FULL SPECTRUM ENERGY

I. INTRODUCTION

The objective of the Full Spectrum Energy system ("FSE") is to provide energy providers with a tool for evaluating remote electric generation projects using renewable and non-renewable resources indigenous to the project area ("Phase I Analysis"). Piceance Natural Gas, Inc. ("PNG"), in partnership with the U. S. Department of Interior and National Renewable Energy Laboratory, created the web page, fullspectrumenergy.com, to assist Navajo Tribal Utility (NTUA) planners in their Phase I evaluation of remote electric generation projects. Based on the initial feasibility data generated from FSE, planners can develop a more formalized, commercial feasibility analysis ("Phase II Analysis"). PNG is employing FSE on other domestic and international projects.

II. HOW FSE WORKS

Renewable Energy Analysis:

One of the key objectives of the FSE pilot project is to provide users with a more "user friendly" system for analyzing and optimizing various renewable energy options. To accomplish this objective, FSE employs NREL's Homer model. Homer is an effective but complex tool; it requires substantive knowledge of the various renewable systems in order to complete an accurate analysis. FSE is designed for planners who do not have such an extensive renewable energy knowledge base.

FSE is specifically designed for planners who are asking two critical questions:

1. Are there renewable energy resources at a specific point of demand?
2. If so, is there a commercially viable configuration of renewable assets (e.g. wind, photovoltaic, natural gas hybrid, etc.) that could meet the demand profile of a specific project?

If the FSE analysis indicates that the resources are limited or that the asset configuration is not commercially viable, planners can focus their efforts on other, more conventional options or re-examine their assumptions.

If, however, the FSE analysis indicates that there are commercially viable options to meet the electric generation needs of a specific project, planners can proceed with a Phase II analysis. In a Phase II analysis, the full Homer and natural gas development models can be employed to further identify the commercially viable options. From there, planners can develop a site-specific plan of development.

Task #1: Define Project Demand. At the top of the FSE main page, there are five windows: Sun, Wind, Natural Gas, Water and Electric Solutions.

Users interested in wind or solar data can click on either of those *Wind* and *Solar* windows. The *Natural Gas* and *Water* windows provide data for possible conventional natural gas and coalbed methane development. The *Electric Solutions* window enables users to generate integrated economic analyses for specific projects.

Once in the Electric Solutions page, users can click on the Mixed Cost Model tab (or they can review a sample output by clicking on the Sample Output Model tab). In the Mixed Cost Model page, FSE users must select one of the five base scenarios that best fits the demand profile of their specific project. Users must choose whether the proposed project is a stand alone project or also connected to the existing grid.

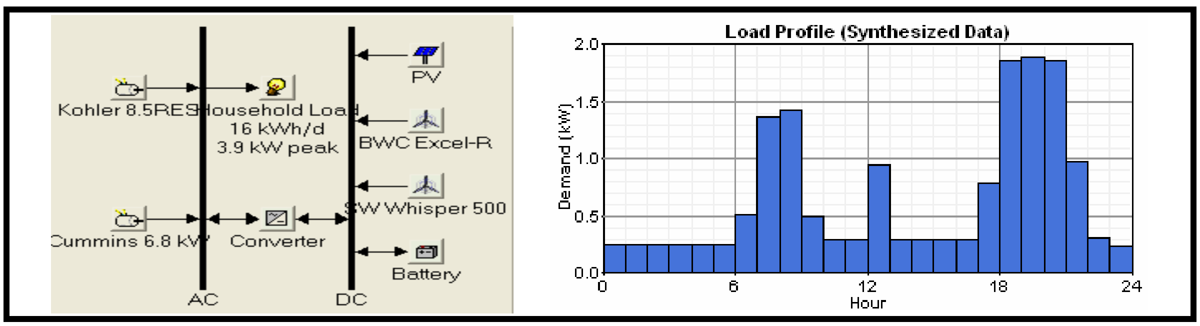
The Five Base Demand Scenarios.

1. **FSE Master – Household.**

- This scenario models the electric demand of a more standard single-family residence. The average load is 16 kWh/day or 0.67 kW. The peak hourly load over the year is 3.9 kW. The average daily load profile peaks in the evening, with varying peaks throughout the day.

- Possible load sources include the grid (if available), an 85 kW propane generator, a 6.8 kW diesel or natural gas generator, a solar photovoltaic array of up to 6 kW, up to four 3 kW DC wind turbines, and 9 kW DC wind turbine. The system can also include an AC/DC converter with a capacity of up to a 5 kW, plus as many as 48 large deep-cycle lead-acid batteries.

Household Load Profile

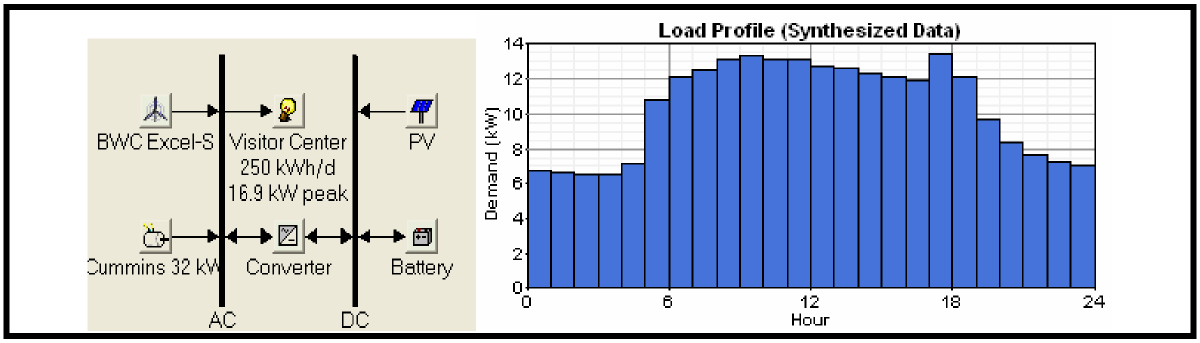


2. FSE Master – Visitor Building Center

- This scenario models the electric load typical of a small, commercial building, with relatively high daytime loads and a lower night-time load. There is no seasonal variation in the load data. The average load is 250 kWh/day or 10.4 kW, and peak hourly load over the year is 16.9 kW.

- Possible load sources include the grid (if available), a 32 kW diesel or natural gas generator, a solar photovoltaic array of up to 160 kW, and up to six 12 kW AC wind turbines. The system can also include an AC/DC converter with a capacity of up to 40 kW, plus as many as 384 large deep-cycle lead acid batteries.

