Knight Piésold CONSULTING

Appendix A
Wind Data Report from the Chignik Lagoon Met-Tower

Project:
CHK_LAGOON

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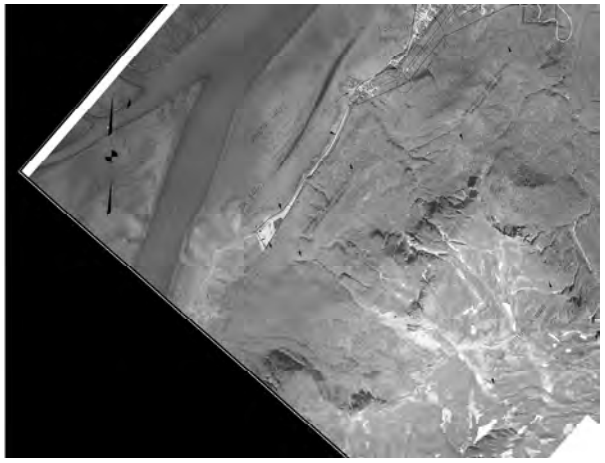
Meteo data report - Main results

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Mast position: UTM WGS 84 Zone: 4 East: 527,445 North: 6,238,893

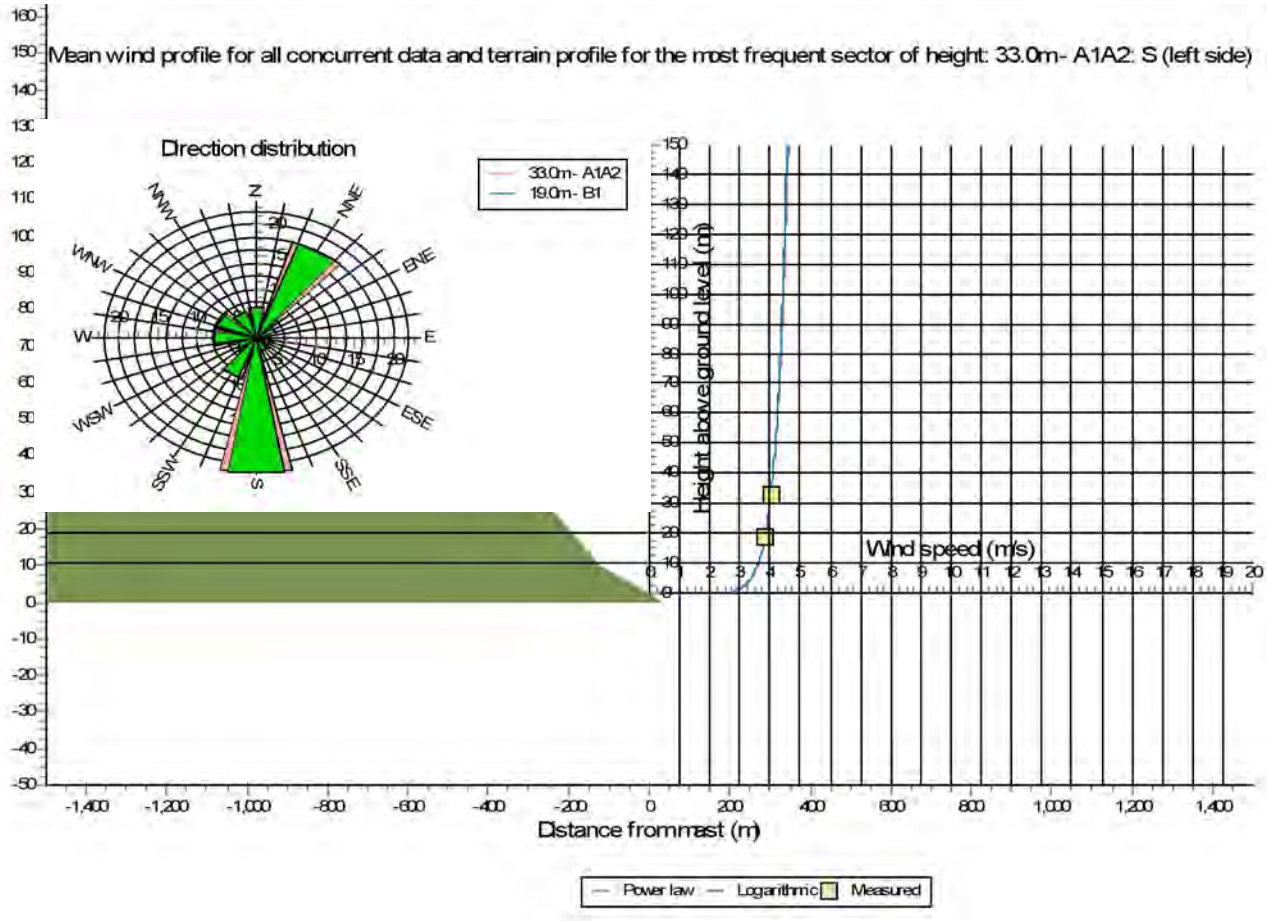
Measurement heights and wind speeds (in this report)
Disabled data not included in overview table below

ID	Height [m]	Data recovery [%]	Records	U_max [m/s]	U_mean *) [m/s]
33.0m - A1A2	33.0	100.0	57556	17.6	3.9
19.0m - B1	19.0	100.0	57556	17.0	3.7



Scale: 50,000

*) U_mean is simple arithmetic average



Profile characteristics for best curve fit through all data (Note: Values are only fully valid in flat terrain)

Shear exponent	0.0904		(Power law profile)
Roughness lenght	0.0004	m class 0.13	(Equivalent roughness for logarithmic profile)

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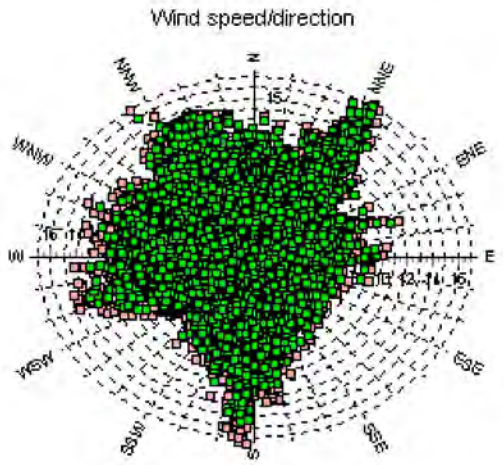
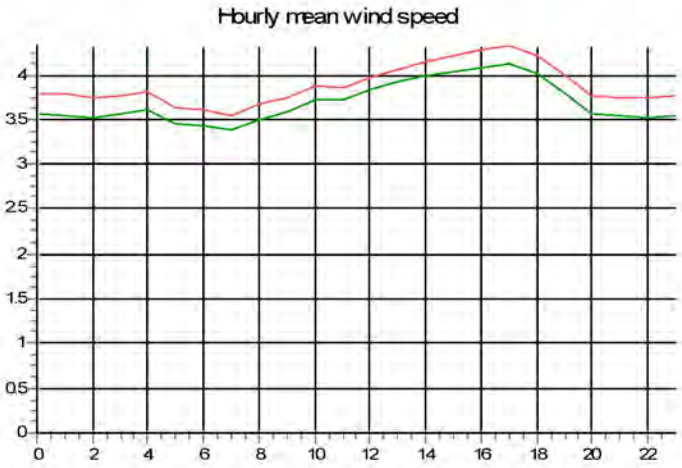
Meteo data report - Main results

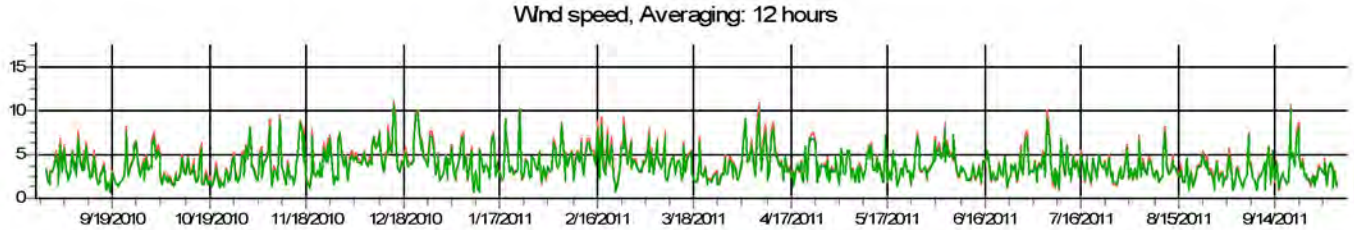
Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

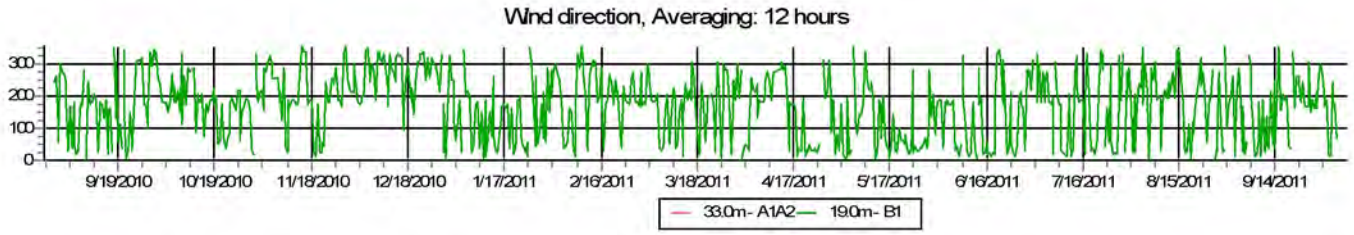


Statistics

	Signal	Unit	Count	Of period [%]	Mean	Weibull mean	Weibull A	Weibull k
33.0m - A1A2	WS, all	m/s	57556	100.0	3.88	4.02	4.51	1.69
33.0m - A1A2	WD, all	Degrees	57556	100.0	239.41			
33.0m - A1A2	Tu, all		23872	41.5	0.20			
33.0m - A1A2	T, all	Deg C	57556	100.0	4.51			
19.0m - B1	WS, all	m/s	57556	100.0	3.69	3.83	4.30	1.73
19.0m - B1	WD, all	Degrees	57556	100.0	239.41			
19.0m - B1	Tu, all		22367	38.9	0.24			







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Meteo data report - Import filters, files and heights

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Import filter: I1
Files/Folders
C:\WindPro\WINDPRO_Data\PROJECTS\LPB\CHK_LAGOON\METDATA\A1A2merge\ChLag_FINAL_withtime.txt

Time zone for measurements: Same as in the project properties: (GMT-09:00) Alaska
Line with header: 1
Header field separator: "Tab"
First line with data: 2
Data field separator: "Tab"

Column	Channel	Type	Sub type	Unit	Height	Name
1		Time stamp	Date&Time	mm/dd/yy hh:mm		
2		Wind speed	Mean	m/s	33.0 m	A1A2 - 33m
3		Wind speed	Mean	m/s	19.0 m	B1 - 19m
4		Wind direction	Mean	Degrees	32.0 m	WD - 32m
5		Temperature	Mean	Deg C	3.0 m	T - 3m
6		Turbulence intensity	Mean		33.0 m	Tu - 33m
7		Turbulence intensity	Mean		19.0 m	Tu_B1 - 19m

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Meteo data report - Missing data - calendar view

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **33.0m - A1A2**
Signal: **WS**

- some records missing, disabled, erroneous, or out of range current day
- all records missing, disabled, erroneous, or out of range current day

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	0.0	**0**																													0	0	0
Sep/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dec/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Mar/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
May/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Jul/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	0.0	**0**	0	0	0																												
Total	**0.0**	**0**																															

Signal: **WD**

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	0.0	**0**																													0	0	0
Sep/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dec/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Mar/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
May/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Jul/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	0.0	**0**	0	0	0																												
Total	**0.0**	**0**																															

Signal: **Tu**

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	61.9	**2674**	48	111	67	66	131	76	72	61	79	52	30	130	60	123	144	91	135	144	98	143	140	117	32	92	53	28	86	73	111	81	
Oct/2010	68.8	**3071**	63	31	14	119	120	138	139	128	139	84	105	76	111	72	130	21	128	120	141	139	87	133	142	129	137	54	119	125	28	74	25
Nov/2010	54.5	**2354**	58	104	98	74	66	18	88	86	138	40	116	102	121	126	58	1	30	137	128	61	119	95	71	30	40	103	131	10	57	48	
Dec/2010	38.0	**1695**	109	50	62	62	79	39	78	56	11	4	39	76	16	32	1	60	89	66	60	71	40	0	13	20	70	6	22	114	92	130	128
Jan/2011	63.3	**2826**	76	72	141	103	2	62	115	51	121	144	38	98	144	68	70	122	130	80	33	100	120	109	84	125	50	132	51	95	55	120	115
Feb/2011	43.3	**1745**	94	53	33	105	32	89	61	117	93	60	25	76	16	16	57	38	62	101	15	40	139	144	66	3	52	19	61	78			
Mar/2011	61.3	**2735**	93	77	54	52	50	30	67	79	74	119	52	108	84	123	49	30	84	132	101	57	108	138	142	124	116	133	70	114	54	105	116
Apr/2011	49.7	**2147**	88	67	31	44	43	77	0	71	29	112	3	27	62	87	75	122	113	140	130	74	81	69	7	1	93	89	97	89	99	127	
May/2011	58.9	**2629**	73	76	107	65	68	85	112	101	117	62	25	64	71	86	130	18	114	66	76	143	101	82	108	127	89	9	107	94	126	89	38
Jun/2011	57.0	**2464**	26	27	12	41	23	42	75	107	95	118	144	85	133	73	102	46	48	129	137	108	121	71	125	90	89	114	55	68	50	110	
Jul/2011	62.5	**2792**	87	125	71	69	57	36	117	115	79	59	80	108	89	72	116	53	100	94	85	108	83	78	75	88	121	142	120	105	96	67	97
Aug/2011	65.3	**2913**	110	94	68	75	109	62	128	116	136	78	44	105	51	88	110	103	78	143	132	121	83	48	82	76	104	128	91	90	131	52	77
Sep/2011	70.8	**3059**	140	92	129	139	58	68	136	144	127	91	118	97	59	105	140	108	142	65	62	49	15	74	107	134	138	127	99	96	88	112	
Oct/2011	71.4	**240**	80	112	48																												
Total	**58.6**	**33684**																															

Signal: **T**

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	0.0	**0**																													0	0	0
Sep/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

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Meteo data report - Missing data - calendar view

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

...continued from previous page

			Day																												
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Oct/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dec/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Mar/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
May/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Jul/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	0.0	**0**	0	0	0																												
Total	**0.0**	**0**																															

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Meteo data report - Missing data - calendar view

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **19.0m - B1**
Signal: **WS**

- some records missing, disabled, erroneous, or out of range current day
- all records missing, disabled, erroneous, or out of range current day

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	0.0	**0**																													0	0	0
Sep/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dec/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Mar/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
May/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Jul/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	0.0	**0**	0	0	0																												
Total	**0.0**	**0**																															

Signal: **WD**

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	0.0	**0**																													0	0	0
Sep/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dec/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Mar/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
May/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Jul/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	0.0	**0**	0	0	0																												
Total	**0.0**	**0**																															

Signal: **Tu**

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	64.8	**2798**	54	118	69	67	136	72	83	67	86	60	34	122	71	130	144	99	135	144	100	143	141	122	39	96	60	32	96	83	111	84	
Oct/2010	73.3	**3270**	65	41	22	125	131	141	142	131	140	93	113	86	114	96	136	25	139	135	144	140	97	135	143	137	138	62	122	129	39	79	30
Nov/2010	57.5	**2486**	70	113	99	78	67	20	93	100	143	43	119	106	129	134	59	3	33	139	129	62	117	97	74	40	48	109	135	10	62	55	
Dec/2010	41.1	**1836**	111	55	72	72	81	48	85	59	17	9	43	82	21	38	1	64	96	75	64	76	45	0	15	27	73	7	26	117	96	134	127
Jan/2011	66.3	**2959**	75	80	142	140	50	65	108	57	123	144	38	102	144	66	70	125	132	80	36	100	130	110	85	126	53	136	52	100	54	121	115
Feb/2011	46.1	**1860**	103	57	36	105	32	91	61	119	94	62	40	82	20	25	59	45	63	108	17	54	141	144	69	4	59	23	66	81			
Mar/2011	63.9	**2852**	103	85	55	53	55	30	73	81	72	121	52	113	85	128	52	40	89	133	102	62	111	141	143	128	125	137	76	121	56	111	119
Apr/2011	52.2	**2257**	86	68	33	46	55	79	0	77	34	120	5	32	77	97	82	128	117	137	127	77	79	60	8	4	95	91	106	93	109	135	
May/2011	59.4	**2653**	73	76	101	70	73	91	114	107	120	68	28	62	71	88	135	18	108	66	74	142	95	79	108	126	86	9	103	98	135	90	39
Jun/2011	57.7	**2492**	32	31	16	43	29	41	68	107	100	117	141	86	133	81	102	50	41	123	138	112	123	78	130	80	79	114	56	72	51	118	
Jul/2011	64.1	**2862**	95	128	82	76	58	38	112	117	78	53	76	110	94	85	119	48	105	101	79	106	81	78	74	92	122	142	129	114	101	72	97
Aug/2011	69.4	**3098**	111	97	67	78	111	69	132	123	138	89	46	116	74	95	115	103	77	143	132	126	96	62	86	86	121	129	97	96	135	55	93
Sep/2011	73.3	**3166**	140	96	132	140	59	74	140	144	124	93	120	96	65	105	142	113	144	66	64	47	21	85	119	137	141	130	110	107	96	116	
Oct/2011	77.4	**260**	84	128	48																												
Total	**61.2**	**35189**																															

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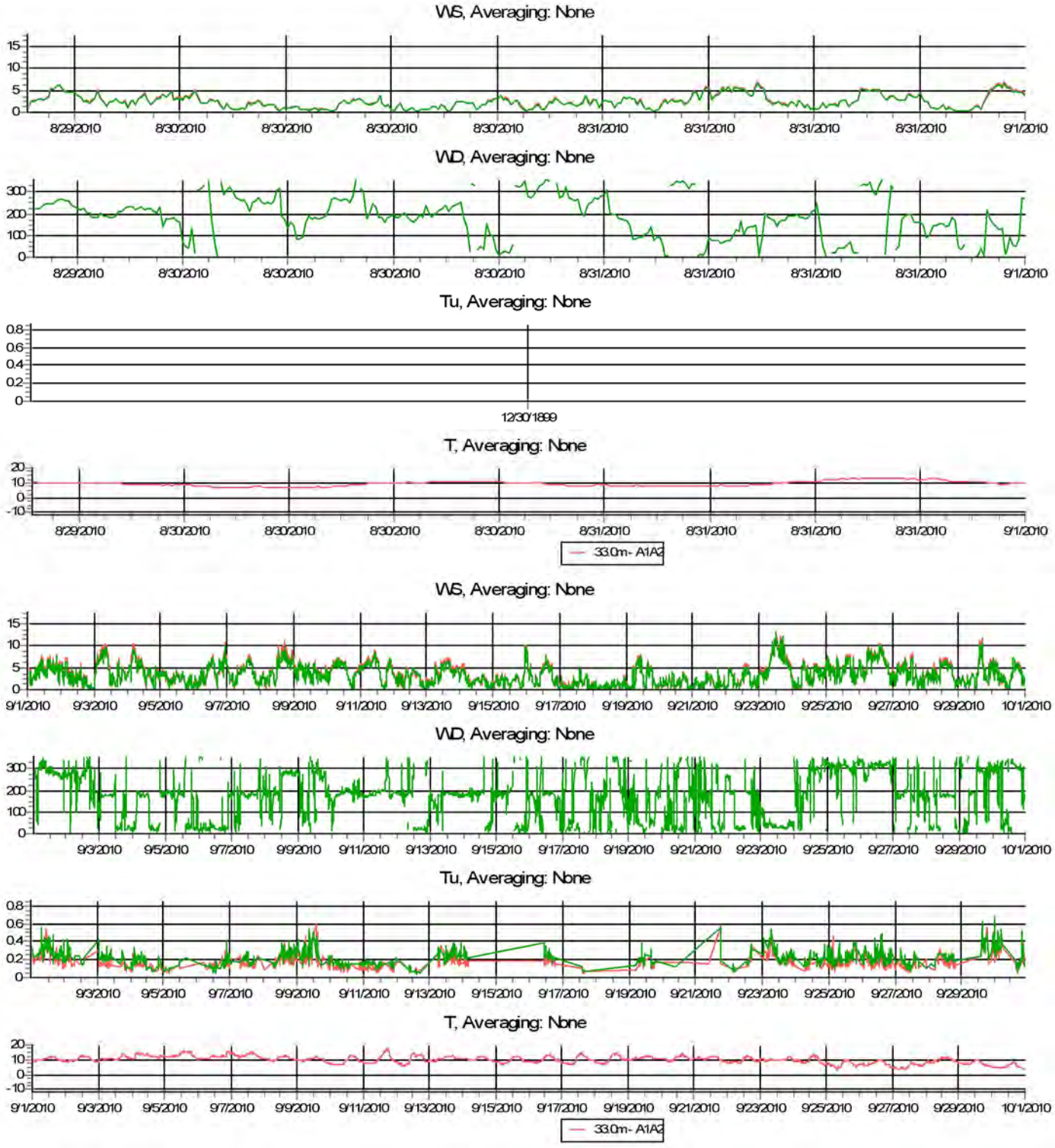
Meteo data report - Time series graphs

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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Meteo data report - Time series graphs

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

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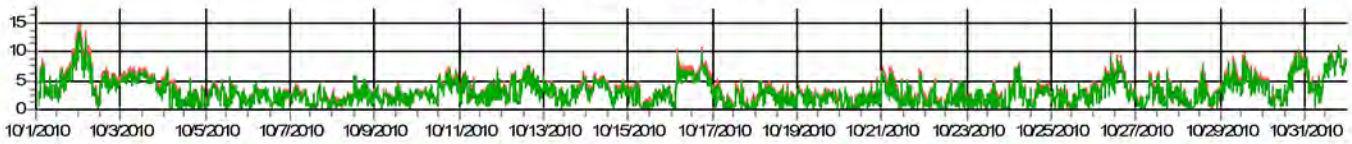

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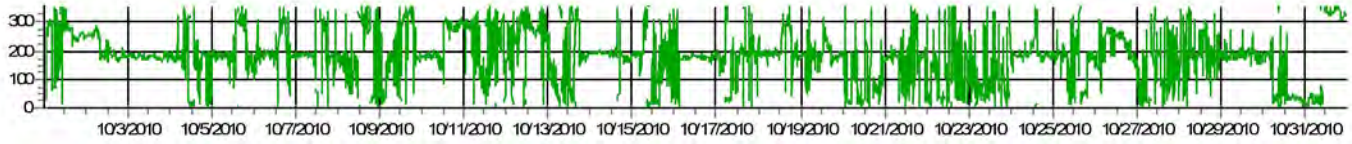

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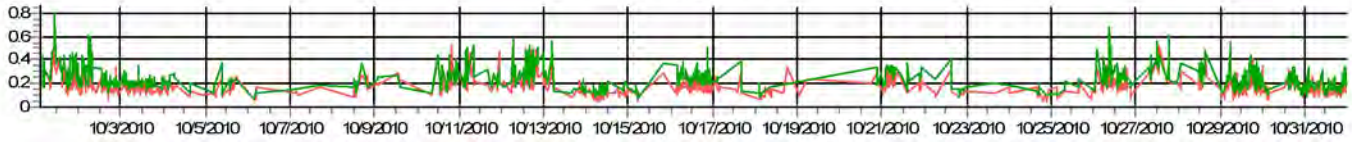

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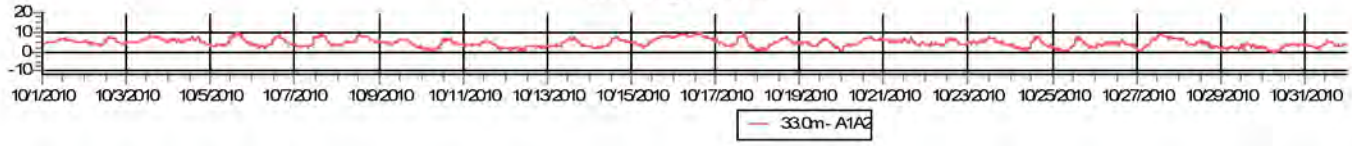

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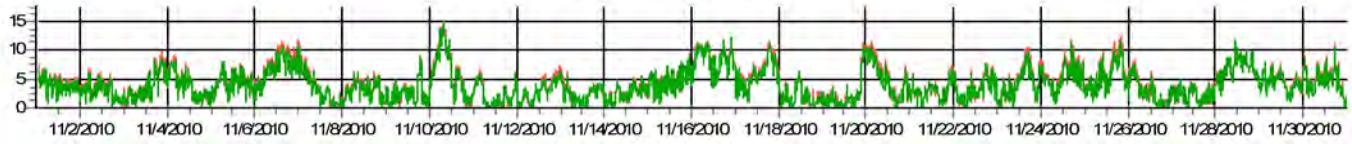

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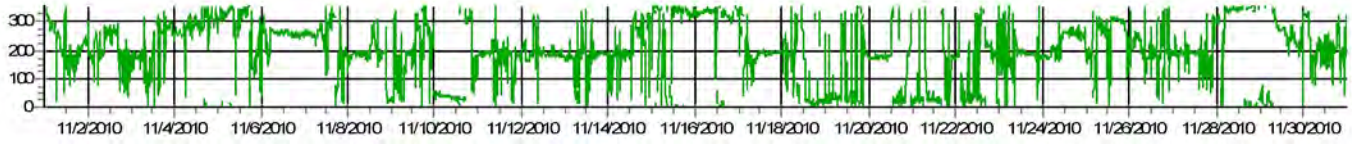

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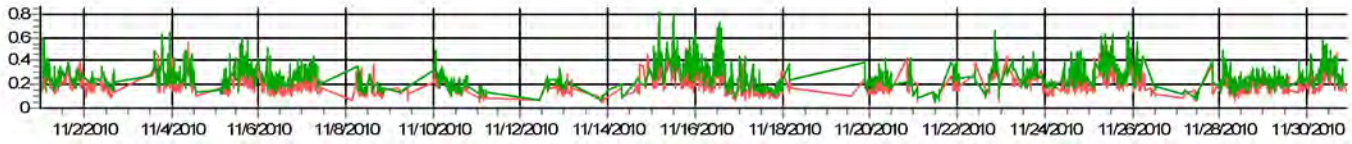

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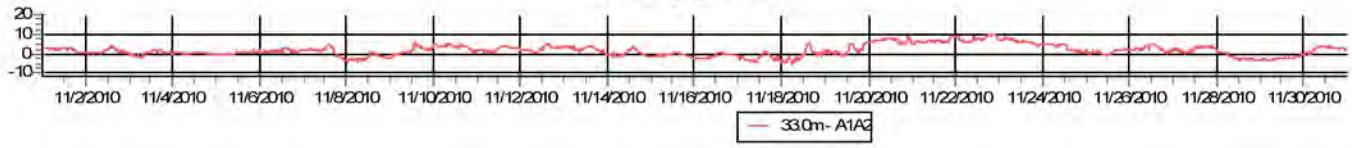

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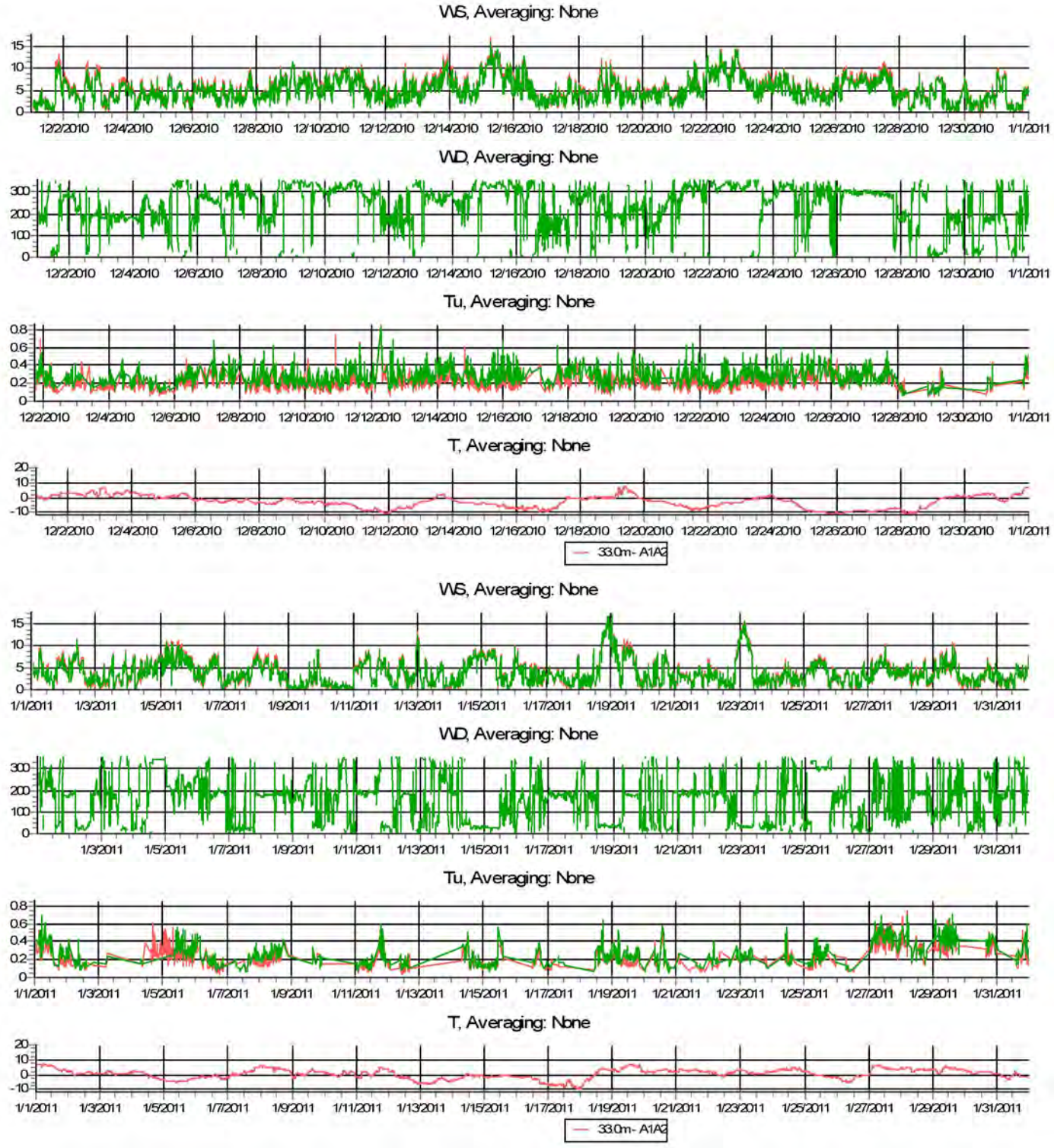
Meteo data report - Time series graphs

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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Meteo data report - Time series graphs

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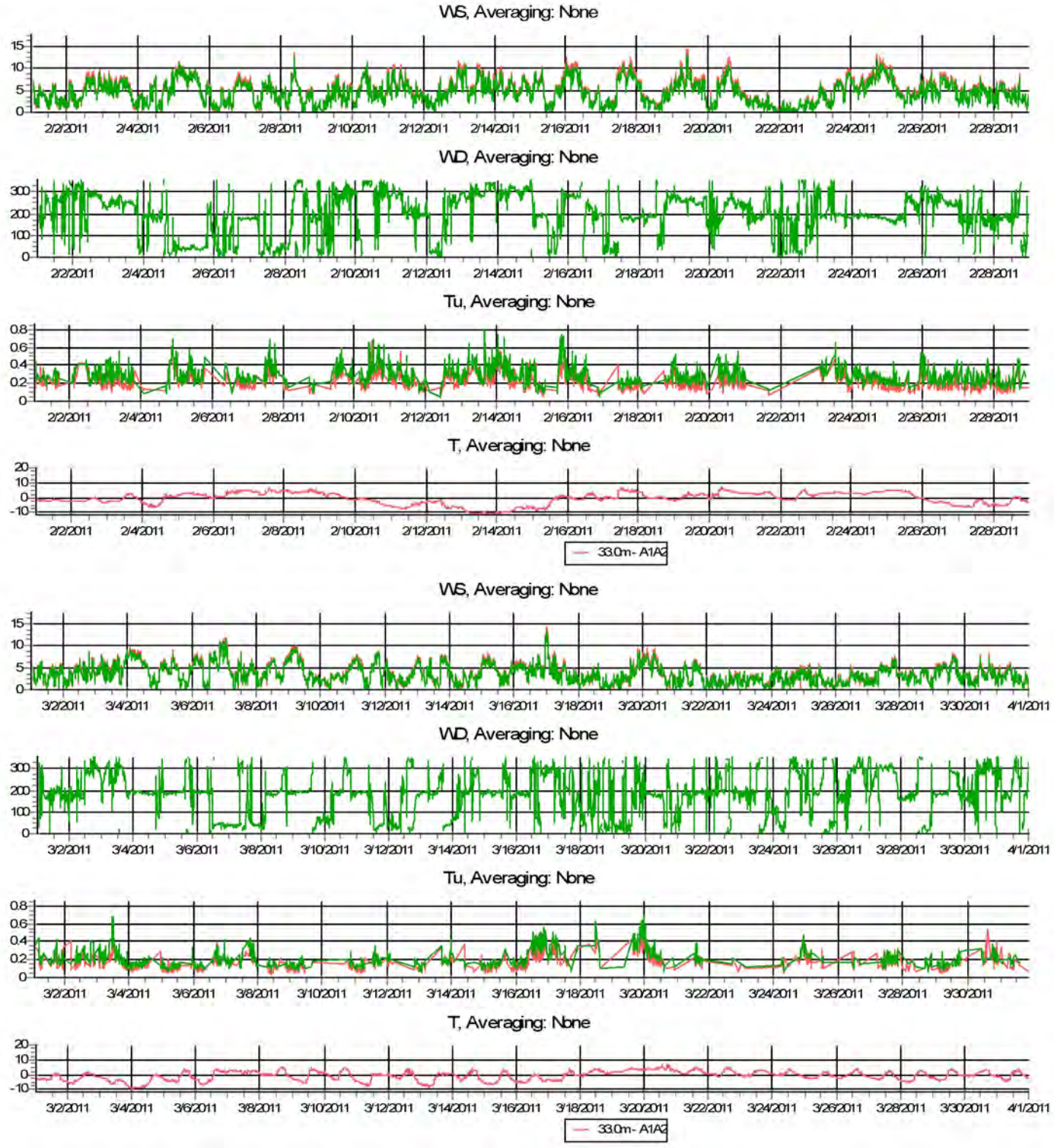

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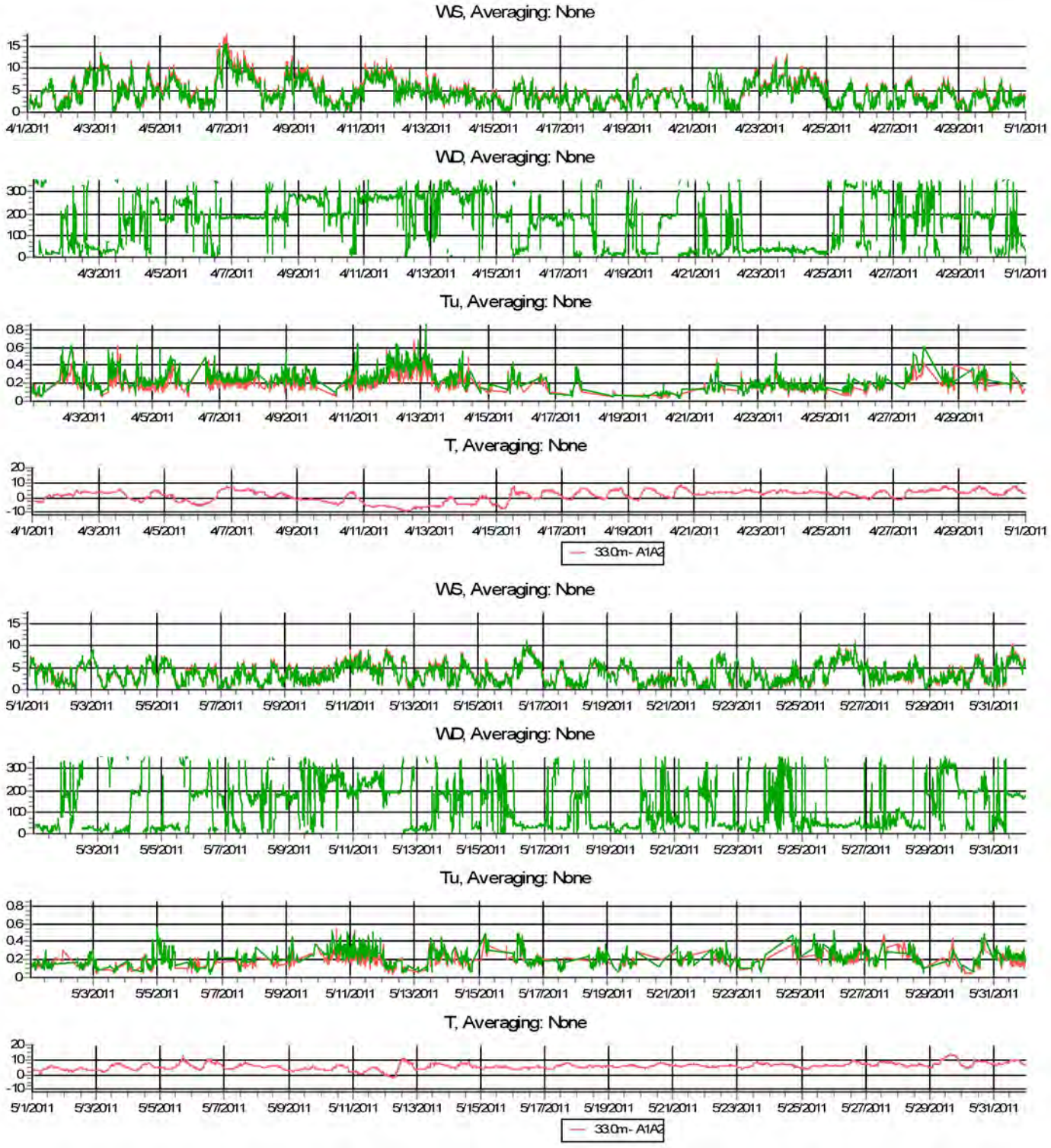

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Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

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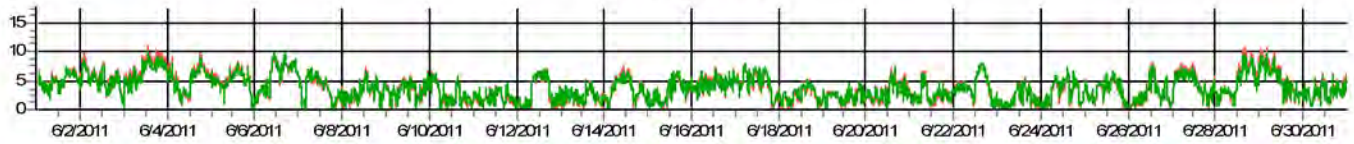

