Economic Feasibility of Owning a Small Wind Generator

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Outline

- Research Goals
- Solution/Process
- System Studies
- Conclusions

Research Goals

- Develop a tool to estimate the amount of energy that will be produced by residential sized renewable energy systems

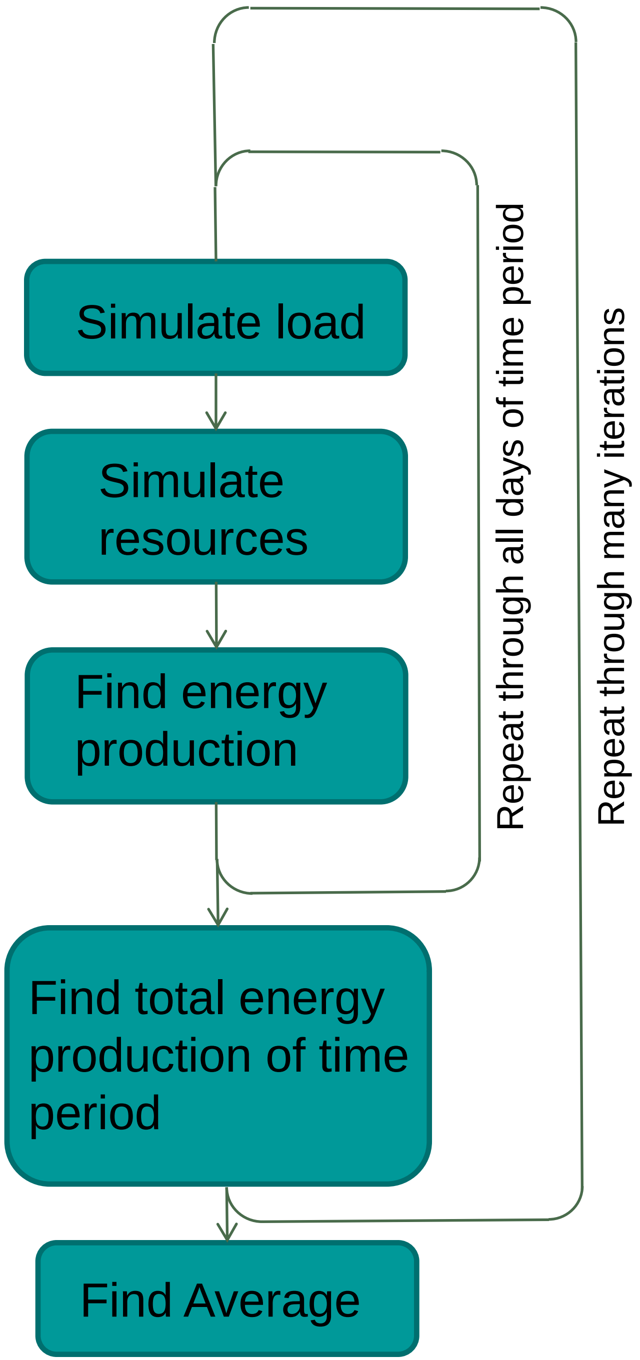
- Use this tool to analyze several systems in various locations to…