Visitors Building Load Profile

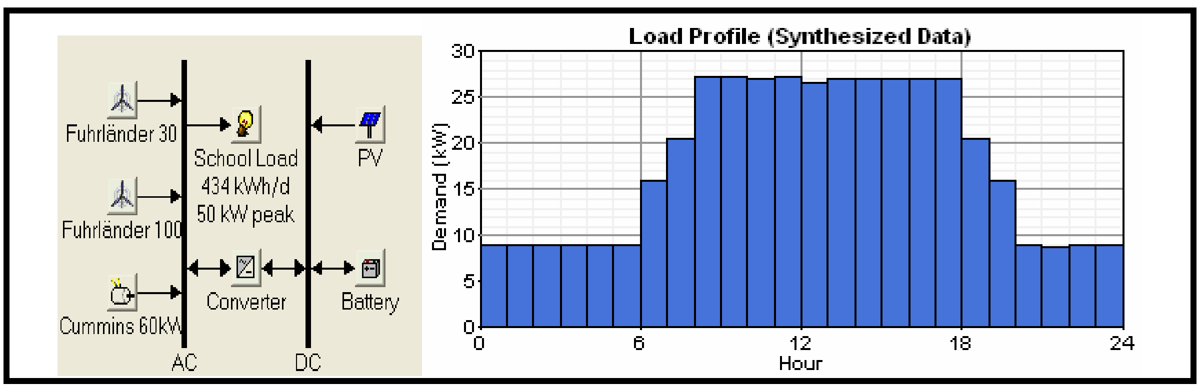


3. FSE Master – School

- This scenario models the electric load of a standard, small school, with approximately 150 students. Both the daytime and night time load are fairly constant, but the daytime load is about four times higher than the night time load during the school year. In July and August the daytime load is only about 50% higher than the night time load. The average daily load is 434 kWh/day or 18 kW, and the peak hourly load over the year is 50kW.

- Possible load sources include the grid (if available), a 60 Kw diesel generator, a solar photovoltaic array of up to 160 kW, up to two 30 kW wind turbines, and up to two 100kW wind turbines. The system can also include an AC/DC converter with a capacity of up to a 100 kW, plus as many as 384 large deep-cycle lead acid batteries.

School Load Profile

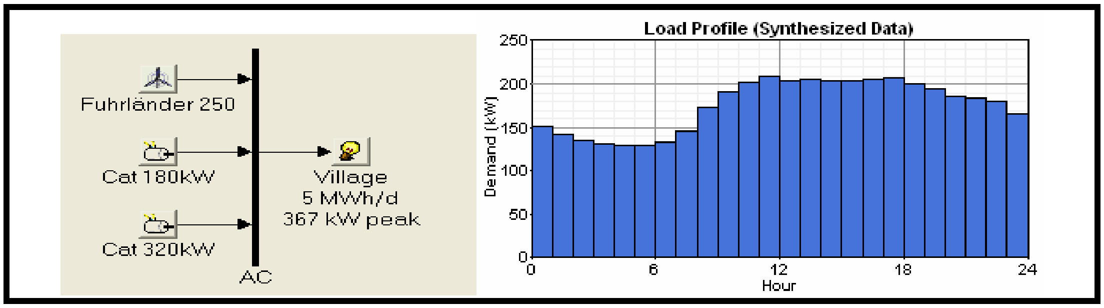


4. FSE Master – Village

- This scenario models the electric demand typical of a village of a few hundred inhabitants. The average electric load is 5000 kWh/day or 208 kW, and the peak hourly load, which occurs in the winter, is 367 kW.

- Possible power sources include the grid (if available), a 1.25 Mw diesel generator, and up to three 600 kW wind turbines.

Village Load Profile

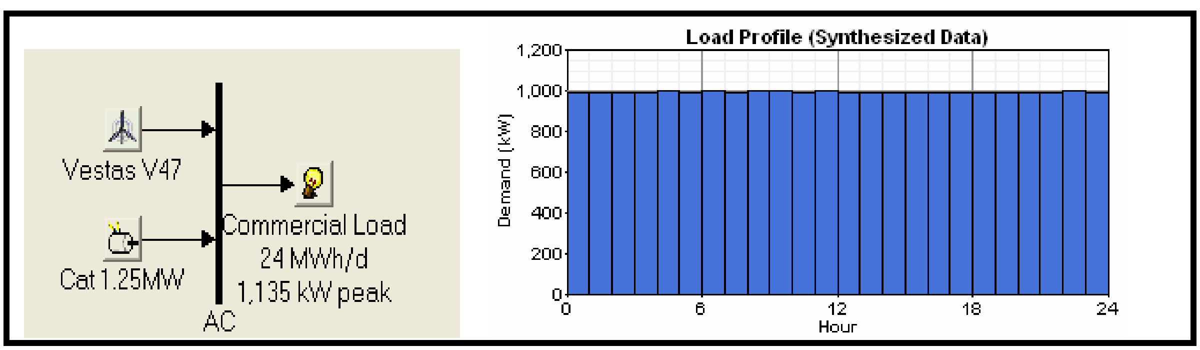


5. **FSE Commercial Load**

- This scenario is a near constant electric demand typical of a continuous commercial load, such as a small manufacturing or chemical plant. The average electric load is 24 MWh/day or 1Mw. There is a small amount of random variation in the electric load, resulting in an annual peak hourly load of 1.14 Mw.

- Possible power sources include the grid (if available), a 1.25 Mw diesel generator, and up to three 600 kW wind turbines.

Commercial Load Profile



After selecting the appropriate load scenario, users can then click on the Select Scenario tab. The resulting pop up page provides users a menu of input items ("Input Sheet"): Latitude/Longitude coordinates for the Solar analysis, wind speed for the Wind analysis and natural gas price for the Natural Gas Fired Electric Generation analysis.

In the following analysis, we engaged FSE to evaluate an electric generation system for a school project that was not grid connected. We completed the Data Input sheet: 5 m/s wind speed and 6 $/MMBtu (.212$/m3):

Data Input Sheet

Project Information	
Author	David Burnett
Notes	Off Line School

Solar: Location		
Latitude	40	N
Longitude	105	W

Wind	
Annual Ave Speed (m/s)	5

Wind resource information may be found in various published wind maps. For example see current, validated, NREL wind maps covering some states or older NREL wind maps for all states. The resource is shown as a "wind power class." A conversion table showing average wind speed in m/s for each wind power class may be found here.

Natural gas

Enter either $/mmBtu or $/m3, other value will be calculated:	
Price ($/mmBtu)	6
Fuel Cost ($/m3)	0.212
Note: $/m3 is used in calculation	

Run Optimization

FSE uses default inputs for all input categories except for those contained in the Input Sheet. It should be noted that in order to get the full value of the Homer system analysis, users need to familiarize themselves with the complete menu of input options available with Homer. For users using the full Homer system, the input menu is divided into four categories. *Load inputs* describe the system's electrical and thermal loads. *Resource inputs* describe the available renewable energy resources (using monthly or hourly data) and the price and characteristics of fossil fuels.

Component inputs describe the cost and performance of the power system components. *Optimization inputs* describe the allowable size range for each system component and various constraints on the power system. Multiple values can be specified for most variables when the data is uncertain or the user is interested in a potentially wide range of applications. Homer performs its optimization procedure for each sensitivity case, or combination of values.

After users have completed the Input Sheet, they click on the Run Optimization tab.

The Run Optimization tab engages the FSE cost modeling tool to simulate the operation of a predefined load profile and calculate the cost of meeting the energy needs using different combinations of energy sources.