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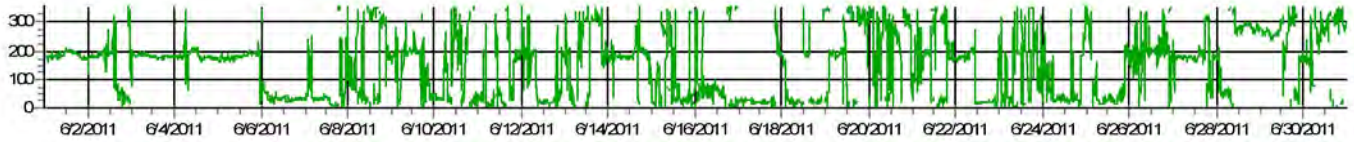

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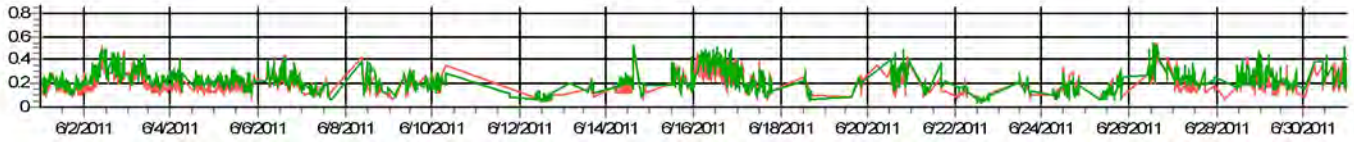

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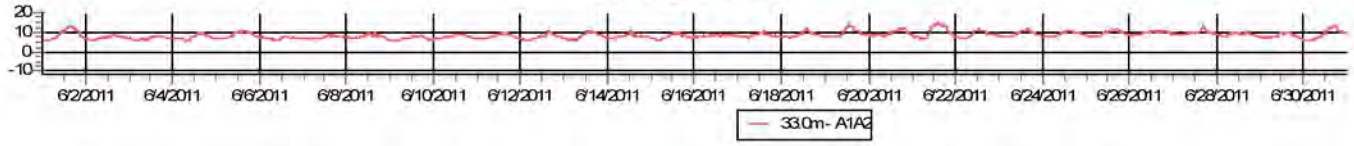

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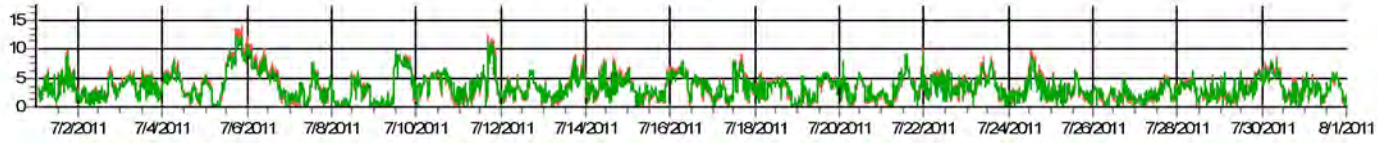

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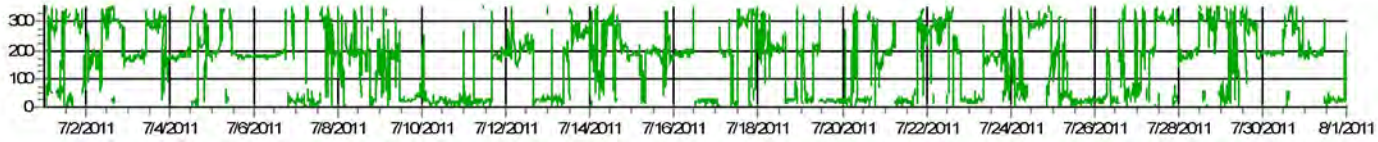

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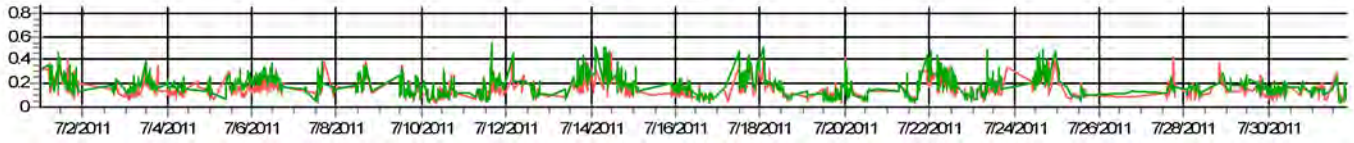

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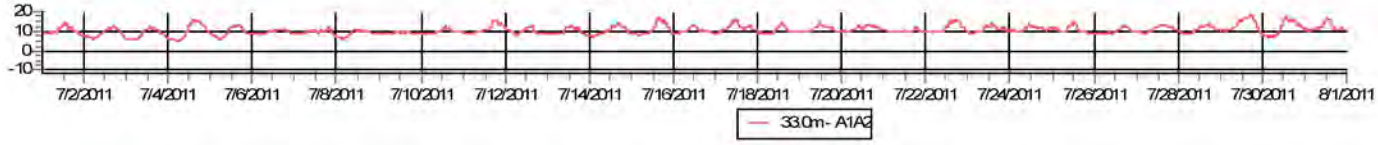

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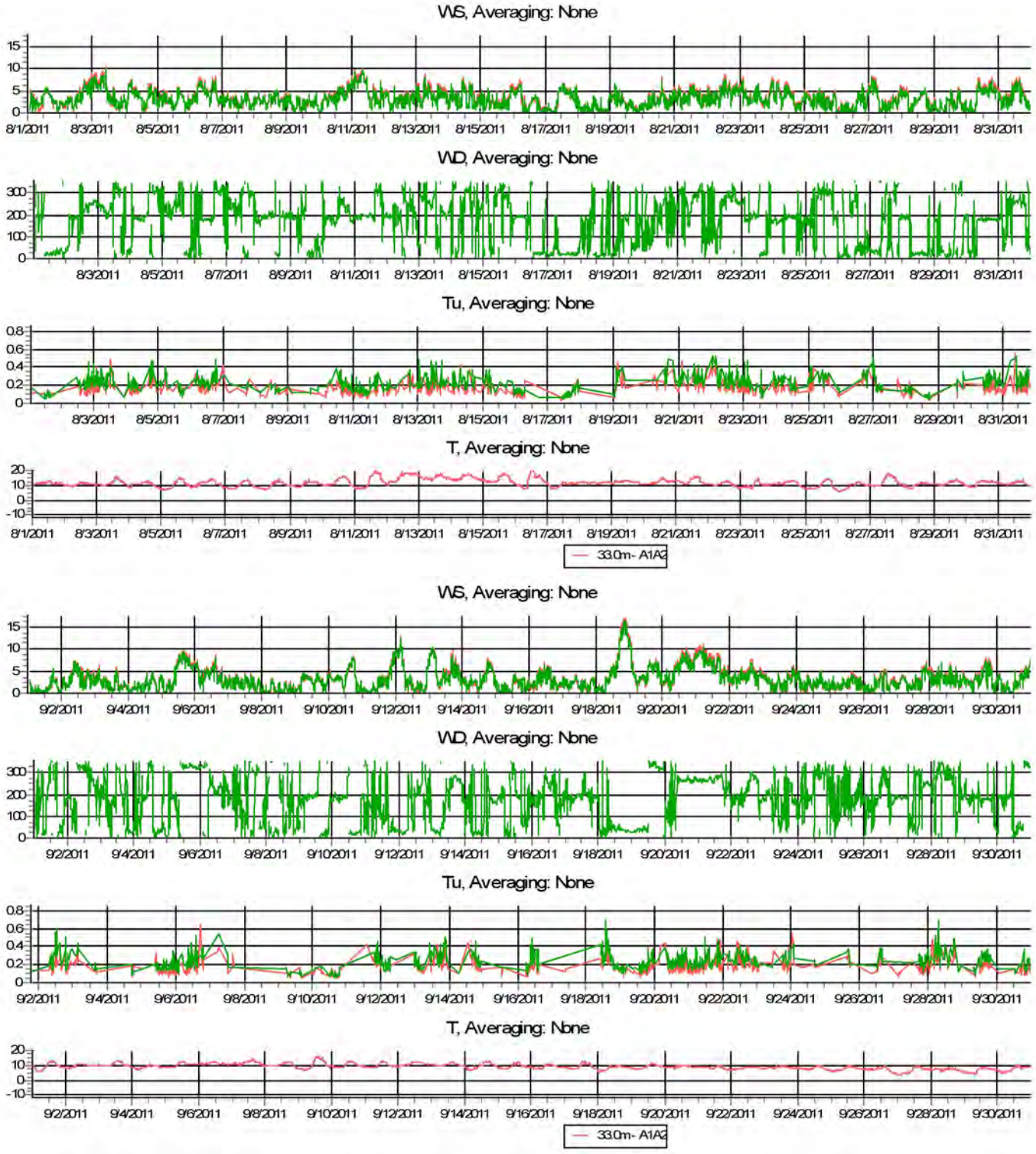
Meteo data report - Time series graphs

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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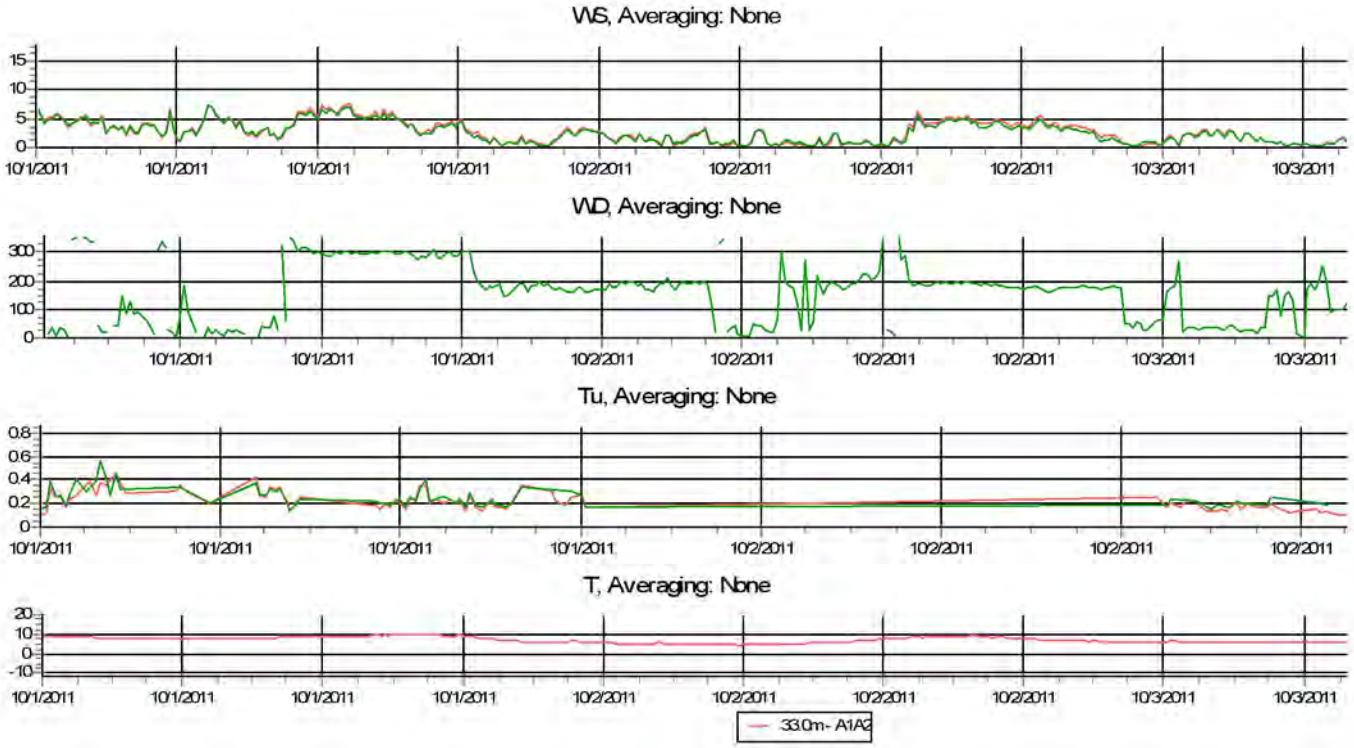
Meteo data report - Time series graphs

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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Meteo data report - Frequency distribution (TAB file data)

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Frequency distribution (TAB file data)

33.0m - A1A2

Bin	Start	End	Sum	0-N	1-NNE	2-NE	3-ENE	4-E	5-ESE	6-SE	7-SSE	8-S	9-SSW	10-SW	11-WSW	12-W	13-WNW	14-NW	15-NNW
Mean			3.88	3.12	3.83	3.91	2.42	2.14	2.08	2.11	2.82	4.31	3.78	3.18	4.48	4.99	4.86	4.25	4.30
0		0.49	2168	215	289	195	78	87	65	91	141	250	210	119	82	78	65	86	117
1	0.50	1.49	8602	642	1175	705	474	440	367	441	642	1104	729	315	264	316	280	323	385
2	1.50	2.49	8928	628	1271	734	417	348	251	330	556	1395	887	306	282	312	359	402	450
3	2.50	3.49	9033	455	1351	768	333	197	161	213	489	1737	987	346	345	369	416	454	412
4	3.50	4.49	7886	325	1126	490	171	115	83	109	378	1749	1023	278	335	417	506	447	334
5	4.50	5.49	6539	226	920	394	96	47	43	63	239	1467	776	242	358	482	483	438	265
6	5.50	6.49	5294	159	720	360	54	36	28	24	148	1306	545	143	286	492	478	289	226
7	6.50	7.49	3634	110	454	273	16	9	9	13	63	863	407	72	230	355	325	229	206
8	7.50	8.49	2380	86	339	181	9	5	2	3	35	485	204	33	154	280	225	173	166
9	8.50	9.49	1411	63	172	126	2	5	1	0	14	282	107	6	81	172	173	94	113
10	9.50	10.49	867	33	91	91	3	2	0	0	5	194	44	2	45	126	102	36	93
11	10.50	11.49	406	20	35	44	1	0	0	0	2	88	8	0	25	56	65	16	46
12	11.50	12.49	156	6	30	21	1	0	0	0	0	36	3	0	7	13	16	8	15
13	12.50	13.49	113	4	17	34	0	0	0	0	0	19	0	0	8	6	3	11	11
14	13.50	14.49	80	1	21	16	0	0	0	0	0	11	1	0	5	2	2	3	18
15	14.50	15.49	27	0	14	6	0	0	0	0	0	4	0	0	2	0	0	0	1
16	15.50	16.49	17	0	6	2	0	0	0	0	0	9	0	0	0	0	0	0	0
17	16.50	17.49	13	0	3	3	0	0	0	0	0	6	0	0	0	0	0	1	0
18	17.50	18.49	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
19	18.50	19.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	19.50	20.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	20.50	21.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	21.50	22.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	22.50	23.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	23.50	24.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	24.50	25.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	25.50	26.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	26.50	27.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	27.50	28.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	28.50	29.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	29.50	30.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	30.50	31.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	31.50	32.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	32.50	33.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	33.50	34.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	34.50	35.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	35.50	36.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	36.50	37.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	37.50	38.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	38.50	39.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	39.50	40.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	40.50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Meteo data report - Frequency distribution (TAB file data)

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Frequency distribution (TAB file data)

19.0m - B1

Bin	Start	End	Sum	0-N	1-NNE	2-NE	3-ENE	4-E	5-ESE	6-SE	7-SSE	8-S	9-SSW	10-SW	11-WSW	12-W	13-WNW	14-NW	15-NNW
Mean			3.69	3.14	3.86	3.87	2.41	2.11	1.97	2.02	2.66	3.98	3.55	2.96	4.10	4.58	4.44	4.03	4.21
0		0.49	1831	187	236	158	68	56	61	74	105	192	176	109	77	74	67	81	110
1	0.50	1.49	8664	607	1085	655	419	442	393	460	657	1198	745	336	282	330	320	345	390
2	1.50	2.49	9724	647	1319	796	463	387	262	357	641	1549	1003	358	334	366	387	418	437
3	2.50	3.49	9877	474	1346	807	358	207	157	205	545	2001	1170	372	388	415	496	499	437
4	3.50	4.49	8245	348	1155	507	183	111	69	105	347	1838	1033	298	360	494	569	487	341
5	4.50	5.49	6789	233	983	421	98	36	37	56	234	1609	739	206	364	533	537	426	277
6	5.50	6.49	5047	167	762	339	38	34	24	17	104	1206	514	121	297	481	430	274	239
7	6.50	7.49	3227	113	483	286	16	9	6	12	52	641	327	47	187	336	289	218	205
8	7.50	8.49	1965	81	317	180	6	4	0	1	16	372	143	10	117	219	205	141	153
9	8.50	9.49	1137	57	161	110	3	3	1	0	9	226	63	5	51	155	120	69	104
10	9.50	10.49	537	30	77	70	2	2	0	0	2	90	13	0	32	51	63	20	85
11	10.50	11.49	227	19	35	39	1	0	0	0	0	39	4	0	9	17	10	15	39
12	11.50	12.49	117	5	24	27	0	0	0	0	0	22	1	0	6	3	4	10	15
13	12.50	13.49	79	5	16	26	0	0	0	0	0	5	0	0	5	2	1	6	13
14	13.50	14.49	55	0	19	13	0	0	0	0	0	10	0	0	0	0	0	0	13
15	14.50	15.49	24	0	10	6	0	0	0	0	0	8	0	0	0	0	0	0	0
16	15.50	16.49	8	0	3	3	0	0	0	0	0	1	0	0	0	0	0	1	0
17	16.50	17.49	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	17.50	18.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	18.50	19.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	19.50	20.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	20.50	21.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	21.50	22.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	22.50	23.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	23.50	24.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	24.50	25.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	25.50	26.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	26.50	27.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	27.50	28.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	28.50	29.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	29.50	30.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	30.50	31.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	31.50	32.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	32.50	33.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	33.50	34.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	34.50	35.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	35.50	36.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	36.50	37.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	37.50	38.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	38.50	39.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	39.50	40.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	40.50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Meteo data report - Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

33.0m - A1A2

Bin	Start	End	Mean	0-N	1-NNE	2-NE	3-ENE	4-E	5-ESE	6-SE	7-SSE	8-S	9-SSW	10-SW	11-WSW	12-W	13-WNW	14-NW	15-NNW
Mean			0.31	0.33	0.26	0.31	0.37	0.48	0.54	0.42	0.25	0.25	0.29	0.35	0.28	0.34	0.39	0.33	0.29
0		0.49																	
1	0.50	1.49																	
2	1.50	2.49																	
3	2.50	3.49																	
4	3.50	4.49	0.35	0.39	0.29	0.36	0.38	0.45	0.55	0.46	0.26	0.28	0.32	0.36	0.33	0.41	0.47	0.39	0.38
5	4.50	5.49	0.33	0.36	0.27	0.33	0.36	0.48	0.51	0.37	0.25	0.26	0.29	0.36	0.31	0.37	0.42	0.37	0.31
6	5.50	6.49	0.31	0.32	0.26	0.33	0.35	0.52	0.56	0.37	0.25	0.24	0.29	0.37	0.29	0.34	0.41	0.32	0.28
7	6.50	7.49	0.29	0.33	0.25	0.29	0.39	0.50	0.47	0.50	0.25	0.24	0.27	0.30	0.24	0.32	0.36	0.31	0.27
8	7.50	8.49	0.28	0.29	0.24	0.29	0.38	0.37	0.53		0.24	0.24	0.27	0.34	0.24	0.27	0.34	0.27	0.24
9	8.50	9.49	0.27	0.23	0.23	0.28		0.33			0.25	0.23	0.23	0.31	0.22	0.28	0.31	0.24	0.23
10	9.50	10.49	0.26	0.23	0.25	0.27					0.16	0.23	0.23	0.24	0.22	0.26	0.31	0.25	0.22
11	10.50	11.49	0.25	0.20	0.22	0.27					0.13	0.22	0.26		0.17	0.29	0.29	0.27	0.22
12	11.50	12.49	0.24	0.21	0.21	0.26						0.24	0.27		0.18	0.24	0.28	0.23	0.17
13	12.50	13.49	0.24	0.13	0.23	0.26						0.28			0.17	0.23	0.22	0.19	0.17
14	13.50	14.49	0.24		0.24	0.26						0.27			0.15	0.16	0.23	0.17	0.14
15	14.50	15.49	0.25		0.24	0.24						0.28			0.14				
16	15.50	16.49	0.29		0.21	0.20						0.32							
17	16.50	17.49	0.28		0.24	0.19						0.29							
18	17.50	18.49	0.28									0.28							
19	18.50	19.49																	
20	19.50	20.49																	
21	20.50	21.49																	
22	21.50	22.49																	
23	22.50	23.49																	
24	23.50	24.49																	
25	24.50	25.49																	
26	25.50	26.49																	
27	26.50	27.49																	
28	27.50	28.49																	
29	28.50	29.49																	
30	29.50	30.49																	
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Meteo data report - Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

19.0m - B1

Bin	Start	End	Mean	0-N	1-NNE	2-NE	3-ENE	4-E	5-ESE	6-SE	7-SSE	8-S	9-SSW	10-SW	11-WSW	12-W	13-WNW	14-NW	15-NNW
Mean			0.37	0.40	0.26	0.36	0.51	0.56	0.56	0.50	0.37	0.31	0.30	0.43	0.41	0.40	0.40	0.39	0.40
0		0.49																	
1	0.50	1.49																	
2	1.50	2.49																	
3	2.50	3.49																	
4	3.50	4.49	0.41	0.44	0.28	0.43	0.52	0.49	0.58	0.48	0.38	0.33	0.33	0.44	0.47	0.47	0.46	0.44	0.52
5	4.50	5.49	0.38	0.42	0.27	0.38	0.50	0.61	0.54	0.49	0.35	0.31	0.30	0.44	0.43	0.44	0.43	0.42	0.44
6	5.50	6.49	0.36	0.41	0.26	0.37	0.51	0.62	0.56	0.52	0.43	0.30	0.31	0.43	0.40	0.40	0.40	0.37	0.38
7	6.50	7.49	0.34	0.39	0.26	0.33	0.50	0.47	0.52	0.66	0.36	0.31	0.28	0.41	0.37	0.35	0.36	0.35	0.38
8	7.50	8.49	0.32	0.36	0.25	0.33	0.55	0.51			0.28	0.30	0.27	0.46	0.33	0.33	0.33	0.33	0.35
9	8.50	9.49	0.31	0.29	0.25	0.29					0.39	0.29	0.23	0.35	0.33	0.32	0.32	0.29	0.35
10	9.50	10.49	0.30	0.30	0.26	0.31					0.19	0.26	0.22		0.26	0.34	0.30	0.28	0.31
11	10.50	11.49	0.28	0.23	0.22	0.25						0.28	0.31		0.27	0.28	0.29	0.32	0.30
12	11.50	12.49	0.28	0.25	0.23	0.30						0.30			0.26	0.25	0.27	0.30	0.25
13	12.50	13.49	0.26	0.27	0.23	0.27						0.29			0.21	0.25		0.25	0.23
14	13.50	14.49	0.28		0.26	0.26						0.33							0.20
15	14.50	15.49	0.30		0.25	0.27						0.32							
16	15.50	16.49	0.24		0.25	0.20													
17	16.50	17.49	0.25		0.25														
18	17.50	18.49																	
19	18.50	19.49																	
20	19.50	20.49																	
21	20.50	21.49																	
22	21.50	22.49																	
23	22.50	23.49																	
24	23.50	24.49																	
25	24.50	25.49																	
26	25.50	26.49																	
27	26.50	27.49																	
28	27.50	28.49																	
29	28.50	29.49																	
30	29.50	30.49																	
31	30.50	31.49																	
32	31.50	32.49																	
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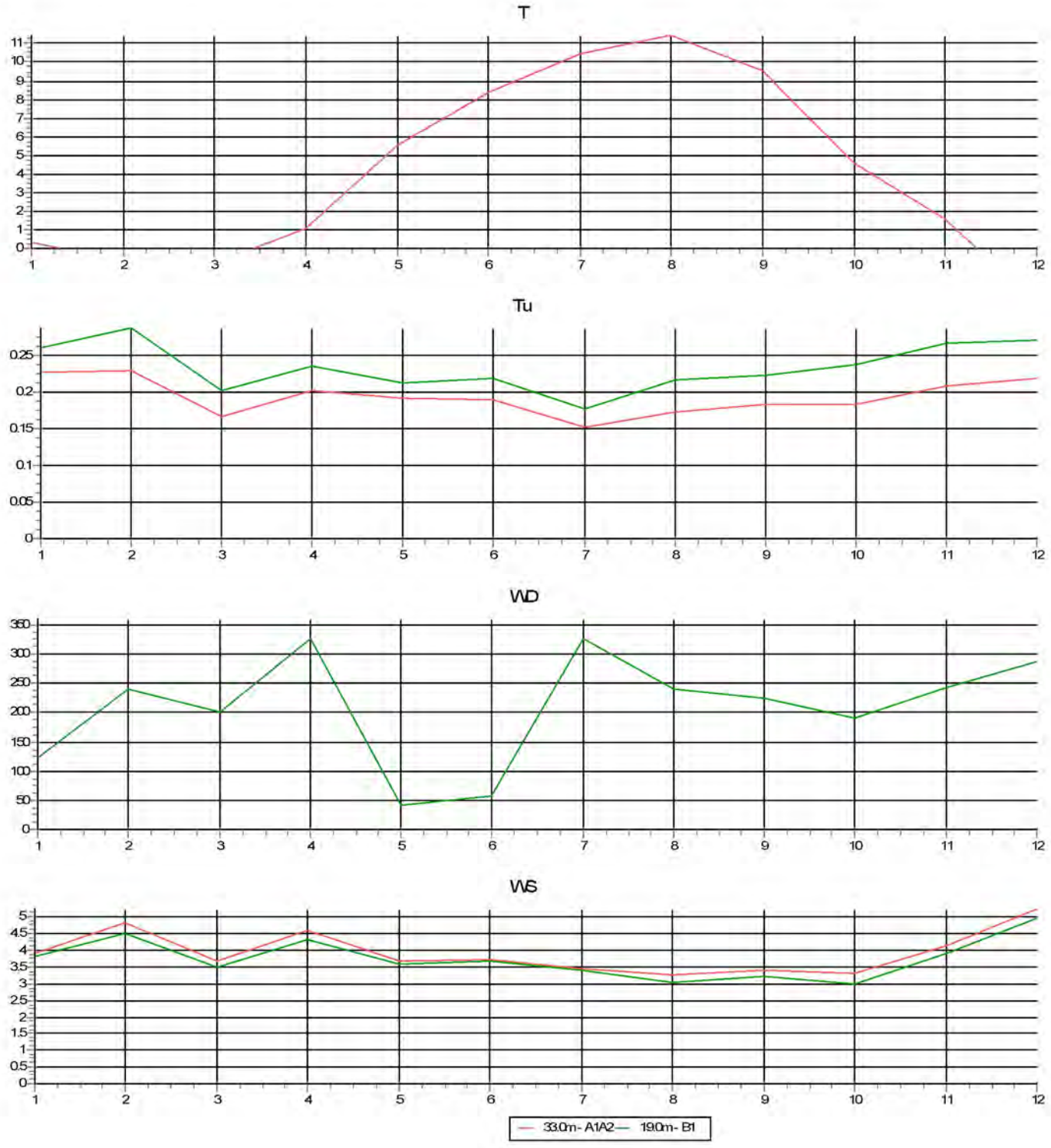
Meteo data report - Monthly graphs aggregated

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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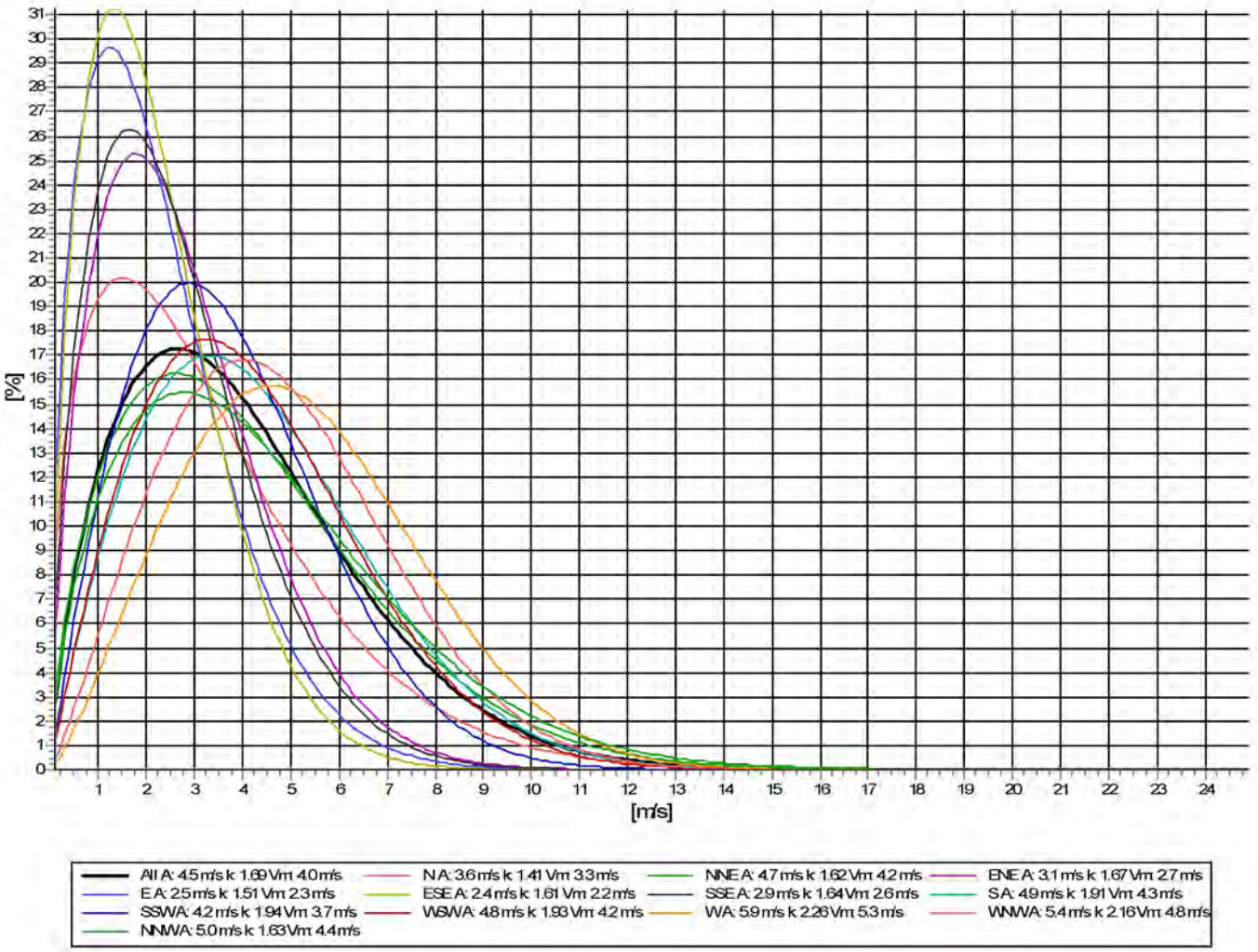
Meteo data report - Weibull data overview

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **33.0m - A1A2**

Weibull data

Sector	A [m/s]	k	f	Mean wind speed [m/s]
0-N	3.65	1.413	7.15	3.32
1-NNE	4.71	1.623	18.02	4.22
2-ENE	3.07	1.672	5.02	2.74
3-E	2.52	1.513	2.94	2.27
4-ESE	2.44	1.606	2.44	2.19
5-SSE	2.92	1.637	4.58	2.62
6-S	4.90	1.907	23.43	4.35
7-SSW	4.21	1.938	9.01	3.73
8-WSW	4.76	1.932	5.02	4.22
9-W	5.93	2.263	7.91	5.26
10-WNW	5.37	2.157	7.84	4.75
11-NNW	4.96	1.633	6.65	4.44
Mean	**4.51**	**1.687**	**100.00**	**4.02**



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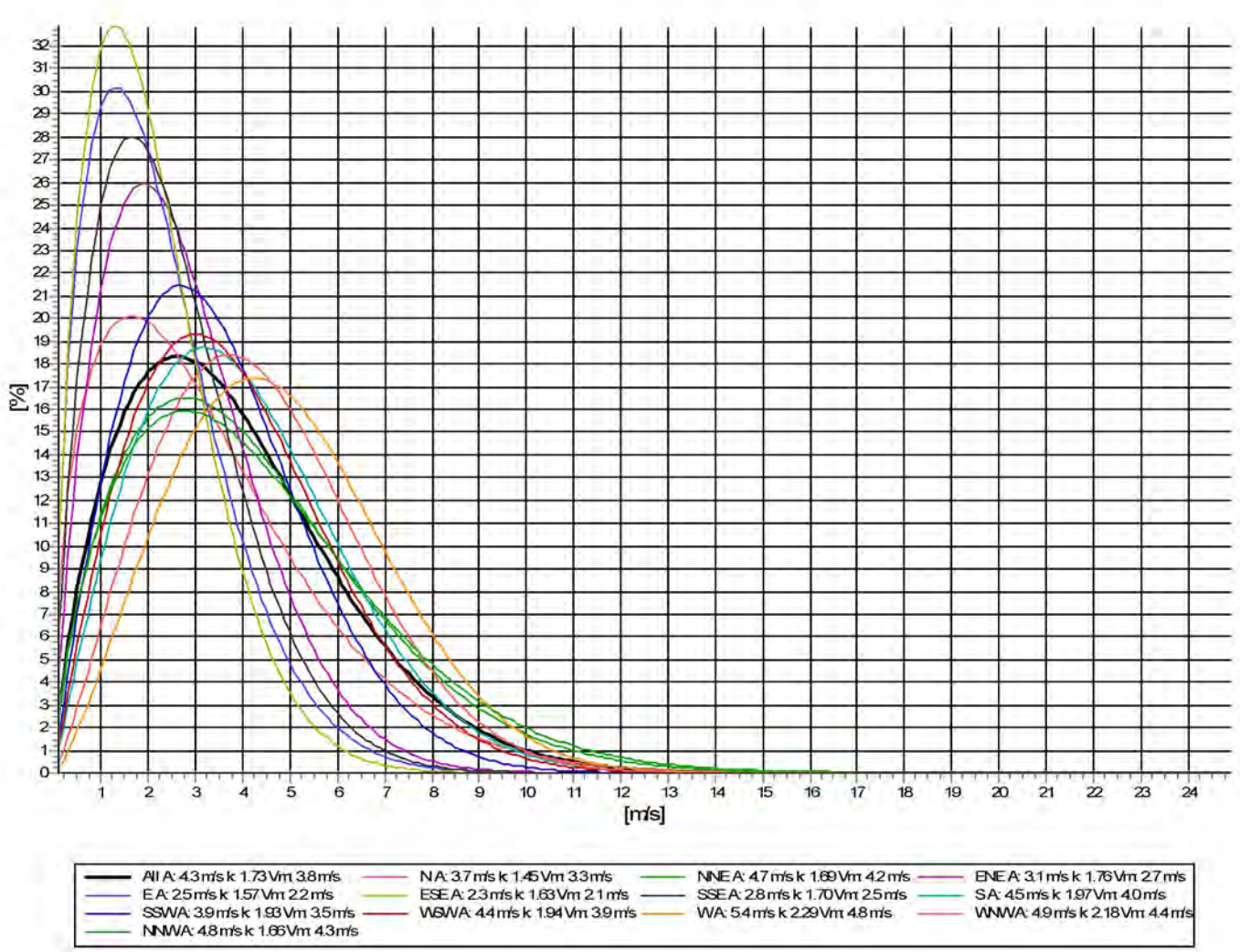
Meteo data report - Weibull data overview

Mast: A1A2 Merged - GOOD; A1A2_GOOD; A1A2_merged data **Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **19.0m - B1**

Weibull data

Sector	A [m/s]	k	f	Mean wind speed [m/s]
0-N	3.68	1.450	7.15	3.33
1-NNE	4.72	1.691	18.02	4.22
2-ENE	3.07	1.760	5.02	2.73
3-E	2.50	1.571	2.94	2.25
4-ESE	2.33	1.626	2.44	2.09
5-SSE	2.79	1.697	4.58	2.49
6-S	4.55	1.975	23.43	4.03
7-SSW	3.91	1.935	9.01	3.47
8-WSW	4.36	1.941	5.02	3.86
9-W	5.44	2.295	7.91	4.82
10-WNW	4.94	2.178	7.84	4.37
11-NNW	4.85	1.657	6.65	4.33
Mean	**4.30**	**1.730**	**100.00**	**3.83**



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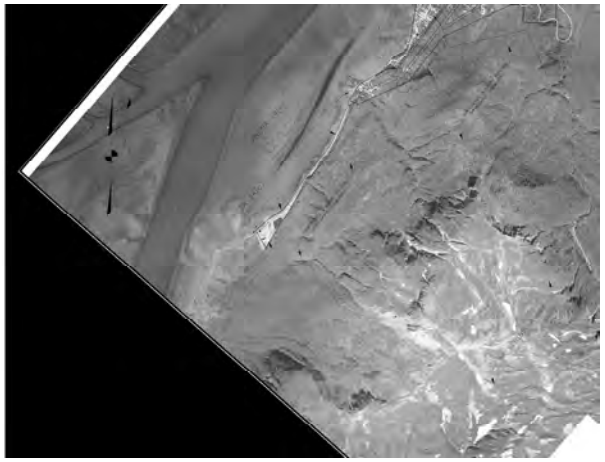
Meteo data report - Main results

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Mast position: UTM WGS 84 Zone: 4 East: 527,445 North: 6,238,891

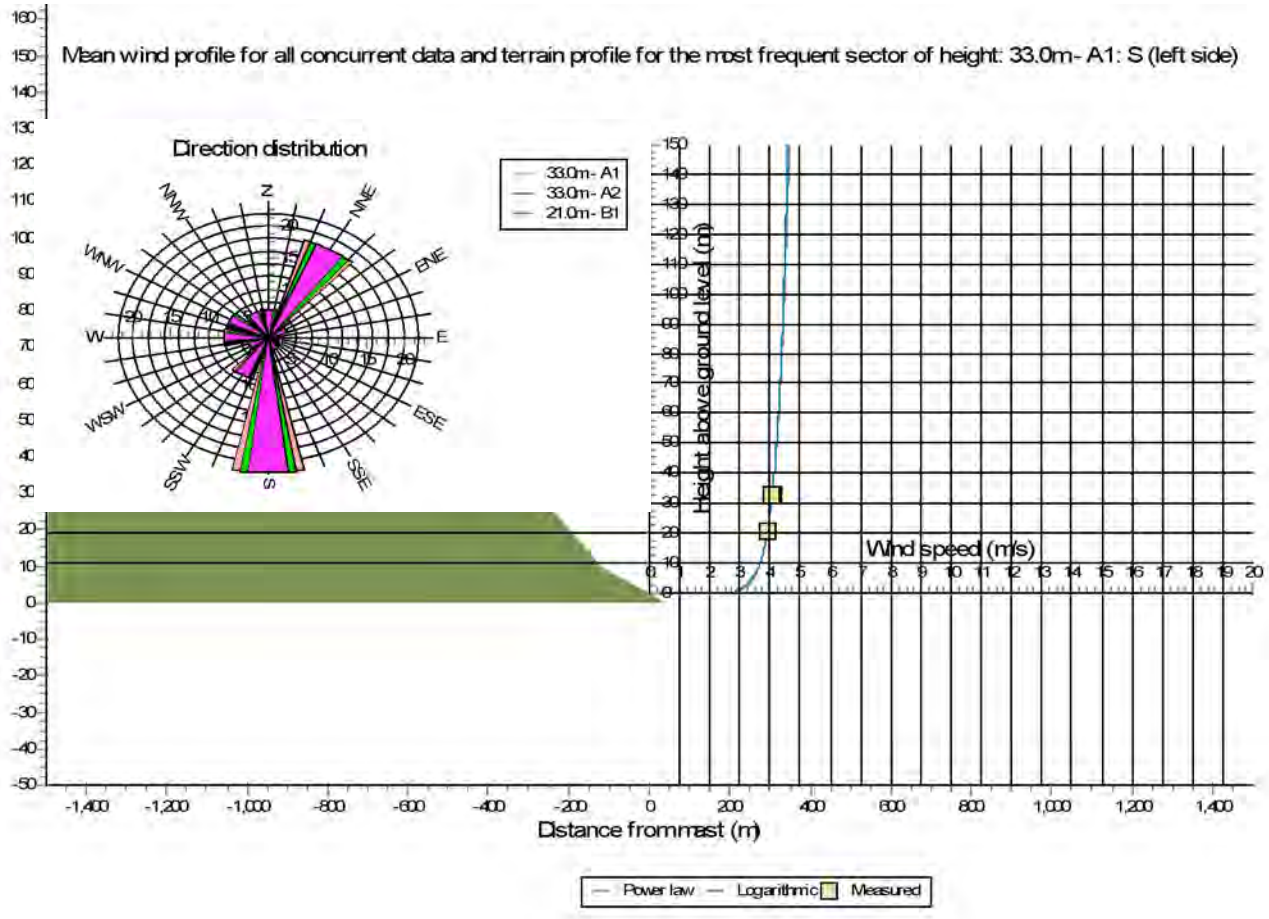
Measurement heights and wind speeds (in this report)
Disabled data not included in overview table below