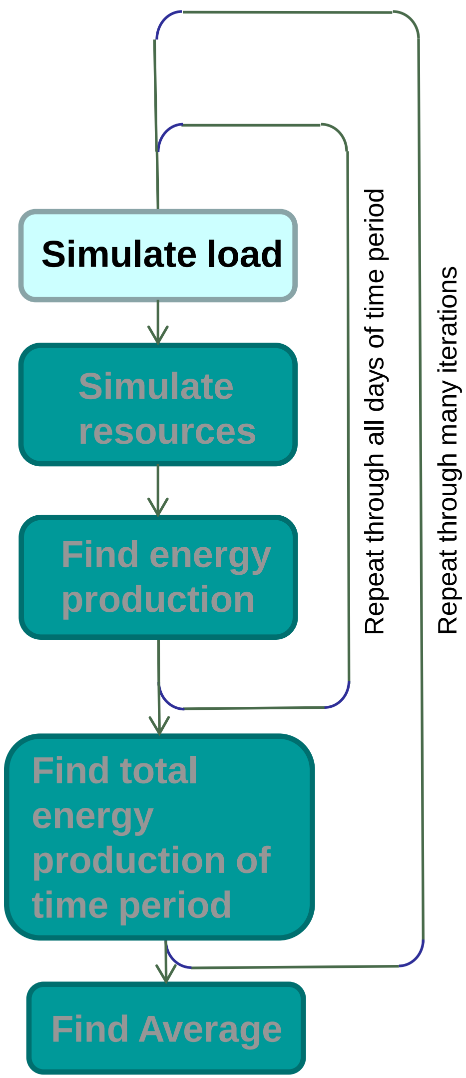
  …determine expected energy production

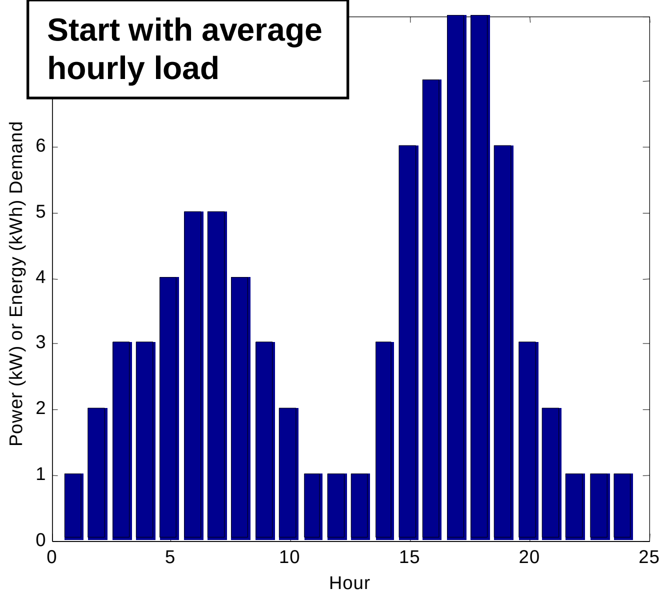
  …determine if system is economically viable

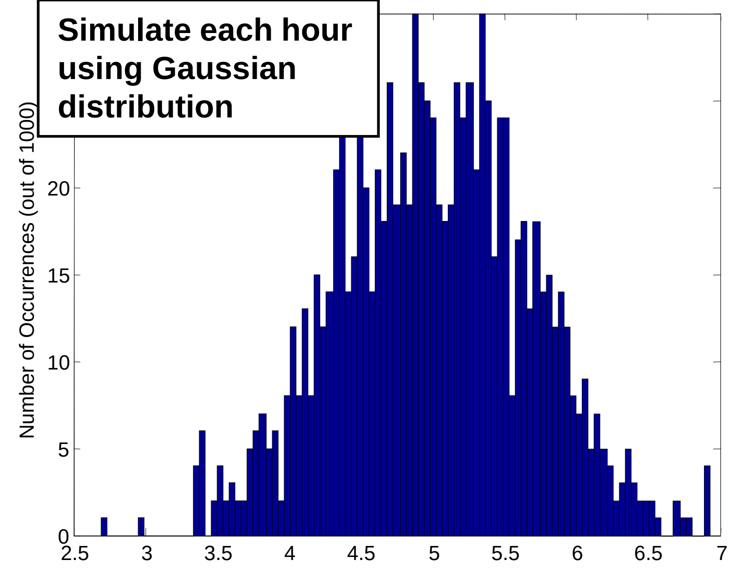
Process

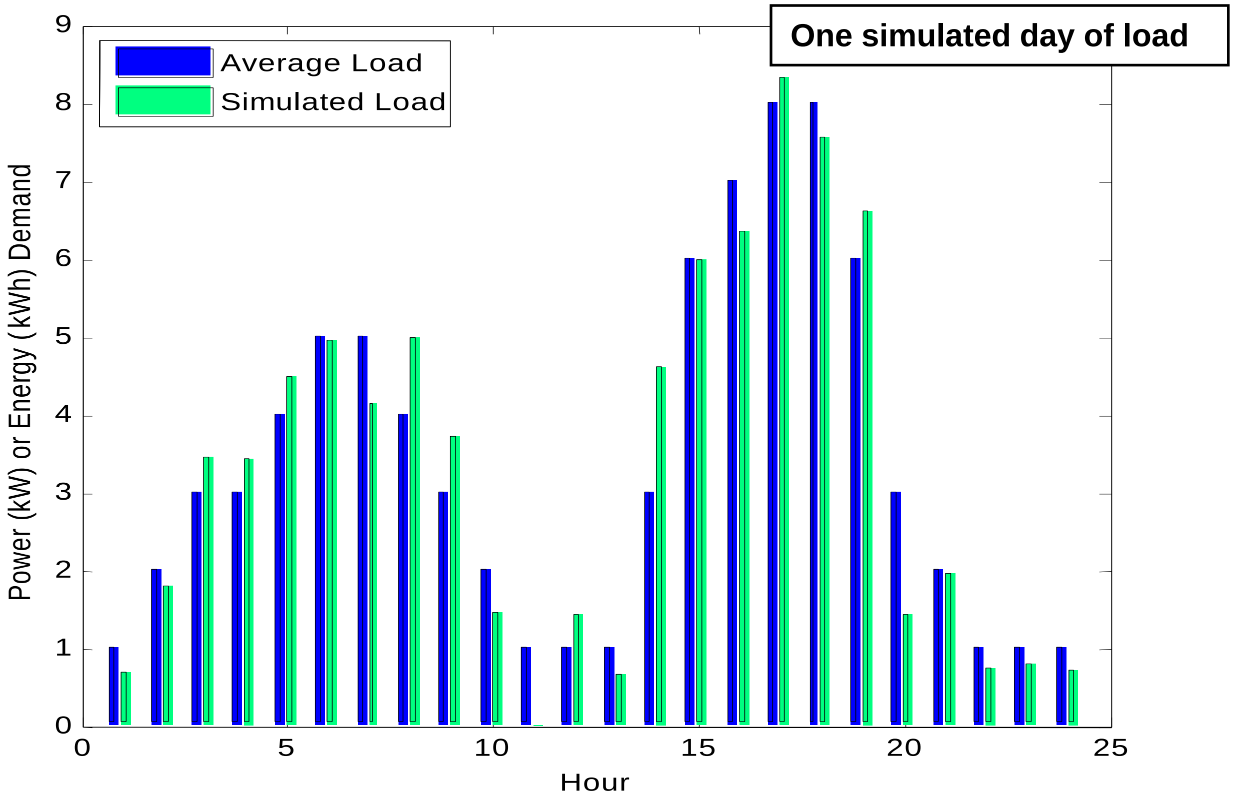
1. Simulate load based on statistical data
2. Simulate renewable energy resource based on statistical data
3. Using a power curve, determine the amount energy produced by the renewable generator at each time interval
4. Determine the amount of saved energy and excess energy produced
5. Repeat for the number of days in the desired time period (while keeping track of total energy production)
6. Repeat all steps for the desired number of iterations to find an average