In the case of the School example, after completing the Input Sheet, we clicked on the Run Optimization tab. FSE created the following report:

Run Optimization Report

The cost modeler has simulated the 755 feasible systems that supply the specified **Load** and meet the specified **Constraints** with the specified **Resources** and **Economics**.

The systems considered contain some or all of the following components. (Click on any component in the following table for more details).

Type	Description	Values Considered
Photovoltaic		0, 10, 20, 40, 80, 160 kW

Converter		0, 20, 40, 60, 100 kW
Generator	**Cummins 60kW**	0, 60 kW
Wind Turbine	**Fuhrländer 30**	0, 1, 2 (qty)
Wind Turbine	**Fuhrländer 100**	0, 1, 2 (qty)
Battery	**Surrette 4KS25P**	0, 24, 48, 96, 192, 384 (qty)

The top system in each of 11 categories is ranked below from lowest to highest Net Present Value. Click on any system's header for more detail.

SYSTEM 1

Total net present cost:	$ 836,598	
Total Capital Cost:	$ 512,000	
Levelized cost of energy:	41.30	¢/kWh

System Components

Wind Turbine 1	2	(qty)
Generator 1	60.0	kW
Battery	96	(qty)
Converter	40	kW

View more details...

SYSTEM 2

Total net present cost:	$ 844,324	
Total Capital Cost:	$ 442,000	
Levelized cost of energy:	41.70	¢/kWh

System Components

PV	10.00	kW
Wind Turbine 1	1	(qty)
Generator 1	60.0	kW
Battery	96	(qty)
Converter	40	kW

View more details...

SYSTEM 3

Total net present cost:	$ 902,607	
Total Capital Cost:	$ 186,000	
Levelized cost of energy:	44.60	¢/kWh

System Components

Generator 1	60.0	kW
Battery	48	(qty)
Converter	20	kW

View more details...

FSE provides a simulation of three levels of outputs: capital cost, net present cost, annual PV array energy production, and fuel usage, as well as hourly data like wind turbine power production or battery state of charge. Optimization results rank all of the different systems simulated for a particular sensitivity case according to net present cost. Sensitivity outputs show the effects of changes in sensitivity variables in tabular or graphic format.

In addition, FSE provides users with a cost summary of the project, a summary list of optimal components that meet the load profile, annual production and annual consumption.

In the School example, FSE produced 11 sample electric generation options. The optimal case was a wind/natural gas-fired generator hybrid system. The levelized cost of this system was 41.30 cents/kWh. It is interesting to note that, based on the FSE data, wind alone or solar alone do not appear to be economic options. They only become economic when configured with a gas-fired electric generation system.

Using the grid connect feature, FSE can analyze and compare systems connected to the grid. In the School example, we assumed a grid rate of 8 cents/kWh. FSE determined that if grid capacity alone was available, the grid option is the most cost effective option. A grid/renewable generation hybrid may be feasible in the 11-12 cents/kWh range.

Clearly, at 41.30 cents/kWh, the optimal stand alone electric generation system cannot compete with the existing grid. Where there is not an existing grid, or where there are emission issues, renewable/natural gas hybrids may be the optimal options.

For a more detailed analysis of each of the eleven options simulated by FSE, users can click on the “view more details” tabs. Users can further drill into the data by clicking on the four information tabs at the bottom of the detailed analysis sheets.

The Input Summary Sheet

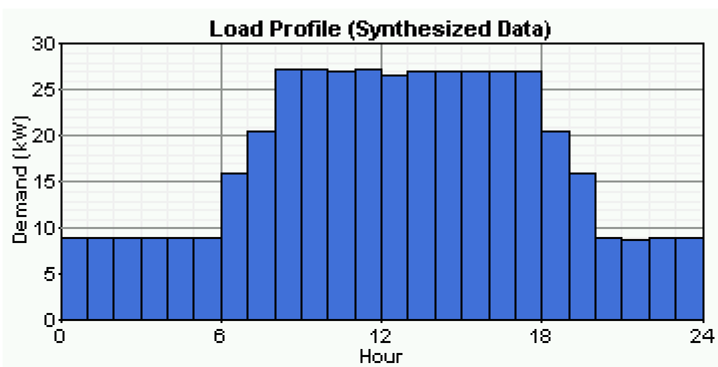
Included in this report are the AC load, PV data and Solar Resource data, DC wind turbine data, and AC diesel/natural gas data. The following Input Summary Sheet is for the school example.

INPUT SUMMARY SHEET

File name:
File version: 2.19
Author: David Burnett
Notes: School

AC LOAD: SCHOOL LOAD

Data source: Synthetic
Daily noise: 8%
Hourly noise: 10%
Scaled annual average: 434 kWh/d
Scaled peak load: 49.6 kW
Load factor: 0.364



PV

Size (kW)	Capital ($)	Replacement ($)	O&M ($/yr)
1.000	6,000	6,000	0

Sizes to consider: 0, 10, 20, 40, 80, 160 kW
Lifetime: 20 yr
Derating factor: 90%
Tracking system: No Tracking
Slope: 40 deg
Azimuth: 0 deg
Ground reflectance: 20%

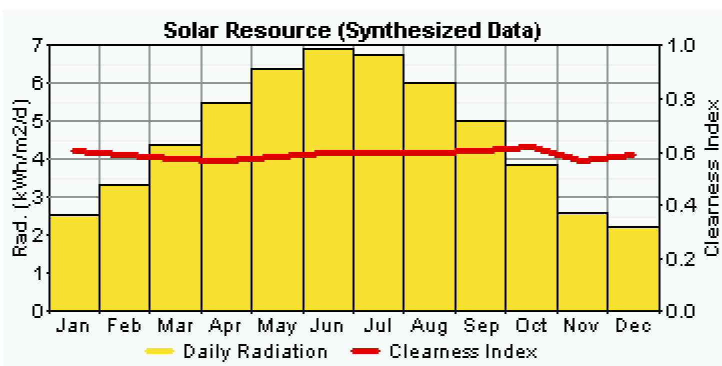
SOLAR RESOURCE

Latitude: 40 degrees 0 minutes North
Longitude: 105 degrees 0 minutes West
Time zone: GMT -7:00

Data source: Synthetic

Month	Clearness Index	Average Radiation
		(kWh/m^2/day)
Jan	0.604	2.560
Feb	0.591	3.330
Mar	0.577	4.400
Apr	0.570	5.480
May	0.581	6.400
Jun	0.597	6.920
Jul	0.598	6.750
Aug	0.596	6.030
Sep	0.608	5.040
Oct	0.620	3.850
Nov	0.568	2.580
Dec	0.592	2.260

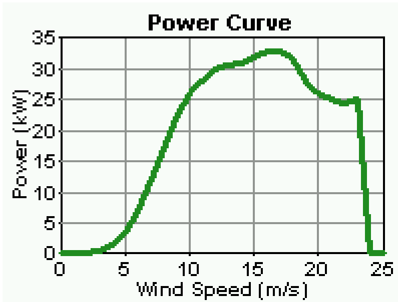
Scaled annual average: 4.64 kWh/m2/d



AC WIND TURBINE: FUHRLÄNDER 30

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1	130,000	130,000	3,000

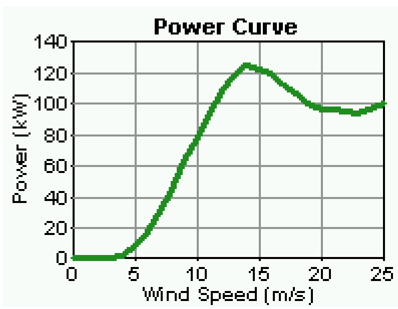
Quantities to consider: 0, 1, 2
Lifetime: 25 yr
Hub height: 27 m