ID	Height [m]	Data recovery [%]	Records	U_max [m/s]	U_mean *) [m/s]
33.0m - A1	33.0	93.9	54020	17.7	3.9
33.0m - A2	33.0	94.2	54205	17.5	3.9
21.0m - B1	21.0	93.7	53957	17.0	3.8



Scale: 50,000

*) *U_mean is simple arithmetic average*



Profile characteristics for best curve fit through all data (Note: Values are only fully valid in flat terrain)
Shear exponent 0.0873 (Power law profile)
Roughness lenght 0.0003 m class 0.07 (Equivalent roughness for logarithmic profile)

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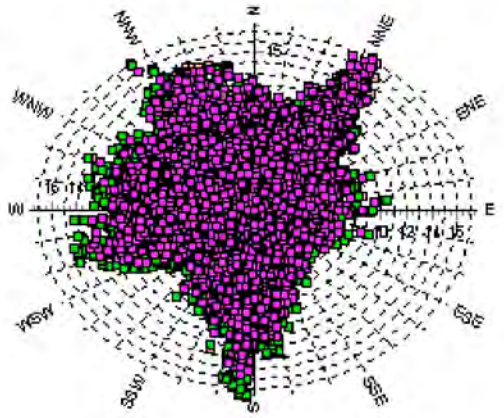
Meteo data report - Main results

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

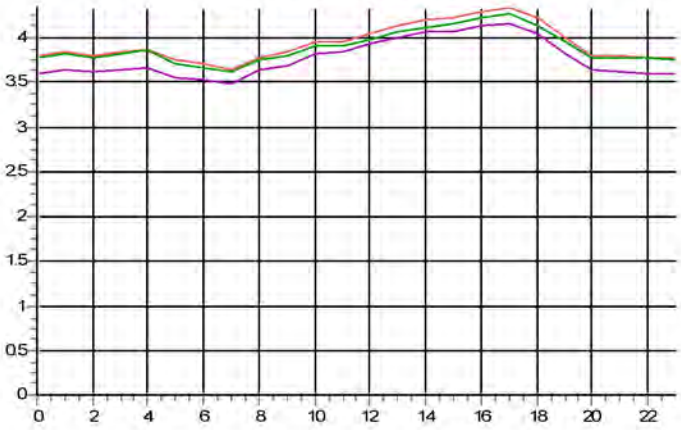
Wind speed/direction



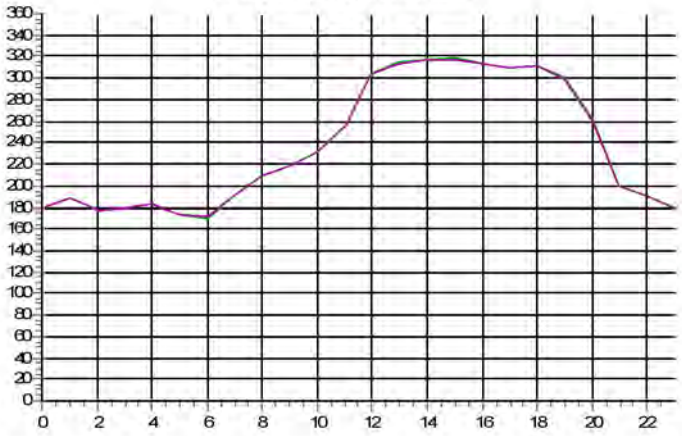
Statistics

	Signal	Unit	Count	Of period [%]	Mean	Weibull mean	Weibull A	Weibull k
33.0m - A1	WS, all	m/s	57556	100.0	3.74			
33.0m - A1	WS, enabled	m/s	54020	93.9	3.94	4.10	4.60	1.71
33.0m - A1	WD, all	Degrees	57556	100.0	241.43			
33.0m - A1	WD, enabled	Degrees	53942	93.7	240.44			
33.0m - A1	Tu, all		57556	100.0	0.30			
33.0m - A1	Tu, enabled		23852	41.4	0.23			
33.0m - A1	T, all	Deg C	57379	99.7	4.50			
33.0m - A1	T, enabled	Deg C	56987	99.0	4.50			
33.0m - A2	WS, all	m/s	57556	100.0	3.71			
33.0m - A2	WS, enabled	m/s	54205	94.2	3.90	4.03	4.52	1.73
33.0m - A2	Tu, all		57556	100.0	0.29			
33.0m - A2	Tu, enabled		23454	40.7	0.23			
33.0m - A2	WD, all	Degrees	57556	100.0	241.43			
33.0m - A2	WD, enabled	Degrees	54141	94.1	240.63			
21.0m - B1	WS, all	m/s	57556	100.0	3.58			
21.0m - B1	WS, enabled	m/s	53957	93.7	3.77	3.90	4.38	1.76
21.0m - B1	Tu, all		57556	100.0	0.30			
21.0m - B1	Tu, enabled		22367	38.9	0.24			
21.0m - B1	WD, all	Degrees	57556	100.0	241.43			
21.0m - B1	WD, enabled	Degrees	53879	93.6	239.89			

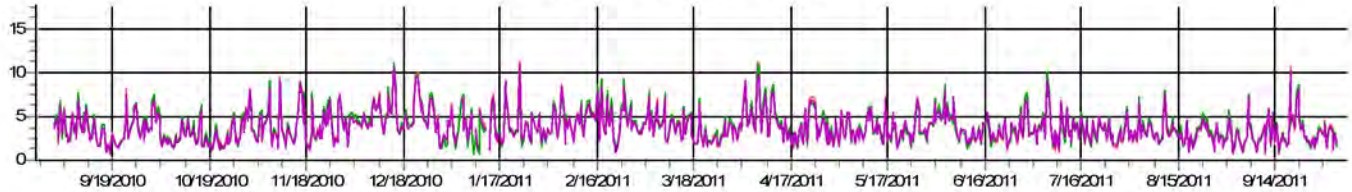
Hourly mean wind speed



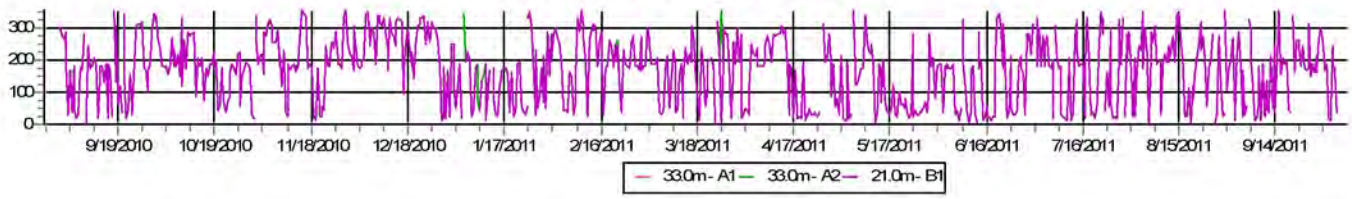
Hourly mean wind direction



Wind speed, Averaging: 12 hours



Wind direction, Averaging: 12 hours



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Meteo data report - Import filters, files and heights

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Import filter: I1
Files/Folders
+C:\WindPro\WINDPRO_Data\PROJECTS\LPB\CHK_LAGOON\METDATA\CLG_TOWER\PROCESSED\AllData*.txt

Time zone for measurements: Same as in the project properties: (GMT-09:00) Alaska
Line with header: 171
Header field separator: "Tab"
First line with data: 172
Data field separator: "Tab"

Column	Channel	Type	Sub type	Unit	Height	Name
1		Time stamp	Date&Time	m/d/y h:m:s		
2	1	Wind speed	Mean	m/s	33.0 m	A1
3	1	Wind speed	StdDev	m/s	33.0 m	A1
6	2	Wind speed	Mean	m/s	33.0 m	A2
7	2	Wind speed	StdDev	m/s	33.0 m	A2
10	3	Wind speed	Mean	m/s	21.0 m	B1
11	3	Wind speed	StdDev	m/s	21.0 m	B1
26	7	Wind direction	Mean	Degrees	32.0 m	AVANE
27	7	Wind direction	StdDev	Degrees	32.0 m	AVANE
34	9	Temperature	Mean	Deg C	3.0 m	CH9Avg
35	9	Temperature	StdDev	Deg C	3.0 m	CH9SD

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Meteo data report - Missing data - calendar view

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **33.0m - A1**
Signal: **WS**

- some records missing, disabled, erroneous, or out of range current day
- all records missing, disabled, erroneous, or out of range current day

Day

Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	3.8	**165**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	20	60	0	0	0	0	19	11	0	0	0	0	0	9	45	0	
Oct/2010	3.6	**160**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	19	0	0	0	78	3	7	15	0	0	34	0
Nov/2010	5.4	**234**	0	0	0	0	1	0	13	3	60	0	11	35	24	10	0	0	0	45	16	0	10	0	0	0	0	3	3	0	0	0	
Dec/2010	6.1	**274**	45	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85	28	44	70
Jan/2011	18.3	**815**	0	20	80	58	0	0	1	2	80	89	4	50	127	3	25	69	20	17	0	29	0	22	29	12	1	45	12	0	0	7	13
Feb/2011	5.5	**223**	0	0	2	51	23	20	0	62	0	0	0	1	0	0	16	0	0	3	0	3	13	29	0	0	0	0	0	0			
Mar/2011	5.8	**260**	1	0	0	21	0	3	0	13	0	4	12	18	36	12	0	0	0	9	0	0	70	4	13	29	7	2	0	1	0	0	5
Apr/2011	11.8	**509**	62	5	0	1	0	54	0	0	0	28	0	0	0	0	3	40	45	48	77	0	0	0	0	0	18	10	50	24	0	44	
May/2011	4.7	**209**	0	20	4	0	0	6	16	44	0	0	0	0	6	7	0	0	33	21	0	0	0	0	15	0	0	0	0	0	0	37	0
Jun/2011	5.9	**256**	0	0	0	0	0	0	0	0	18	47	85	0	0	0	40	0	0	10	16	0	0	0	0	11	29	0	0	0	0	0	
Jul/2011	0.2	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Aug/2011	0.3	**13**	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	1.0	**45**	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	6.8	**23**	0	0	23																												
Total	**6.1**	**3536**																															

Signal: **WD**

Day

Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	3.8	**165**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	20	60	0	0	0	0	19	11	0	0	0	0	0	9	45	0	
Oct/2010	3.6	**160**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	19	0	0	0	78	3	7	15	0	0	34	0
Nov/2010	5.4	**234**	0	0	0	0	1	0	13	3	60	0	11	35	24	10	0	0	0	45	16	0	10	0	0	0	0	3	3	0	0	0	
Dec/2010	6.1	**274**	45	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85	28	44	70
Jan/2011	18.3	**815**	0	20	80	58	0	0	1	2	80	89	4	50	127	3	25	69	20	17	0	29	0	22	29	12	1	45	12	0	0	7	13
Feb/2011	5.5	**223**	0	0	2	51	23	20	0	62	0	0	0	1	0	0	16	0	0	3	0	3	13	29	0	0	0	0	0	0			
Mar/2011	7.6	**338**	1	0	0	21	0	3	0	13	0	4	12	18	36	12	0	0	0	9	0	0	70	4	13	44	70	2	0	1	0	0	5
Apr/2011	11.8	**509**	62	5	0	1	0	54	0	0	0	28	0	0	0	0	3	40	45	48	77	0	0	0	0	0	18	10	50	24	0	44	
May/2011	4.7	**209**	0	20	4	0	0	6	16	44	0	0	0	0	6	7	0	0	33	21	0	0	0	0	15	0	0	0	0	0	0	37	0
Jun/2011	5.9	**256**	0	0	0	0	0	0	0	0	18	47	85	0	0	0	40	0	0	10	16	0	0	0	0	11	29	0	0	0	0	0	
Jul/2011	0.2	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Aug/2011	0.3	**13**	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	1.0	**45**	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	6.8	**23**	0	0	23																												
Total	**6.3**	**3614**																															

Signal: **Tu**

Day

Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	61.9	**2675**	48	111	67	66	131	75	72	61	80	54	30	130	60	123	144	91	135	144	98	143	140	117	31	92	54	27	86	73	111	81	
Oct/2010	68.5	**3056**	63	31	14	119	120	137	139	127	138	85	104	76	110	71	130	21	128	120	140	138	86	133	142	127	137	53	118	125	26	74	24
Nov/2010	54.5	**2353**	57	103	97	76	64	18	89	87	138	40	116	102	121	127	57	1	30	137	128	61	119	95	71	30	41	103	131	9	57	48	
Dec/2010	37.8	**1689**	109	49	62	62	79	39	79	55	11	5	38	76	17	31	1	58	89	67	60	71	39	0	14	20	69	6	22	114	92	127	128
Jan/2011	63.1	**2815**	75	72	141	103	2	63	115	51	121	144	38	98	144	66	69	122	129	80	33	99	120	109	84	124	50	132	52	93	52	118	116
Feb/2011	43.3	**1747**	93	54	33	105	32	89	61	116	93	61	25	76	16	16	58	38	62	101	15	40	139	144	66	3	52	20	61	78			
Mar/2011	61.4	**2743**	93	79	54	52	50	30	65	80	74	120	52	108	84	123	49	32	84	132	101	57	108	138	142	122	117	134	73	112	54	108	116
Apr/2011	50.1	**2164**	88	65	30	44	43	77	0	71	29	113	3	26	69	93	75	122	113	140	130	74	81	69	7	1	93	90	99	89	99	131	
May/2011	58.9	**2631**	73	76	106	65	68	85	112	101	117	63	26	64	71	86	130	17	114	66	76	143	101	80	108	126	89	9	107	98	127	89	38
Jun/2011	57.1	**2468**	26	27	12	41	23	42	73	108	95	118	144	85	133	73	102	44	48	129	138	109	121	71	125	90	89	114	55	70	50	113	
Jul/2011	62.8	**2803**	87	127	73	69	57	36	118	115	78	57	80	110	89	72	116	53	100	94	85	108	81	79	76	88	121	142	121	108	97	69	97
Aug/2011	65.4	**2921**	109	94	68	77	109	62	131	116	134	78	44	105	51	87	110	103	78	143	131	123	85	49	82	76	105	128	92	90	131	52	78
Sep/2011	70.9	**3063**	140	93	129	139	58	69	139	144	127	91	118	97	59	105	140	111	142	64	59	49	16	74	106	136	138	127	99	95	88	111	
Oct/2011	70.2	**236**	76	112	48																												
Total	**58.6**	**33704**																															

Signal: **T**

Day

Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	0.0	**1**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

To be continued on next page...

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Meteo data report - Missing data - calendar view

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

...continued from previous page

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Oct/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dec/2010	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan/2011	5.1	**228**	0	0	0	31	0	0	0	2	80	86	4	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Mar/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
May/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Jul/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	0.0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	0.0	**0**	0	0	0																												
Total	**1.0**	**569**																															

Project:
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Meteo data report - Missing data - calendar view

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **33.0m - A2**
Signal: **WS**

- some records missing, disabled, erroneous, or out of range current day
- all records missing, disabled, erroneous, or out of range current day

			Day																												
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	4.6	**199**	1	24	1	0	0	0	0	0	0	0	0	9	0	0	20	60	0	0	0	0	19	11	0	0	0	0	0	9	45	0	
Oct/2010	3.6	**160**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	19	0	0	0	78	3	7	15	0	0	34	0
Nov/2010	5.1	**219**	0	0	1	0	0	0	11	1	58	1	11	35	24	11	0	0	0	43	5	0	10	0	0	0	0	4	4	0	0	0	
Dec/2010	6.1	**274**	45	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	28	44	70
Jan/2011	15.1	**673**	0	20	81	27	0	0	2	0	44	39	0	30	127	3	23	69	21	17	0	29	0	22	29	12	1	42	12	0	0	9	14
Feb/2011	4.6	**186**	0	0	1	51	23	17	0	62	0	0	0	1	0	0	13	0	0	3	0	2	3	10	0	0	0	0	0	0			
Mar/2011	5.4	**242**	0	0	0	21	0	0	0	13	0	3	10	18	33	5	0	0	0	0	0	0	69	4	13	46	2	1	0	0	0	0	4
Apr/2011	11.6	**502**	59	5	0	1	0	54	0	0	0	28	0	0	0	0	2	40	45	45	77	0	0	0	0	0	18	10	50	24	0	44	
May/2011	4.7	**209**	0	20	4	0	0	6	16	44	0	0	0	0	6	7	0	0	33	21	0	0	0	0	15	0	0	0	0	0	0	37	0
Jun/2011	5.9	**256**	0	0	0	0	0	0	0	0	18	47	85	0	0	0	40	0	0	10	16	0	0	0	0	11	29	0	0	0	0	0	
Jul/2011	0.2	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Aug/2011	0.3	**13**	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	1.0	**45**	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	6.8	**23**	0	0	23																												
Total	**5.8**	**3351**																															

Signal: **Tu**

			Day																												
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	63.0	**2722**	48	111	76	75	133	88	72	60	78	52	30	135	60	123	144	91	136	144	101	143	140	118	34	92	53	28	90	75	111	81	
Oct/2010	69.7	**3110**	63	31	13	119	120	138	139	131	139	84	105	76	111	75	133	21	129	122	142	140	92	135	142	131	137	55	120	126	31	78	32
Nov/2010	54.5	**2355**	58	103	98	73	64	18	88	85	141	42	115	101	120	126	58	1	30	137	129	59	125	94	71	29	39	102	132	10	59	48	
Dec/2010	37.8	**1688**	109	51	62	57	78	38	78	54	11	5	39	74	16	34	1	60	88	65	59	70	39	0	13	19	70	6	22	115	97	130	128
Jan/2011	63.8	**2850**	78	79	143	87	2	62	119	46	124	144	39	100	144	69	71	121	131	83	37	104	124	110	87	127	50	133	51	96	55	120	114
Feb/2011	42.7	**1723**	95	54	33	105	32	91	63	118	93	59	25	78	16	16	54	38	62	97	15	40	135	144	64	2	43	17	60	74			
Mar/2011	61.5	**2744**	90	75	53	52	50	31	78	77	76	118	55	110	83	121	49	28	84	133	100	60	109	140	144	129	110	133	66	122	50	102	116
Apr/2011	50.1	**2165**	96	67	30	46	40	77	0	61	29	112	3	27	60	86	80	119	112	142	136	75	85	77	10	6	94	89	93	88	96	129	
May/2011	61.4	**2742**	87	80	108	66	71	92	108	99	116	62	22	62	83	90	129	22	126	71	91	143	108	86	112	128	91	13	117	104	125	91	39
Jun/2011	58.3	**2520**	21	28	10	41	22	47	86	112	96	120	144	90	132	69	108	47	60	135	137	108	121	68	125	104	101	113	51	68	50	106	
Jul/2011	65.2	**2912**	90	125	71	69	58	36	116	113	82	71	90	110	91	72	115	69	99	95	109	121	95	84	87	88	125	140	120	102	96	66	107
Aug/2011	65.3	**2914**	117	92	68	74	110	59	126	114	135	78	42	101	51	87	110	103	89	144	135	117	81	47	81	71	102	131	94	98	130	51	76
Sep/2011	71.1	**3072**	143	91	125	143	60	64	136	144	132	97	118	97	57	103	140	106	141	65	69	48	15	69	109	134	139	127	99	99	88	114	
Oct/2011	72.9	**245**	85	112	48																												
Total	**59.3**	**34102**																															

Signal: **WD**

			Day																												
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	4.6	**199**	1	24	1	0	0	0	0	0	0	0	0	9	0	0	20	60	0	0	0	0	19	11	0	0	0	0	0	9	45	0	
Oct/2010	3.6	**160**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	19	0	0	0	78	3	7	15	0	0	34	0
Nov/2010	5.1	**219**	0	0	1	0	0	0	11	1	58	1	11	35	24	11	0	0	0	43	5	0	10	0	0	0	0	4	4	0	0	0	
Dec/2010	6.1	**274**	45	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	28	44	70
Jan/2011	15.1	**673**	0	20	81	27	0	0	2	0	44	39	0	30	127	3	23	69	21	17	0	29	0	22	29	12	1	42	12	0	0	9	14
Feb/2011	4.6	**186**	0	0	1	51	23	17	0	62	0	0	0	1	0	0	13	0	0	3	0	2	3	10	0	0	0	0	0	0			
Mar/2011	6.9	**306**	0	0	0	21	0	0	0	13	0	3	10	18	33	5	0	0	0	0	0	0	69	4	13	47	65	1	0	0	0	0	4
Apr/2011	11.6	**502**	59	5	0	1	0	54	0	0	0	28	0	0	0	0	2	40	45	45	77	0	0	0	0	0	18	10	50	24	0	44	
May/2011	4.7	**209**	0	20	4	0	0	6	16	44	0	0	0	0	6	7	0	0	33	21	0	0	0	0	15	0	0	0	0	0	0	37	0
Jun/2011	5.9	**256**	0	0	0	0	0	0	0	0	18	47	85	0	0	0	40	0	0	10	16	0	0	0	0	11	29	0	0	0	0	0	
Jul/2011	0.2	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Aug/2011	0.3	**13**	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	1.0	**45**	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	6.8	**23**	0	0	23																												
Total	**5.9**	**3415**																															

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Meteo data report - Missing data - calendar view

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **21.0m - B1**
Signal: **WS**

- some records missing, disabled, erroneous, or out of range current day
- all records missing, disabled, erroneous, or out of range current day

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	4.6	**199**	1	24	1	0	0	0	0	0	0	0	0	9	0	0	20	60	0	0	0	0	19	11	0	0	0	0	0	9	45	0	
Oct/2010	3.6	**162**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	19	0	0	0	78	5	7	15	0	0	34	0
Nov/2010	4.9	**211**	0	0	0	2	1	0	14	1	58	0	8	29	24	4	0	0	0	46	11	0	10	0	0	0	0	2	1	0	0	0	
Dec/2010	6.0	**266**	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	25	43	70
Jan/2011	19.8	**886**	0	18	78	112	49	0	0	2	80	86	4	49	124	1	21	69	20	15	0	29	0	22	29	12	0	37	12	0	0	7	10
Feb/2011	6.0	**243**	0	0	0	51	23	12	0	62	0	0	0	3	0	0	16	0	2	27	0	4	10	33	0	0	0	0	0	0			
Mar/2011	5.0	**225**	0	0	0	21	0	0	0	13	0	3	10	18	31	2	0	0	0	2	0	0	69	3	13	29	6	2	0	0	0	0	3
Apr/2011	11.8	**511**	61	5	0	1	0	54	0	0	0	29	0	0	0	0	2	40	47	50	77	0	0	0	0	0	17	10	50	24	0	44	
May/2011	4.7	**209**	0	20	4	0	0	6	16	44	0	0	0	0	6	7	0	0	33	21	0	0	0	0	15	0	0	0	0	0	0	37	0
Jun/2011	5.9	**256**	0	0	0	0	0	0	0	0	18	47	85	0	0	0	40	0	0	10	16	0	0	0	0	11	29	0	0	0	0	0	
Jul/2011	0.2	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Aug/2011	0.3	**13**	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	1.0	**45**	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	6.8	**23**	0	0	23																												
Total	**6.3**	**3599**																															

Signal: **Tu**

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	64.8	**2798**	54	118	69	67	136	72	83	67	86	60	34	122	71	130	144	99	135	144	100	143	141	122	39	96	60	32	96	83	111	84	
Oct/2010	73.3	**3270**	65	41	22	125	131	141	142	131	140	93	113	86	114	96	136	25	139	135	144	140	97	135	143	137	138	62	122	129	39	79	30
Nov/2010	57.5	**2486**	70	113	99	78	67	20	93	100	143	43	119	106	129	134	59	3	33	139	129	62	117	97	74	40	48	109	135	10	62	55	
Dec/2010	41.1	**1836**	111	55	72	72	81	48	85	59	17	9	43	82	21	38	1	64	96	75	64	76	45	0	15	27	73	7	26	117	96	134	127
Jan/2011	66.3	**2959**	75	80	142	140	50	65	108	57	123	144	38	102	144	66	70	125	132	80	36	100	130	110	85	126	53	136	52	100	54	121	115
Feb/2011	46.1	**1860**	103	57	36	105	32	91	61	119	94	62	40	82	20	25	59	45	63	108	17	54	141	144	69	4	59	23	66	81			
Mar/2011	63.9	**2852**	103	85	55	53	55	30	73	81	72	121	52	113	85	128	52	40	89	133	102	62	111	141	143	128	125	137	76	121	56	111	119
Apr/2011	52.2	**2257**	86	68	33	46	55	79	0	77	34	120	5	32	77	97	82	128	117	137	127	77	79	60	8	4	95	91	106	93	109	135	
May/2011	59.4	**2653**	73	76	101	70	73	91	114	107	120	68	28	62	71	88	135	18	108	66	74	142	95	79	108	126	86	9	103	98	135	90	39
Jun/2011	57.7	**2492**	32	31	16	43	29	41	68	107	100	117	141	86	133	81	102	50	41	123	138	112	123	78	130	80	79	114	56	72	51	118	
Jul/2011	64.1	**2862**	95	128	82	76	58	38	112	117	78	53	76	110	94	85	119	48	105	101	79	106	81	78	74	92	122	142	129	114	101	72	97
Aug/2011	69.4	**3098**	111	97	67	78	111	69	132	123	138	89	46	116	74	95	115	103	77	143	132	126	96	62	86	86	121	129	97	96	135	55	93
Sep/2011	73.3	**3166**	140	96	132	140	59	74	140	144	124	93	120	96	65	105	142	113	144	66	64	47	21	85	119	137	141	130	110	107	96	116	
Oct/2011	77.4	**260**	84	128	48																												
Total	**61.2**	**35189**																															

Signal: **WD**

			Day																													
Month/Year	%	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aug/2010	100.0	**340**																													52	144	144
Sep/2010	4.6	**199**	1	24	1	0	0	0	0	0	0	0	0	9	0	0	20	60	0	0	0	0	19	11	0	0	0	0	0	9	45	0	
Oct/2010	3.6	**162**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	19	0	0	0	78	5	7	15	0	0	34	0
Nov/2010	4.9	**211**	0	0	0	2	1	0	14	1	58	0	8	29	24	4	0	0	0	46	11	0	10	0	0	0	0	2	1	0	0	0	
Dec/2010	6.0	**266**	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	25	43	70
Jan/2011	19.8	**886**	0	18	78	112	49	0	0	2	80	86	4	49	124	1	21	69	20	15	0	29	0	22	29	12	0	37	12	0	0	7	10
Feb/2011	6.0	**243**	0	0	0	51	23	12	0	62	0	0	0	3	0	0	16	0	2	27	0	4	10	33	0	0	0	0	0	0			
Mar/2011	6.8	**303**	0	0	0	21	0	0	0	13	0	3	10	18	31	2	0	0	0	2	0	0	69	3	13	44	69	2	0	0	0	0	3
Apr/2011	11.8	**511**	61	5	0	1	0	54	0	0	0	29	0	0	0	0	2	40	47	50	77	0	0	0	0	0	17	10	50	24	0	44	
May/2011	4.7	**209**	0	20	4	0	0	6	16	44	0	0	0	0	6	7	0	0	33	21	0	0	0	0	15	0	0	0	0	0	0	37	0
Jun/2011	5.9	**256**	0	0	0	0	0	0	0	0	18	47	85	0	0	0	40	0	0	10	16	0	0	0	0	11	29	0	0	0	0	0	
Jul/2011	0.2	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Aug/2011	0.3	**13**	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep/2011	1.0	**45**	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	
Oct/2011	6.8	**23**	0	0	23																												
Total	**6.4**	**3677**																															

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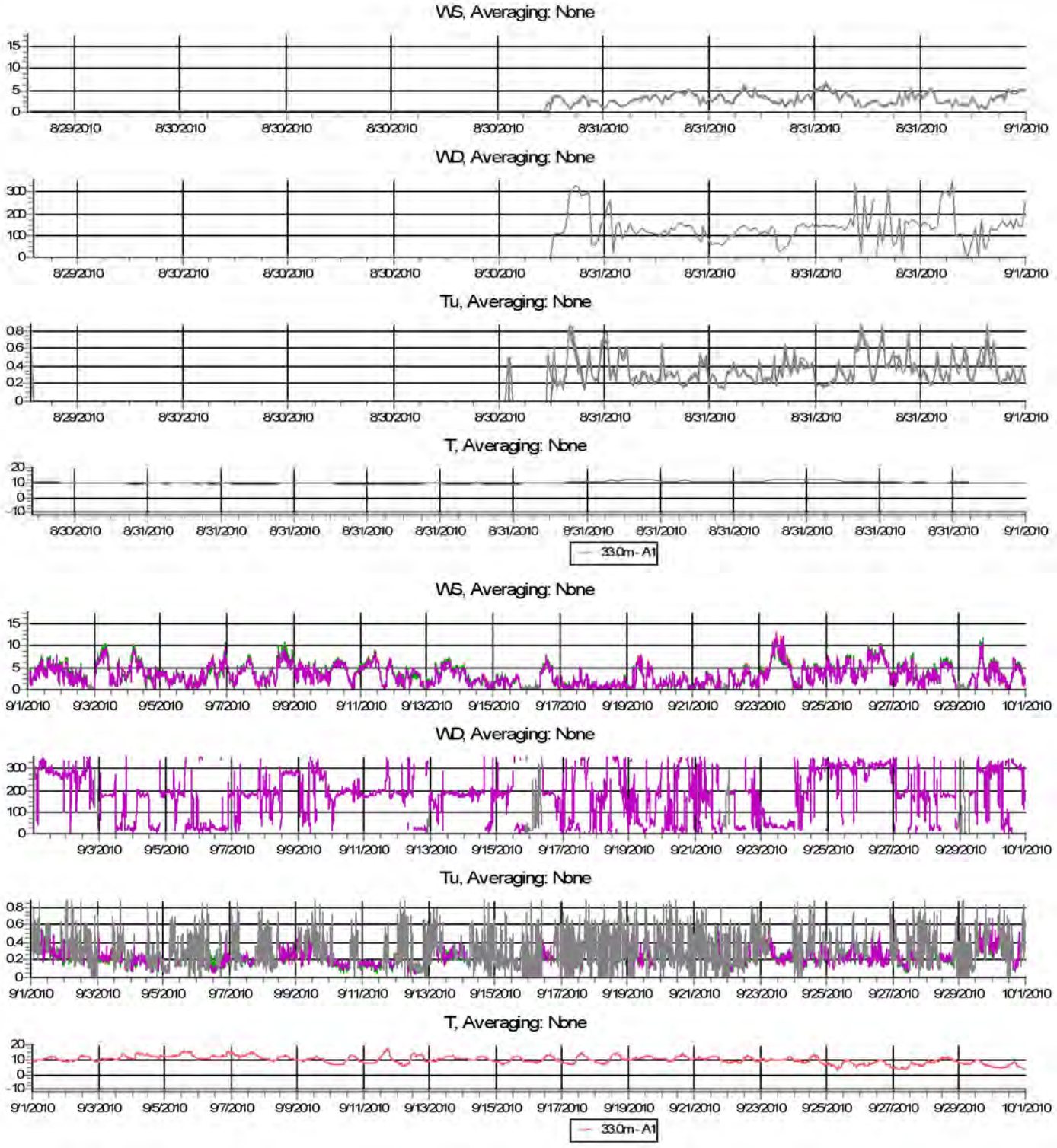
Meteo data report - Time series graphs

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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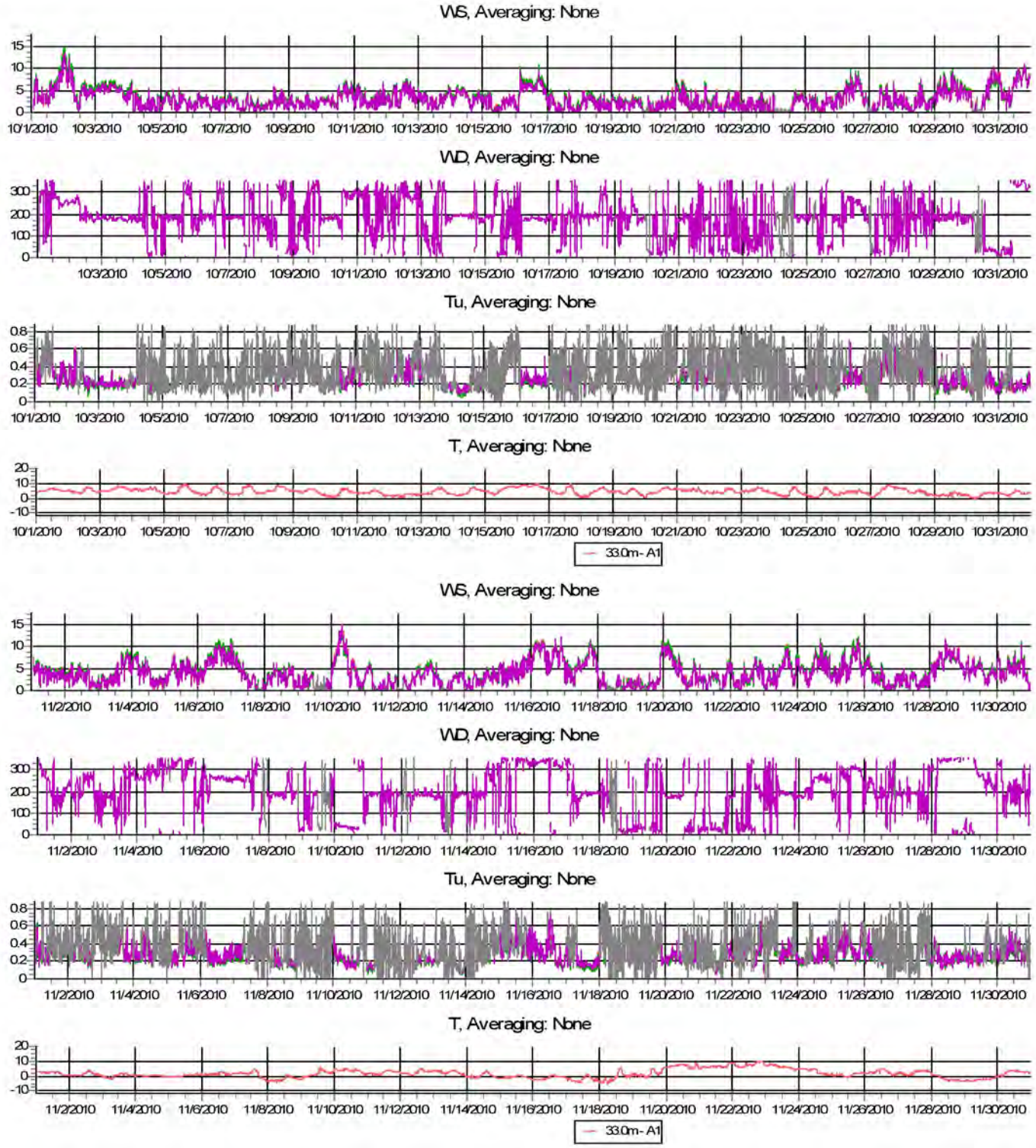
Meteo data report - Time series graphs

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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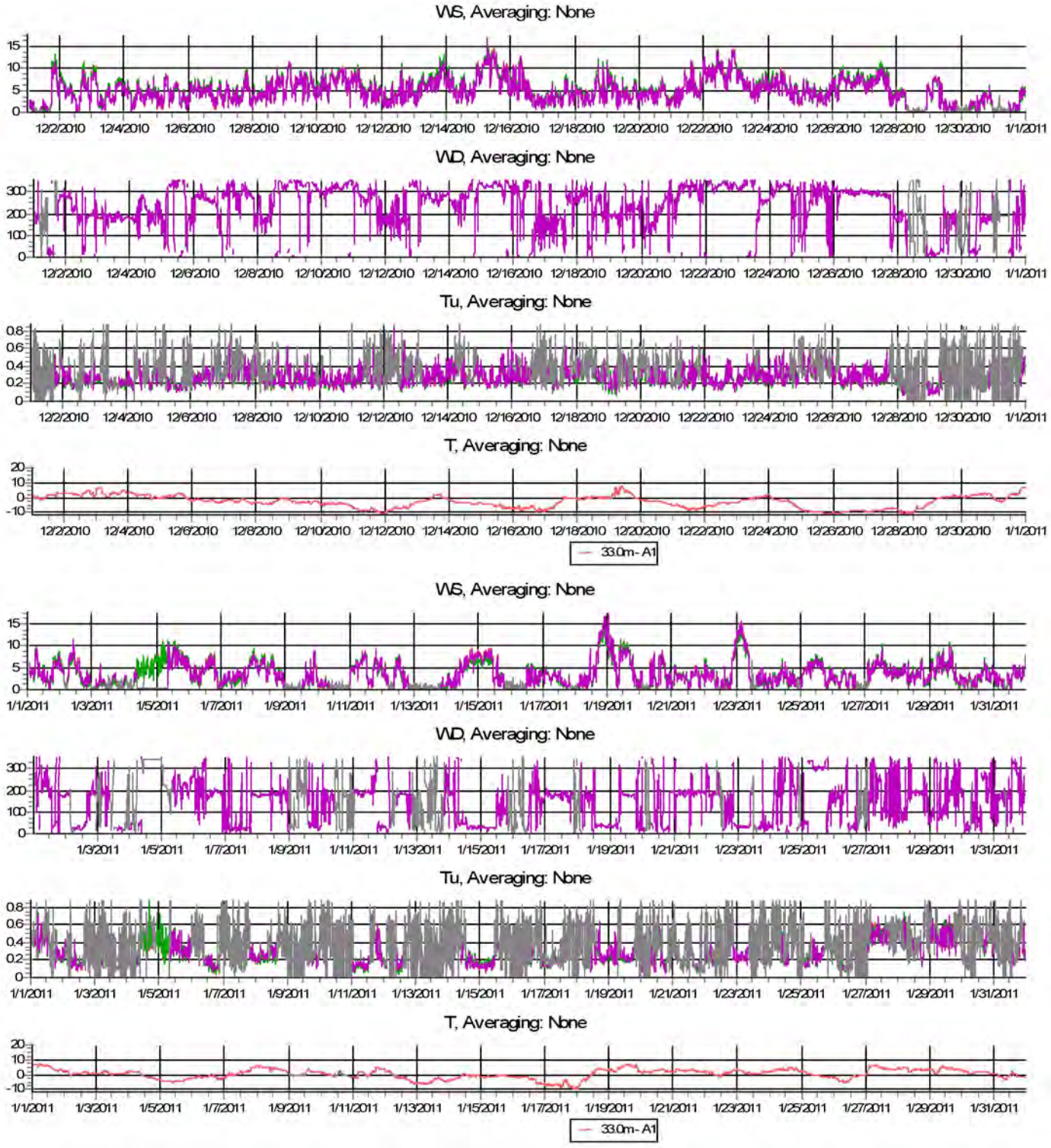
Meteo data report - Time series graphs