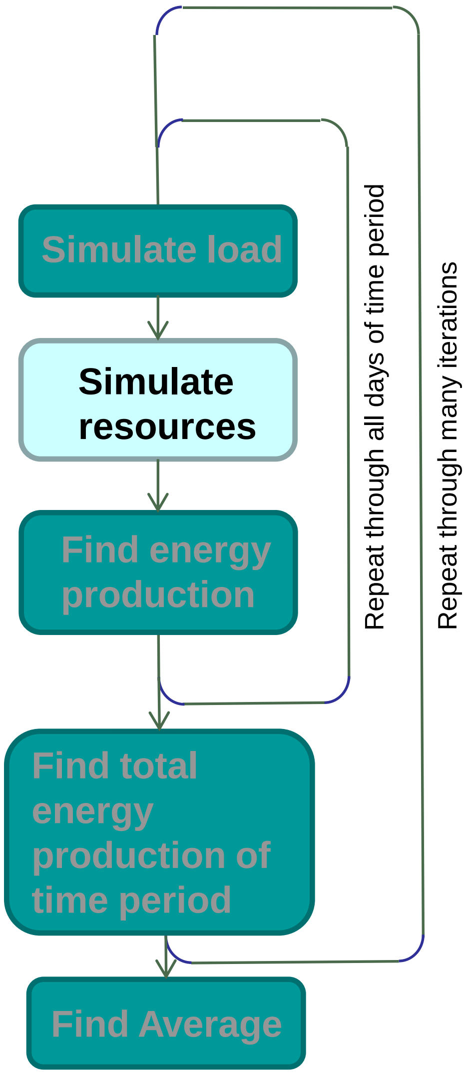


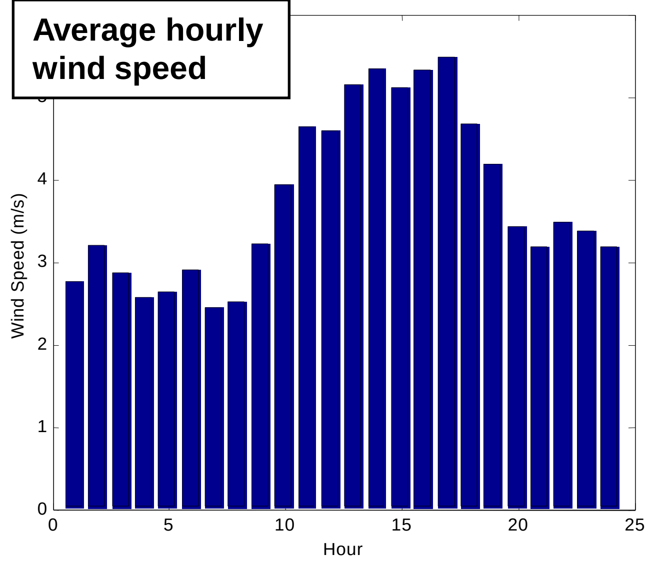

Simulate load
Simulate resources
Find energy production
Find total energy production of time period
Find Average
Repeat through all days of time period
Repeat through many iterations

