	February	March	April	May	June	July	August	September	October	November	December
Series1	4,049.00	4,176.00	4,708.00	2,433.00	3,510.00	6,357.00	4,996.00	5,138.00	2,849.00	3,435.00	3,713.00	5,181.00

Table 1

The total kWh per year is 50,545. There is no information on the load factor or peak load for the community. NTUA's system-wide load factor is 60.5%, but the load factor for a small community such as White Rock should be much lower. Assuming a 40% load factor would result in a peak load of 14.4 kW. We also don't have any information on the daily load shape so we estimated an average load shape as shown in Figure 2.

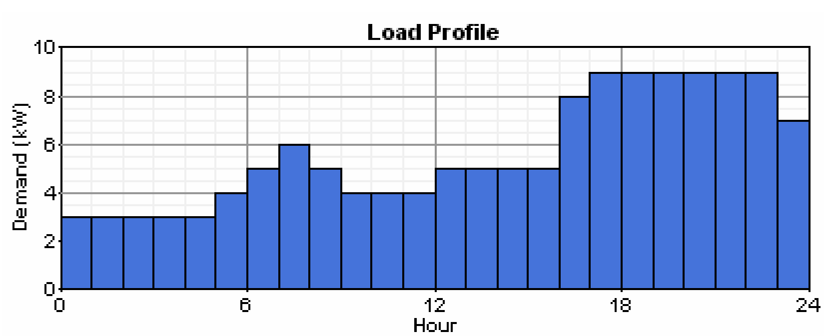


Figure 2

The average daily peak in Figure 2 is 9 kW, but the annual peak is 14.4 due to randomization that HOMER introduces into the load profile so that every day is not the same.

Two load scenarios were modeled. The first one is based on current loads. The second one assumed that the load increased by 48% but the existing distribution system could not handle peak loads in excess of 15 kW. The purpose of this analysis was to compare different distributed generation technologies that could be used to keep the peak load below 15 kW.

SOLAR RESOURCE

Solar Resource data was obtained from NREL's resource database through HOMER's automatic data retrieval mechanism for Latitude 36 5' North and 108 16' West. The annual average radiation is 5.62 kWh per square meter per day. The monthly values reach a high of about 8 kWh per square meter per day during May – July and a low of about 3 kWh per square meter per day during December and January. The monthly data is shown graphically in Figure 3.

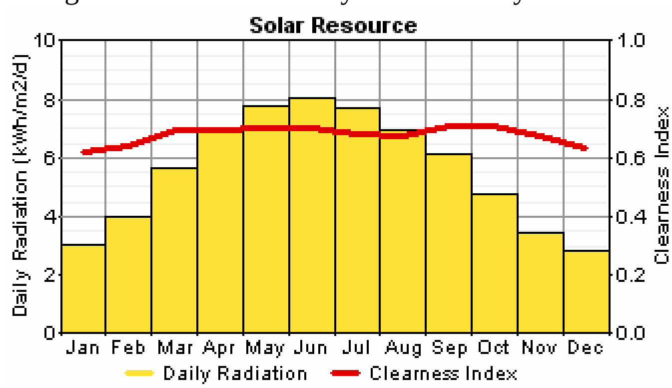


Figure 3

The effect of shorter winter days is clearly evident in the daily radiation columns. To a lesser extent the slight increase in cloudiness during the winter and the short July – August monsoon is also apparent.

WIND RESOURCE

The wind resource is much more site specific than the solar resource, nor is good wind data as conveniently available. In the attached spreadsheet we have assembled some available wind data for the Four Corner States. We have used data from Albuquerque as a proxy for White Rock under the assumption that the seasonal and daily patterns and the statistical properties, such as the autocorrelation and Weibull k factor will be similar. The overall strength of the wind resource may be different so a sensitivity analysis was performed on the annual average wind speed, while keeping these other parameters constant. If wind power looks potentially promising a more extensive resource assessment should be performed at the specific site.

NATURAL GAS RESOURCE

The White Rock area is located in the southern portion of the San Juan Basin. This portion of the basin is called the Chaco Slope. Structurally, this region exhibits a monoclinal north dip into the basin of about 100-150 feet per mile. The upper portion of the Menefee formation is exposed at the surface in this area. The Fruitland formation is not present. The Fruitland outcrop is approximately 10 miles to the north of White Rock.

Minor production from the Menefee and Dakota formations is present at the Stony Butte field primarily in section 36 of T22N R14W.The Menefee section is shallow in the area. The producing sand zone is at a depth of 800-900 feet. The Dakota formation is at a depth of approximately 3500 feet. The field exists on a small structural closure that was mapped in 1927 by the Midwest Refining Company. Midwest drilled the first well on the structure, an unsuccessful Dakota Test. The first Menefee production was completed in 1950. The cumulative production in the field is approximately 25,000 BO. The field is currently abandoned.