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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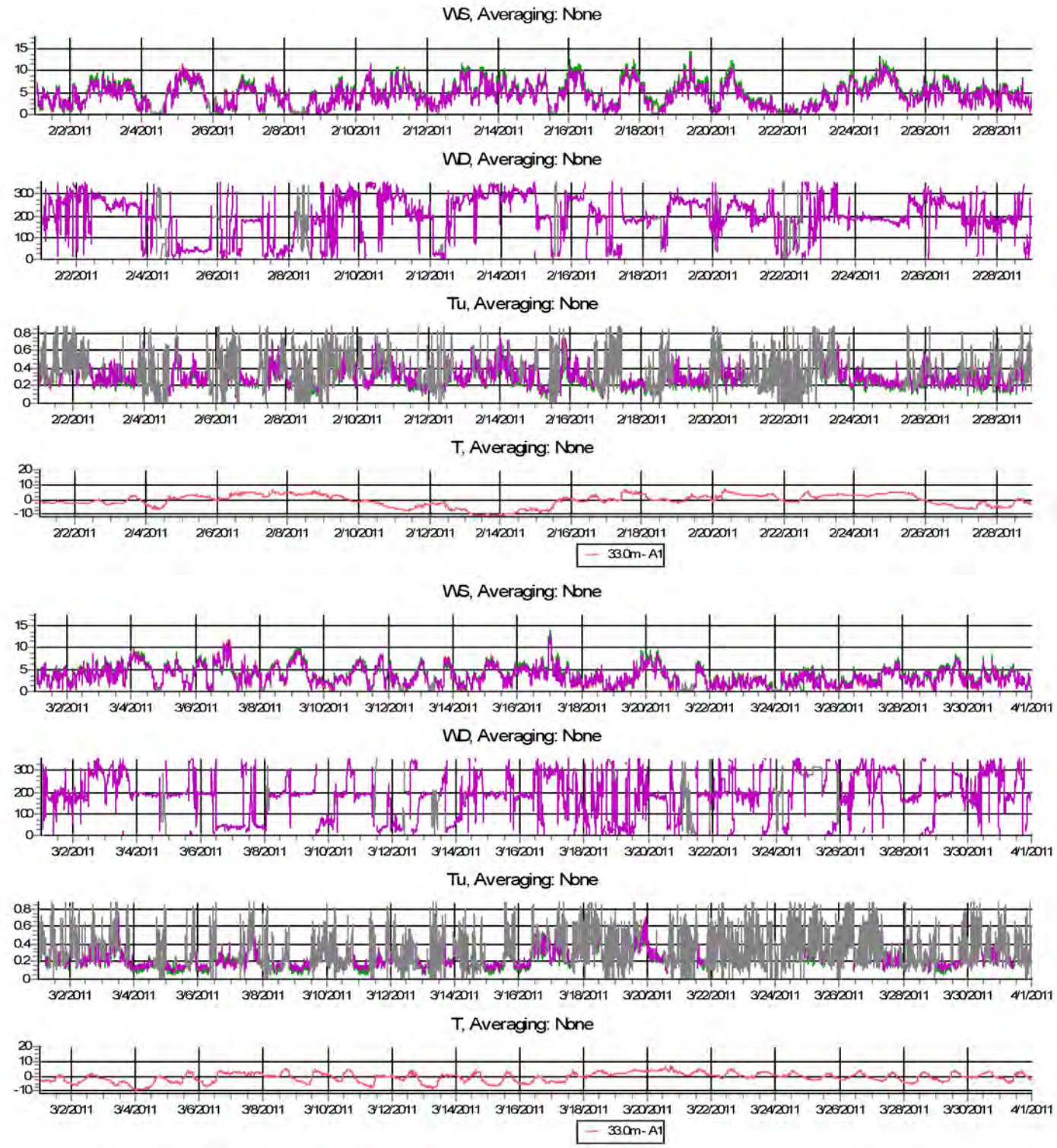
Meteo data report - Time series graphs

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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Meteo data report - Time series graphs

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

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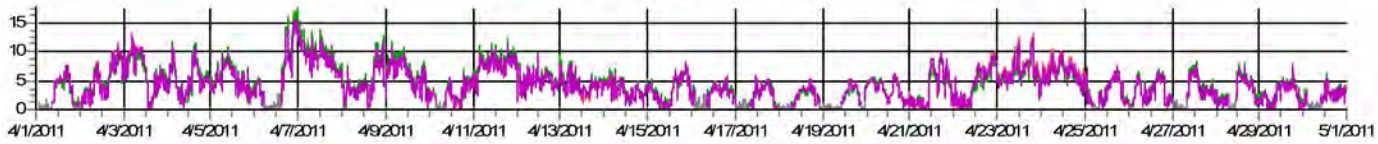

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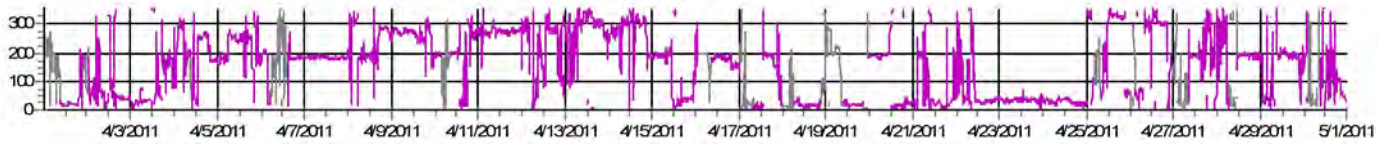

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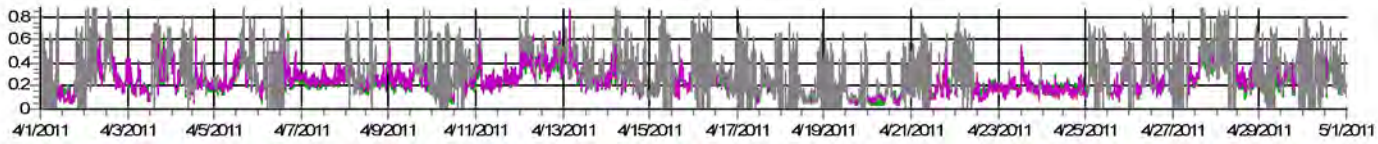

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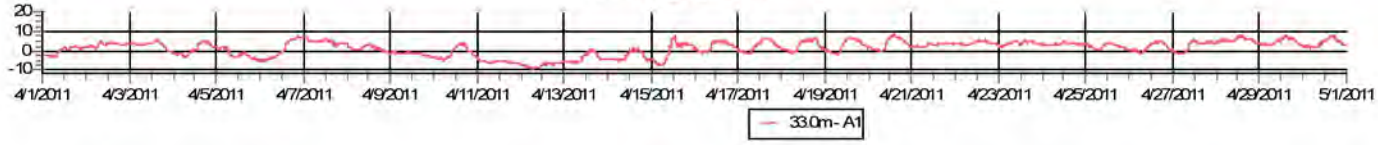

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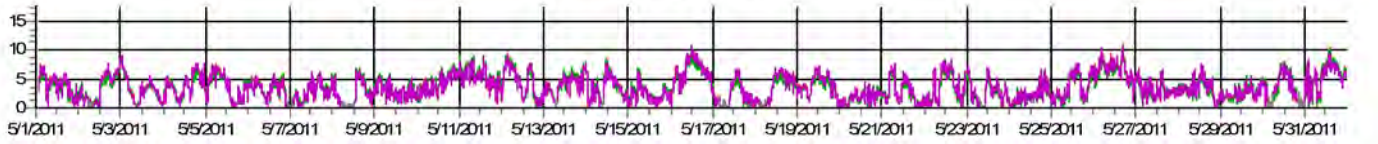

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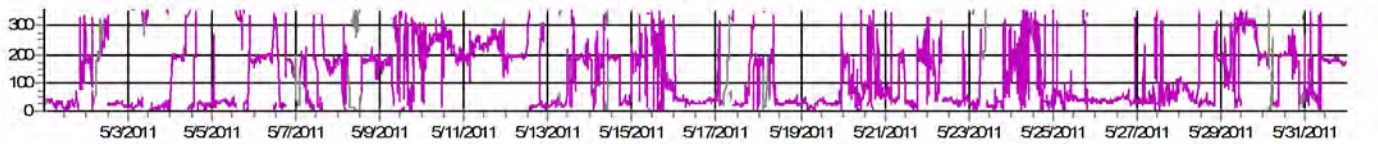

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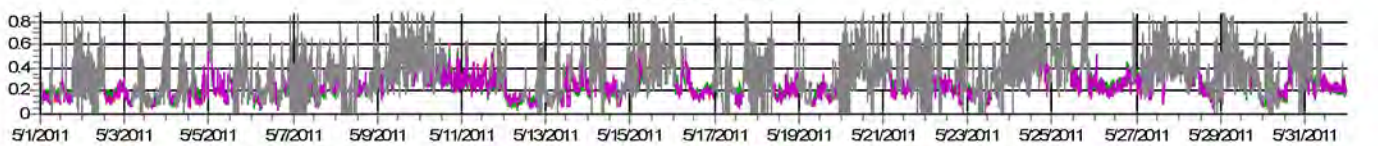

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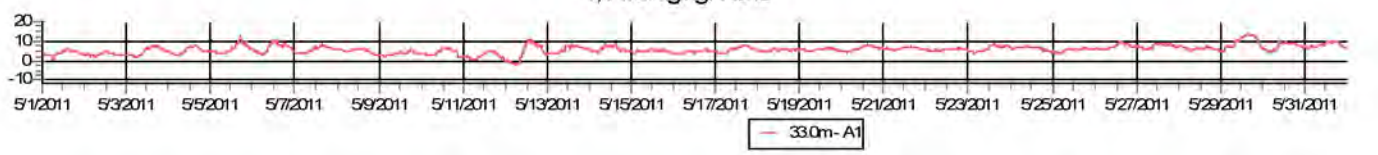

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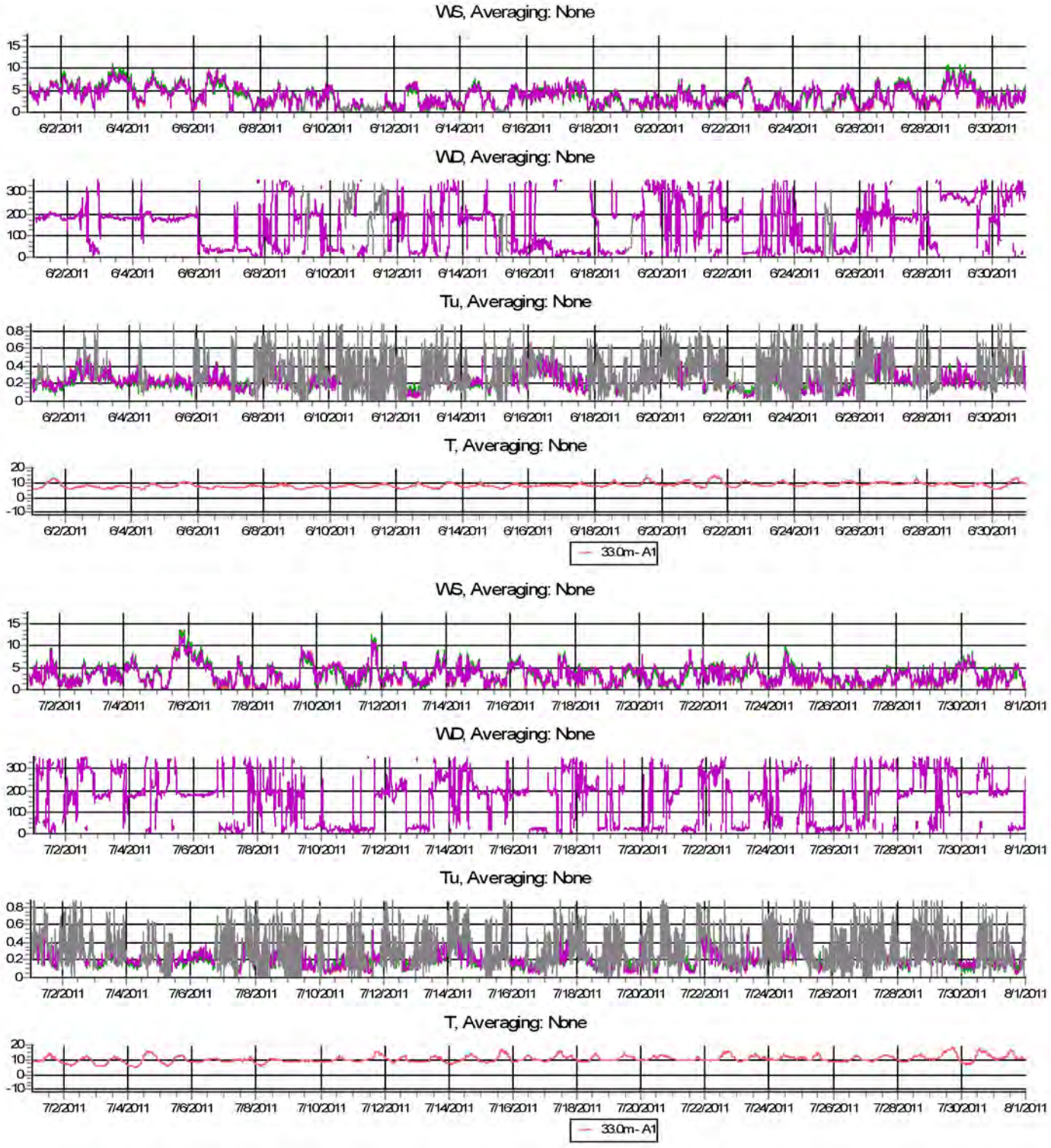
Meteo data report - Time series graphs

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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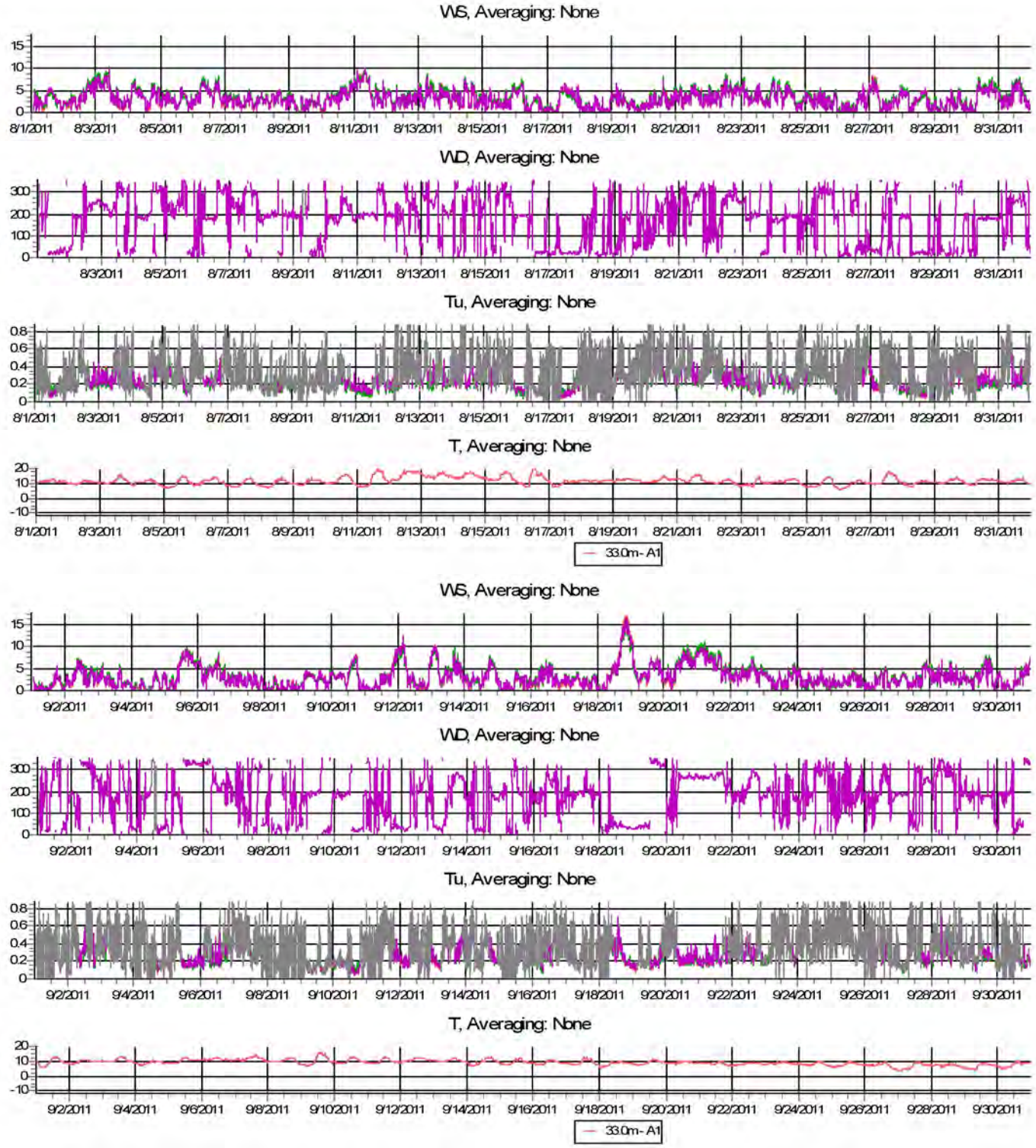
Meteo data report - Time series graphs

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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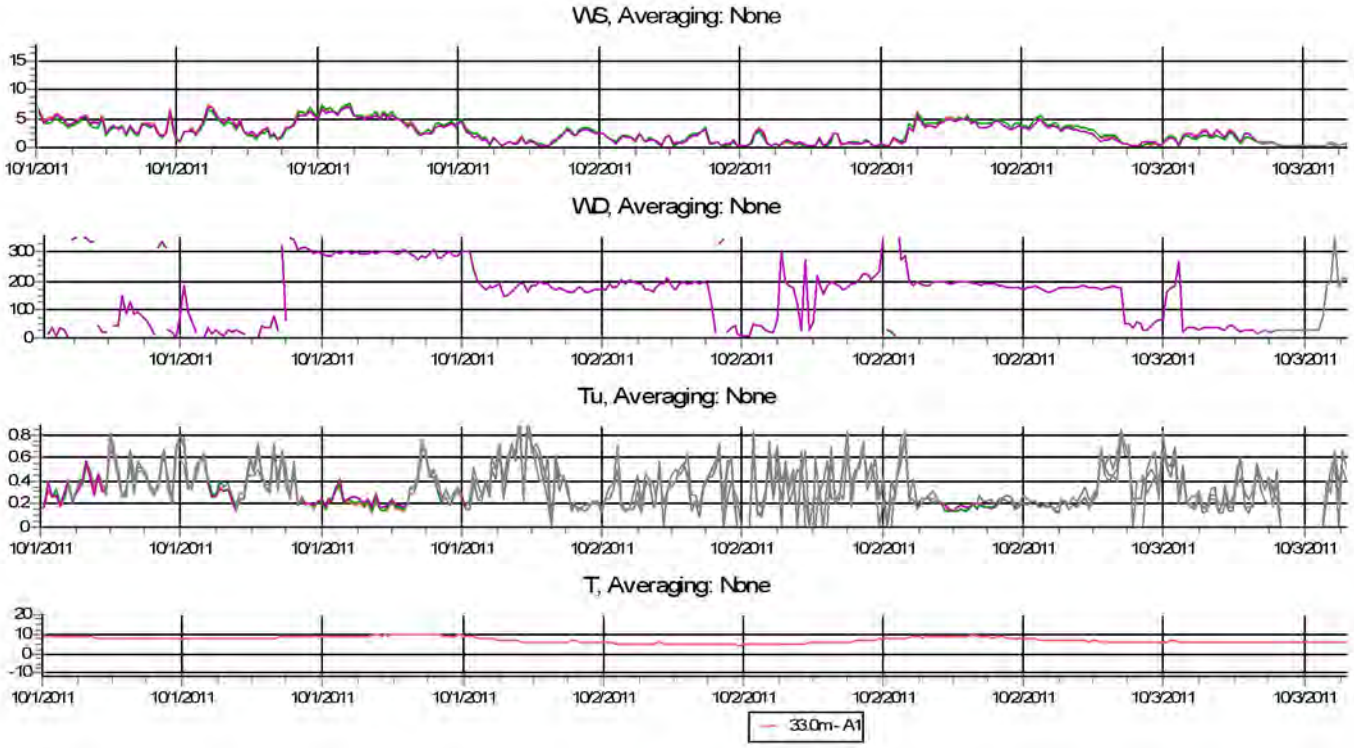
Meteo data report - Time series graphs

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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Meteo data report - Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

33.0m - A1

Bin	Start	End	Mean	0-N	1-NNE	2-NE	3-ENE	4-E	5-ESE	6-SE	7-SSE	8-S	9-SSW	10-SW	11-WSW	12-W	13-WNW	14-NW	15-NNW
Mean			0.36	0.40	0.26	0.35	0.53	0.57	0.54	0.52	0.36	0.30	0.29	0.43	0.40	0.39	0.39	0.39	0.41
0		0.49																	
1	0.50	1.49																	
2	1.50	2.49																	
3	2.50	3.49																	
4	3.50	4.49	0.41	0.45	0.29	0.41	0.54	0.53	0.54	0.53	0.38	0.33	0.32	0.45	0.47	0.47	0.47	0.45	0.53
5	4.50	5.49	0.38	0.45	0.27	0.39	0.52	0.58	0.54	0.49	0.35	0.31	0.29	0.44	0.44	0.44	0.41	0.42	0.46
6	5.50	6.49	0.36	0.40	0.26	0.36	0.50	0.59	0.56	0.55	0.37	0.29	0.29	0.44	0.41	0.40	0.40	0.37	0.40
7	6.50	7.49	0.33	0.40	0.25	0.32	0.54	0.61	0.45	0.64	0.36	0.28	0.27	0.36	0.34	0.37	0.36	0.35	0.38
8	7.50	8.49	0.32	0.35	0.24	0.32	0.53	0.51	0.52		0.35	0.29	0.27	0.42	0.34	0.32	0.33	0.32	0.35
9	8.50	9.49	0.30	0.28	0.23	0.30		0.46			0.35	0.28	0.23	0.35	0.32	0.31	0.31	0.29	0.33
10	9.50	10.49	0.29	0.30	0.25	0.28					0.23	0.27	0.23	0.38	0.31	0.29	0.31	0.28	0.31
11	10.50	11.49	0.28	0.27	0.22	0.27					0.18	0.25	0.26		0.23	0.33	0.28	0.30	0.31
12	11.50	12.49	0.26	0.21	0.21	0.26						0.28	0.27		0.26	0.26	0.28	0.32	0.25
13	12.50	13.49	0.25		0.23	0.26						0.27			0.24	0.25	0.24	0.27	0.22
14	13.50	14.49	0.25	0.19	0.24	0.26						0.28			0.21	0.23		0.24	0.21
15	14.50	15.49	0.25		0.24	0.24						0.28			0.20				
16	15.50	16.49	0.29		0.21	0.20						0.32							
17	16.50	17.49	0.29		0.24	0.20						0.30							
18	17.50	18.49	0.26									0.26							
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Meteo data report - Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

33.0m - A2

Bin	Start	End	Mean	0-N	1-NNE	2-NE	3-ENE	4-E	5-ESE	6-SE	7-SSE	8-S	9-SSW	10-SW	11-WSW	12-W	13-WNW	14-NW	15-NNW
Mean			0.36	0.40	0.28	0.35	0.52	0.56	0.54	0.49	0.35	0.29	0.28	0.42	0.40	0.39	0.39	0.39	0.41
0		0.49																	
1	0.50	1.49																	
2	1.50	2.49																	
3	2.50	3.49																	
4	3.50	4.49	0.40	0.44	0.30	0.39	0.52	0.53	0.55	0.50	0.36	0.32	0.31	0.45	0.46	0.48	0.47	0.46	0.53
5	4.50	5.49	0.38	0.43	0.28	0.37	0.50	0.57	0.51	0.47	0.35	0.30	0.28	0.43	0.43	0.44	0.42	0.42	0.45
6	5.50	6.49	0.36	0.39	0.27	0.35	0.50	0.59	0.56	0.48	0.32	0.28	0.28	0.43	0.41	0.40	0.41	0.37	0.40
7	6.50	7.49	0.34	0.40	0.27	0.33	0.56	0.59	0.47	0.61	0.40	0.28	0.27	0.36	0.34	0.37	0.36	0.35	0.38
8	7.50	8.49	0.32	0.33	0.25	0.31	0.54	0.51	0.53		0.34	0.28	0.26	0.43	0.35	0.33	0.34	0.32	0.34
9	8.50	9.49	0.30	0.27	0.26	0.29		0.52			0.35	0.28	0.23	0.35	0.31	0.31	0.31	0.30	0.33
10	9.50	10.49	0.29	0.30	0.24	0.28					0.22	0.27	0.25	0.36	0.31	0.30	0.31	0.29	0.30
11	10.50	11.49	0.29	0.22	0.23	0.27					0.18	0.26	0.26		0.24	0.32	0.29	0.32	0.31
12	11.50	12.49	0.26	0.31	0.24	0.26						0.25	0.26		0.26	0.26	0.28	0.31	0.25
13	12.50	13.49	0.26	0.19	0.25	0.26						0.27			0.24	0.25	0.22	0.26	0.24
14	13.50	14.49	0.24		0.22	0.25						0.28			0.22	0.23	0.23	0.25	0.20
15	14.50	15.49	0.26		0.22	0.22						0.28			0.18				
16	15.50	16.49	0.31									0.32							
17	16.50	17.49	0.29									0.28							
18	17.50	18.49																	
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Meteo data report - Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Mean + 1.28 x Stddev on turbulence (IEC ed. 3)

21.0m - B1

Bin	Start	End	Mean	0-N	1-NNE	2-NE	3-ENE	4-E	5-ESE	6-SE	7-SSE	8-S	9-SSW	10-SW	11-WSW	12-W	13-WNW	14-NW	15-NNW
Mean			0.37	0.40	0.26	0.36	0.51	0.56	0.56	0.50	0.37	0.31	0.30	0.43	0.41	0.40	0.40	0.39	0.40
0		0.49																	
1	0.50	1.49																	
2	1.50	2.49																	
3	2.50	3.49																	
4	3.50	4.49	0.41	0.44	0.28	0.43	0.52	0.49	0.58	0.48	0.38	0.33	0.33	0.44	0.47	0.47	0.46	0.44	0.53
5	4.50	5.49	0.38	0.42	0.27	0.38	0.50	0.61	0.54	0.49	0.35	0.31	0.30	0.44	0.43	0.44	0.43	0.42	0.44
6	5.50	6.49	0.36	0.41	0.26	0.37	0.51	0.62	0.56	0.52	0.43	0.30	0.31	0.43	0.40	0.40	0.40	0.37	0.38
7	6.50	7.49	0.34	0.39	0.26	0.33	0.50	0.47	0.52	0.66	0.36	0.31	0.28	0.41	0.37	0.35	0.36	0.35	0.38
8	7.50	8.49	0.32	0.36	0.25	0.33	0.55	0.51			0.28	0.30	0.27	0.46	0.33	0.33	0.33	0.33	0.35
9	8.50	9.49	0.31	0.29	0.25	0.29					0.39	0.29	0.23	0.35	0.33	0.32	0.32	0.29	0.35
10	9.50	10.49	0.30	0.30	0.26	0.31					0.19	0.26	0.22		0.26	0.34	0.30	0.28	0.31
11	10.50	11.49	0.28	0.23	0.22	0.25						0.28	0.31		0.27	0.28	0.29	0.32	0.30
12	11.50	12.49	0.28	0.25	0.23	0.30						0.30			0.26	0.25	0.27	0.30	0.25
13	12.50	13.49	0.26	0.27	0.23	0.27						0.29			0.21	0.25		0.25	0.23
14	13.50	14.49	0.28		0.26	0.26						0.33							0.20
15	14.50	15.49	0.30		0.25	0.27						0.32							
16	15.50	16.49	0.24		0.25	0.20													
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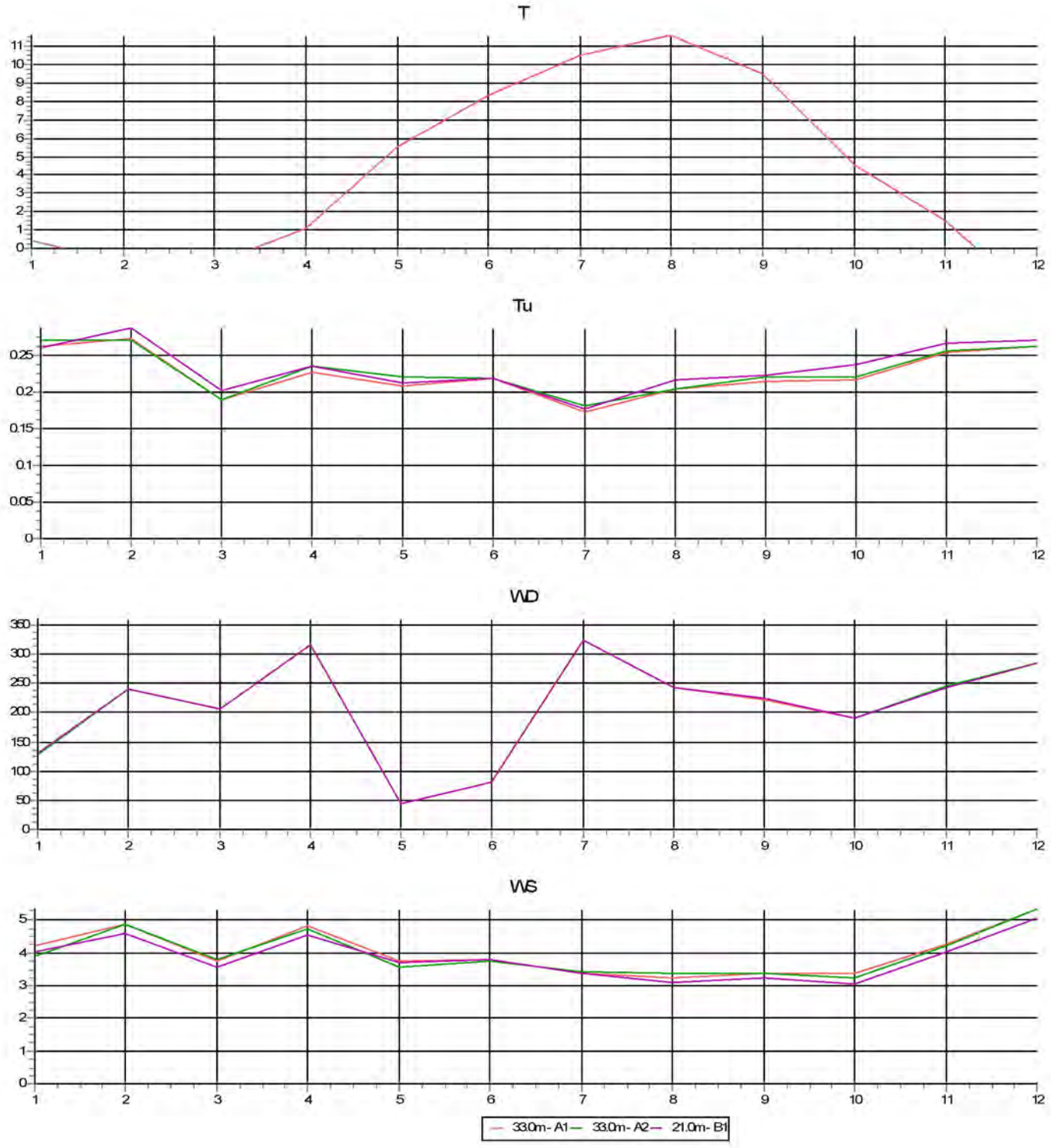
Meteo data report - Monthly graphs aggregated

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)



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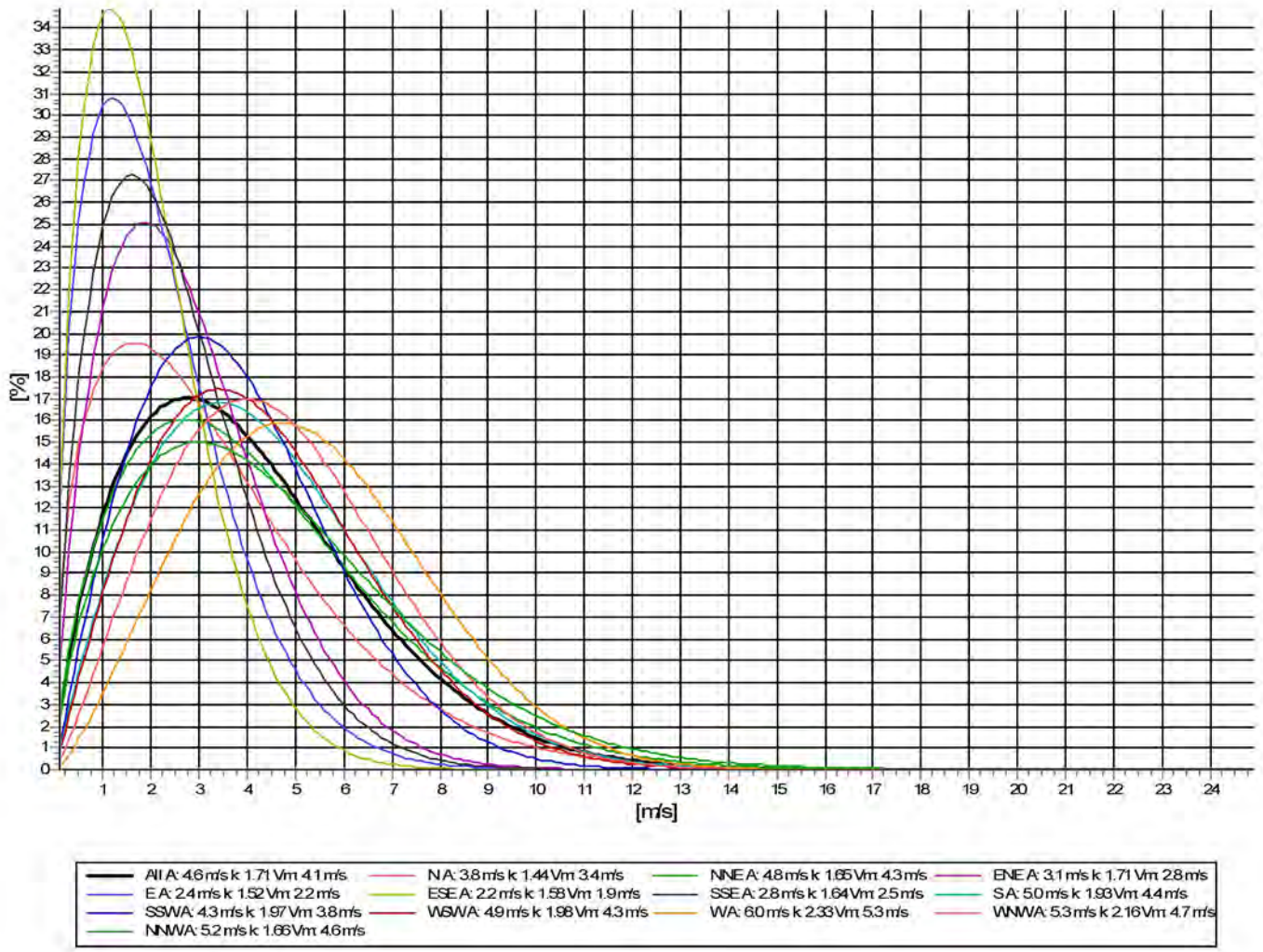
Meteo data report - Weibull data overview

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **33.0m - A1**

Weibull data

Sector	A [m/s]	k	f	Mean wind speed [m/s]
0-N	3.77	1.435	6.64	3.43
1-NNE	4.80	1.648	18.54	4.29
2-ENE	3.12	1.709	4.93	2.78
3-E	2.43	1.518	2.73	2.19
4-ESE	2.17	1.580	2.24	1.95
5-SSE	2.82	1.645	4.35	2.52
6-S	4.98	1.927	23.79	4.42
7-SSW	4.29	1.973	9.13	3.80
8-WSW	4.89	1.984	5.02	4.33
9-W	6.01	2.328	8.05	5.33
10-WNW	5.33	2.161	8.03	4.72
11-NNW	5.16	1.665	6.56	4.61
Mean	**4.60**	**1.707**	**100.00**	**4.10**



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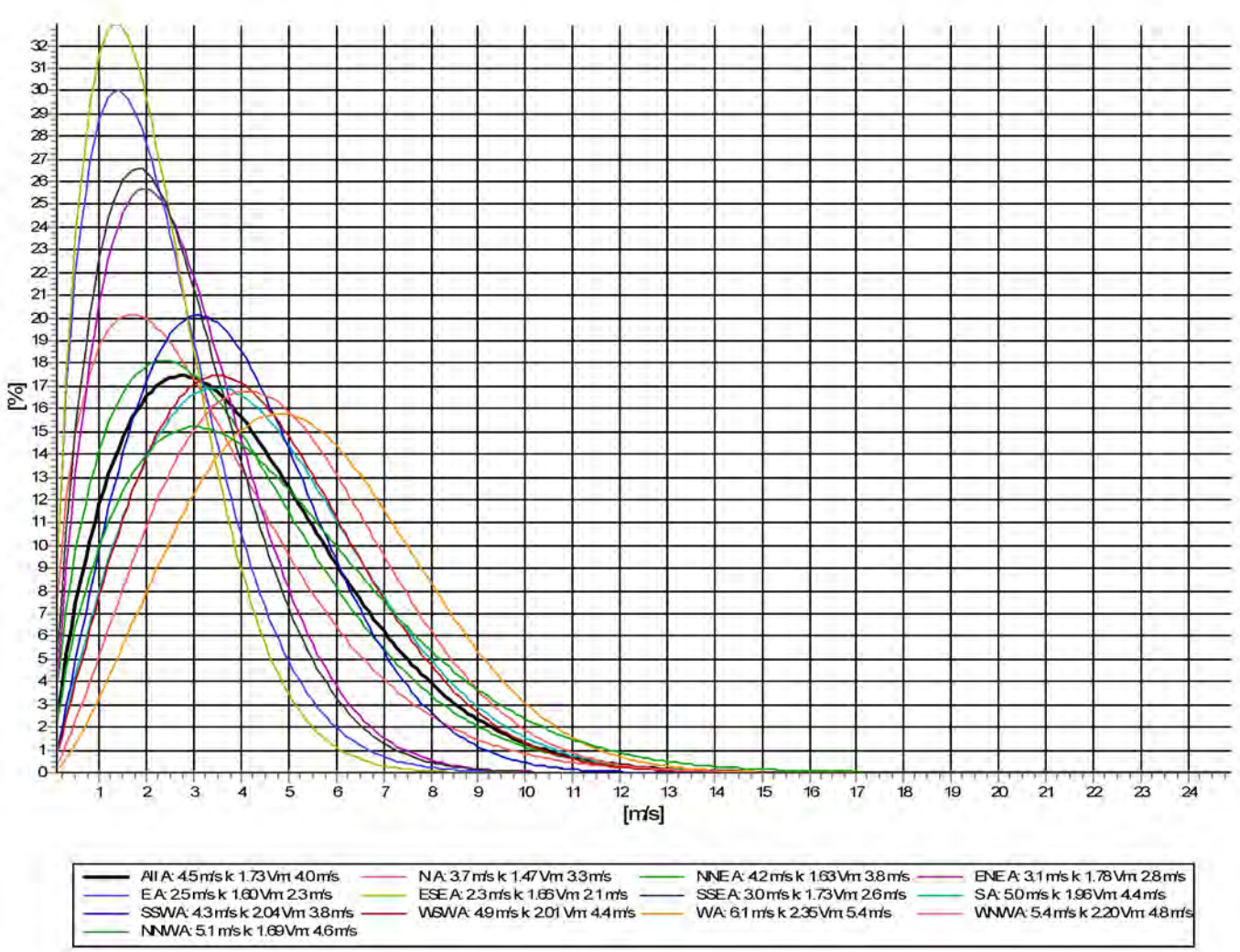
Meteo data report - Weibull data overview