AC WIND TURBINE: FUHRLÄNDER 100

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1	380,000	380,000	9,500

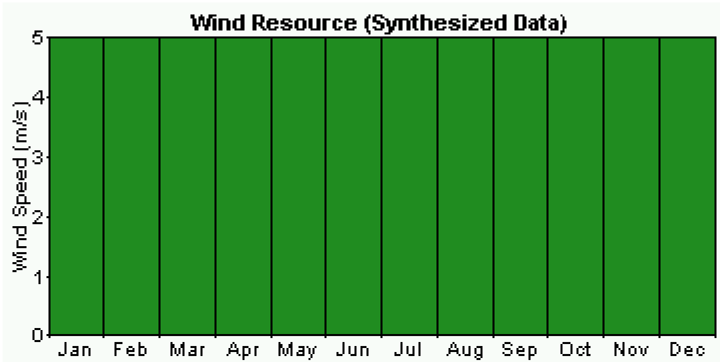
Quantities to consider:	0, 1, 2
Lifetime:	25 yr
Hub height:	35 m



WIND RESOURCE

Data source: Synthetic

Month	Wind Speed (m/s)
Jan	5
Feb	5
Mar	5
Apr	5
May	5
Jun	5
Jul	5
Aug	5
Sep	5
Oct	5
Nov	5
Dec	5

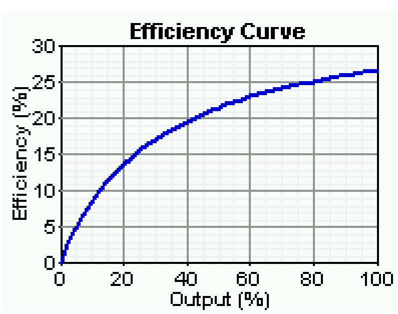


Weibull k: 2.00
Autocorrelation factor: 0.850
Diurnal pattern strength: 0.250
Hour of peak wind speed: 15
Scaled annual average: 5 m/s
Anemometer height: 10 m
Altitude: 0 m
Wind shear profile: Logarithmic
Surface roughness length: 0.01 m

AC GENERATOR: CUMMINS 60KW

Size (kW)	Capital ($)	Replacement ($)	O&M ($/hr)
1.000	2,000	2,000	0.013

Sizes to consider: 0, 60 kW
Lifetime: 15,000 hrs
Min. load ratio: 25%
Heat recovery ratio: 0%
Fuel used: Natural gas
Fuel curve intercept: 0.09 L/hr/kW
Fuel curve slope: 0.289 L/hr/kW



FUEL: NATURAL GAS

Price: $ 0.212/m3
Lower heating value: 45.0 MJ/kg

Density: 0.790 kg/m3
Carbon content: 67.0%
Sulfur content: 0.330%

BATTERY: SURRETTE 4KS25P

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1	1,000	1,000	20.00

Quantities to consider: 0, 24, 48, 96, 192, 384
Voltage: 4 V
Nominal capacity: 1,900 Ah
Lifetime throughput: 10,569 kWh

CONVERTER

Size (kW)	Capital ($)	Replacement ($)	O&M ($/yr)
1.000	900	900	0

Sizes to consider: 0, 20, 40, 60, 100 kW
Lifetime: 10 yr
Inverter efficiency: 92%
Inverter can parallel with AC generator: Yes
Rectifier relative capacity: 100%
Rectifier efficiency: 90%

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%

The System Summary Sheet.

The system summary sheet provides users with a more extensive breakdown of the system architecture, consumption and demand curves, and component cost breakdown and emissions data.

Again, the following data is derived from the School example.

System Summary

SYSTEM ARCHITECTURE

Wind turbine:	2	Fuhrländer 30
Cummins 60kW:	60	kW
Battery:	96	Surrette 4KS25P
Inverter:	40	kW
Rectifier:	40	kW

Dispatch strategy: Cycle Charging

COST SUMMARY

Total net present cost: 836,598 $
Levelized cost of energy: 0.413 $/kWh

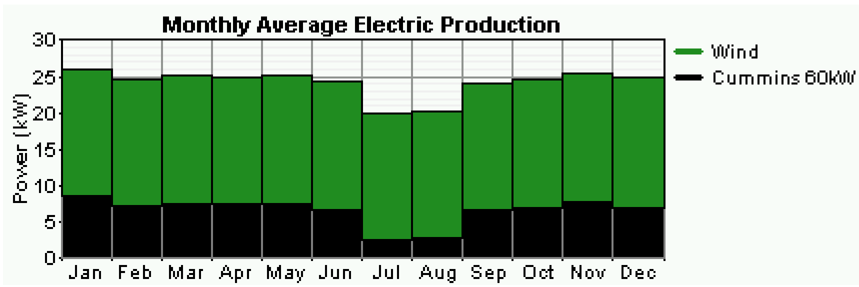
COST BREAKDOWN

Component	Initial Capital	Annualized Capital	Annualized Replacement	Annual O&M	Annual Fuel	Total Annualized
	($)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Fuhrländer 30	260,000	20,339	0	6,000	0	26,339
Cummins 60kW	120,000	9,387	5,321	1,031	5,015	20,754

Battery	96,000	7,510	3,983	1,920	0	13,413
Converter	36,000	2,816	2,123	0	0	4,939
Totals	512,000	40,052	11,426	8,951	5,015	65,444

ANNUAL ELECTRIC ENERGY PRODUCTION

Component	Production (kWh/yr)	Fraction
Wind turbines	153,345	73%
Cummins 60kW	57,764	27%
Total	211,110	100%



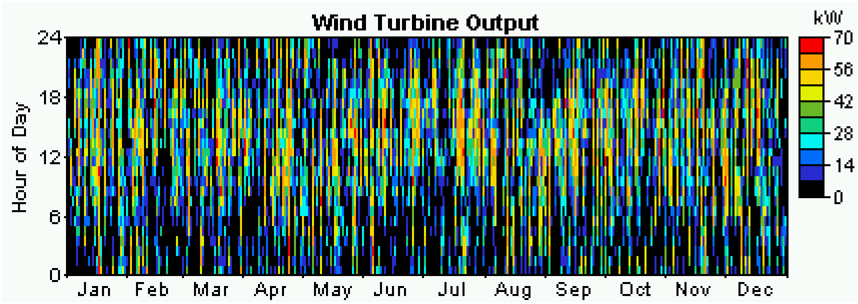
ANNUAL ELECTRIC ENERGY CONSUMPTION

Load	Consumption (kWh/yr)	Fraction
AC primary load	158,410	100%
Total	158,410	100%