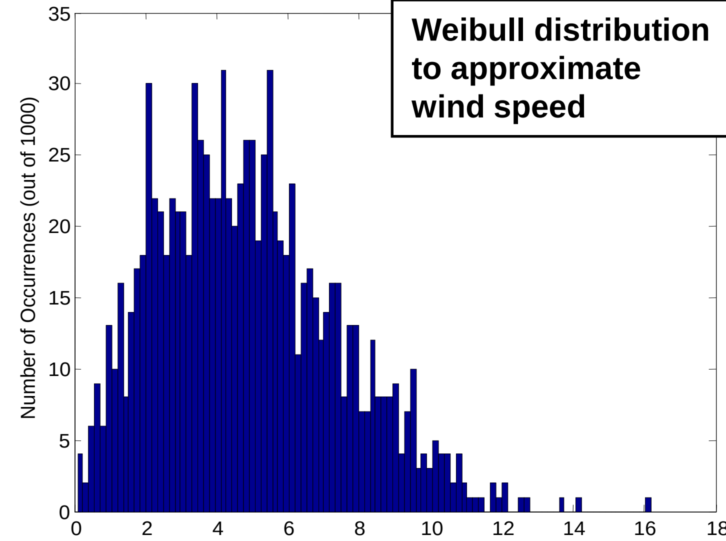

Start with average hourly load
Power (kW) or Energy (kWh) Demand
Hour

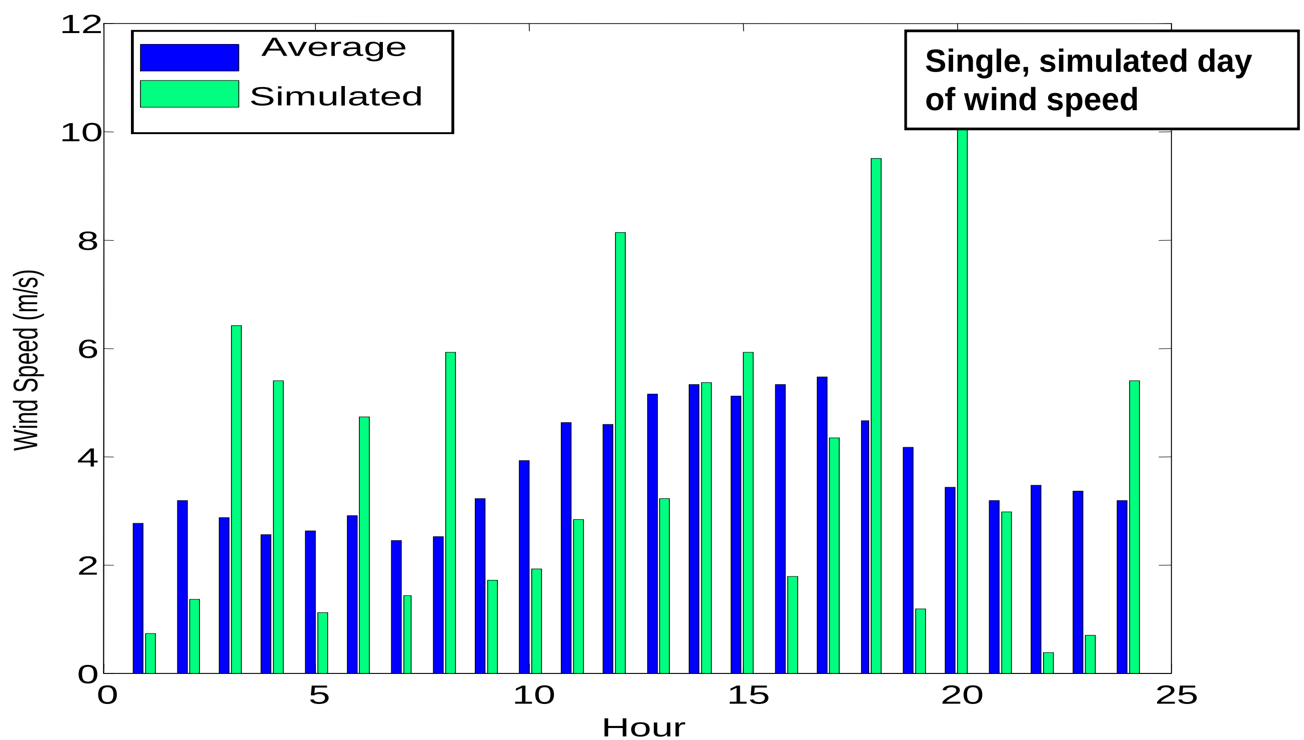

Simulate each hour using Gaussian distribution
Number of Occurrences (out of 1000)