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **33.0m - A2**

Weibull data

Sector	A [m/s]	k	f	Mean wind speed [m/s]
0-N	3.68	1.468	6.71	3.33
1-NNE	4.23	1.626	18.54	3.79
2-ENE	3.11	1.780	4.92	2.77
3-E	2.54	1.604	2.74	2.28
4-ESE	2.35	1.663	2.24	2.10
5-SSE	2.97	1.733	4.36	2.65
6-S	4.99	1.957	23.77	4.43
7-SSW	4.32	2.036	9.12	3.82
8-WSW	4.93	2.010	5.01	4.37
9-W	6.09	2.348	8.03	5.40
10-WNW	5.45	2.195	8.01	4.83
11-NNW	5.13	1.693	6.55	4.58
Mean	**4.52**	**1.733**	**100.00**	**4.03**



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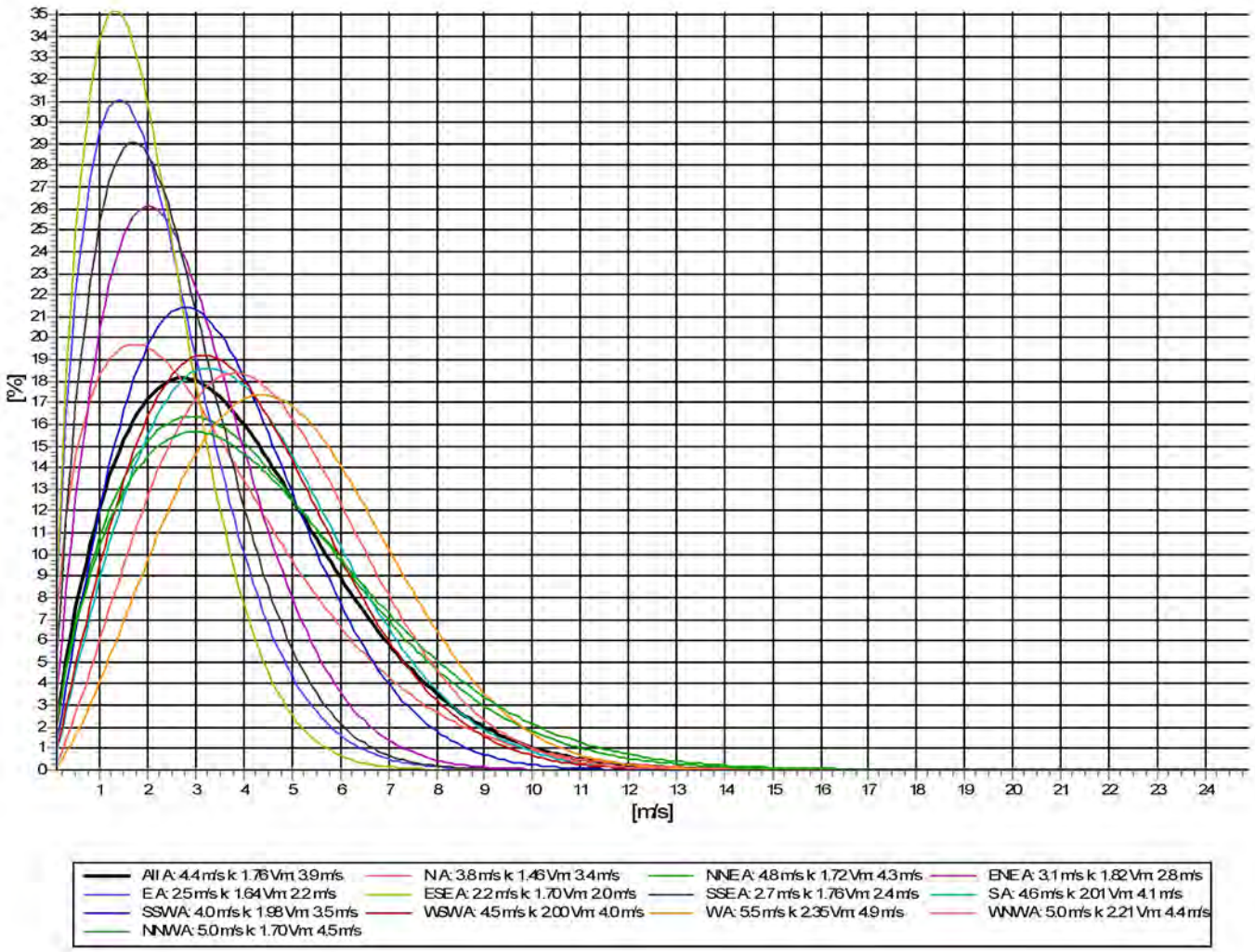
Meteo data report - Weibull data overview

Mast: CLG Met-Data - GOOD; CLG_MET_GOOD**Period:** Full period: 8/29/2010 - 10/3/2011 (13.1 months)

Height: **21.0m - B1**

Weibull data

Sector	A [m/s]	k	f	Mean wind speed [m/s]
0-N	3.75	1.463	6.57	3.40
1-NNE	4.80	1.719	18.55	4.28
2-ENE	3.10	1.823	4.94	2.76
3-E	2.48	1.642	2.75	2.22
4-ESE	2.22	1.698	2.25	1.98
5-SSE	2.73	1.757	4.38	2.43
6-S	4.62	2.006	23.77	4.09
7-SSW	3.97	1.975	9.10	3.52
8-WSW	4.47	2.000	5.02	3.96
9-W	5.54	2.351	8.06	4.91
10-WNW	5.01	2.215	8.04	4.44
11-NNW	4.99	1.696	6.57	4.45
Mean	**4.38**	**1.759**	**100.00**	**3.90**



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Appendix B
Measure Correlate Predict: Correlation Between Tower Data and PAJC AWOS Station

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MCP - Measure data - overview

Calculation: MCP CLG_TWR to CLK_TWR

Meteo data objects

1: Local measurements (site data): A1A2 Merged - GOOD.33.0m - A1A2
First date: 8/29/2010
Last date: 10/3/2011
Time step: 10 min
Data points: 57556
Enabled: 100.0 %
Mean wind speed: 4.02 m/s
Time Series Data: Yes

2: Long term reference: Chignik Lake Tower Data.28.0m - A1A2
First date: 11/1/2009
Last date: 3/16/2011
Time step: 10 min
Data points: 72006
Enabled: 100.0 %
Mean wind speed: 6.81 m/s
Time Series Data: Yes

Project:
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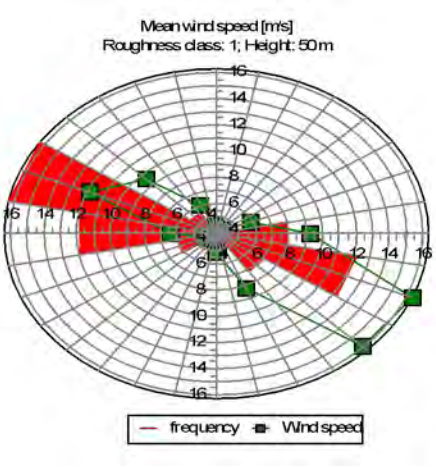
MCP - Detailed Statgen

Calculation: MCP CLG_TWR to CLK_TWR

Name
A1A2 Merged - GOOD (Regression MCP using Chignik Lake Tower Data)
Source
USER
Country
United States
Site Coordinates
UTM WGS 84 Zone: 4 East: 527,445 North: 6,238,893
Comments
From MCP

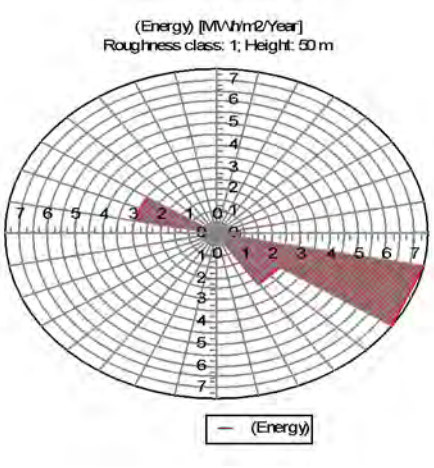
Mean wind speed [m/s]

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	11.05	7.99	6.94	5.43
25.0	12.03	9.35	8.40	7.03
50.0	12.80	10.48	9.59	8.30
100.0	13.63	11.78	10.93	9.65
200.0	14.60	13.45	12.57	11.18



Wind energy [kWh/m2/Year]

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	16,842	8,032	5,435	2,643
25.0	19,992	11,766	8,980	5,531
50.0	22,453	14,971	12,162	8,563
100.0	25,293	18,684	15,863	12,156
200.0	28,760	24,124	20,979	16,635



WTG energy [kWh/m2/Year]

Normal rated WTG (0.45 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	2,072	1,387	1,060	589
25.0	2,154	1,757	1,502	1,089
50.0	2,154	1,990	1,817	1,473
100.0	2,154	2,135	2,057	1,833
200.0	2,154	2,154	2,154	2,083

High wind rated WTG (0.55 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	2,361	1,545	1,137	608
25.0	2,460	1,984	1,682	1,171
50.0	2,460	2,264	2,057	1,647
100.0	2,460	2,437	2,344	2,076
200.0	2,460	2,460	2,460	2,374

Low wind rated WTG (0.35 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	1,822	1,247	973	562
25.0	1,904	1,507	1,318	997
50.0	1,904	1,740	1,567	1,300
100.0	1,904	1,885	1,807	1,583
200.0	1,904	1,904	1,904	1,833

Key numbers

Wind energy is relative to 3300 kWh/m2/year for roughness class 1 and 50 m hub height
WTG energy is relative to 1025 kWh/m2/year for roughness class 1 and 50 m hub height

Name	Distance [km]	Wind energy [%]	WTG energy [%]
Current wind statistic		453.7	194.1
A1A2 Merged - GOOD (Regression MCP using Chignik Airport)	0.0	407.0	195.8
Myles's Tower (Regression MCP using Chignik Airport)	8.8	60.6	66.0
Chignik Airport - PAJC 10.00 m	11.5	237.3	162.9
Chignik Lake Tower Data (Regression MCP using Chignik Airport)	11.5	300.4	191.1

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MCP -

Calculation: MCP CLG_TWR to CLK_TWR

1: Local measurements (site data)	A1A2 Merged - GOOD
Height	33.00 m
Period	8/29/2010 to 10/3/2011 1.1 years
Mean wind speed	4.02 m/s
Filters used	Not Filtered
2: Long term reference	Chignik Lake Tower Data
Height	28.00 m
Period	11/1/2009 to 3/16/2011 1.4 years
Mean wind speed	6.81 m/s
Filters used	Not Filtered

Calculation setup

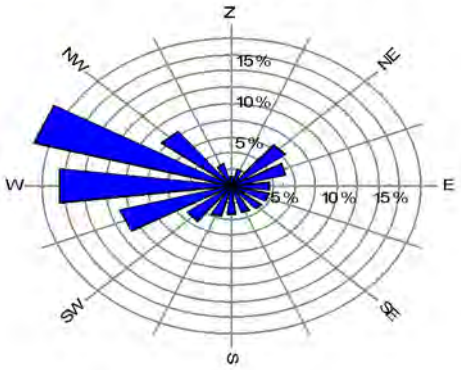
Method	Find transfer function for each sector
Number of sectors	16
Skip angle differences larger than	30.00
Skip wind speeds less than	3.00
Regression model (wind speed)	Linear (1st order polynomial)
Regression model (wind direction)	Constant (0th order polynomial)
Wind speed model - use residual resampling	Yes
Wind direction model - use residual resampling	Yes

Results

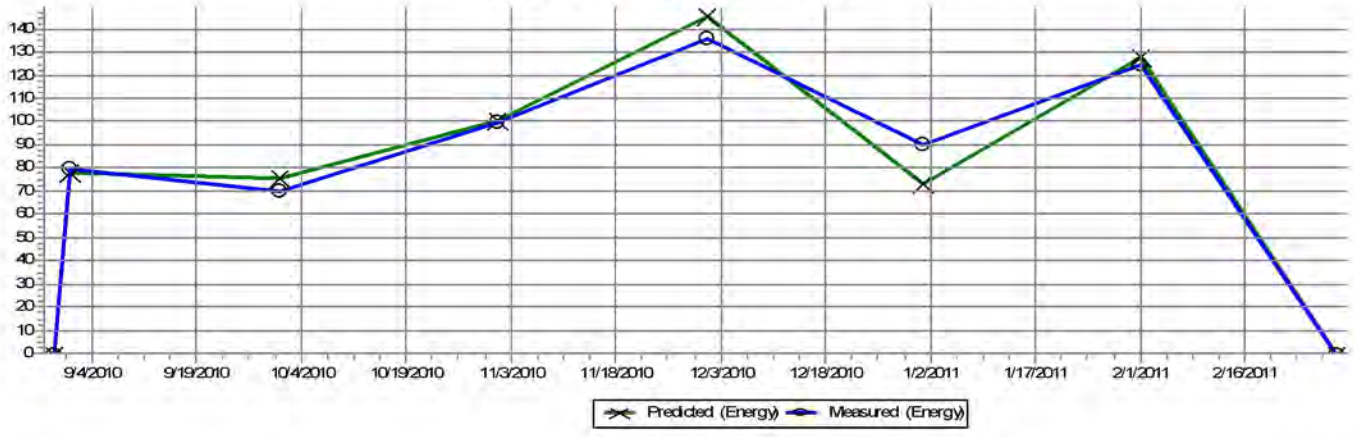
Measure height a.g.l.	33.0 m
Mean wind in measure height	4.05 m/s
Key height a.g.l.	37.0 m
Mean wind in key height	4.39 m/s
Wind energy	453.7
WTG energy	194.1
r - wind speed	0.4540
s - wind speed	1.7580 m/s
r - wind index	0.9600
s - wind index	9.5128 %
Time of calculation	10/21/2011 8:41 AM

Expected long term WTG energy direction distribution AT SITE

Hub height: 37.0



Comparing measured and predicted data



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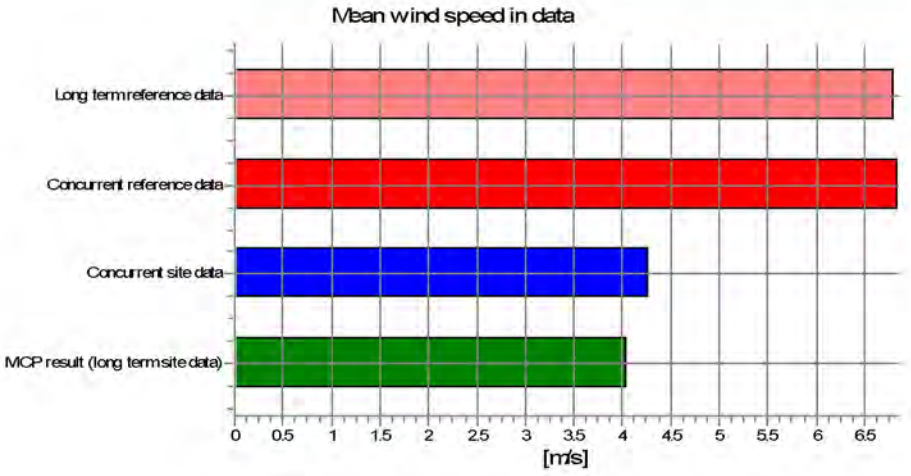
MCP - Regression MCP report (basic/overview)

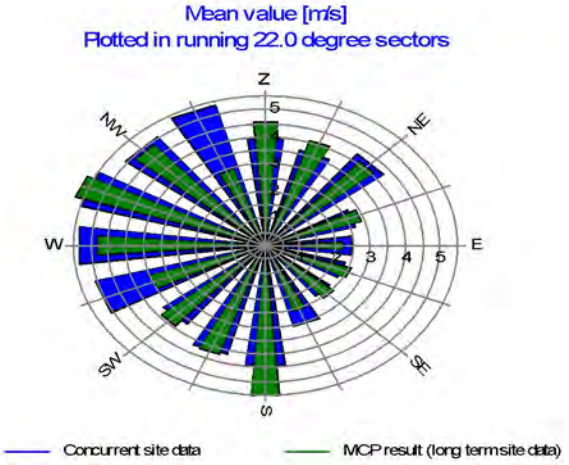
Calculation: MCP CLG_TWR to CLK_TWR

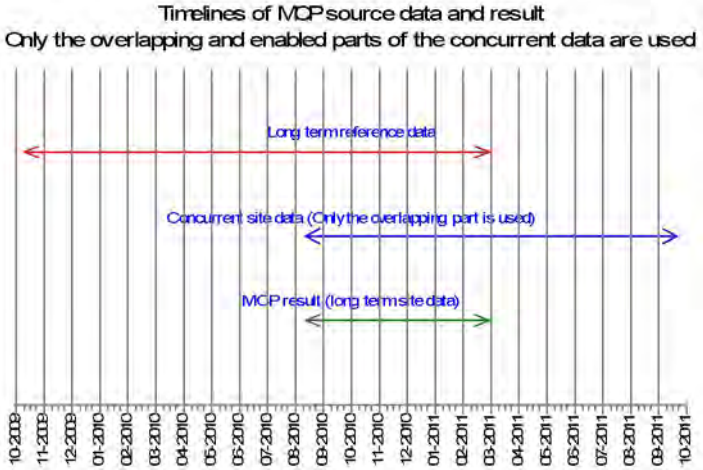
MCP method used:
Regression MCP

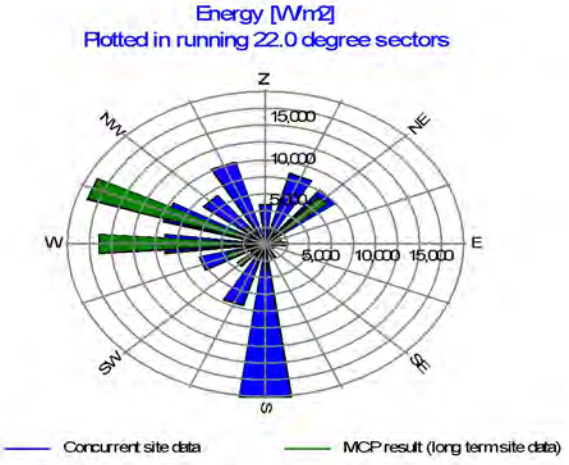
Long term reference data:
Chignik Lake Tower Data
Height: 28.00

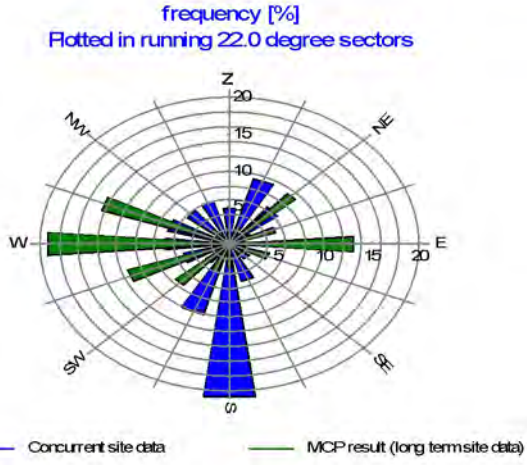
Concurrent site data:
A1A2 Merged - GOOD
Height: 33.00











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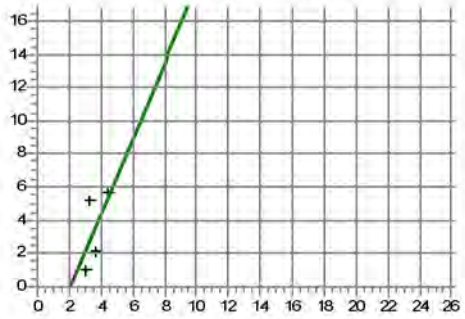
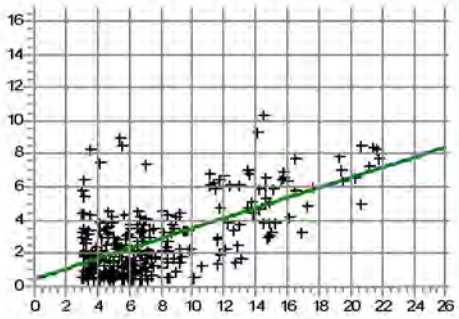
MCP - Regression MCP report - details on wind speed fit

Calculation: MCP CLG_TWR to CLK_TWR

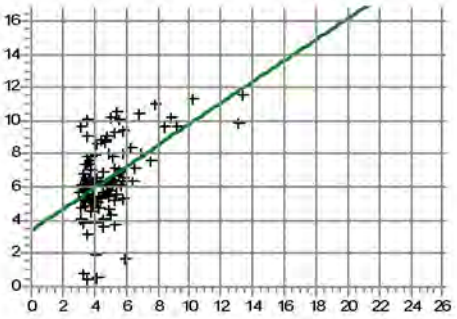
Winds in sector 0 degrees



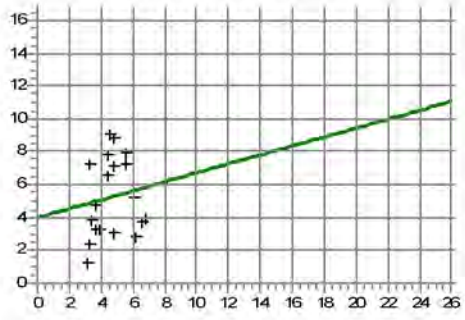
Winds in sector 90 degrees



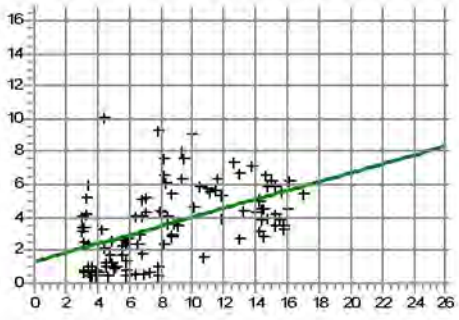
Winds in sector 180 degrees



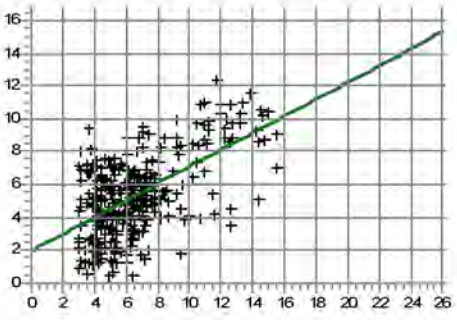
Winds in sector 22.5 degrees



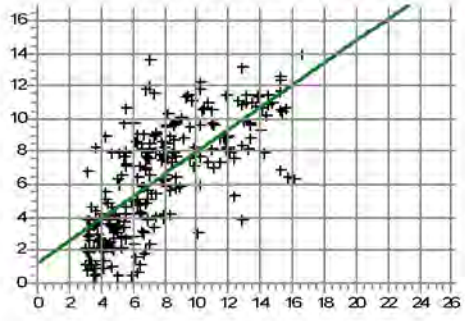
Winds in sector 112.5 degrees



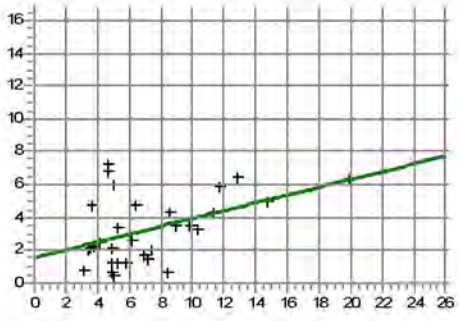
Winds in sector 202.5 degrees



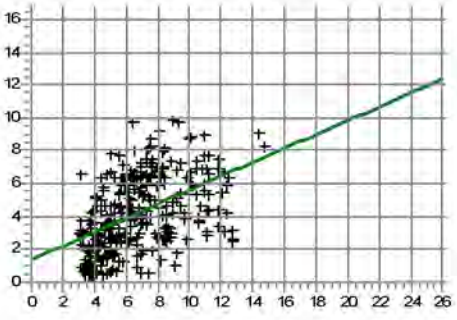
Winds in sector 45 degrees



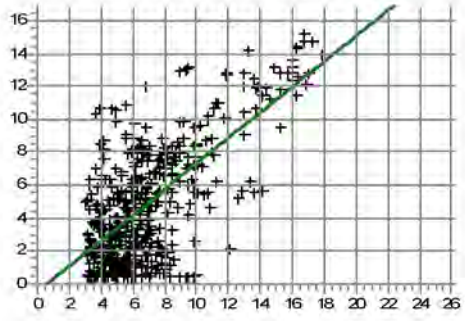
Winds in sector 135 degrees



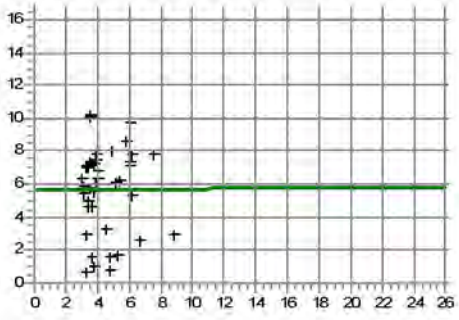
Winds in sector 225 degrees



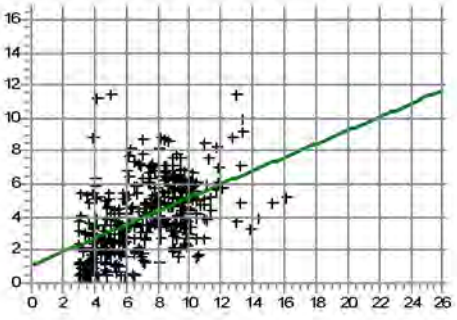
Winds in sector 67.5 degrees



Winds in sector 157.5 degrees



Winds in sector 247.5 degrees



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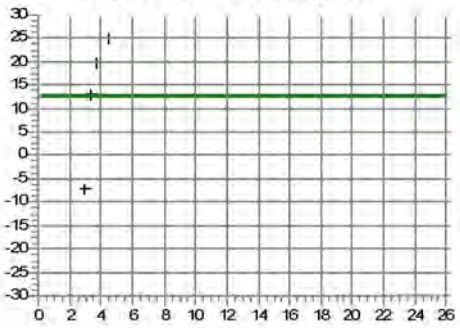
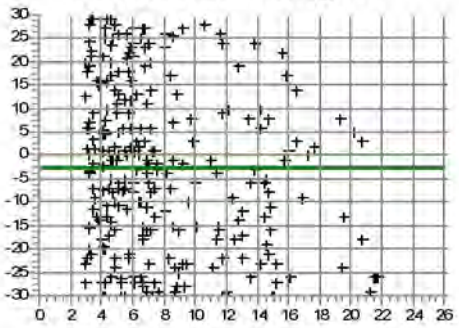
MCP - Regression MCP report - details on wind veer fit

Calculation: MCP CLG_TWR to CLK_TWR

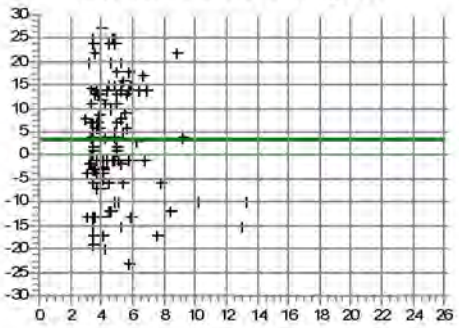
Wind veer in sector 0 degrees



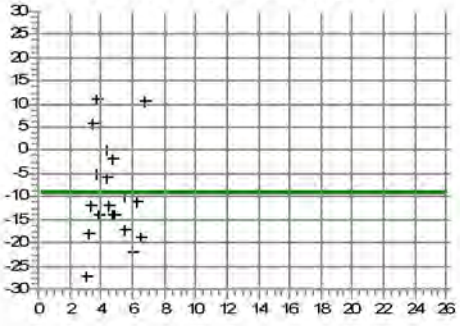
Wind veer in sector 90 degrees



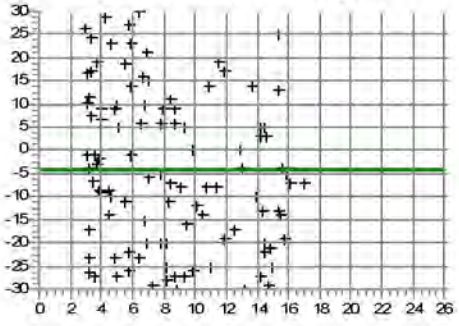
Wind veer in sector 180 degrees



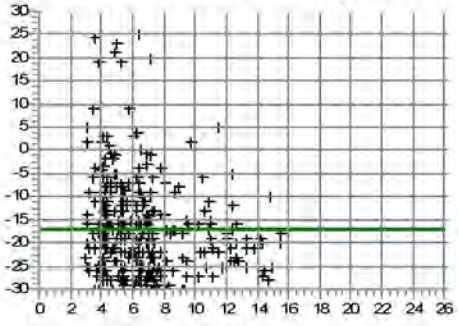
Wind veer in sector 22.5 degrees



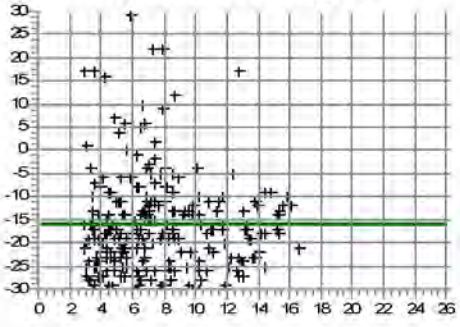
Wind veer in sector 112.5 degrees



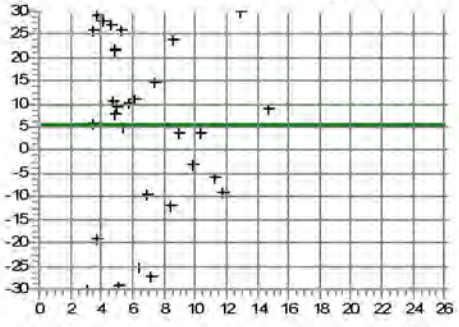
Wind veer in sector 202.5 degrees



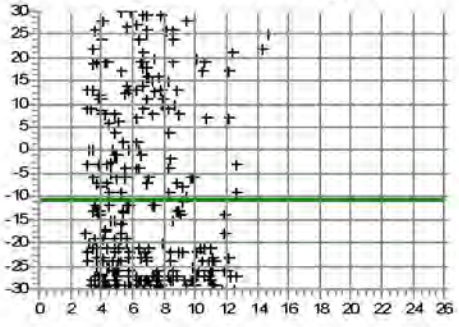
Wind veer in sector 45 degrees



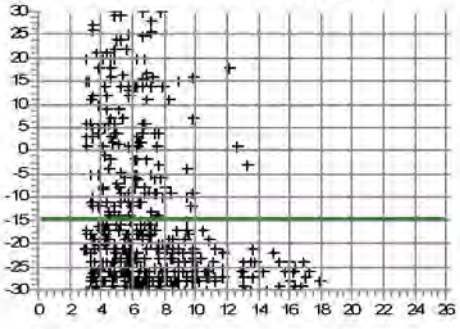
Wind veer in sector 135 degrees



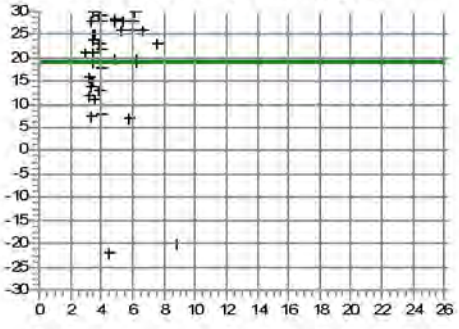
Wind veer in sector 225 degrees



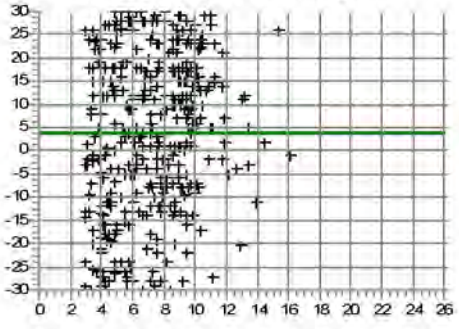
Wind veer in sector 67.5 degrees



Wind veer in sector 157.5 degrees



Wind veer in sector 247.5 degrees



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MCP - Measure data - overview

Calculation: MCP CLK to PAJC

Meteo data objects

1: Local measurements (site data): Chignik Lake Tower Data.28.0m - A1A2
First date: 11/1/2009
Last date: 3/16/2011
Time step: 10 min
Data points: 72006
Enabled: 100.0 %
Mean wind speed: 6.81 m/s
Time Series Data: Yes

2: Long term reference: Chignik Airport.10.0m - PAJC
First date: 2/25/1998
Last date: 10/10/2011
Time step: 20 min
Data points: 230457
Enabled: 100.0 %
Mean wind speed: 5.21 m/s
Time Series Data: Yes

Filter values

Filter for site data
Averaging time: 20 min

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MCP - Detailed Statgen

Calculation: MCP CLK to PAJC

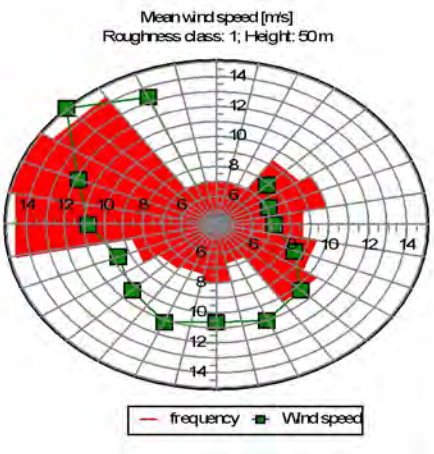
Name
Chignik Lake Tower Data (Regression MCP using Chignik Airport)
Source
USER
Country
United States
Site Coordinates
UTM WGS 84 Zone: 4 East: 516,816 North: 6,234,342
Comments
From MCP

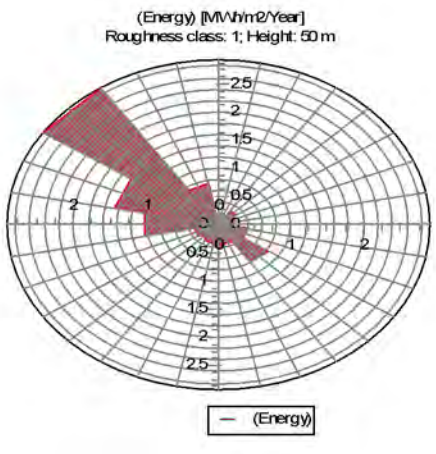
Mean wind speed [m/s]

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	10.84	7.78	6.76	5.31
25.0	11.81	9.12	8.21	6.89
50.0	12.58	10.26	9.39	8.15
100.0	13.43	11.62	10.76	9.54
200.0	14.45	13.41	12.46	11.14

Wind energy [kWh/m2/Year]

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	11,738	4,589	3,021	1,460
25.0	15,021	7,223	5,274	3,125
50.0	17,925	9,913	7,659	5,042
100.0	21,727	13,694	10,955	7,739
200.0	26,987	20,615	16,638	11,990





WTG energy [kWh/m2/Year]

Normal rated WTG (0.45 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	2,044	1,321	1,005	553
25.0	2,137	1,700	1,448	1,044
50.0	2,154	1,958	1,768	1,432
100.0	2,154	2,121	2,031	1,805
200.0	2,154	2,154	2,154	2,079

High wind rated WTG (0.55 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	2,328	1,463	1,073	569
25.0	2,440	1,916	1,618	1,118
50.0	2,460	2,226	1,998	1,600
100.0	2,460	2,420	2,313	2,042
200.0	2,460	2,460	2,460	2,370

Low wind rated WTG (0.35 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	1,794	1,192	924	531
25.0	1,887	1,450	1,285	959
50.0	1,904	1,708	1,518	1,276
100.0	1,904	1,871	1,781	1,555
200.0	1,904	1,904	1,904	1,829

Key numbers

Wind energy is relative to 3300 kWh/m2/year for roughness class 1 and 50 m hub height
WTG energy is relative to 1025 kWh/m2/year for roughness class 1 and 50 m hub height

Name	Distance [km]	Wind energy [%]	WTG energy [%]
Current wind statistic		300.4	191.1
A1A2 Merged - GOOD (Regression MCP using Chignik Airport)	11.5	407.0	195.8
A1A2 Merged - GOOD (Regression MCP using Chignik Lake Tower Data)	11.5	453.7	194.1
Myles's Tower (Regression MCP using Chignik Airport)	20.2	60.6	66.0
Chignik Airport - PAJC 10.00 m	22.9	237.3	162.9

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MCP -

Calculation: MCP CLK to PAJC

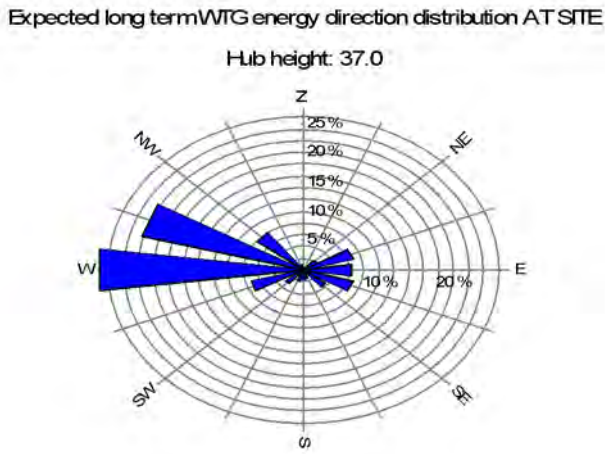
1: Local measurements (site data)	Chignik Lake Tower Data
Height	28.00 m
Period	11/1/2009 to 3/16/2011 1.4 years
Mean wind speed	6.78 m/s
Filters used	(Averaging)
2: Long term reference	Chignik Airport
Height	10.00 m
Period	2/25/1998 to 10/10/2011 13.6 years
Mean wind speed	5.21 m/s
Filters used	Not Filtered