The main area of production in the basin is approximately 25 or more miles to the northeast. The closest production in Paleozoic rocks is at Tocito Dome, a structural trap approximately 25 miles to the northwest. The Pennsylvanian section correlative to the producing zones at Tocito is all tight limestone in the Stony Butte field. Other penetrations of this section in the area are also tight.

Oil and gas exploration potential in this area exists in Cretaceous reservoirs of the Menefee, Gallup and Dakota formations. Production in the region to date is almost exclusively from structural traps. Structures are most often mapable on the surface.

Exploration for stratigraphic traps in the Menefee, Gallup and Dakota formations may be possible in the region. Updip pinchouts of individual sand bodies may trap oil.

The White Rock area is highly prospective for both conventional gas and coalbed methane production.

GENERATORS

We analyzed two different types of generators, a micro turbine and a reciprocating engine. Both were powered by natural gas. The reciprocating engine had a lower capital cost and higher efficiency, but the micro-turbine had lower maintenance costs. The lower maintenance costs were somewhat offset by a higher standby service call cost, which HOMER does not have a way to model. All of the input assumptions are summarized in Appendix X. We scaled cost data for 250 kW generators down to 20 kW. This underestimates the cost of a smaller generator. Additional analysis is planned looking at more expensive small generators.

RESULTS

The least cost option for the base case load scenario, representing the current situation, is to continue to supply the entire load from the grid. However, in the future load scenario where the grid was inadequate to meet the peak load HOMER recommended adding a gas-fired reciprocating engine. Figure 4 shows summary HOMER results for the high load case that is least favorable to the gas-fired system, namely an 8 meter per second wind resource and a gas price of $.40 per cubic meter.

Primary Load 1 (kWh/d) 200 Wind Speed (m/s) 8 Natural gas Price ($/m3) 0.4

Double click on a system below for simulation results. Categorized Overall Export

PV (kW)	EW15	XLS	Gen1 (kW)	Micro (kW)	Conv. (kW)	Grid (kW)	Initial Capital	Total NPC	COE ($/kWh)	Ren. Frac.	Natural gas (m3)	Gen1 (hrs)	Micro (hrs)
			20			15	$ 4,800	$ 45,781	0.049	0.00	1,625	1,044	
			20	20		15	$ 22,800	$ 59,692	0.064	0.00	1,625	1,044	0
				20		15	$ 18,000	$ 69,942	0.075	0.00	3,425		1,044
		1	20			15	$ 34,800	$ 70,597	0.072	0.39	782	519	
		1	20	20		15	$ 52,800	$ 84,508	0.087	0.39	782	519	0
5			20		5	15	$ 43,300	$ 85,627	0.092	0.15	1,525	983	
		1		20		15	$ 48,000	$ 86,469	0.089	0.39	1,702		519
5			20	20	5	15	$ 61,300	$ 99,538	0.107	0.15	1,525	983	0
5				20	5	15	$ 56,500	$ 108,847	0.117	0.15	3,224		983
5		1	20		5	15	$ 73,300	$ 111,072	0.109	0.51	749	499	
5		1	20	20	5	15	$ 91,300	$ 124,983	0.123	0.51	749	499	0
5		1		20	5	15	$ 86,500	$ 126,732	0.125	0.51	1,637		499

Figure 4

The Net Present Cost of the optimal solution is $45,781. This should be compared to the Net Present Cost of upgrading the distribution system. The wind turbine does not appear to be cost effective even if the annual average wind speed were as high as 8 meters per second. This is not surprising since a dispatchable generator is still required because the wind power will not always be adequate at the times that it is needed. The wind power does reduce the gas required by approximately 50%.

APPENDIX

HOMER INPUT SUMMARY

File name: White Rock.hmr

File version:

Author:

AC LOAD: PRIMARY LOAD 1

Data source: Synthetic

Daily noise: 13.5%

Hourly noise: 13.5%

Scaled annual average: 135, 200 kWh/d

Scaled peak load: 14.43, 21.4 kW

Load factor: 0.390

PV

Size (kW)	Capital ($)	Replacement ($)	O&M ($/yr)
1.000	7,000	7,000	0

Sizes to consider:	0, 5 kW
Lifetime:	20 yr
Derating factor:	90%
Tracking system:	No Tracking
Slope:	36.1 deg
Azimuth:	0 deg
Ground reflectance:	20%

SOLAR RESOURCE

Latitude:	36 degrees 5 minutes North
Longitude:	108 degrees 16 minutes West
Time zone:	GMT -7:00