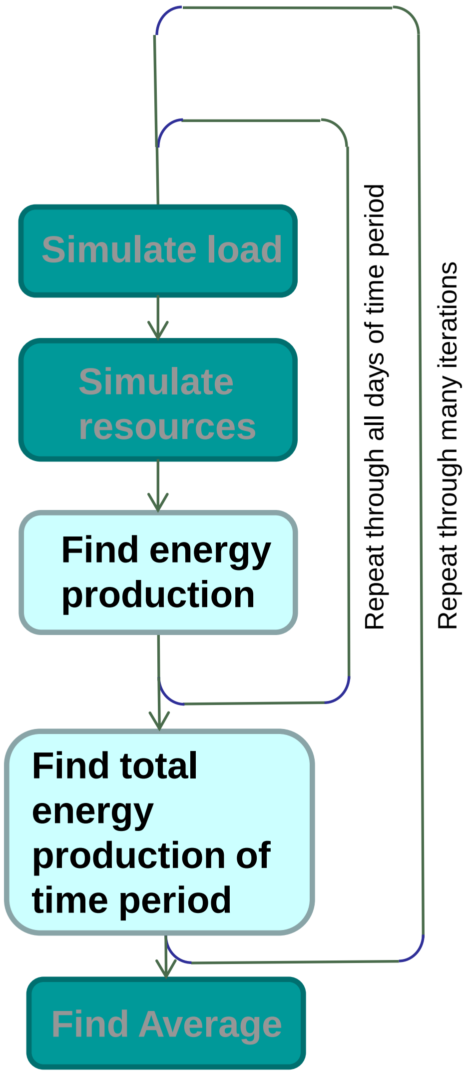

One simulated day of load
Average Load
Simulated Load
Power (kW) or Energy (kWh) Demand
Hour

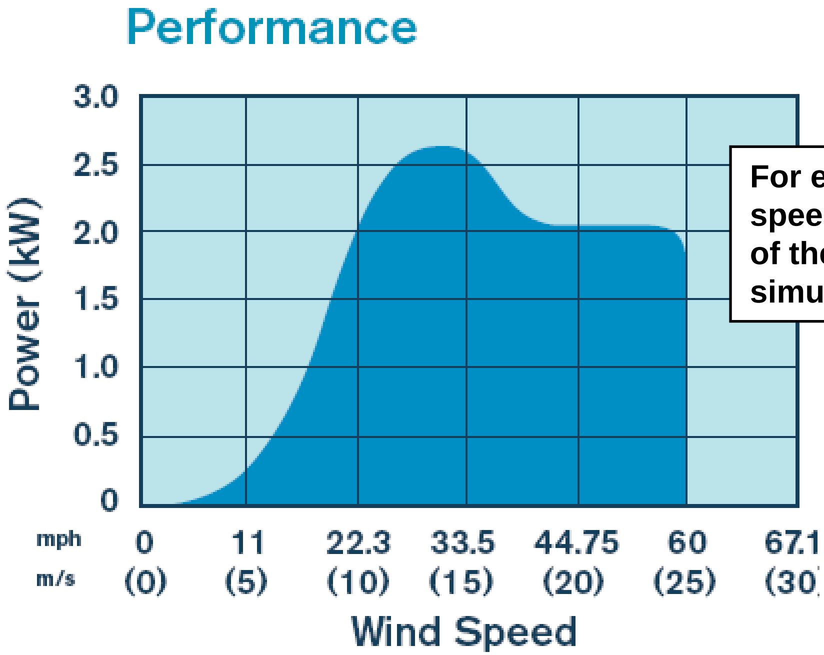

Simulate load
Simulate resources
Find energy production
Find total energy production of time period
Find Average
Repeat through all days of time period
Repeat through many iterations