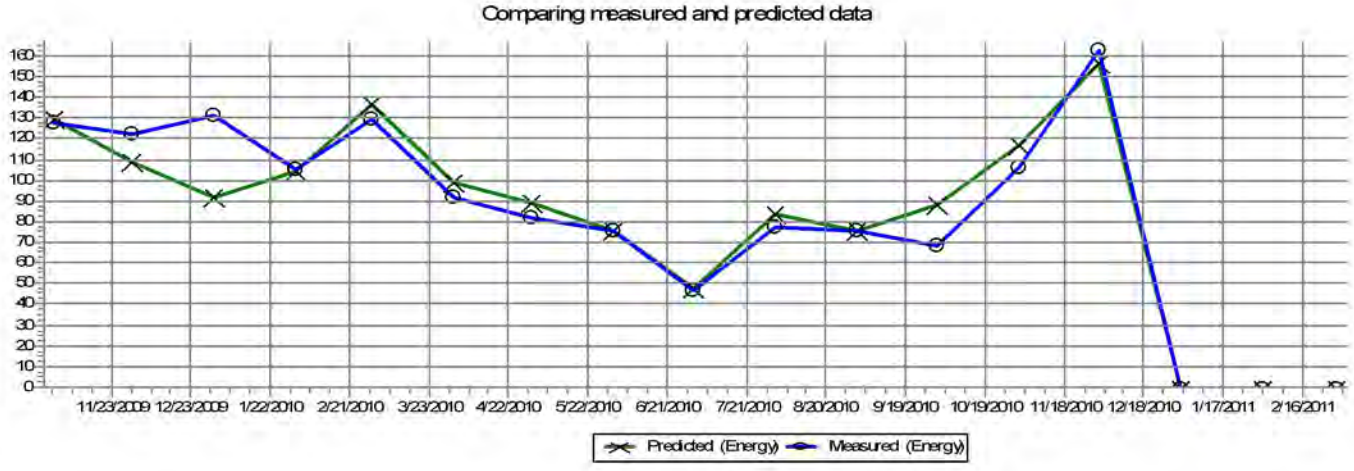
Calculation setup

Method	Find transfer function for each sector
Number of sectors	16
Skip angle differences larger than	30.00
Skip wind speeds less than	3.00
Regression model (wind speed)	Linear (1st order polynomial)
Regression model (wind direction)	Constant (0th order polynomial)
Wind speed model - use residual resampling	Yes
Wind direction model - use residual resampling	Yes

Results

Measure height a.g.l.	28.0 m
Mean wind in measure height	7.02 m/s
Key height a.g.l.	37.0 m
Mean wind in key height	7.56 m/s
Wind energy	300.4
WTG energy	191.1
r - wind speed	0.6645
s - wind speed	2.4949 m/s
r - wind index	0.9016
s - wind index	12.6905 %
Time of calculation	10/21/2011 8:45 AM





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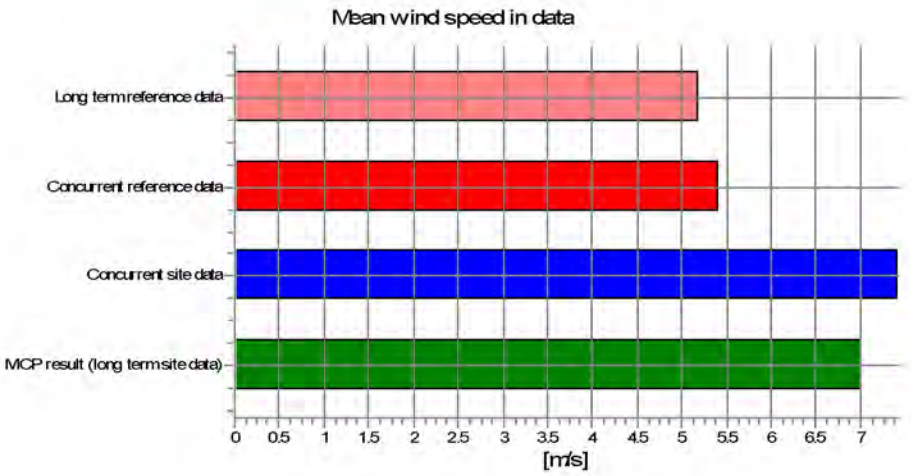
MCP - Regression MCP report (basic/overview)

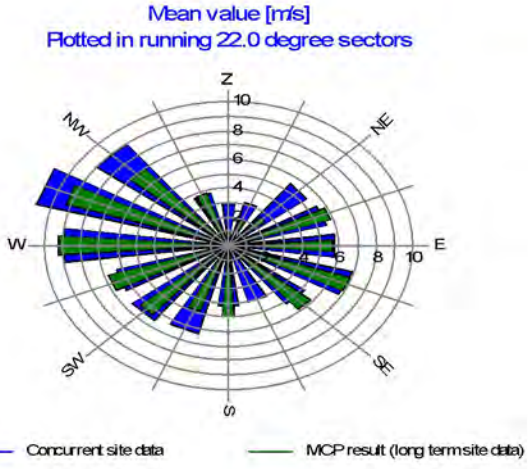
Calculation: MCP CLK to PAJC

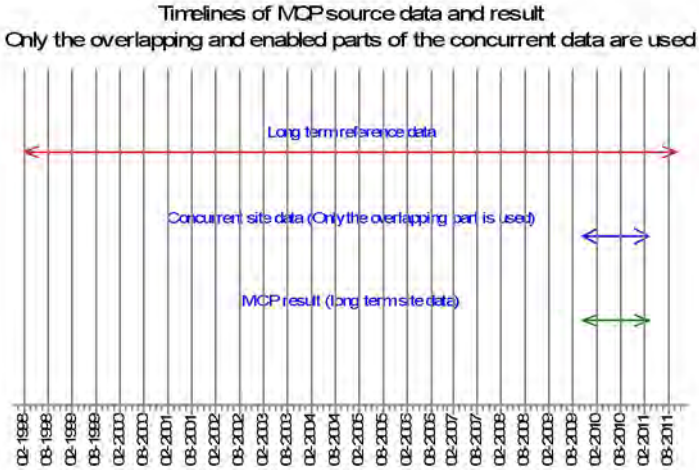
MCP method used:
Regression MCP

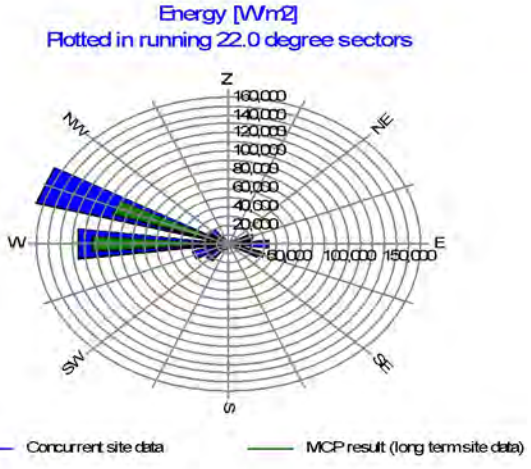
Long term reference data:
Chignik Airport
Height: 10.00

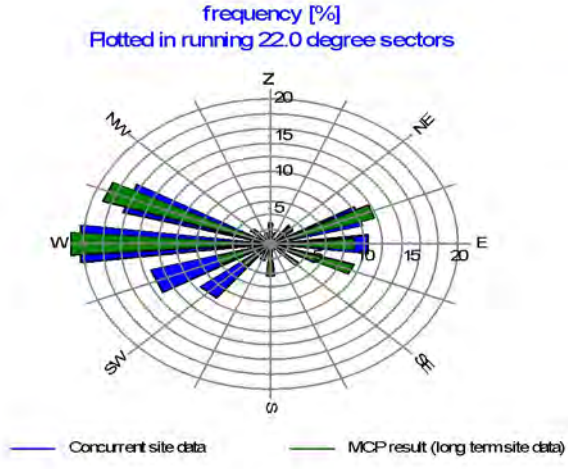
Concurrent site data:
Chignik Lake Tower Data
Height: 28.00











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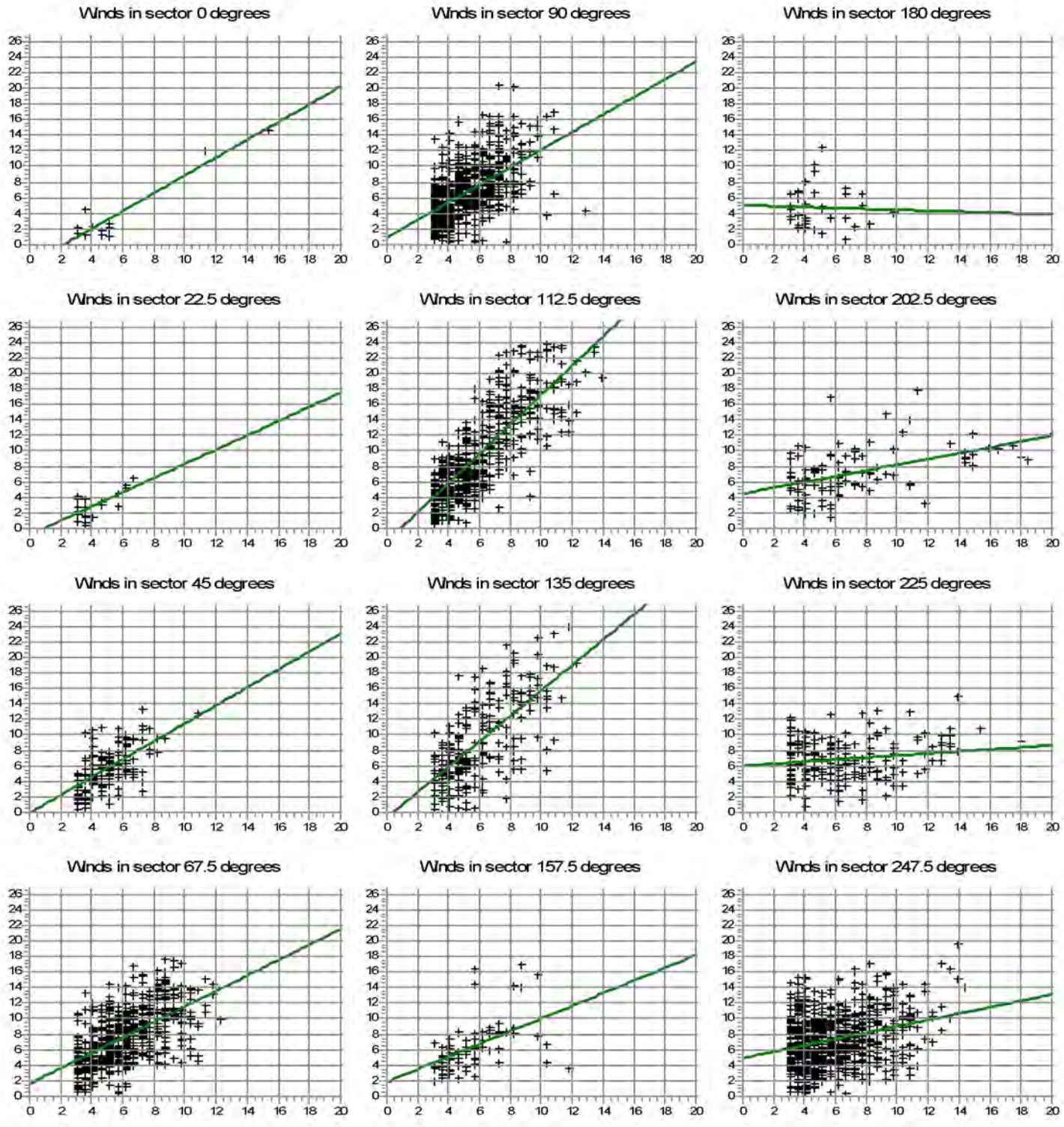
MCP - Regression MCP report - details on wind speed fit

Calculation: MCP CLK to PAJC



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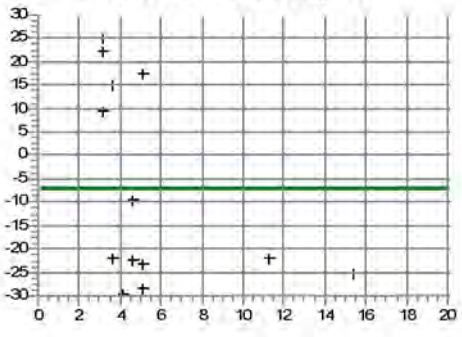
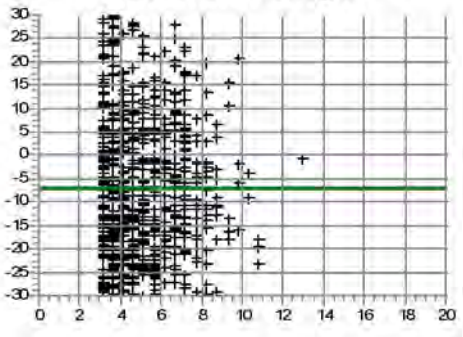
MCP - Regression MCP report - details on wind veer fit

Calculation: MCP CLK to PAJC

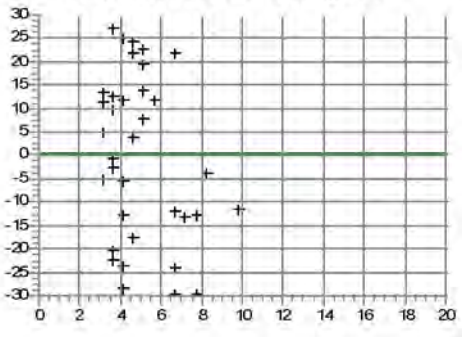
Wind veer in sector 0 degrees



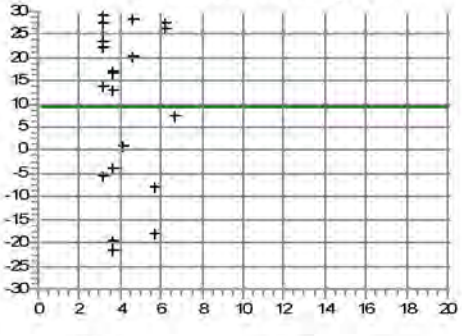
Wind veer in sector 90 degrees



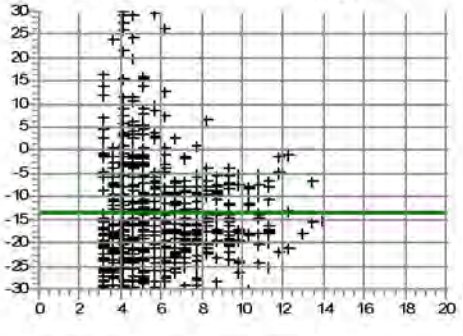
Wind veer in sector 180 degrees



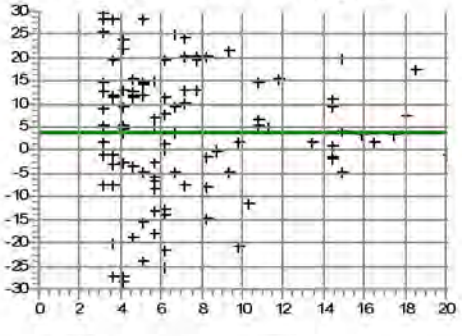
Wind veer in sector 22.5 degrees



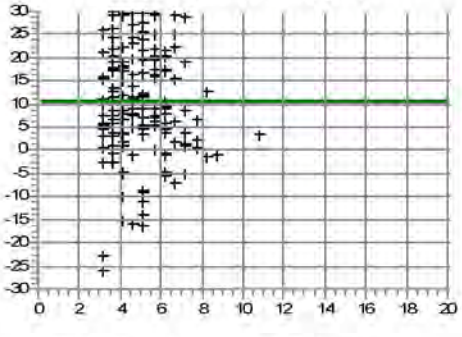
Wind veer in sector 112.5 degrees



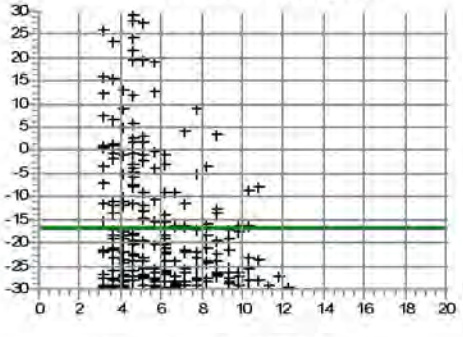
Wind veer in sector 202.5 degrees



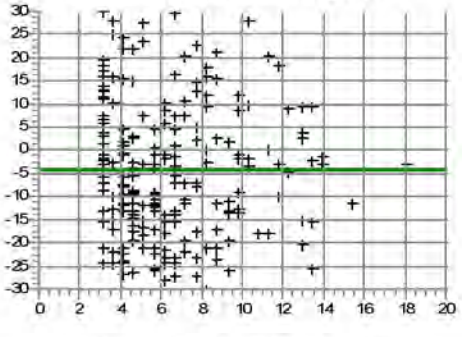
Wind veer in sector 45 degrees



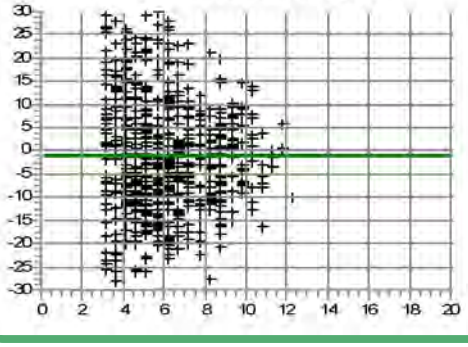
Wind veer in sector 135 degrees



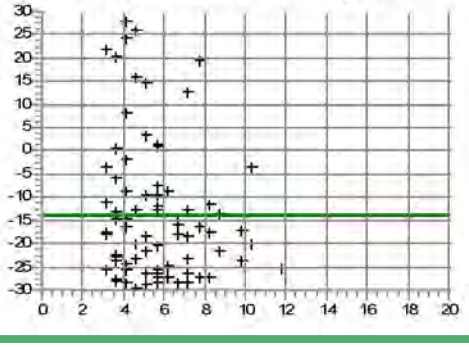
Wind veer in sector 225 degrees



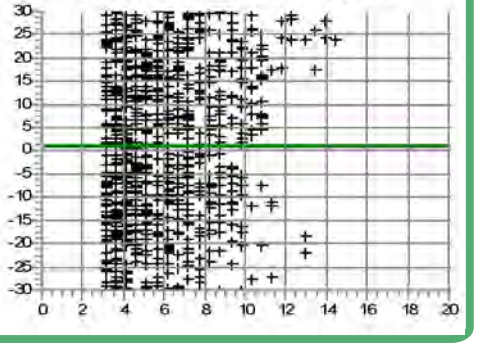
Wind veer in sector 67.5 degrees



Wind veer in sector 157.5 degrees



Wind veer in sector 247.5 degrees



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MCP - Measure data - overview

Calculation: MCP CLG to PAJC

Meteo data objects

1: Local measurements (site data): A1A2 Merged - GOOD.33.0m - A1A2
First date: 8/29/2010
Last date: 10/3/2011
Time step: 10 min
Data points: 57556
Enabled: 100.0 %
Mean wind speed: 4.02 m/s
Time Series Data: Yes

2: Long term reference: Chignik Airport.10.0m - PAJC
First date: 2/25/1998
Last date: 10/10/2011
Time step: 20 min
Data points: 230457
Enabled: 100.0 %
Mean wind speed: 5.21 m/s
Time Series Data: Yes

Filter values

Filter for site data
Averaging time: 20 min

Project:
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Calculated:
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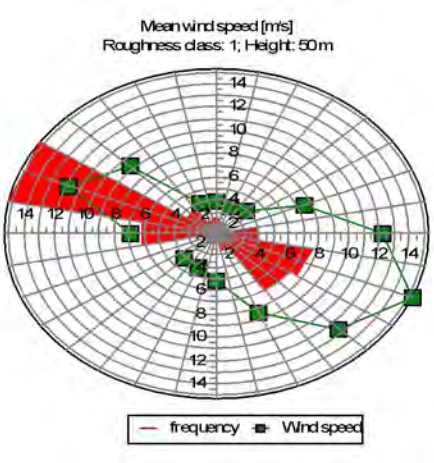
MCP - Detailed Statgen

Calculation: MCP CLG to PAJC

Name
A1A2 Merged - GOOD (Regression MCP using Chignik Airport)
Source
USER
Country
United States
Site Coordinates
UTM WGS 84 Zone: 4 East: 527,445 North: 6,238,893
Comments
From MCP

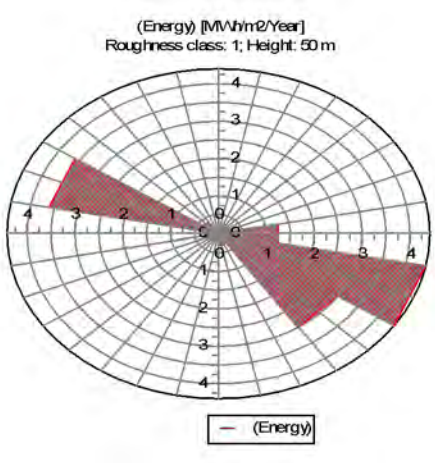
Mean wind speed [m/s]

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	11.24	8.09	7.03	5.52
25.0	12.22	9.46	8.50	7.14
50.0	13.01	10.59	9.70	8.43
100.0	13.86	11.89	11.03	9.80
200.0	14.83	13.53	12.63	11.34



Wind energy [kWh/m2/Year]

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	15,844	6,428	4,218	2,032
25.0	19,829	9,982	7,299	4,317
50.0	23,098	13,430	10,450	6,912
100.0	26,903	17,772	14,507	10,396
200.0	31,521	24,401	20,438	15,302



WTG energy [kWh/m2/Year]

Normal rated WTG (0.45 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	2,088	1,416	1,088	617
25.0	2,154	1,786	1,531	1,125
50.0	2,154	2,007	1,844	1,510
100.0	2,154	2,145	2,070	1,870
200.0	2,154	2,154	2,154	2,096

High wind rated WTG (0.55 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	2,381	1,581	1,170	637
25.0	2,460	2,019	1,716	1,216
50.0	2,460	2,284	2,089	1,691
100.0	2,460	2,449	2,359	2,120
200.0	2,460	2,460	2,460	2,391

Low wind rated WTG (0.35 kW/m2)

Height	Roughness class/Length			
[m]	0 0.00 m	1 0.03 m	2 0.10 m	3 0.40 m
10.0	1,838	1,266	997	586
25.0	1,904	1,536	1,336	1,028
50.0	1,904	1,757	1,594	1,323
100.0	1,904	1,895	1,820	1,620
200.0	1,904	1,904	1,904	1,846

Key numbers

Wind energy is relative to 3300 kWh/m2/year for roughness class 1 and 50 m hub height
WTG energy is relative to 1025 kWh/m2/year for roughness class 1 and 50 m hub height

Name	Distance [km]	Wind energy [%]	WTG energy [%]
Current wind statistic		407.0	195.8
A1A2 Merged - GOOD (Regression MCP using Chignik Lake Tower Data)	0.0	453.7	194.1
Myles's Tower (Regression MCP using Chignik Airport)	8.8	60.6	66.0
Chignik Airport - PAJC 10.00 m	11.5	237.3	162.9
Chignik Lake Tower Data (Regression MCP using Chignik Airport)	11.5	300.4	191.1

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Calculated:
10/21/2011 8:48 AM/2.7.486

MCP -

Calculation: MCP CLG to PAJC

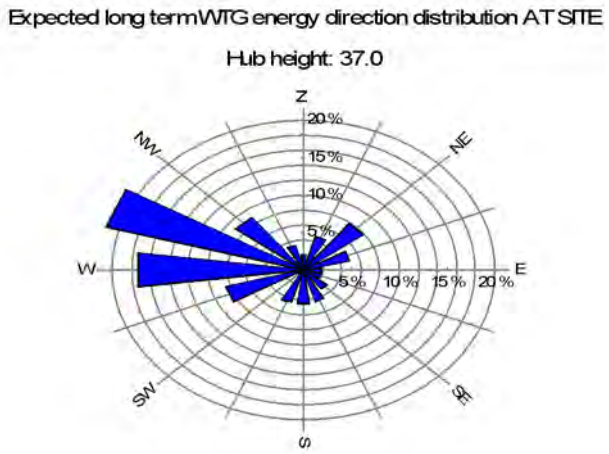
1: Local measurements (site data)	A1A2 Merged - GOOD
Height	33.00 m
Period	8/29/2010 to 10/3/2011 1.1 years
Mean wind speed	3.98 m/s
Filters used	(Averaging)
2: Long term reference	Chignik Airport
Height	10.00 m
Period	2/25/1998 to 10/10/2011 13.6 years
Mean wind speed	5.21 m/s
Filters used	Not Filtered

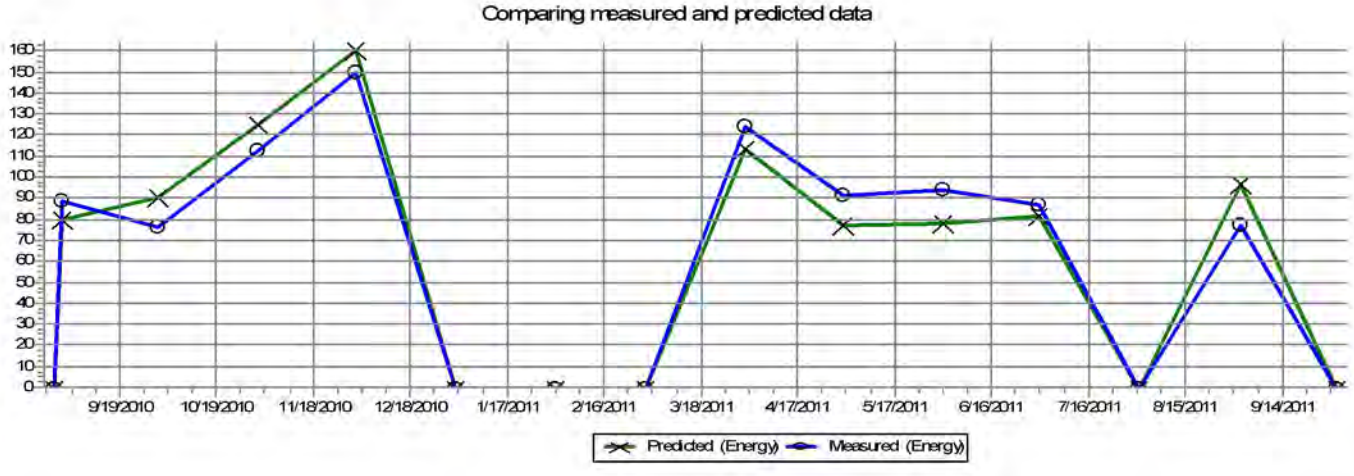
Calculation setup

Method	Find transfer function for each sector
Number of sectors	16
Skip angle differences larger than	30.00
Skip wind speeds less than	3.00
Regression model (wind speed)	Linear (1st order polynomial)
Regression model (wind direction)	Constant (0th order polynomial)
Wind speed model - use residual resampling	Yes
Wind direction model - use residual resampling	Yes

Results

Measure height a.g.l.	33.0 m
Mean wind in measure height	4.07 m/s
Key height a.g.l.	37.0 m
Mean wind in key height	4.36 m/s
Wind energy	407.0
WTG energy	195.8
r - wind speed	0.4677
s - wind speed	1.5427 m/s
r - wind index	0.8686
s - wind index	14.8905 %
Time of calculation	10/21/2011 8:48 AM





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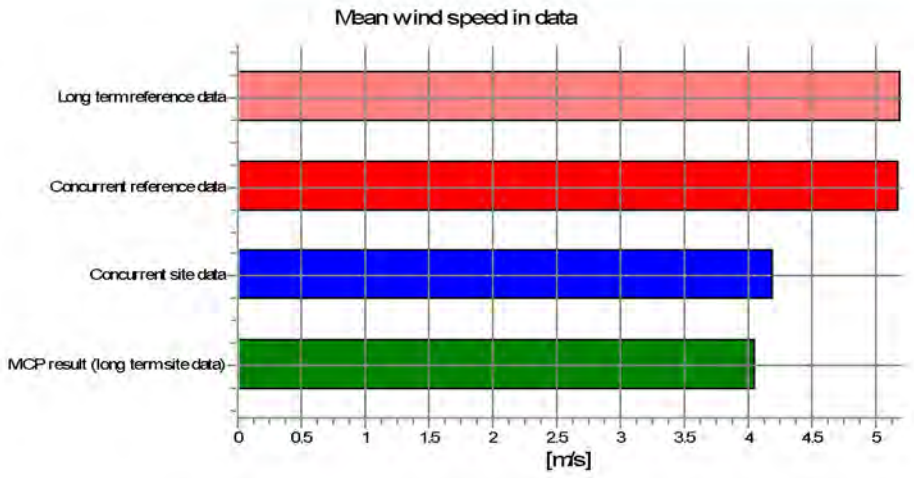
MCP - Regression MCP report (basic/overview)

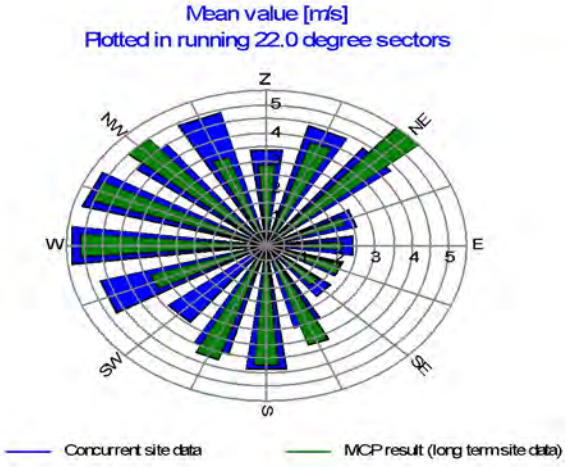
Calculation: MCP CLG to PAJC

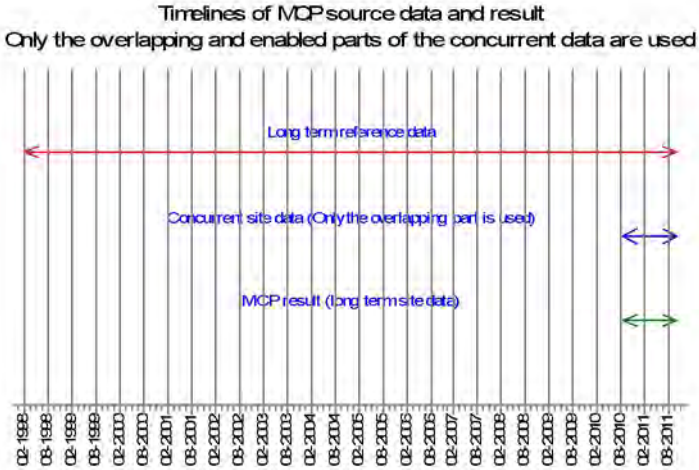
MCP method used:
Regression MCP

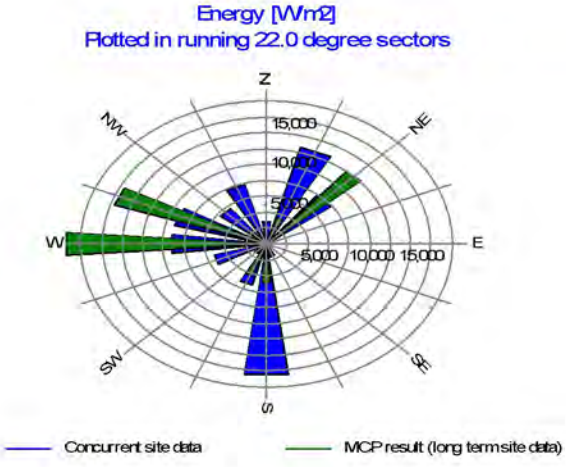
Long term reference data:
Chignik Airport
Height: 10.00

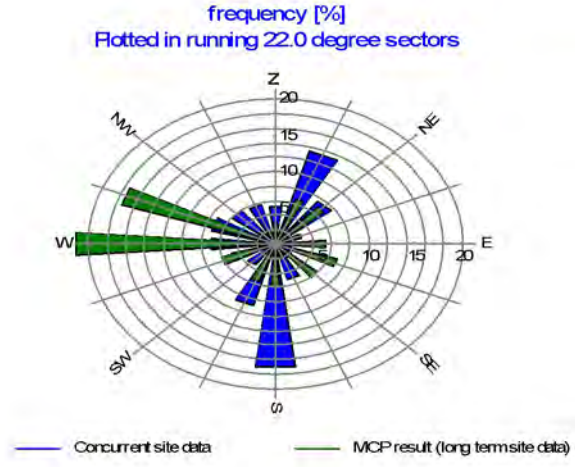
Concurrent site data:
A1A2 Merged - GOOD
Height: 33.00











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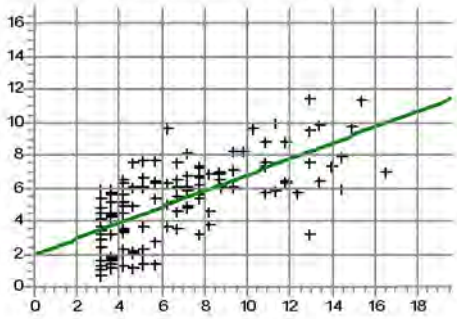
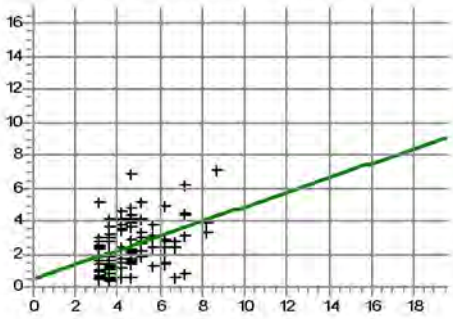
MCP - Regression MCP report - details on wind speed fit

Calculation: MCP CLG to PAJC

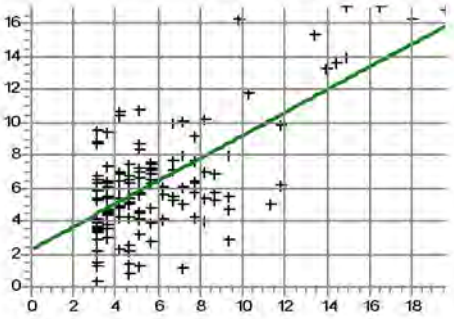
Winds in sector 0 degrees



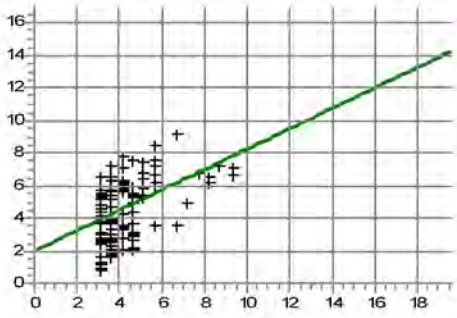
Winds in sector 90 degrees



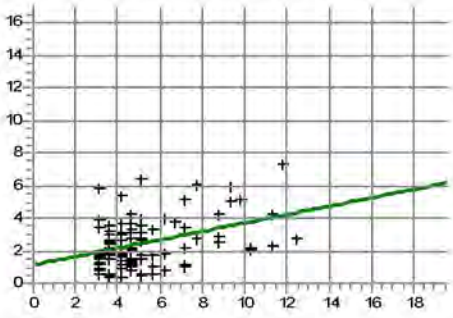
Winds in sector 180 degrees



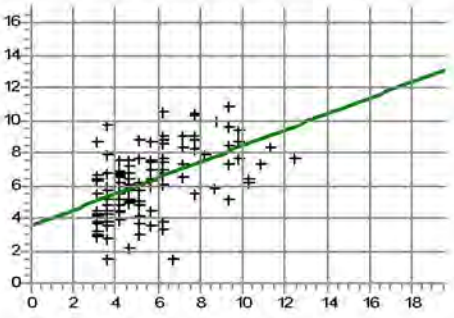
Winds in sector 22.5 degrees



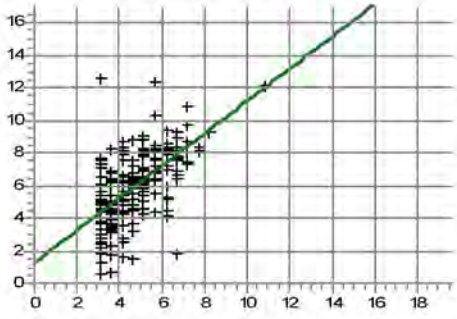
Winds in sector 112.5 degrees



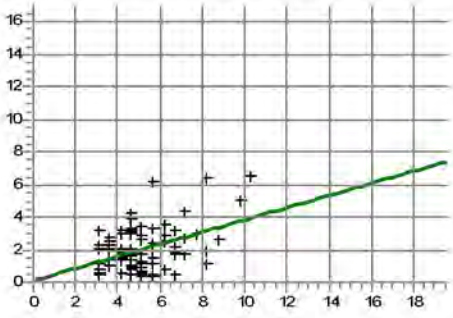
Winds in sector 202.5 degrees



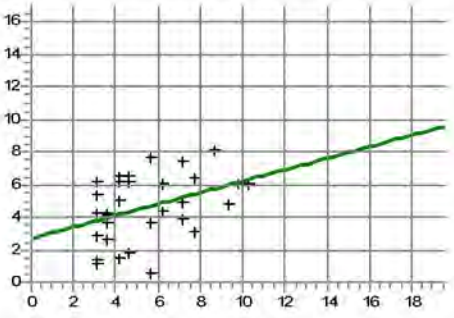
Winds in sector 45 degrees



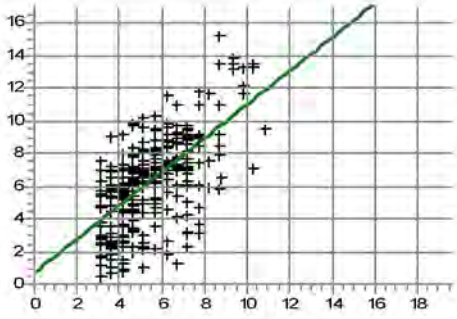
Winds in sector 135 degrees



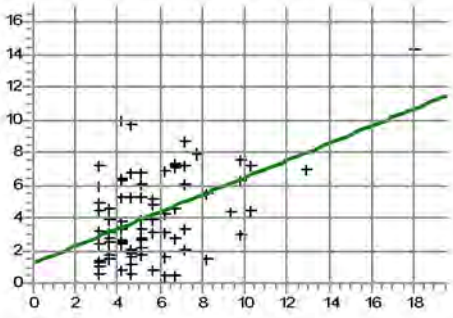
Winds in sector 225 degrees



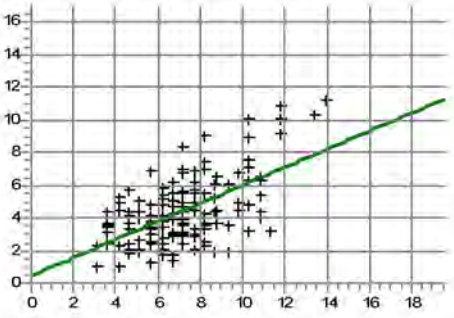
Winds in sector 67.5 degrees



Winds in sector 157.5 degrees



Winds in sector 247.5 degrees



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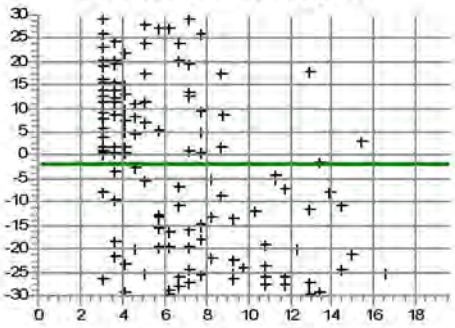
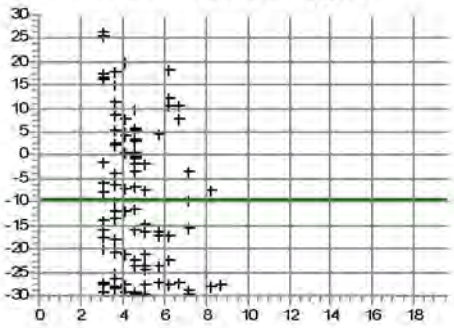
MCP - Regression MCP report - details on wind veer fit