Variable	Value	Units
Renewable fraction:	0.726	
Excess electricity:	27,865	kWh/yr
Unmet load:	0	kWh/yr
Capacity shortage:	0	kWh/yr

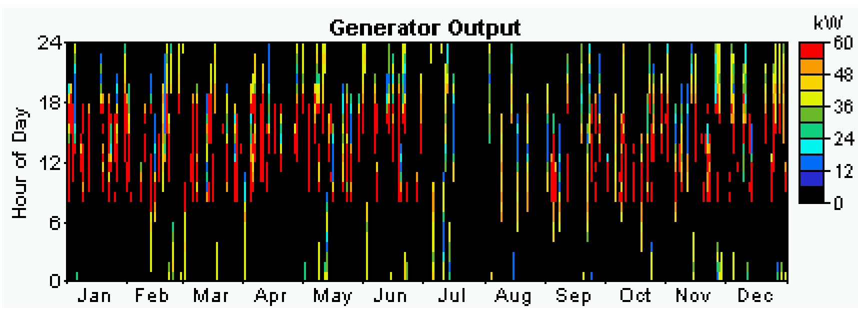
AC WIND TURBINE: FUHRLÄNDER 30

Variable	Value	Units
Total capacity:	66.0	kW
Average output:	17.51	kW
Minimum output:	0.000	kW
Maximum output:	66.0	kW
Wind penetration:	96.8	%
Capacity factor:	26.5	%
Hours of operation:	7,948	hr/yr



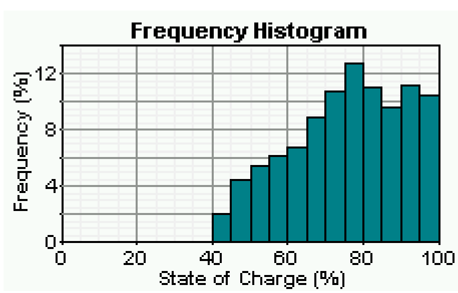
CUMMINS 60KW

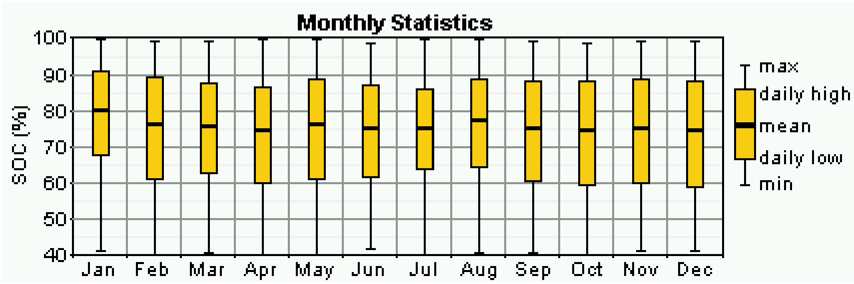
Variable	Value	Units
Hours of operation:	1,289	hr/yr
Number of starts:	175	starts/yr
Operational life:	11.64	yr
Average electrical output:	44.8	kW
Minimum electrical output:	15.00	kW
Maximum electrical output:	60.0	kW
Annual fuel usage:	23,655	m3/yr
Specific fuel usage:	0.410	m3/kWh
Average electrical efficiency:	24.7	%

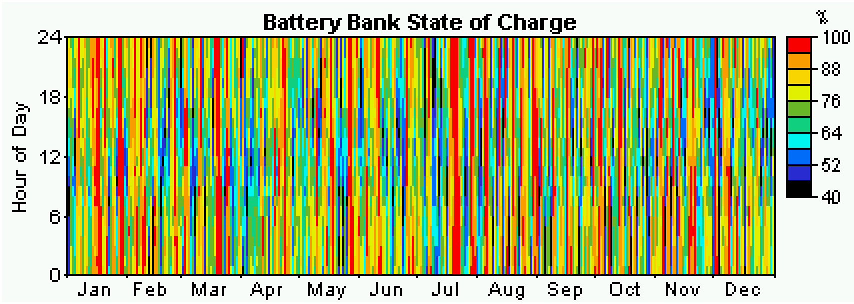


BATTERY

Variable	Value	Units
Battery throughput	60,295	kWh/yr
Battery life	12.00	yr
Battery autonomy	24.2	hours







EMISSIONS

Pollutant	Emissions (kg/yr)
Carbon dioxide	45,908
Carbon monoxide	0
Unburned hydrocarbons	0
Particulate matter	0
Sulfur dioxide	123.3
Nitrogen oxides	0

The FSE output helps users answer the key questions: Are there indigenous natural resources that can power renewable energy systems in remote areas? And, if the answer to the first question is affirmative, what are the renewable electric generation options? And what are the range of costs and benefits associated with each electric generation option—including emissions data. It many cases, the resources are present, but because of the nature of the load, the cost of installing the optimal renewable system is not cost effective. Perhaps, the optimal solution is expanding the grid or developing stand alone natural gas-electric generation systems.

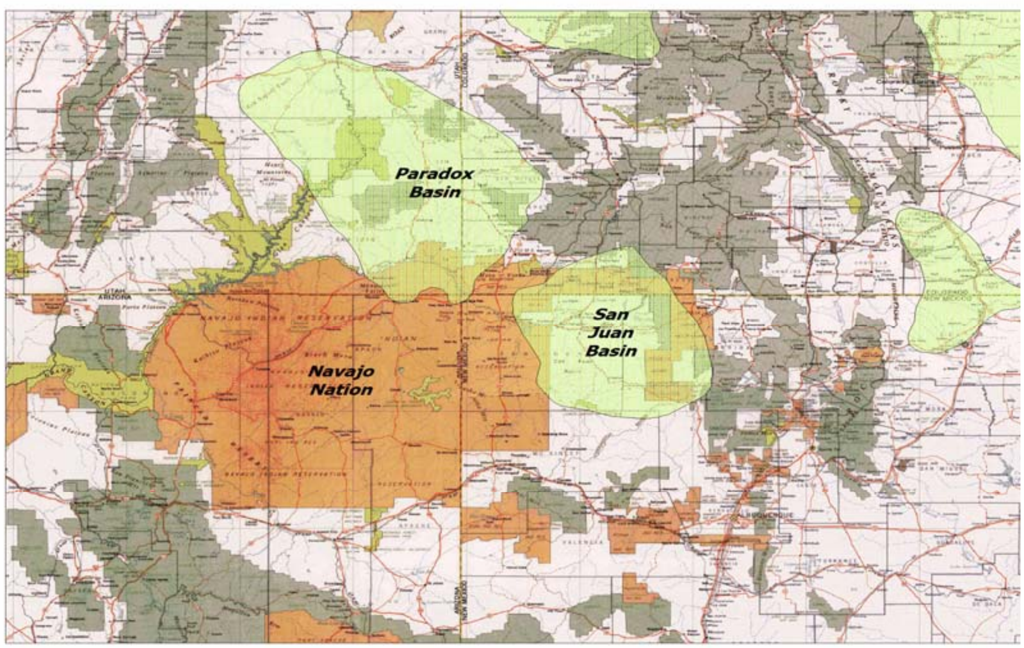
Natural Gas Resource Assessment:

Again, the purpose of FSE is to provide users with an initial analysis of natural gas potential for gas fired electric generation systems. Along with FSE's renewable energy analysis, users can employ the FSE natural gas models to help make generalized natural gas assessments. Once FSE models have indicated that there is natural gas potential to warrant further analysis, users can complete a more site specific, Phase II resource analysis.