Average hourly wind speed
Wind Speed (m/s)
Hour

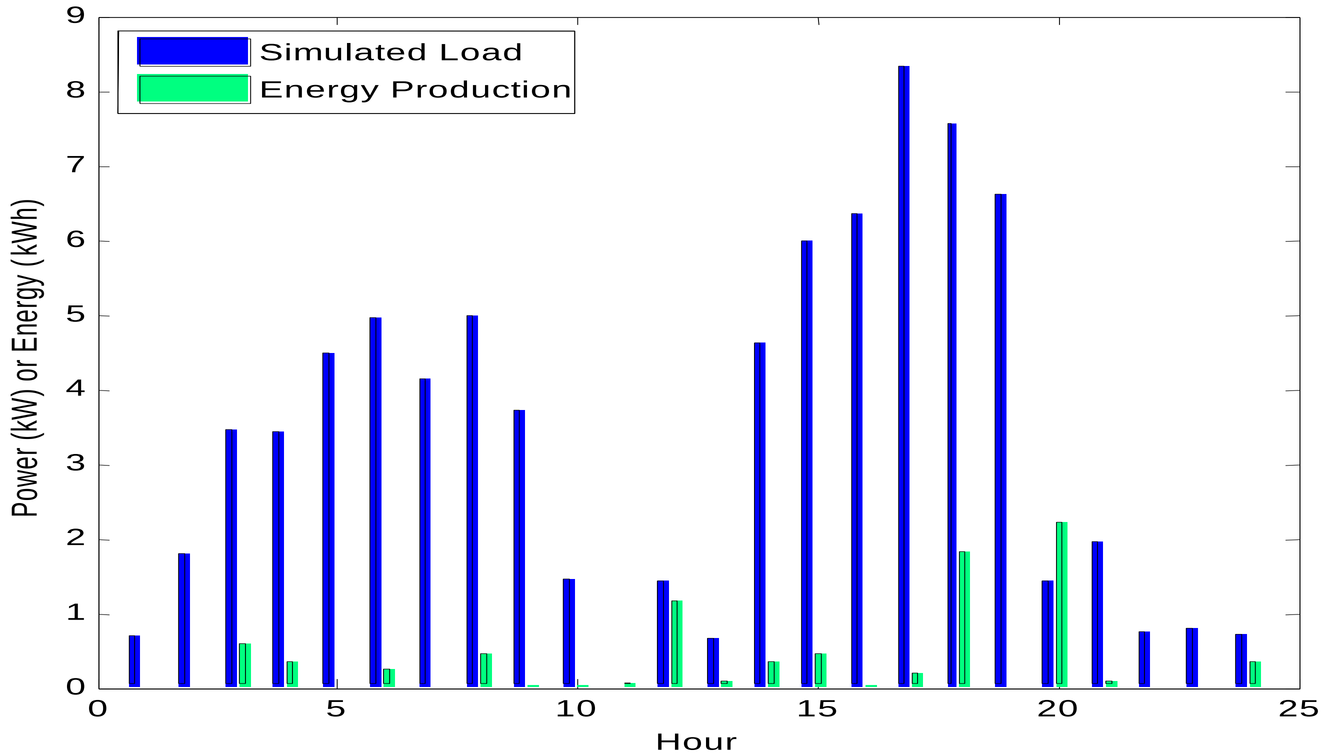

Weibull distribution to approximate wind speed
Number of Occurrences (out of 1000)