Calculation: MCP CLG to PAJC

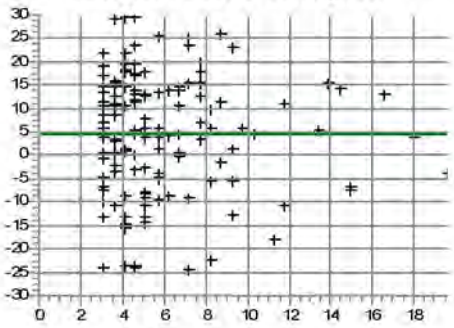
Wind veer in sector 0 degrees



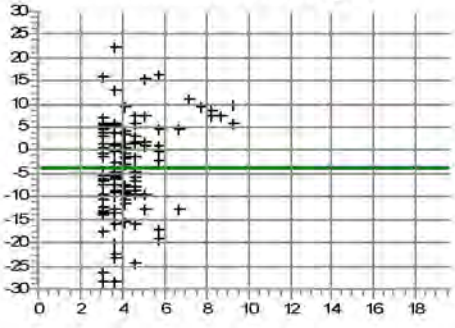
Wind veer in sector 90 degrees



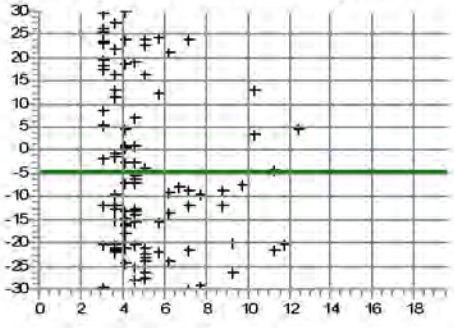
Wind veer in sector 180 degrees



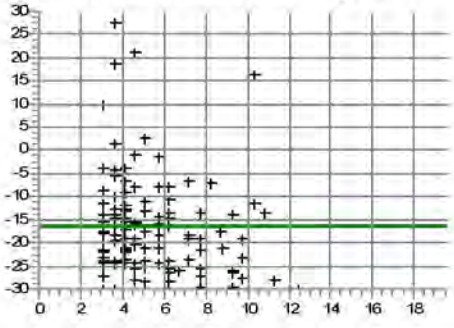
Wind veer in sector 22.5 degrees



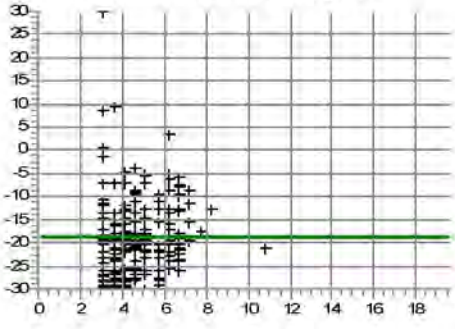
Wind veer in sector 112.5 degrees



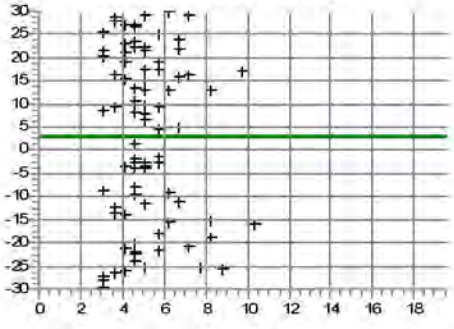
Wind veer in sector 202.5 degrees



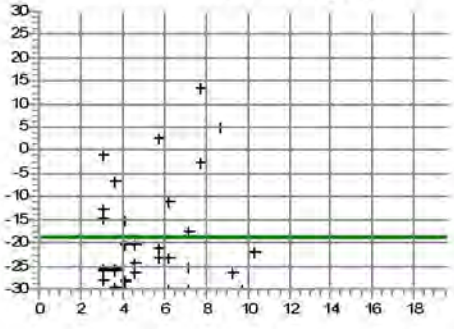
Wind veer in sector 45 degrees



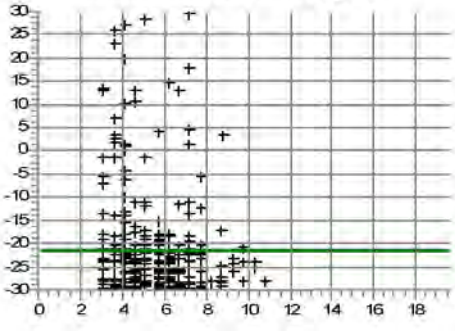
Wind veer in sector 135 degrees



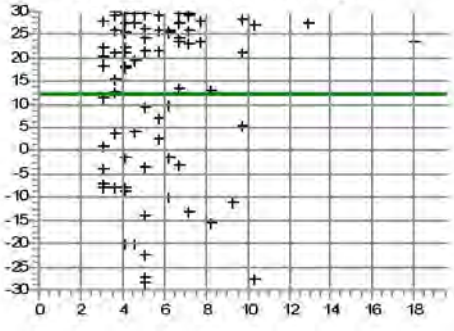
Wind veer in sector 225 degrees



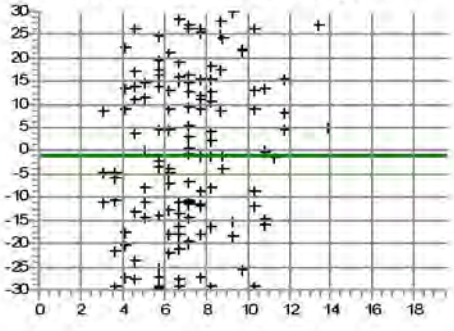
Wind veer in sector 67.5 degrees



Wind veer in sector 157.5 degrees



Wind veer in sector 247.5 degrees



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Appendix C
Annual Energy Calculations, 37 m Hub-Heights (approximately 120 ft AGL)

Project:
CHK_LAGOON

Description:
AEP for basic wind turbine models and locations. Turbulence calculated from merged A1A2 data from 6-20 m/s, 16 sectors. Air density with the appropriate mean temperature and 50% RH.

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Calculated:
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PARK - Main Result

Calculation: AEP calculations

Wake Model No model

Calculation Settings

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.251 kg/m³ to 1.264 kg/m³
Air density relative to standard	102.1 %
Hub altitude above sea level (asl)	39.4 m to 146.1 m
Annual mean temperature at hub alt.	3.6 °C to 4.3 °C
Pressure at WTGs	995.2 hPa to 1,008.3 hPa
Relative humidity	50.0 %

Wake Model Parameters No model parameters

Wake calculation settings

Angle [°]			Wind speed [m/s]		
start	end	step	start	end	step
0.5	360.0	1.0	0.5	30.5	1.0

Scale 1:12,500

New WTG

Resource file(s)

C:\WindPro\WINDPRO_Data\PROJECTS\LPB\CHK_LAGOON\CHK_LAGOON_Res_25_Hub_30_37_40_0.rsf

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-10.0% [MWh]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results¤) Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	8,438.4	7,594.5	8,438.4	100.0	44.1	843.8	3,865	9.1

¤) *Based on Result-10.0%*

Calculated Annual Energy for each of 9 new WTGs with total 2.0 MW rated power

	Terrain	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy Result [MWh]	Result-10.0% [MWh]	Park Efficiency [%]	Mean wind speed [m/s]
1	A	No	NORTHWIND	100 Arctic-100	100	21.0	37.0	USER	Arctic 100	402.2	362	100.0	8.30
2	A	No	NORTHWIND	100 Arctic-100	100	21.0	37.0	USER	Arctic 100	354.2	319	100.0	7.59
3	A	No	NORTHWIND	100 Arctic-100	100	21.0	37.0	USER	Arctic 100	525.1	473	100.0	11.34
4	A	Yes	ENERCON	E-33 MODIFIED-330	330	33.4	37.0	USER	Level 0 - guaranteed* - - 02/2004	1,392.5	1,253	100.0	8.30
5	A	Yes	ENERCON	E-33 MODIFIED-330	330	33.4	37.0	USER	Level 0 - guaranteed* - - 02/2004	1,229.0	1,106	100.0	7.59
6	A	Yes	ENERCON	E-33 MODIFIED-330	330	33.4	37.0	USER	Level 0 - guaranteed* - - 02/2004	1,796.8	1,617	100.0	11.34
7	A	No	NORWIN	225-29-225	225	29.0	37.0	USER	Power Curve	854.3	769	100.0	8.30
8	A	No	NORWIN	225-29-225	225	29.0	37.0	USER	Power Curve	741.3	667	100.0	7.59
9	A	No	NORWIN	225-29-225	225	29.0	37.0	USER	Power Curve	1,142.9	1,029	100.0	11.34

WTG siting

		UTM WGS84 Zone: 4 East	North	Z [m]	Row data/Description
		UTM WGS84 Zone: 4			
1	New	528,874	6,240,657	26.2	Northwind 1
2	New	528,563	6,240,812	2.4	Northwind 2
3	New	529,381	6,240,882	109.1	Northwind 3
4	New	528,874	6,240,657	26.2	Enercon 1
5	New	528,563	6,240,812	2.4	Enercon2

To be continued on next page...

Project:
CHK_LAGOON

Description:
AEP for basic wind turbine models and locations. Turbulence calculated from merged A1A2 data from 6-20 m/s, 16 sectors. Air density with the appropriate mean temperature and 50% RH.

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PARK - Main Result

Calculation: AEP calculations

...continued from previous page

		UTM WGS84 Zone: 4 East	North	Z	Row data/Description
		UTM WGS84 Zone: 4		[m]	
6	New	529,381	6,240,882	109.1	Enercon 3
7	New	528,874	6,240,657	26.2	Aeronautica 1
8	New	528,563	6,240,812	2.4	Aeronautica 2
9	New	529,381	6,240,882	109.1	Aeronautica 3

Project:
CHK_LAGOON

Description:
AEP for basic wind turbine models and locations. Turbulence calculated from merged A1A2 data from 6-20 m/s, 16 sectors. Air density with the appropriate mean temperature and 50% RH.

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Calculated:
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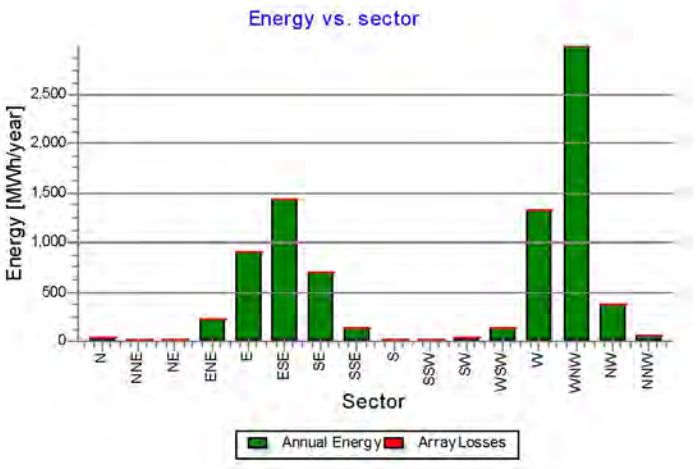
PARK - Production Analysis

Calculation: AEP calculations**WTG:** All new WTGs, Air density varies with WTG position 1.251 kg/m³ - 1.264 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 NE	3 ENE	4 E	5 ESE	6 SE	7 SSE	8 S	9 SSW	10 SW	11 WSW	12 W	13 WNW	14 NW	15 NNW	Total
Roughness based energy	[MWh]	36.5	27.4	25.6	225.7	901.9	1,442.5	693.9	124.2	17.6	15.1	32.0	141.1	1,332.1	2,991.2	376.2	55.5	8,438.4
Resulting energy	**[MWh]**	**36.5**	**27.4**	**25.6**	**225.7**	**901.9**	**1,442.5**	**693.9**	**124.2**	**17.6**	**15.1**	**32.0**	**141.1**	**1,332.1**	**2,991.2**	**376.2**	**55.5**	**8,438.4**
Specific energy	[kWh/m²]																	1,494
Specific energy	[kWh/kW]																	4,294
Utilization	[%]	38.2	38.7	37.8	22.3	17.3	11.9	12.9	16.4	38.3	37.2	39.0	38.2	31.3	18.2	17.3	29.3	17.5
Operational	[Hours/year]	155	148	103	292	824	1,119	617	179	93	120	180	411	1,386	1,897	330	128	7,983
Full Load Equivalent	[Hours/year]	19	14	13	115	459	734	353	63	9	8	16	72	678	1,522	191	28	4,294



Project:
CHK_LAGOON

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Calculated:
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PARK - Power Curve Analysis

Calculation: AEP calculations**WTG:** 1 - NORTHWIND 100 Arctic 60Hz 100 21.0 !O! Arctic 100, Hub height: 37.0 m

Name: Arctic 100
Source: SpecSheet

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
10/12/2009	USER	10/12/2009	10/12/2009	25.0	Stall	Standard stall

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	146	222	306	379	427	493
NORTHWIND 100 Arctic 60Hz 100 21.0 !O! Arctic 100	[MWh]	147	222	298	369	431	482
Check value	[%]	0	0	2	3	-1	2

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

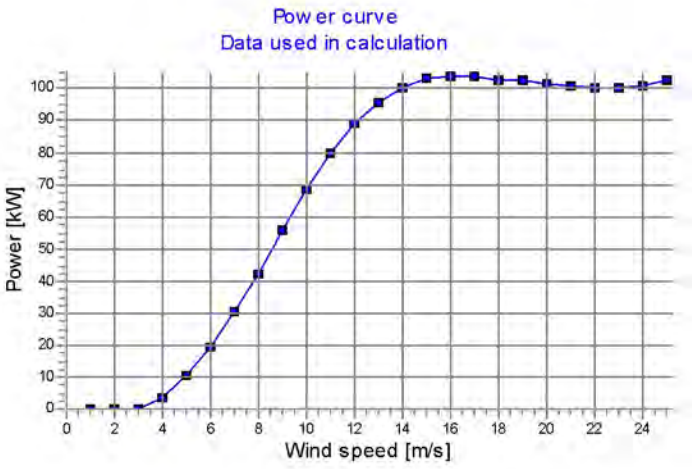
Original data from Windcat, Air density: 1.225 kg/m³

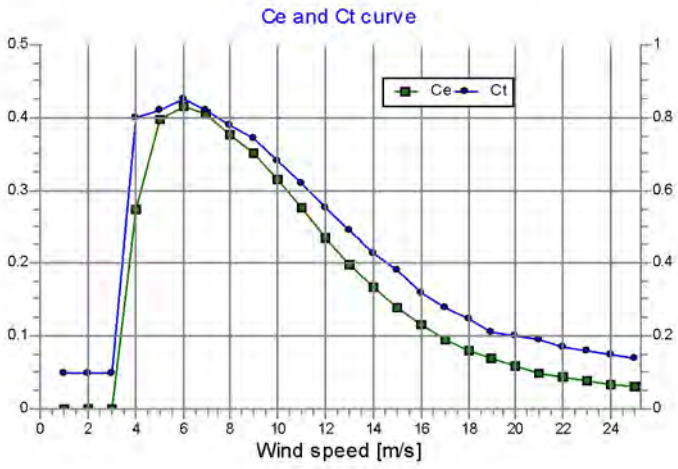
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.0	0.0	0.00	1.0	0.10
2.0	0.0	0.00	2.0	0.10
3.0	0.0	0.00	3.0	0.10
4.0	3.7	0.27	4.0	0.80
5.0	10.5	0.40	5.0	0.82
6.0	19.0	0.41	6.0	0.85
7.0	29.4	0.40	7.0	0.82
8.0	41.0	0.38	8.0	0.78
9.0	54.3	0.35	9.0	0.74
10.0	66.8	0.31	10.0	0.68
11.0	77.7	0.28	11.0	0.62
12.0	86.4	0.24	12.0	0.55
13.0	92.8	0.20	13.0	0.49
14.0	97.3	0.17	14.0	0.43
15.0	100.0	0.14	15.0	0.38
16.0	100.8	0.12	16.0	0.32
17.0	100.6	0.10	17.0	0.28
18.0	99.8	0.08	18.0	0.25
19.0	99.4	0.07	19.0	0.21
20.0	98.6	0.06	20.0	0.20
21.0	97.8	0.05	21.0	0.19
22.0	97.3	0.04	22.0	0.17
23.0	97.3	0.04	23.0	0.16
24.0	98.0	0.03	24.0	0.15
25.0	99.7	0.03	25.0	0.14
			26.0	0.13
			27.0	0.12
			28.0	0.11

Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1.261 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.0	0.00	2.50- 3.50	0.6	0.6	0.2
4.0	3.8	0.27	3.50- 4.50	3.2	3.8	0.9
5.0	10.8	0.40	4.50- 5.50	8.0	11.7	2.9
6.0	19.6	0.41	5.50- 6.50	14.3	26.1	6.5
7.0	30.3	0.40	6.50- 7.50	21.8	47.9	11.9
8.0	42.2	0.38	7.50- 8.50	30.0	77.9	19.4
9.0	55.9	0.35	8.50- 9.50	37.9	115.7	28.8
10.0	68.8	0.31	9.50-10.50	43.8	159.5	39.7
11.0	80.0	0.28	10.50-11.50	46.1	205.6	51.1
12.0	89.0	0.24	11.50-12.50	44.6	250.2	62.2
13.0	95.5	0.20	12.50-13.50	39.7	289.9	72.1
14.0	100.2	0.17	13.50-14.50	32.6	322.6	80.2
15.0	103.0	0.14	14.50-15.50	25.0	347.5	86.4
16.0	103.8	0.12	15.50-16.50	17.9	365.4	90.9
17.0	103.6	0.10	16.50-17.50	12.2	377.7	93.9
18.0	102.7	0.08	17.50-18.50	8.2	385.9	95.9
19.0	102.3	0.07	18.50-19.50	5.5	391.4	97.3
20.0	101.5	0.06	19.50-20.50	3.7	395.1	98.2
21.0	100.7	0.05	20.50-21.50	2.6	397.7	98.9
22.0	100.2	0.04	21.50-22.50	1.8	399.5	99.3
23.0	100.2	0.04	22.50-23.50	1.3	400.9	99.7
24.0	100.9	0.03	23.50-24.50	0.9	401.8	99.9
25.0	102.6	0.03	24.50-25.50	0.4	402.2	100.0





Project:
CHK_LAGOON

Description:
AEP for basic wind turbine models and locations. Turbulence calculated from merged A1A2 data from 6-20 m/s, 16 sectors. Air density with the appropriate mean temperature and 50% RH.

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Rick Damiani / rdamiani@knightpiesold.com

Calculated:
10/19/2011 12:15 PM/2.7.486

PARK - Power Curve Analysis

Calculation: AEP calculations**WTG:** 5 - ENERCON E-33 MODIFIED 330 33.4 !-! Level 0 - guaranteed* - - 02/2004, Hub height: 37.0 m

Name: Level 0 - guaranteed* - - 02/2004
Source: Enercon

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
4/30/2004	USER	6/23/2006	7/7/2010	25.0	Pitch	User defined

According to Enercon specification ct_E-33_330kW berechnet
* Uncertainties in measurement of power curves can lead to different power curves for the same turbine, so ENERCON uses calculated curves for energy calculations and guarantees. For reference and verification, measured power curves are available at ENERCON (not for use in energy calculations or guarantees!)

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	406	661	925	1,181	1,397	1,588
ENERCON E-33 MODIFIED 330 33.4 !-! Level 0 - guaranteed* - - 02/2004	[MWh]	498	770	1,042	1,291	1,507	1,684
Check value	[%]	-18	-14	-11	-9	-7	-6

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

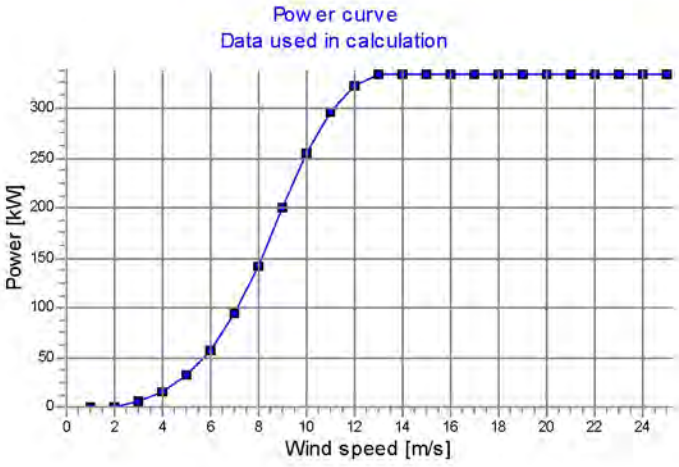
Original data from Windcat, Air density: 1.225 kg/m³

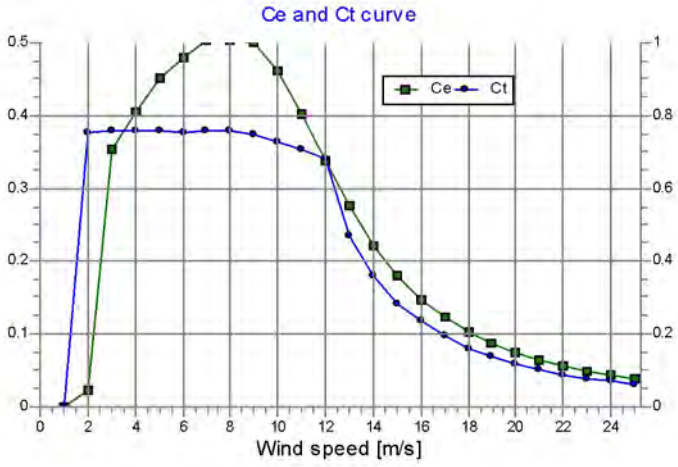
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.0	0.0	0.00	1.0	0.00
2.0	0.0	0.00	2.0	0.75
3.0	5.0	0.35	3.0	0.76
4.0	13.7	0.40	4.0	0.76
5.0	30.0	0.45	5.0	0.76
6.0	55.0	0.47	6.0	0.75
7.0	92.0	0.50	7.0	0.76
8.0	138.0	0.50	8.0	0.76
9.0	196.0	0.50	9.0	0.75
10.0	250.0	0.47	10.0	0.73
11.0	292.8	0.41	11.0	0.71
12.0	320.0	0.35	12.0	0.68
13.0	335.0	0.28	13.0	0.47
14.0	335.0	0.23	14.0	0.36
15.0	335.0	0.18	15.0	0.28
16.0	335.0	0.15	16.0	0.24
17.0	335.0	0.13	17.0	0.20
18.0	335.0	0.11	18.0	0.16
19.0	335.0	0.09	19.0	0.14
20.0	335.0	0.08	20.0	0.12
21.0	335.0	0.07	21.0	0.10
22.0	335.0	0.06	22.0	0.09
23.0	335.0	0.05	23.0	0.08
24.0	335.0	0.05	24.0	0.07

Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1.264 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.1	0.02	1.50- 2.50	0.7	0.7	0.1
3.0	5.3	0.35	2.50- 3.50	4.2	4.9	0.4
4.0	14.4	0.41	3.50- 4.50	12.4	17.4	1.4
5.0	31.3	0.45	4.50- 5.50	27.1	44.5	3.6
6.0	57.3	0.48	5.50- 6.50	49.5	93.9	7.6
7.0	95.3	0.50	6.50- 7.50	79.1	173.0	14.1
8.0	142.8	0.50	7.50- 8.50	113.6	286.7	23.3
9.0	201.4	0.50	8.50- 9.50	145.7	432.4	35.2
10.0	255.4	0.46	9.50-10.50	163.8	596.2	48.5
11.0	297.1	0.40	10.50-11.50	160.9	757.2	61.6
12.0	322.8	0.34	11.50-12.50	139.7	896.9	73.0
13.0	335.0	0.28	12.50-13.50	108.4	1,005.3	81.8
14.0	335.0	0.22	13.50-14.50	76.7	1,082.0	88.0
15.0	335.0	0.18	14.50-15.50	51.2	1,133.2	92.2
16.0	335.0	0.15	15.50-16.50	33.2	1,166.4	94.9
17.0	335.0	0.12	16.50-17.50	21.4	1,187.8	96.6
18.0	335.0	0.10	17.50-18.50	14.0	1,201.8	97.8
19.0	335.0	0.09	18.50-19.50	9.4	1,211.3	98.6
20.0	335.0	0.08	19.50-20.50	6.4	1,217.7	99.1
21.0	335.0	0.07	20.50-21.50	4.4	1,222.1	99.4
22.0	335.0	0.06	21.50-22.50	3.0	1,225.1	99.7
23.0	335.0	0.05	22.50-23.50	2.0	1,227.1	99.8
24.0	335.0	0.04	23.50-24.50	1.3	1,228.5	100.0
25.0	335.0	0.04	24.50-25.50	0.5	1,229.0	100.0





Project:
CHK_LAGOON

Description:
AEP for basic wind turbine models and locations. Turbulence calculated from merged A1A2 data from 6-20 m/s, 16 sectors. Air density with the appropriate mean temperature and 50% RH.

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Rick Damiani / rdamiani@knightpiesold.com

Calculated:
10/19/2011 12:15 PM/2.7.486

PARK - Power Curve Analysis

Calculation: AEP calculations**WTG:** 9 - NORWIN 225-29 225 29.0 !O! Power Curve, Hub height: 37.0 m

Name: Power Curve
Source: http://aeronauticawind.com/aw/library/Spec_Sheet_Norwin225-29_new.pdf

Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
USER	4/12/2011	4/12/2011	25.0	Stall	Standard stall

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	297	465	648	816	926	1,086
NORWIN 225-29 225 29.0 !O! Power Curve	[MWh]	271	440	614	776	920	1,041
Check value	[%]	9	6	6	5	1	4

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

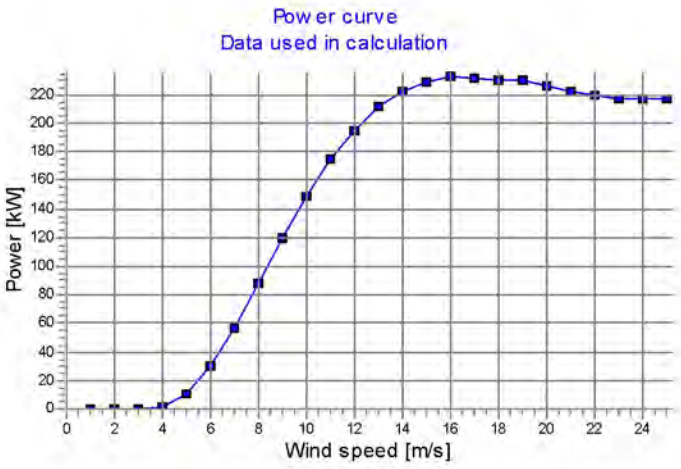
Original data from Windcat, Air density: 1.225 kg/m³

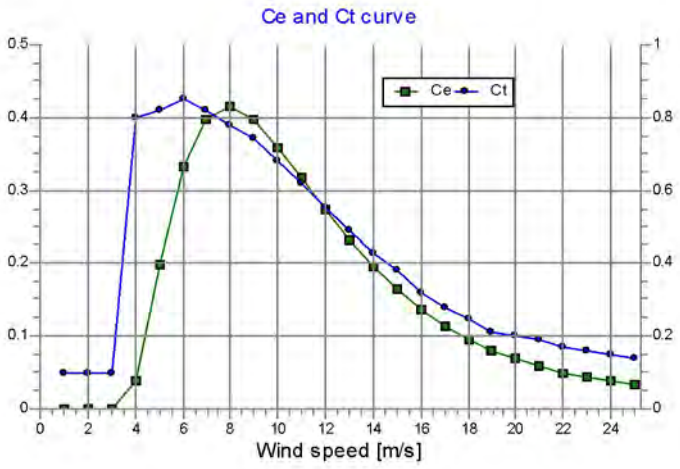
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
4.0	1.0	0.04	1.0	0.10
5.0	10.0	0.20	2.0	0.10
6.0	29.0	0.33	3.0	0.10
7.0	55.0	0.40	4.0	0.80
8.0	86.0	0.42	5.0	0.82
9.0	117.0	0.40	6.0	0.85
10.0	145.0	0.36	7.0	0.82
11.0	171.0	0.32	8.0	0.78
12.0	191.0	0.27	9.0	0.74
13.0	207.0	0.23	10.0	0.68
14.0	218.0	0.20	11.0	0.62
15.0	224.0	0.16	12.0	0.55
16.0	228.0	0.14	13.0	0.49
17.0	227.0	0.11	14.0	0.43
18.0	225.0	0.10	15.0	0.38
19.0	225.0	0.08	16.0	0.32
20.0	222.0	0.07	17.0	0.28
21.0	218.0	0.06	18.0	0.25
22.0	215.0	0.05	19.0	0.21
23.0	212.0	0.04	20.0	0.20
			21.0	0.19
			22.0	0.17
			23.0	0.16
			24.0	0.15
			25.0	0.14
			26.0	0.13
			27.0	0.12
			28.0	0.11

Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1.251 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.0	0.00	2.50- 3.50	0.0	0.0	0.0
4.0	1.0	0.04	3.50- 4.50	1.3	1.3	0.1
5.0	10.2	0.20	4.50- 5.50	6.3	7.7	0.7
6.0	29.6	0.33	5.50- 6.50	15.9	23.6	2.1
7.0	56.2	0.40	6.50- 7.50	29.4	53.0	4.6
8.0	87.8	0.42	7.50- 8.50	45.0	97.9	8.6
9.0	119.5	0.40	8.50- 9.50	60.5	158.5	13.9
10.0	148.1	0.36	9.50-10.50	74.5	232.9	20.4
11.0	174.6	0.32	10.50-11.50	85.8	318.7	27.9
12.0	195.0	0.27	11.50-12.50	93.4	412.1	36.1
13.0	211.4	0.23	12.50-13.50	97.2	509.4	44.6
14.0	222.6	0.20	13.50-14.50	97.2	606.5	53.1
15.0	228.7	0.16	14.50-15.50	93.5	700.1	61.3
16.0	232.8	0.14	15.50-16.50	86.8	786.9	68.8
17.0	231.8	0.11	16.50-17.50	77.6	864.5	75.6
18.0	229.7	0.10	17.50-18.50	67.1	931.6	81.5
19.0	229.7	0.08	18.50-19.50	56.5	988.1	86.5
20.0	226.7	0.07	19.50-20.50	46.0	1,034.0	90.5
21.0	222.6	0.06	20.50-21.50	36.2	1,070.3	93.6
22.0	219.5	0.05	21.50-22.50	28.0	1,098.2	96.1
23.0	216.5	0.04	22.50-23.50	21.3	1,119.6	98.0
24.0	216.5	0.04	23.50-24.50	16.3	1,135.8	99.4
25.0	216.5	0.03	24.50-25.50	7.0	1,142.9	100.0





Project:
CHK_LAGOON

Description:
AEP for basic wind turbine models and locations. Turbulence calculated from merged A1A2 data from 6-20 m/s, 16 sectors. Air density with the appropriate mean temperature and 50% RH.

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Rick Damiani / rdamiani@knightpiesold.com
Calculated:
10/19/2011 12:15 PM/2.7.486

PARK - Wind Data Analysis

Calculation: AEP calculations**Wind data:** A - Resource file(s); Hub height: 37.0

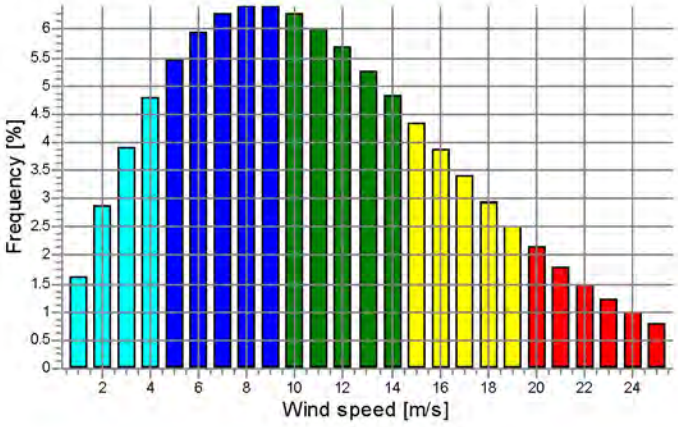
Site Coordinates
UTM WGS 84 Zone: 4 East: 529,381 North: 6,240,882
Northwind 3
Enercon 3
Aeronautica 3

RSF file
C:\WindPro\WINDPRO_Data\PROJECTS\LPB\CHK_LAGOON\CHK_LAGOON_Res_25_Hub_30_37_40_0.rsf

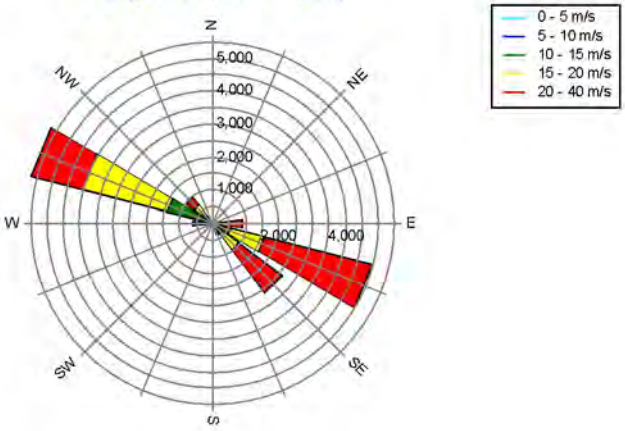
Weibull Data

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	5.82	5.16	2.024	2.2
1 NNE	5.28	4.68	2.060	1.7
2 NE	5.23	4.66	1.744	1.0
3 ENE	7.97	7.14	1.596	2.0
4 E	11.32	10.10	1.710	6.9
5 ESE	16.41	14.54	2.071	16.2
6 SE	15.38	13.63	2.040	10.1
7 SSE	10.96	9.82	1.613	3.0
8 S	5.76	5.10	2.233	1.2
9 SSW	4.80	4.26	2.450	1.6
10 SW	4.90	4.35	2.456	2.0
11 WSW	4.24	3.76	2.007	2.6
12 W	9.04	8.03	2.668	13.6
13 WNW	15.69	14.12	3.501	27.9
14 NW	13.78	12.24	2.583	6.3
15 NNW	7.46	6.66	1.684	1.9
All	12.77	11.34	1.862	100.0

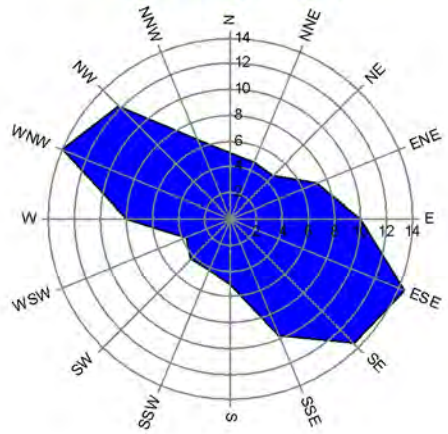
Weibull Distribution



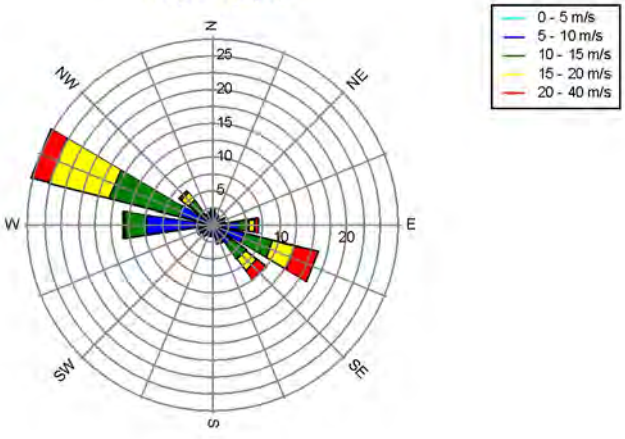
Energy Rose (kWh/m²/year)



Mean w ind speed (m/s)



Frequency (%)



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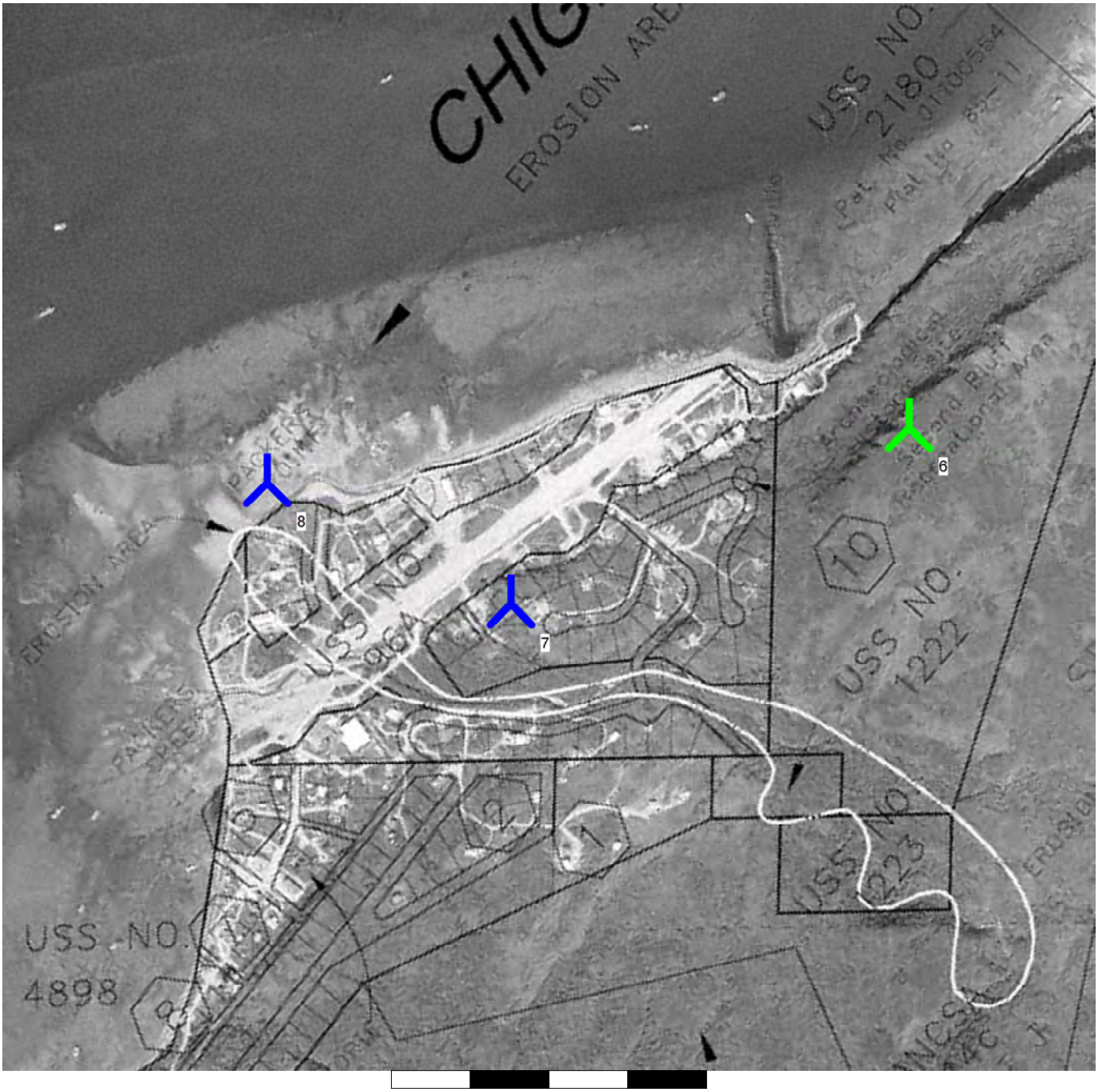
Rick Damiani / rdamiani@knightpiesold.com