Data source: Synthetic

Month	Clearness Index	Average Radiation
		(kWh/m^2/day)
Jan	0.618	3.030
Feb	0.644	4.020
Mar	0.698	5.650
Apr	0.696	6.880
May	0.700	7.760
Jun	0.699	8.080
Jul	0.684	7.730
Aug	0.673	6.930
Sep	0.706	6.130
Oct	0.706	4.790
Nov	0.672	3.490
Dec	0.635	2.850

Scaled annual average: 5.62 kWh/m2/d

AC WIND TURBINE: EW 15

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1	120,000	100,000	2,000

Quantities to consider:	0, 1
Lifetime:	15 yr
Hub height:	25 m

AC WIND TURBINE: BWC EXCEL-S

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1	30,000	30,000	300

Quantities to consider:	0, 1
Lifetime:	15 yr
Hub height:	25 m

WIND RESOURCE

Data source: Synthetic

Month	Wind Speed
	(m/s)
Jan	3.58
Feb	3.93
Mar	4.43
Apr	4.78
May	4.69
Jun	4.38
Jul	3.98
Aug	3.62
Sep	3.76
Oct	3.67
Nov	3.53
Dec	3.40

Weibull k:	1.723
Autocorrelation factor:	0.789
Diurnal pattern strength:	0.255
Hour of peak wind speed:	17
Scaled annual average:	3.98, 5.00, 6.00, 7.00, 8.00 m/s
Anemometer height:	10 m
Altitude:	1,800 m
Wind shear profile:	Logarithmic
Surface roughness length:	0.01 m

AC GENERATOR: RECIP

Size (kW)	Capital ($)	Replacement ($)	O&M ($/hr)
250.000	60,000	60,000	3.000

Sizes to consider:	0, 20 kW
Lifetime:	15,000 hrs

Min. load ratio:	0%
Heat recovery ratio:	0%
Fuel used:	Natural gas
Fuel curve intercept:	0.07 L/hr/kW
Fuel curve slope:	0.2 L/hr/kW

AC GENERATOR: MICROTURBINE

Size (kW)	Capital ($)	Replacement ($)	O&M ($/hr)
250.000	225,000	225,000	2.000

Sizes to consider:	0, 20 kW
Lifetime:	15,000 hrs
Min. load ratio:	30%
Heat recovery ratio:	0%
Fuel used:	Natural gas
Fuel curve intercept:	0.08 L/hr/kW
Fuel curve slope:	0.28 L/hr/kW

FUEL: NATURAL GAS

Price:	$ 0.1, 0.2, 0.3, 0.4/m3
Lower heating value:	45.0 MJ/kg
Density:	0.790 kg/m3
Carbon content:	67.0%
Sulfur content:	0.330%

CONVERTER

Size (kW)	Capital ($)	Replacement ($)	O&M ($/yr)
1.000	700	700	0

Sizes to consider:	0, 5 kW
Lifetime:	15 yr
Inverter efficiency:	90%
Inverter can parallel with AC generator:	Yes
Rectifier relative capacity:	100%
Rectifier efficiency:	85%

GRID

Rate	Power Price	Sellback Rate	Demand Rate	Applicable
	$/kWh	$/kWh	$/kW/mo.	
Rate 1	0.03	0.03	0	Jan-Dec All week 00:00-24:00

CO2 emissions factor: 632 g/kWh

CO emissions factor: 0 g/kWh
UHC emissions factor: 0 g/kWh
PM emissions factor: 0 g/kWh
SO2 emissions factor: 2.74 g/kWh
NOx emissions factor: 1.34 g/kWh
Interconnection cost: $ 0
Standby charge: $ 0/yr
Maximum grid demand: 0, 5, 10, 15 kW
Maximum grid sale: 1,000 kW

ECONOMICS

Annual real interest rate: 6%
Project lifetime: 25 yr
Capacity shortage penalty: $ 0/kWh
System fixed capital cost: $ 0
System fixed O&M cost: $ 0/yr

GENERATOR CONTROL

Check load following: No
Check cycle charging: Yes
Setpoint state of charge: 80%
Allow systems with multiple generators: Yes
Allow multiple generators to operate simultaneously: Yes
Allow systems with generator capacity less than peak load: Yes

EMISSIONS

Carbon dioxide penalty: $ 0/t
Carbon monoxide penalty: $ 0/t
Unburned hydrocarbons penalty: $ 0/t
Particulate matter penalty: $ 0/t
Sulfur dioxide penalty: $ 0/t
Nitrogen oxides penalty: $ 0/t

CONSTRAINTS

Maximum annual capacity shortage: 0%
Minimum renewable fraction: 0%
Operating reserve as percentage of hourly load: 10%
Operating reserve as percentage of peak load: 0%
Operating reserve as percentage of solar power output: 25%
Operating reserve as percentage of wind power output: 50%