Single, simulated day of wind speed
Average
Simulated
Wind Speed (m/s)
Hour

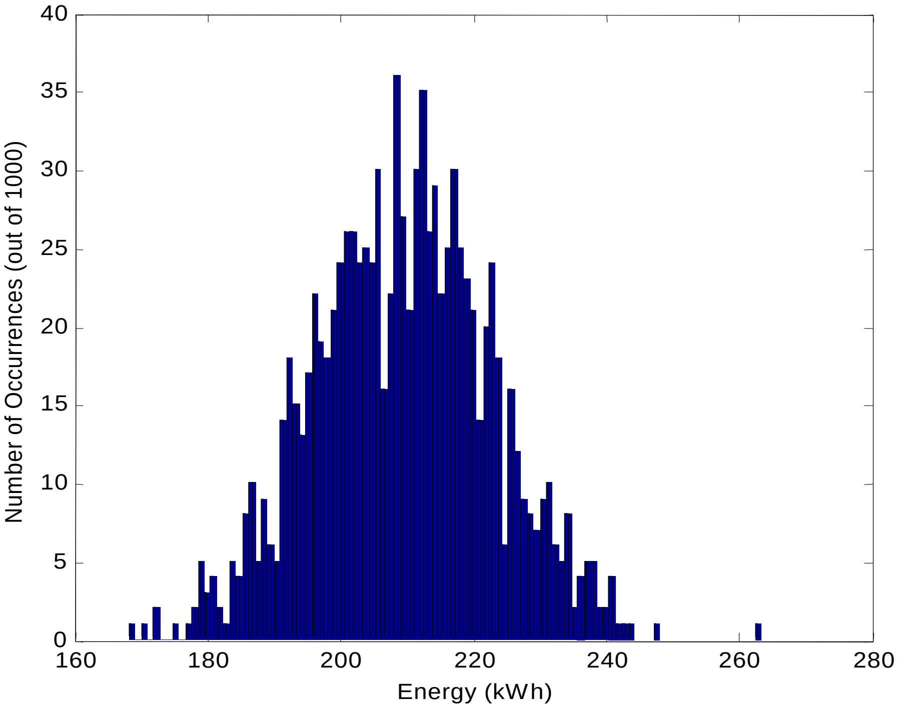




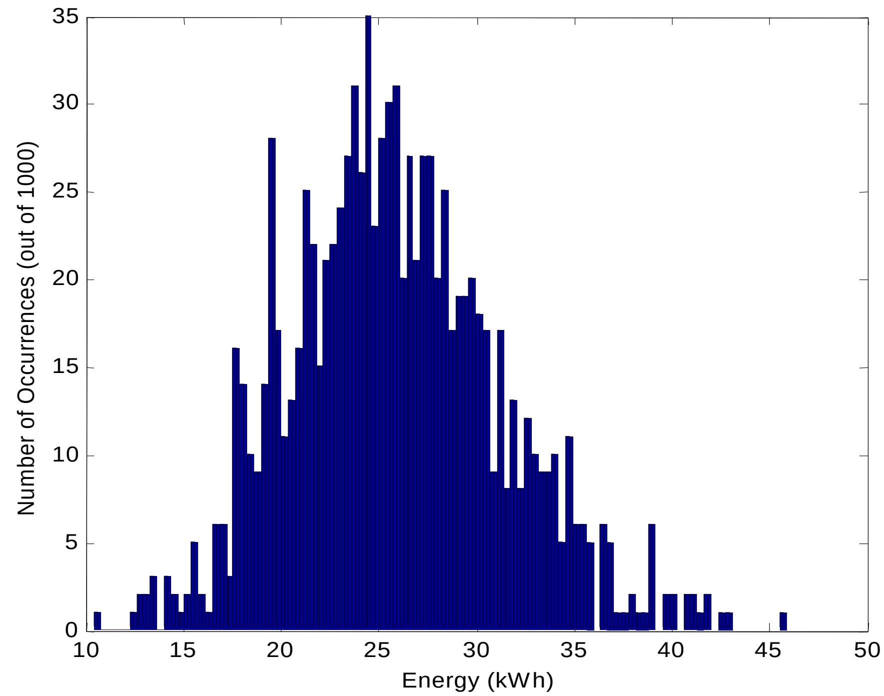
For each hour of simulated wind speed, determine the energy output of the turbine and compare to the simulated load.



Repeat simulations until a trend is found



Histogram of saved energy (one month)



Histogram of excess energy (one month)

Mean: 209.71 kWh

Variance: 178.49

Mean: 25.95 kWh

Variance: 29.21

Systems to Study

Skystream 3.7

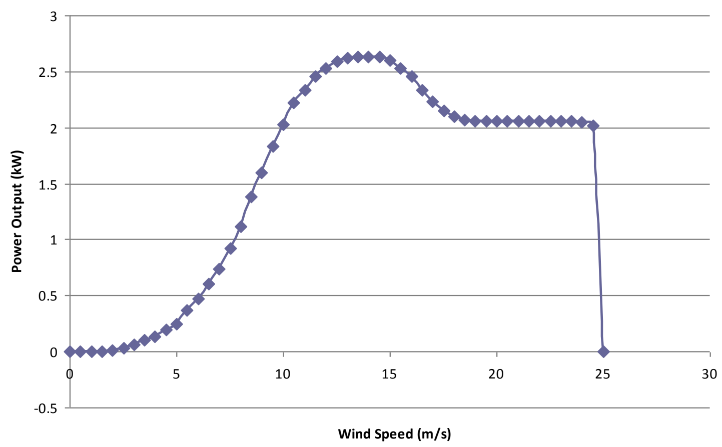
Excel S

EW50

Southwest Windpower - Skystream 3.7

Rated Power Output: 1.9 kW

Rated Wind Speed: 9 m/s or 20 mph



Estimated Cost: $6348

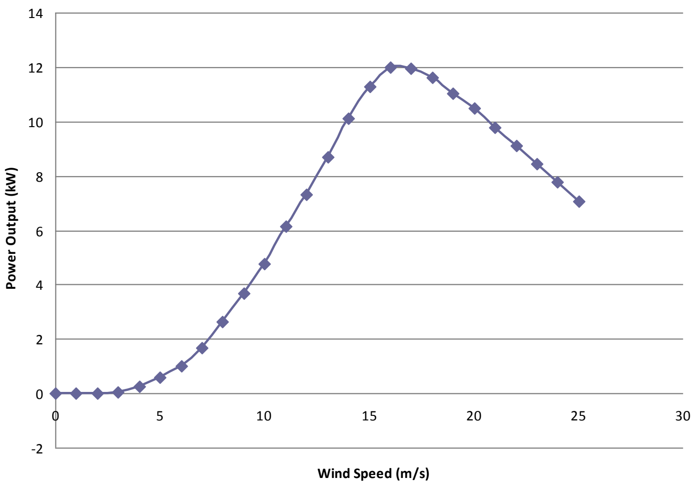
- Equipment and labor not included
- 70’ guyed tower

Tower Options: Various options from 30’ to 70’ including guyed and monopole towers

Bergey – Excel S

Rated Power Output: 10 kW

Rated Wind Speed: 13.9 m/s or 31 mph



Estimated Cost: $41300

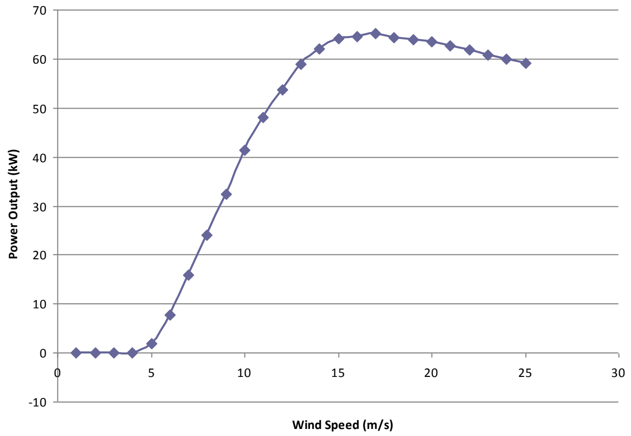
- Equipment and labor not included
- 80’ lattice tower