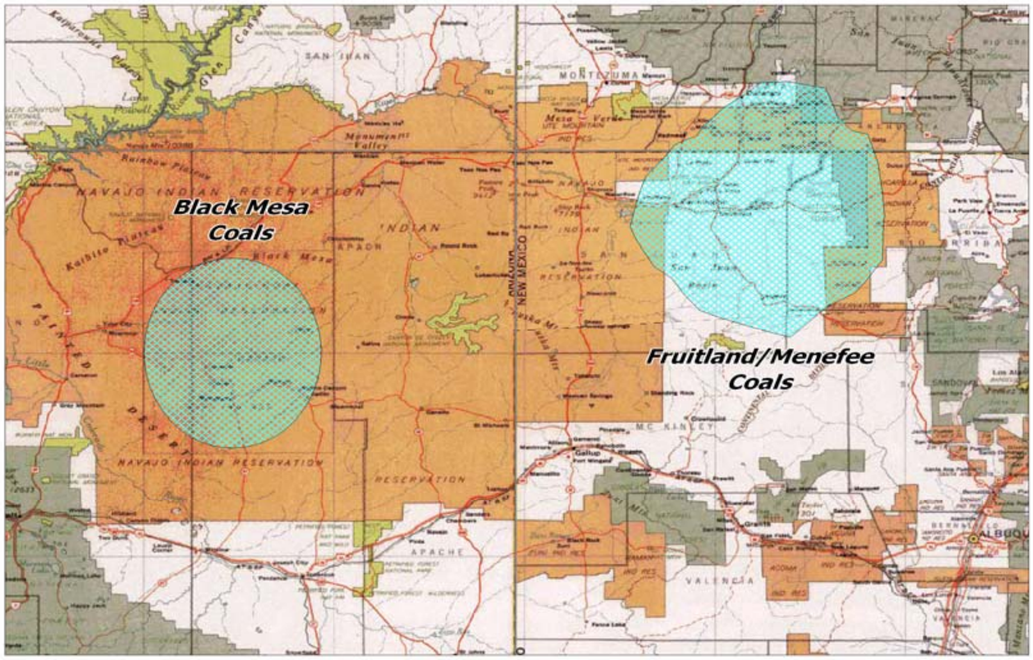
FSE divided the natural gas resource in to two tabs: the *Natural Gas* windows for conventional gas resources and the *Water* window for coalbed methane ("CBM") resources. CBM resources are included in the water tab because CBM resources typically produce large amounts of water as a byproduct of the CBM development—much of the time the produced water are potable or can be cost-effectively treated for agricultural uses.

After selecting the appropriate window, the first step is for users to click on the General Maps bullet. The first map in the *Natural Gas* window, the Geological Overview Map – Conventional Natural Gas, helps direct users to areas of known gas producing geologic regions. The first map in the *Water* window, the General Geological Overview Map – Coalbed Methane, also helps direct users to potential coalbed methane development opportunities. Users can use the scroll and zoom features of the maps to better examine specific areas.

General Geologic Map – Conventional Gas

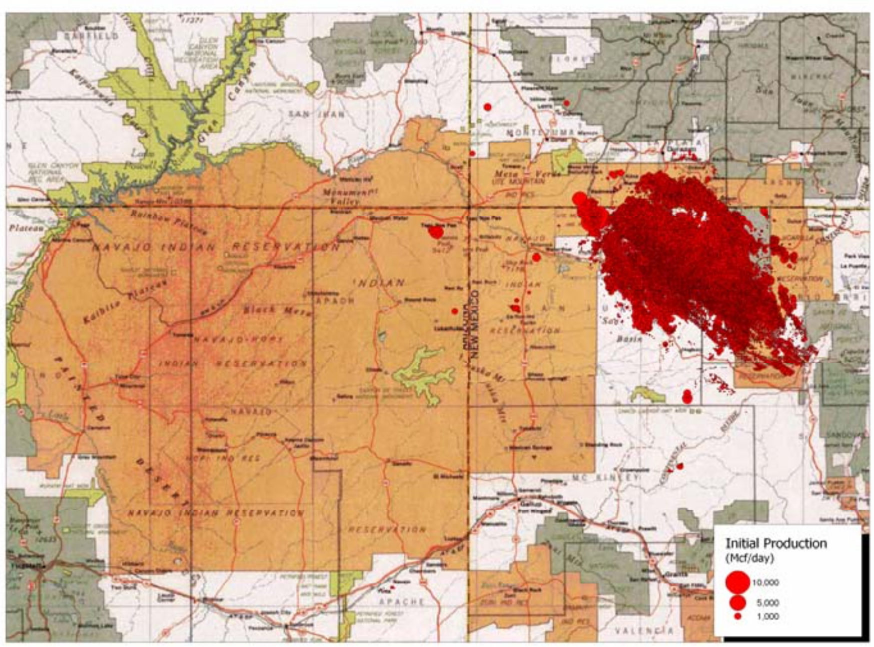


General Geologic Map – Coalbed Methane

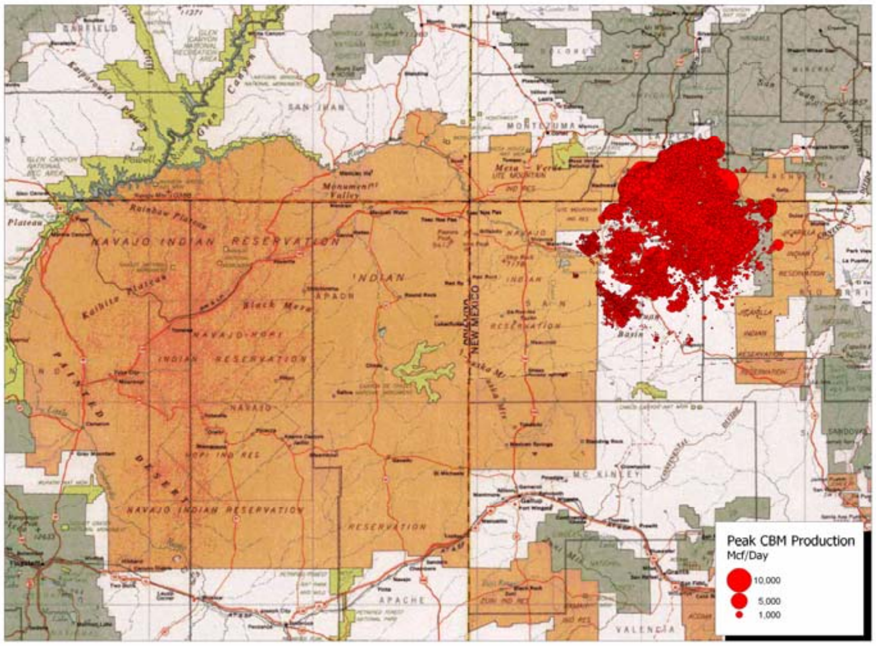


The second map in the *Natural Gas* window, the Initial Production ("IP"), indicates initial production of wells in the major producing areas; obviously, the higher the IP in an area of interest, the better the opportunity for success in terms of developing remote, gas-fired electric generation systems. The second map in the *Water* window, Coalbed Methane – Peak Production, illustrates current CBM producing areas. Since CBM wells typically have low IP's, with production inclining in the first year, the peak production number is a better indicator of CBM potential.

Initial Production - Conventional Gas

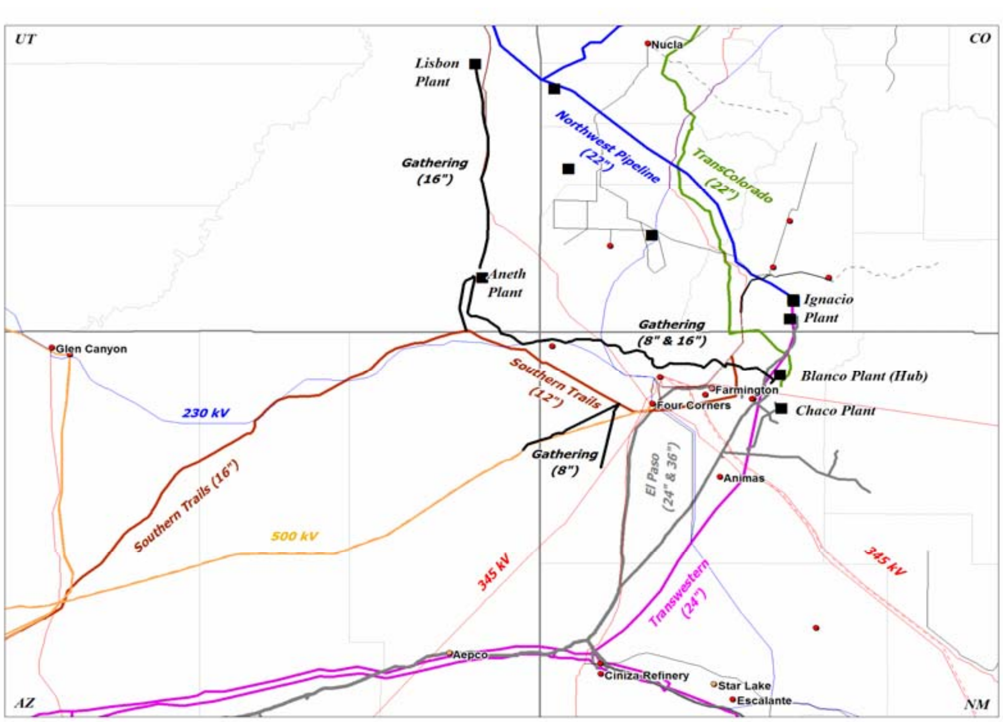


Coalbed Methane – Peak Production



The final map, the general infrastructure map, guides users to areas wherein infrastructure (that is, pipelines, plants, etc) already exists. Infrastructure is a costly part of the natural gas value chain. Users should pay close attention to pipeline and electric generation infrastructure.

General Infrastructure Map



If the production maps indicate production in the area of interest, the next step is to click on the Natural Gas Locator bullet. By scrolling and zooming around the map, users can isolate specific wells by clicking on the colored circles. The large circles indicate high concentration of wells. In the "large circle" areas, users can access individual well data by zooming into the areas; individual well spots will appear; just click on the well spot and the following critical well data will occur: Well Name, API number, Well Type, Well Status, State, County, Reservoir, Legal Description, 1st Month of Production, Last Month of Production, Maximum Production, and Maximum Daily Production. Users can also click on the Satellite and Hybrid tabs to access topographical features relative to specific wells.

Well Production Data

Well Name:	STATE
API:	500000008
Well type:	Gas
Well Status:	ACT
State:	AZ
County:	APACHE
Field:	ST JOHNS
Reservoir:	SUPAI
Location:	22 10N 30E SW SW
First Month:	2002-07-01
First Production:	23172
Last Month:	2004-02-01
Last Prod:	2168
Cumul Prod:	75
Max Prod:	
Max Daily:	

By providing users with this critical well data (in excess of 30,000 in the Well Locator data base), FSE identifies sources of current production (i.e. Navajo Nation royalty production) and future potential gas development (i.e. electric generation-based leasing targets).

To assist users in determining the economic feasibility of drilling for new natural production, FSE developed the Gas Cost Model. Again, the purpose of the FSE Gas Cost Model is to provide a Phase I analysis. At its full potential, the Gas Cost Model is an investment grade tool and geared toward more substantive Phase II analyses; however, for a Phase I analysis, we developed a more simplified tool. Users first click on the Gas Cost Model Bullet; the Gas Cost Input Sheet (below) appears.

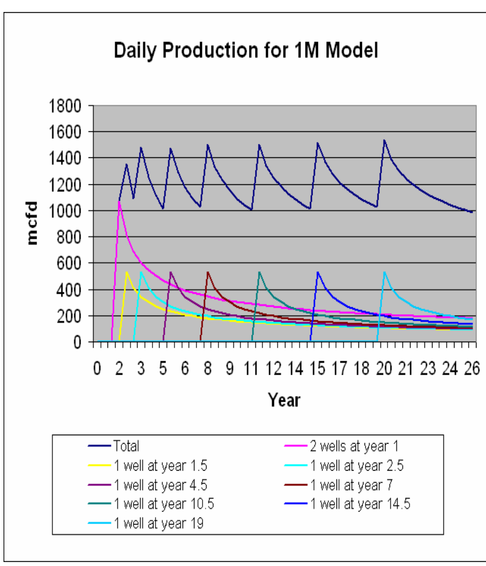
Gas Input Sheet

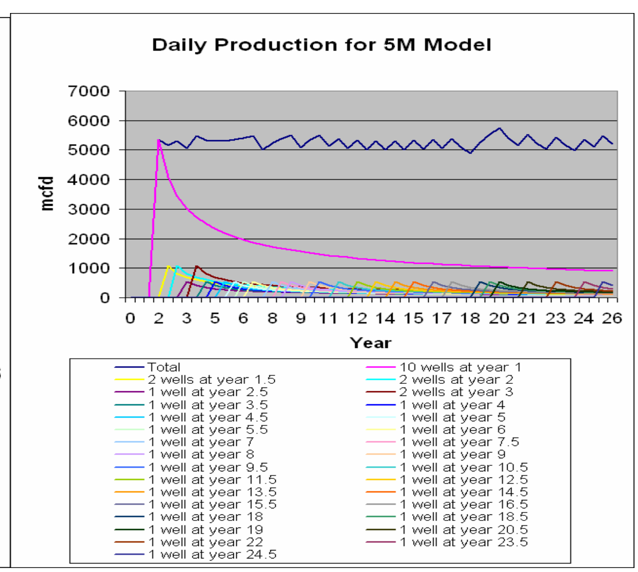
Gas cost models are provided for required minimum daily production of 1, 5, and 10 mmcfpd. To view production curves click here (1 mmcfpd), here (5 mmcfpd), and here (10 mmcfpd).