Tower Options: Various options from 60’ to 140’ including guyed, monopole, and lattice towers

Entegrity – EW50

Rated Power Output: 50 kW

Rated Wind Speed: 11.3 m/s or 25.3 mph



Estimated Cost: $200000

- Estimate from Moscow High School installation
- 100’ monopole tower

Tower Options: Various options from 72’ to 120’ including lattice and monopole towers

Simulations/Results

(Kansas - Without Net Metering)

Assumptions

- All Kansas Locations
- Based on expected energy production in November
- Residential Home with 2.69 kW average yearly load
- Cost of energy = 0.08 $/kWh
- No true net metering (0.02 $/kWh sellback)
- Cost of energy increases by 1% per year

		20 Year Net Present Value (based on production mean)		
		Skystream ($6348)	**Excel S ($41,300)**	**EW50 ($200,000)**
Manhattan, KS - Airport Avg. Wind Speed (60m)	3.32 (class 1)	$2,516.19	$4,949.51	$19,311.69
Manhattan, KS - Proper Avg. Wind Speed (60m)	6.16 (class 2)	$4,252.76	$8,753.35	$31,198.16
Moscow, KS Avg. Wind Speed (60m)	7.96 (class 5)	$6,300.45	$11,688.05	$47,516.05

Simulations/Results

(Kansas - With Net Metering)

Assumptions

- All Kansas Locations
- Based on expected energy production in November
- Residential Home with 2.69 kW average yearly load
- Cost of energy = 0.08 $/kWh
- Net metering (0.08 $/kWh sellback)
- Cost of energy increases by 1% per year

		20 Year Net Present Value (based on production mean)		
		Skystream ($6348)	**Excel S ($41,300)**	**EW50 ($200,000)**
Manhattan, KS - Airport Avg. Wind Speed (60m)	3.32 (class 1)	$2,620.53	$6,503.81	$55,976.90
Manhattan, KS - Proper Avg. Wind Speed (60m)	6.16 (class 2)	$4,512.76	$13,695.64	$97,294.17
Moscow, KS Avg. Wind Speed (60m)	7.96 (class 5)	$6,876.33	$20,446.53	$155,415.69

Simulations/Results

(With Net Metering and High Cost of Energy)

Assumptions

- Based on expected energy production in November
- Residential Home with 2.69 kW average yearly load
- Cost of energy increases by 1% per year

		20 Year Net Present Value (based on production mean)		
		Skystream ($6348)	**Excel S ($41,300)**	**EW50 ($200,000)**
0.24 $/kWh (national high)				
Avg. Wind Speed (60m)	3.32 (class 1)	$7,898.61	$19,609.00	$168,768.05
0.11 $/kWh (national avg.)				
Avg. Wind Speed (60m)	6.16 (class 2)	$6,205.04	$24,368.59	$133,779.28
0.14 $/kWh (11 states with higher)				
Avg. Wind Speed (60m)	7.96 (class 5)	$12,033.58	$35,781.43	$271,969.48

Simulations/Results

(Best Scenarios)

Assumptions

- Residential Home with 2.69 kW average yearly load
- Cost of energy increases by 1% per year

		20 Year Net Present Value (based on production mean)		
Best wind in KS simulated with an average month		**Skystream ($6348)**	**Excel S ($41,300)**	**EW50 ($200,000)**
0.10 $/kWh				
Avg. Wind Speed (60m)	8.25 (class 6)	$9,015.44	$27,221.18	$205,392.81
Best wind in KS simulated with the best month (April)				
0.10 $/kWh				
Avg. Wind Speed (60m)	8.25 (class 6)	$12,148.56	$42,283.35	$291,022.88
Best wind in US simulated with the best month				
0.24 $/kWh				
Avg. Wind Speed (60m)	10.8 (class 7)	$34,048.67	$132,823.78	$871,567.38

Conclusions

- A tool for predicting energy production by renewable energy sources has been developed. From this tool, payback estimates can be found.
- Through these simulations we have found
  - Net metering is not essential if systems are sized properly. However, large wind generators are economically infeasible without it.
  - Proper siting is essential for systems to succeed economically, due to both cost of energy and available wind resources

One Thing to Note

- Most simulations were based on data from the month of November because it is a very average month for both wind resources and electrical load. More accurate analysis could be done by simulating each month of the year individually.

Thanks

Dr. Ruth Douglas Miller

Todd Halling

Questions?