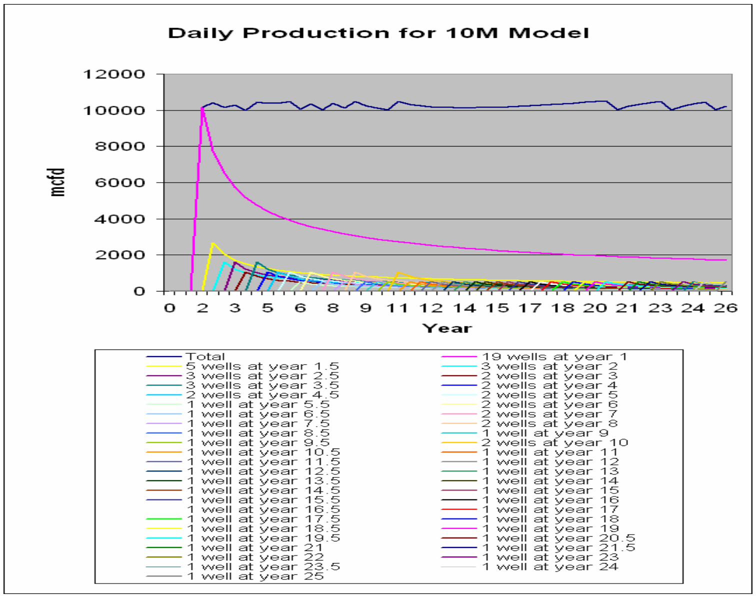
Required Daily Production	1 mmcfd
New Well Capital Cost ($,000s):	1,000
New Well Connection Cost ($,000s):	100
Load Factor (%):	90
Gathering Rate ($/MMBTU):	0.55
Cost Inflation (%):	2
Royalty & Prod Taxes (%):	25
Sales Price ($/MMBTU):	7.00
Price Inflation (%):	2

Users must complete the Input Data Sheet and select one of three deliverability scenarios: 1,000 mcf per day, 5,000 mcf per day or 10,000 mcfpd. FSE calculates the number of wells required to be drilled to maintain the deliverability over the course of the life of an electric generation project. Three production scenarios found in the *Natural Gas* window are typical of more traditional tight gas sand wells common to the Four Corners producing area. The three gas and water production scenarios in the *Water* window are typical of CBM wells common to the San Juan Basin.

Production Curves For The Three Scenarios







Clearly, the three production models produce more gas than will be required to meet most small electric generation loads. In order to attract producers to engage in exploration and production activities in targeted areas, particularly in areas where no production exists and exploration and infrastructure costs are high, larger acreage blocks will likely have to be developed—part of the gas production would be earmarked for gas fired electric generation and part would be sold into the marketplace.

Once users have selected a production profile, they can change the values in the input boxes or retain the default inputs provide in the model. Once the input sheet is completed, users click on the Calculate tab. The Gas Cost Model will calculate, based on a 25 year project life, the internal rate of return, net present value of the investment and payout (in years). The Model also provides annualized economic detail sheet.

Natural Gas Output

Results:

Details

Year(s):	20
IRR:	61.3%
NPV:	7,289
Payback:	2.60

	New Wells Drilled	Production	Gross Receipts	Operating Costs	Capital Costs	Income Tax	Cash Flow	Depreciation (Book)	Depreciation (Tax)
Year 1	3	254	$ 1,603	$ 863	$ 3,000	$(544)	$(1,716)	$ 50	$ 2,100
Year 2	1	517	$ 3,322	$ 1,075	$ 1,020	$ 510	$ 717	$ 117	$ 971
Year 3	0	560	$ 3,672	$ 1,071	$ 0	$ 932	$ 1,669	$ 134	$ 271
Year 4	1	410	$ 2,739	$ 930	$ 1,061	$ 349	$ 399	$ 152	$ 936
Year 5	0	556	$ 3,794	$ 1,118	$ 0	$ 979	$ 1,697	$ 169	$ 229
Year 6	0	431	$ 2,996	$ 896	$ 0	$ 764	$ 1,336	$ 169	$ 190
Year 7	1	502	$ 3,564	$ 1,180	$ 1,126	$ 570	$ 688	$ 188	$ 960
Year 8	0	491	$ 3,555	$ 1,065	$ 0	$ 912	$ 1,578	$ 207	$ 209
Year 9	0	422	$ 3,119	$ 944	$ 0	$ 823	$ 1,352	$ 207	$ 118
Year 10	1	382	$ 2,877	$ 1,010	$ 1,195	$ 379	$ 293	$ 227	$ 919
Year 11	0	565	$ 4,339	$ 1,298	$ 0	$ 1,155	$ 1,886	$ 247	$ 154
Year 12	0	457	$ 3,583	$ 1,087	$ 0	$ 955	$ 1,541	$ 247	$ 108
Year 13	0	412	$ 3,293	$ 1,006	$ 0	$ 880	$ 1,407	$ 247	$ 87
Year 14	1	382	$ 3,113	$ 1,102	$ 1,294	$ 420	$ 297	$ 268	$ 961

Year 15	0	571	$ 4,746	$ 1,427	$ 0	$ 1,268	$ 2,051	$ 290	$ 148
Year 16	0	467	$ 3,963	$ 1,209	$ 0	$ 1,055	$ 1,699	$ 290	$ 116
Year 17	0	425	$ 3,676	$ 1,129	$ 0	$ 989	$ 1,558	$ 290	$ 75
Year 18	0	397	$ 3,502	$ 1,081	$ 0	$ 952	$ 1,469	$ 290	$ 40
Year 19	1	503	$ 4,525	$ 1,525	$ 1,428	$ 784	$ 788	$ 314	$ 1,040
Year 20	0	511	$ 4,689	$ 1,428	$ 0	$ 1,239	$ 2,022	$ 337	$ 163
Year 21	0	455	$ 4,255	$ 1,307	$ 0	$ 1,136	$ 1,812	$ 337	$ 108
Year 22	0	423	$ 4,036	$ 1,246	$ 0	$ 1,091	$ 1,699	$ 337	$ 62
Year 23	0	400	$ 3,894	$ 1,207	$ 0	$ 1,057	$ 1,630	$ 337	$ 45
Year 24	0	382	$ 3,792	$ 1,178	$ 0	$ 1,028	$ 1,586	$ 337	$ 45
Year 25	0	367	$ 3,715	$ 1,157	$ 0	$ 1,005	$ 1,553	$ 337	$ 45

III. CONCLUSION:

FSE is an effective tool for analyzing the initial feasibility of potential projects. It can shed light on natural resource potential, the range of electric generation options and the commercial feasibility of each option. From there, FSE can develop a more substantive Phase II analysis—the final feasibility analysis before moving forward with a site-specific plan of development.

Attached are three examples of sample Phase II studies: White Rock, New Mexico, Four Corners Monument, New Mexico and Coal Mine Mesa, Arizona.