Calculated:
10/19/2011 12:15 PM/2.7.486

PARK - Map

Calculation: AEP calculations**Wind data:** A - Resource file(s); Hub height: 37.0



0 100 200 300 400 m

Map: , Print scale 1:7,500, Map center UTM WGS 84 Zone: 4 East: 528,919 North: 6,240,745

New WTG

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Appendix D
Diesel Only Economics

Knight Piésold
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Diesel @ $4.40/gallon-$1.16/liter
No Thermal Load

System Report - CLG_NW_Enercon.hmr

Sensitivity case

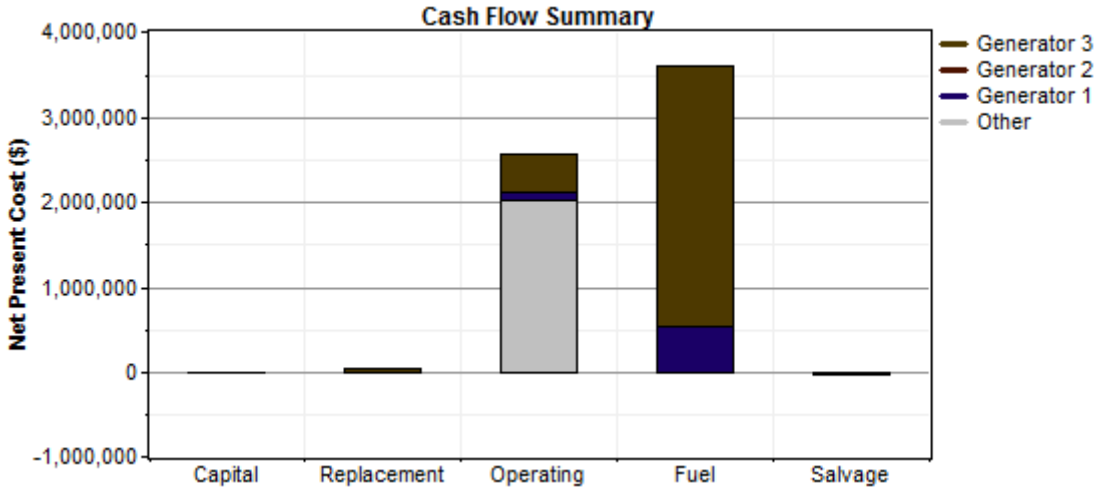
Thermal Load 1 Scaled Average: 0 kWh/d
Diesel Price: 1.16 $/L
Heating Oil Price: 1.16 $/L

System architecture

Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,157,233
Levelized cost of energy	$ 0.749/kWh
Operating cost	$ 410,046/yr



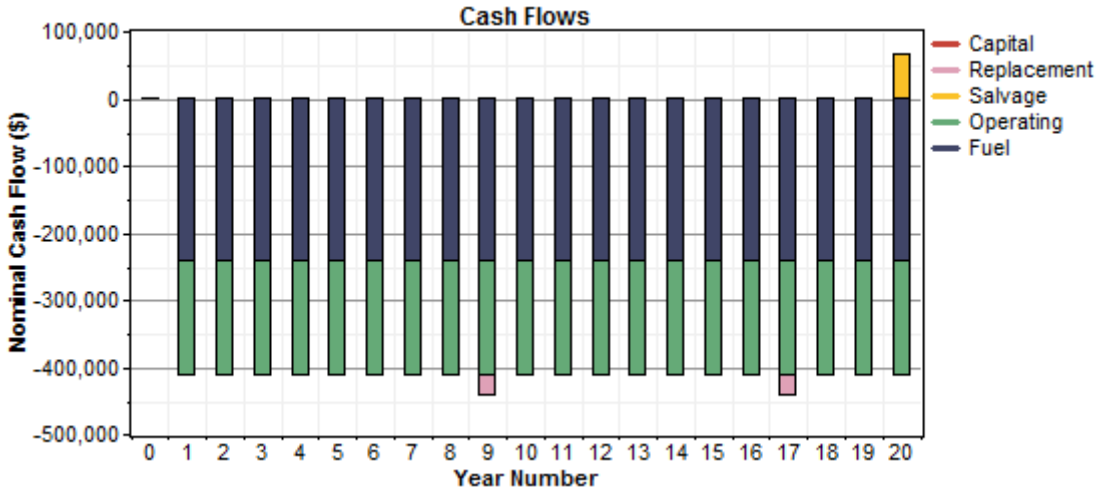
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Generator 3	0	42,459	438,166	3,076,256	-9,625	3,547,256
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	88,234	523,284	-12,100	599,417
Other	0	0	2,027,154	0	0	2,027,154
System	0	42,459	2,553,553	3,599,540	-38,323	6,157,230

Annualized Costs

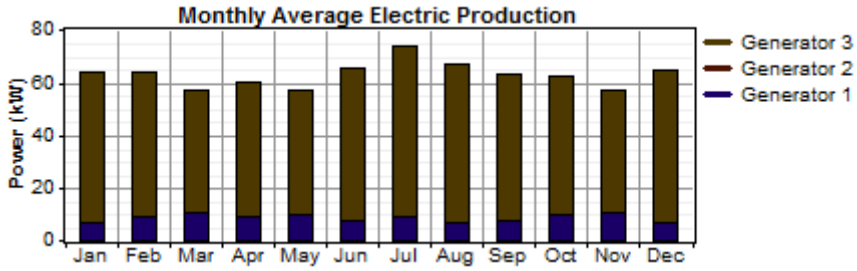
Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Generator 3	0	2,828	29,180	204,866	-641	236,232
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,876	34,849	-806	39,919
Other	0	0	135,000	0	0	135,000

System	0	2,828	170,056	239,714	-2,552	410,046



Electrical

Component	Production (kWh/yr)	Fraction
Generator 3	476,979	86%
Generator 2	0	0%
Generator 1	75,605	14%
Total	552,584	100%



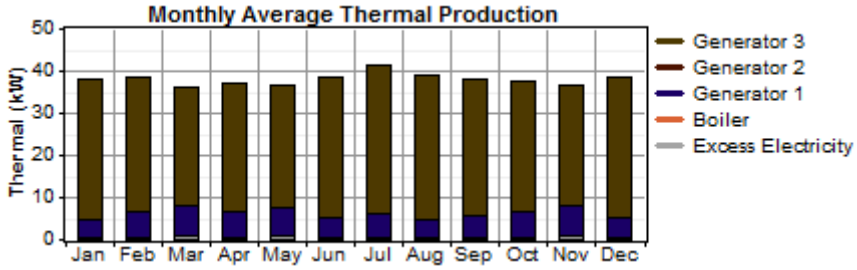
Load	Consumption (kWh/yr)	Fraction
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	5,083	kWh/yr
Unmet load	0.00	kWh/yr
Capacity shortage	0.00	kWh/yr
Renewable fraction	0.000	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	277,385	83%
Generator 1	50,601	15%

Boiler	0	0%
Excess electricity	5,083	2%
Total	333,070	100%



Load	Consumption	Fraction
	(kWh/yr)	
Thermal load	0	
Total	0	

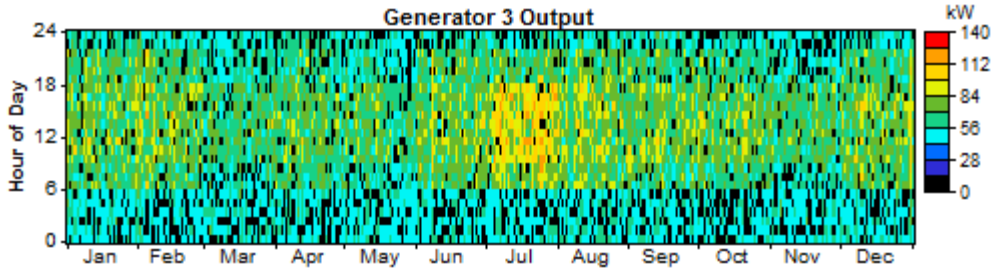
Quantity	Value	Units
Excess thermal energy	333,070	kWh/yr

Generator 3

Quantity	Value	Units
Hours of operation	7,295	hr/yr
Number of starts	1,075	starts/yr
Operational life	8.22	yr
Capacity factor	37.6	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	476,979	kWh/yr
Mean electrical output	65.4	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	277,385	kWh/yr
Mean thermal output	38.0	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	176,608	L/yr
Specific fuel consumption	0.370	L/kWh
Fuel energy input	1,737,828	kWh/yr
Mean electrical efficiency	27.4	%
Mean total efficiency	43.4	%

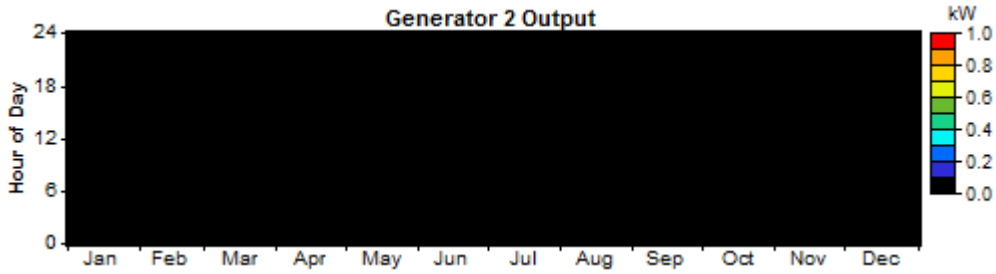


Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr
Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



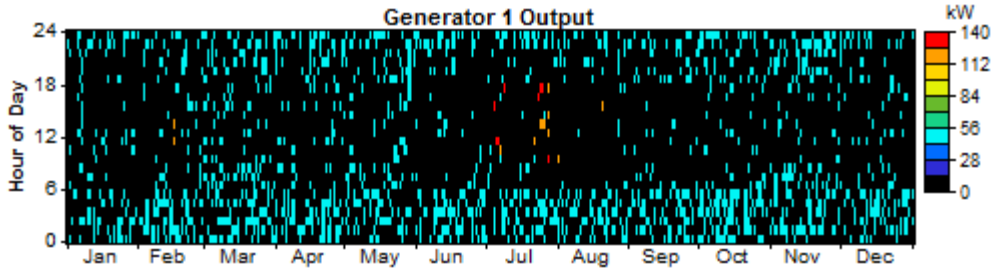
Generator 1

Quantity	Value	Units
Hours of operation	1,469	hr/yr
Number of starts	1,077	starts/yr
Operational life	40.8	yr

Capacity factor	5.39	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	75,605	kWh/yr
Mean electrical output	51.5	kW
Min. electrical output	48.0	kW
Max. electrical output	133	kW
Thermal production	50,601	kWh/yr
Mean thermal output	34.4	kW
Min. thermal output	32.9	kW
Max. thermal output	69.9	kW

Quantity	Value	Units
Fuel consumption	30,042	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	295,612	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	544,178
Carbon monoxide	1,343
Unburned hydocarbons	149
Particulate matter	101
Sulfur dioxide	1,093
Nitrogen oxides	11,986

Knight Piésold CONSULTING

Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

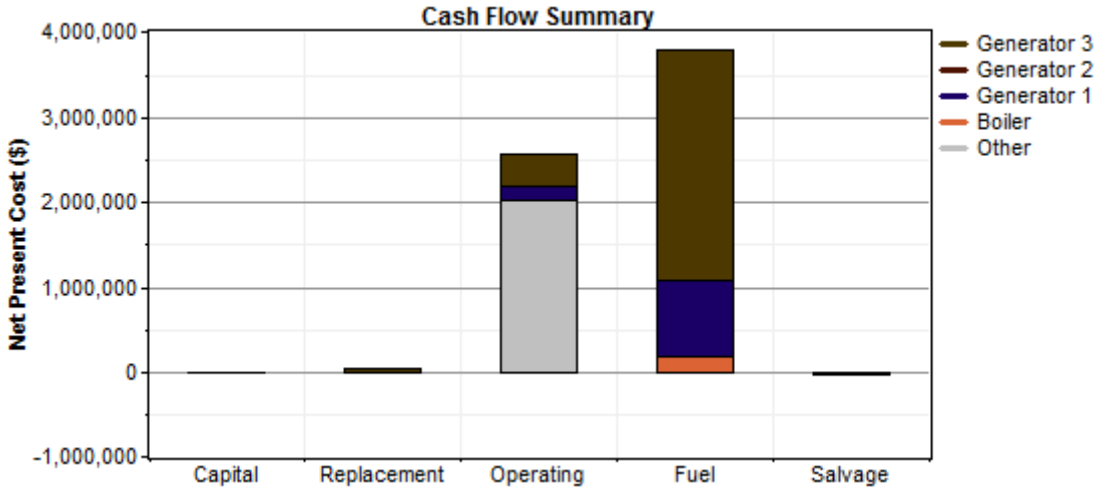
Thermal Load 1 Scaled Average:	1,000	kWh/d
Diesel Price:	1.16	$/L
Heating Oil Price:	1.16	$/L

System architecture

Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,339,313
Levelized cost of energy	$ 0.679/kWh
Operating cost	$ 422,172/yr



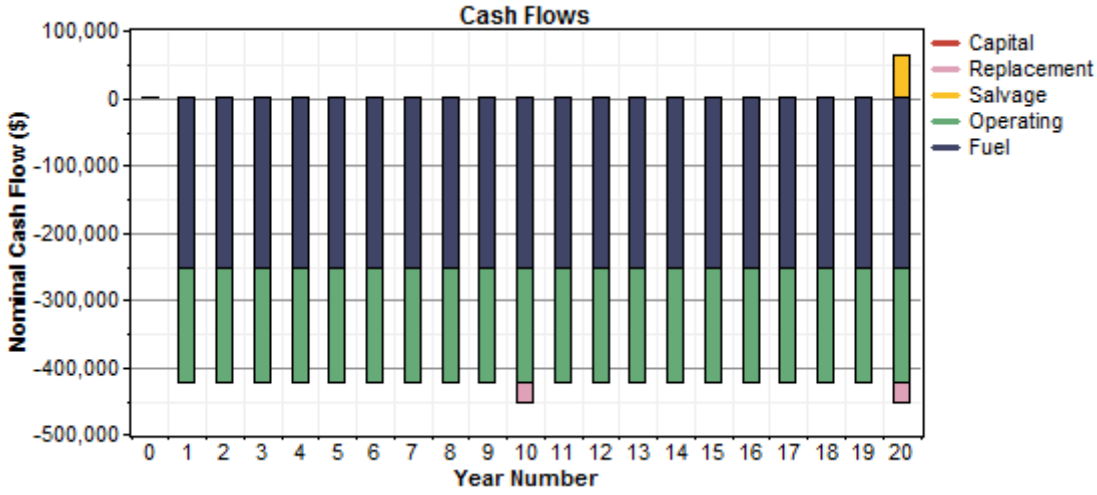
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Generator 3	0	40,281	379,063	2,712,127	-15,180	3,116,290
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	147,337	887,000	-4,323	1,030,013
Boiler	0	0	0	182,451	0	182,451
Other	0	0	2,027,154	0	0	2,027,154
System	0	40,281	2,553,553	3,781,577	-36,101	6,339,310

Annualized Costs

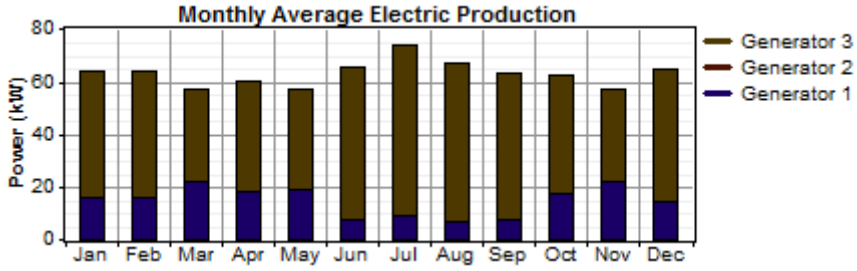
Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Generator 3	0	2,683	25,244	180,616	-1,011	207,532
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	9,812	59,070	-288	68,595

Boiler	0	0	0	12,150	0	12,150
Other	0	0	135,000	0	0	135,000
System	0	2,683	170,056	251,837	-2,404	422,171



Electrical

Component	Production (kWh/yr)	Fraction
Generator 3	424,301	77%
Generator 2	0	0%
Generator 1	128,832	23%
Total	553,133	100%



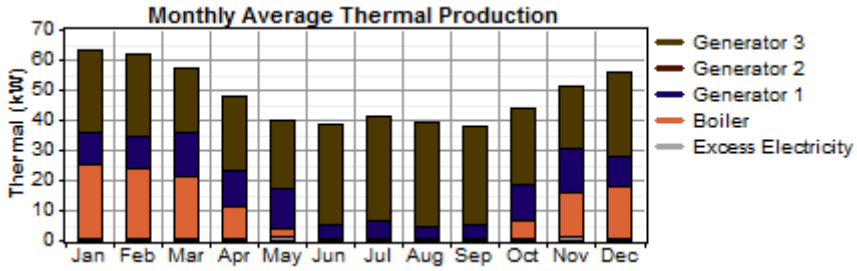
Load	Consumption (kWh/yr)	Fraction
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	5,632	kWh/yr
Unmet load	0.00	kWh/yr
Capacity shortage	0.00	kWh/yr
Renewable fraction	0.000	

Thermal

Component	Production (kWh/yr)	Fraction

Generator 3	243,719	58%
Generator 1	85,617	20%
Boiler	87,609	21%
Excess electricity	5,632	1%
Total	422,578	100%



Load	Consumption (kWh/yr)	Fraction
Thermal load	365,000	100%
Total	365,000	100%

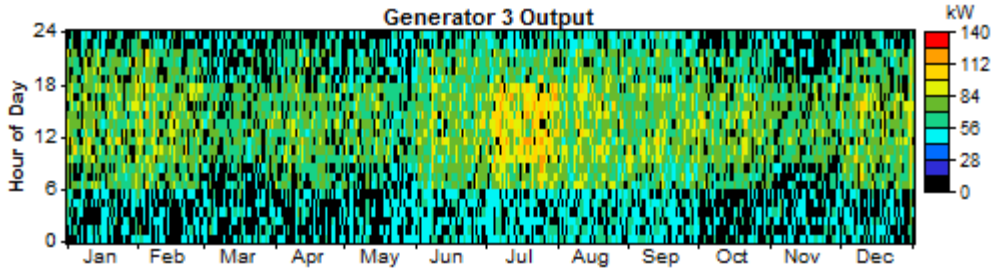
Quantity	Value	Units
Excess thermal energy	57,578	kWh/yr

Generator 3

Quantity	Value	Units
Hours of operation	6,311	hr/yr
Number of starts	1,375	starts/yr
Operational life	9.51	yr
Capacity factor	33.4	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	424,301	kWh/yr
Mean electrical output	67.2	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	243,719	kWh/yr
Mean thermal output	38.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	155,704	L/yr
Specific fuel consumption	0.367	L/kWh
Fuel energy input	1,532,125	kWh/yr
Mean electrical efficiency	27.7	%
Mean total efficiency	43.6	%

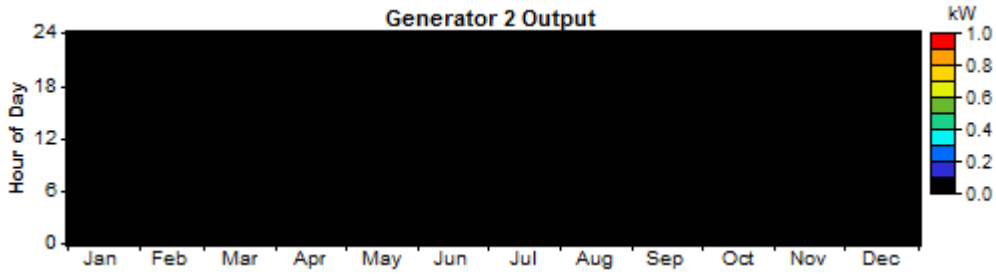


Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr
Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



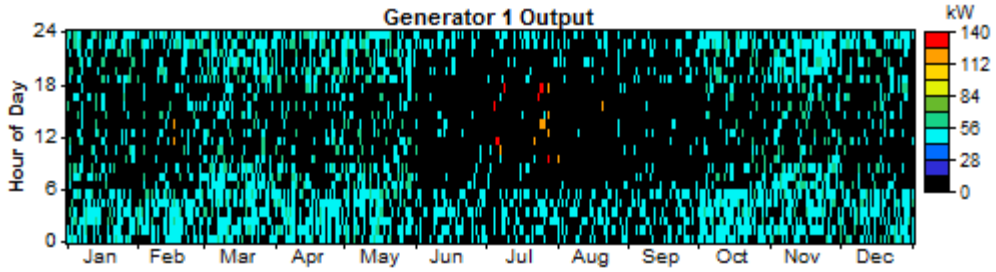
Generator 1

Quantity	Value	Units
Hours of operation	2,453	hr/yr
Number of starts	1,378	starts/yr
Operational life	24.5	yr

Capacity factor	9.19	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	128,832	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	48.0	kW
Max. electrical output	133	kW
Thermal production	85,617	kWh/yr
Mean thermal output	34.9	kW
Min. thermal output	32.9	kW
Max. thermal output	69.9	kW

Quantity	Value	Units
Fuel consumption	50,923	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	501,081	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	571,830
Carbon monoxide	1,343
Unburned hydocarbons	149
Particulate matter	101
Sulfur dioxide	1,149
Nitrogen oxides	11,984

Knight Piésold CONSULTING

Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

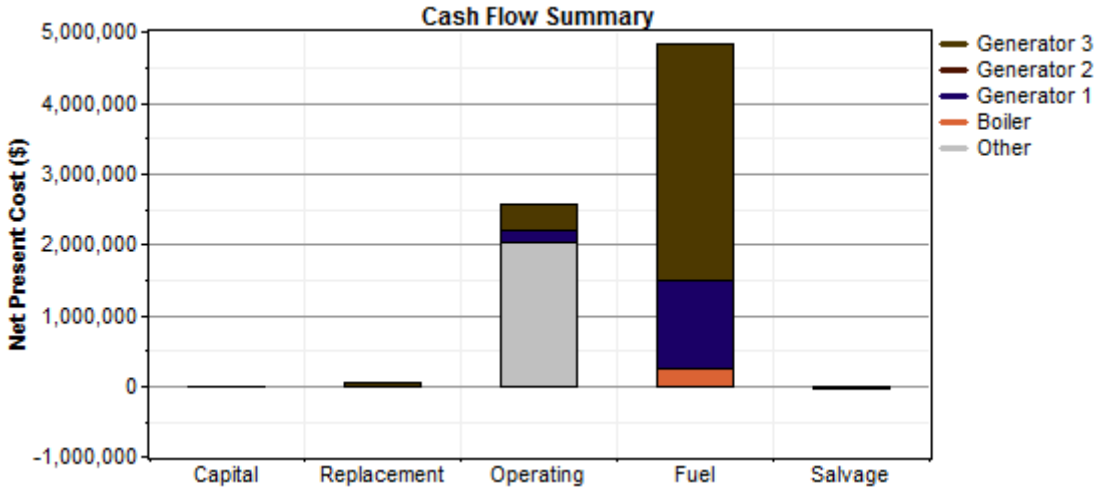
Thermal Load 1 Scaled Average:	1,000	kWh/d
Diesel Price:	1.48	$/L
Heating Oil Price:	1.48	$/L

System architecture

Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,381,500
Levelized cost of energy	$ 0.780/kWh
Operating cost	$ 491,577/yr



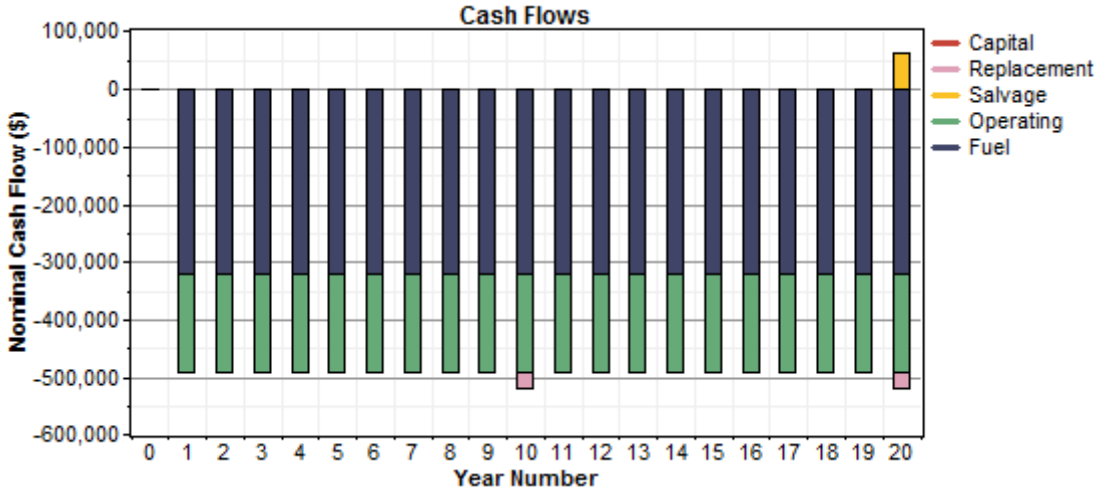
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Generator 3	0	39,589	362,906	3,330,018	-16,699	3,715,813
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	163,494	1,262,389	-2,197	1,423,686
Boiler	0	0	0	231,440	0	231,440
Other	0	0	2,027,154	0	0	2,027,154
System	0	39,589	2,553,553	4,823,847	-35,494	7,381,496

Annualized Costs

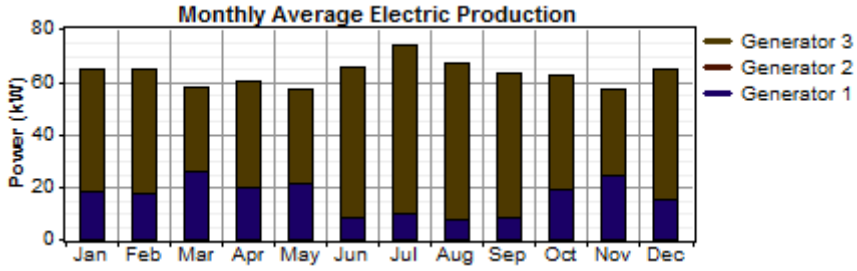
Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Generator 3	0	2,636	24,168	221,765	-1,112	247,458
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	10,888	84,070	-146	94,812

Boiler	0	0	0	15,413	0	15,413
Other	0	0	135,000	0	0	135,000
System	0	2,636	170,056	321,248	-2,364	491,577



Electrical

Component	Production (kWh/yr)	Fraction
Generator 3	409,311	74%
Generator 2	0	0%
Generator 1	143,972	26%
Total	553,283	100%



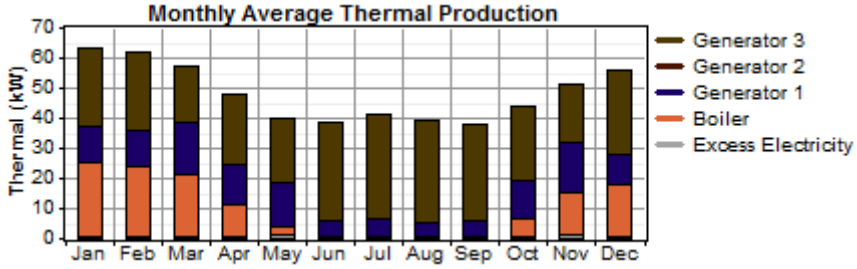
Load	Consumption (kWh/yr)	Fraction
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	5,782	kWh/yr
Unmet load	0.00	kWh/yr
Capacity shortage	0.00	kWh/yr
Renewable fraction	0.000	

Thermal

Component	Production (kWh/yr)	Fraction

Generator 3	234,327	55%
Generator 1	95,445	23%
Boiler	87,104	21%
Excess electricity	5,782	1%
Total	422,658	100%



Load	Consumption	Fraction
	(kWh/yr)	
Thermal load	365,000	100%
Total	365,000	100%

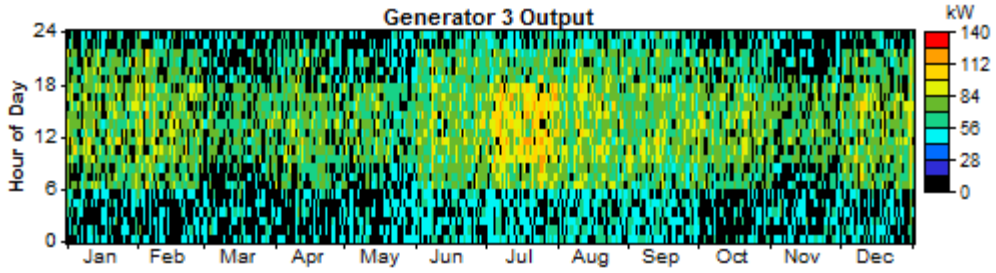
Quantity	Value	Units
Excess thermal energy	57,658	kWh/yr

Generator 3

Quantity	Value	Units
Hours of operation	6,042	hr/yr
Number of starts	1,440	starts/yr
Operational life	9.93	yr
Capacity factor	32.2	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	409,311	kWh/yr
Mean electrical output	67.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	234,327	kWh/yr
Mean thermal output	38.8	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	149,841	L/yr
Specific fuel consumption	0.366	L/kWh
Fuel energy input	1,474,440	kWh/yr
Mean electrical efficiency	27.8	%
Mean total efficiency	43.7	%

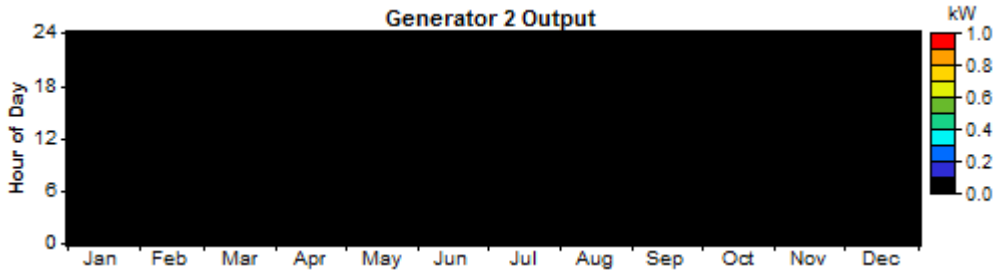


Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr
Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



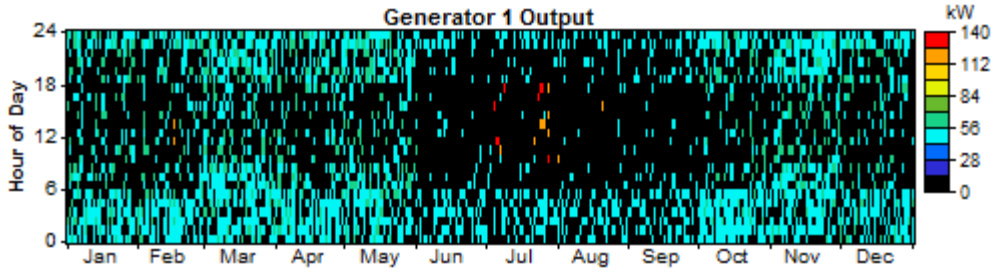
Generator 1

Quantity	Value	Units
Hours of operation	2,722	hr/yr
Number of starts	1,443	starts/yr
Operational life	22.0	yr

Capacity factor	10.3	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	143,972	kWh/yr
Mean electrical output	52.9	kW
Min. electrical output	48.0	kW
Max. electrical output	133	kW
Thermal production	95,445	kWh/yr
Mean thermal output	35.1	kW
Min. thermal output	32.9	kW
Max. thermal output	69.9	kW

Quantity	Value	Units
Fuel consumption	56,804	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	558,951	kWh/yr
Mean electrical efficiency	25.8	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	571,720
Carbon monoxide	1,343
Unburned hydocarbons	149
Particulate matter	101
Sulfur dioxide	1,149
Nitrogen oxides	11,985

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Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

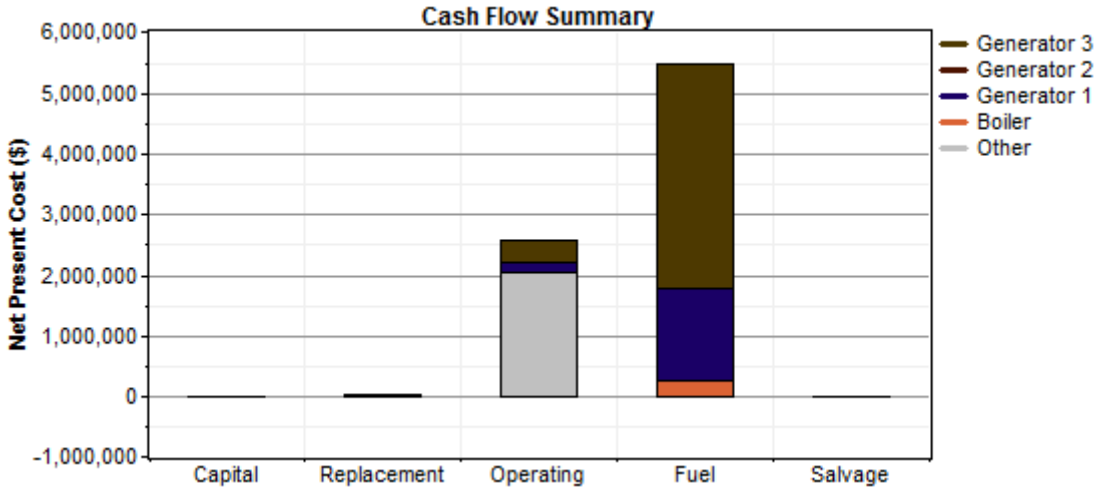
Thermal Load 1 Scaled Average: 1,000 kWh/d
Diesel Price: 1.68 $/L
Heating Oil Price: 1.68 $/L

System architecture

Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 8,033,069
Levelized cost of energy	$ 0.843/kWh
Operating cost	$ 534,969/yr



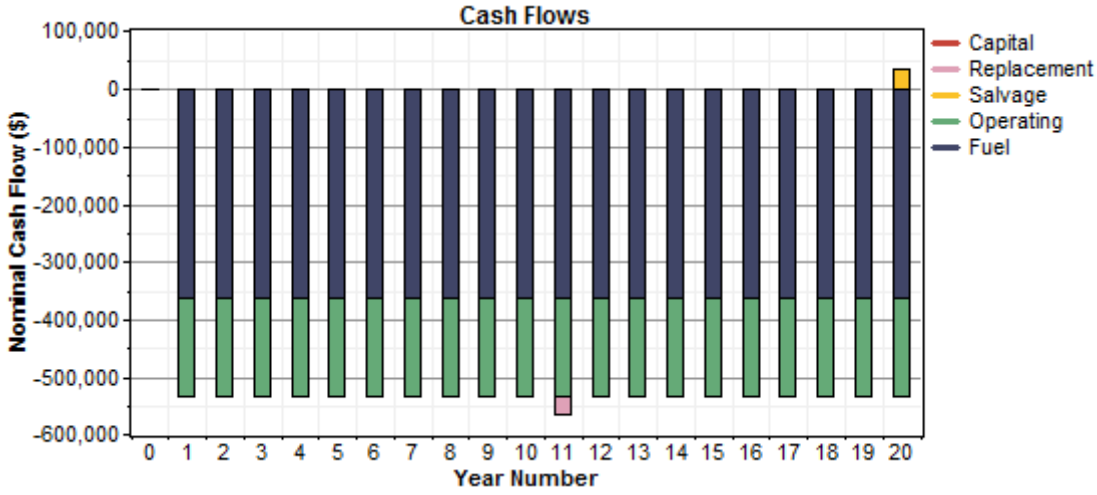
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Generator 3	0	22,463	356,058	3,716,243	-406	4,094,358
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	170,341	1,497,089	-1,296	1,666,133
Boiler	0	0	0	262,017	0	262,017
Other	0	0	2,027,154	0	0	2,027,154
System	0	22,463	2,553,553	5,475,349	-18,300	8,033,065

Annualized Costs

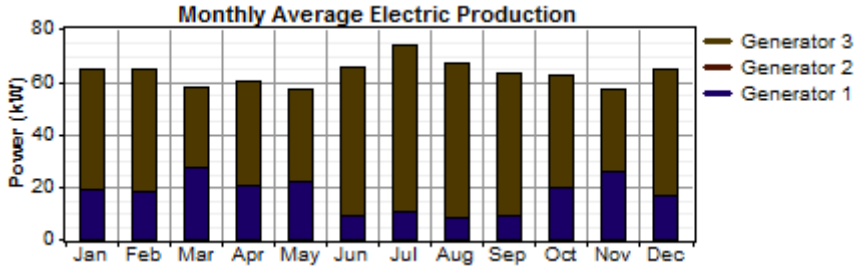
Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Generator 3	0	1,496	23,712	247,486	-27	272,667
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	11,344	99,700	-86	110,957

Boiler	0	0	0	17,449	0	17,449
Other	0	0	135,000	0	0	135,000
System	0	1,496	170,056	364,635	-1,219	534,968



Electrical

Component	Production (kWh/yr)	Fraction
Generator 3	402,783	73%
Generator 2	0	0%
Generator 1	150,555	27%
Total	553,338	100%



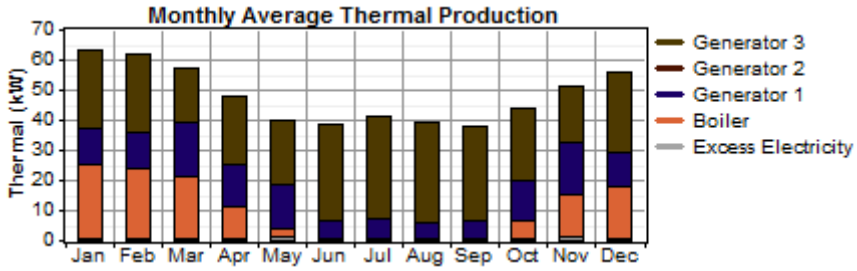
Load	Consumption (kWh/yr)	Fraction
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	5,837	kWh/yr
Unmet load	0.00	kWh/yr
Capacity shortage	0.00	kWh/yr
Renewable fraction	0.000	

Thermal

Component	Production (kWh/yr)	Fraction

Generator 3	230,290	54%
Generator 1	99,683	24%
Boiler	86,872	21%
Excess electricity	5,837	1%
Total	422,682	100%



Load	Consumption (kWh/yr)	Fraction
Thermal load	365,000	100%
Total	365,000	100%

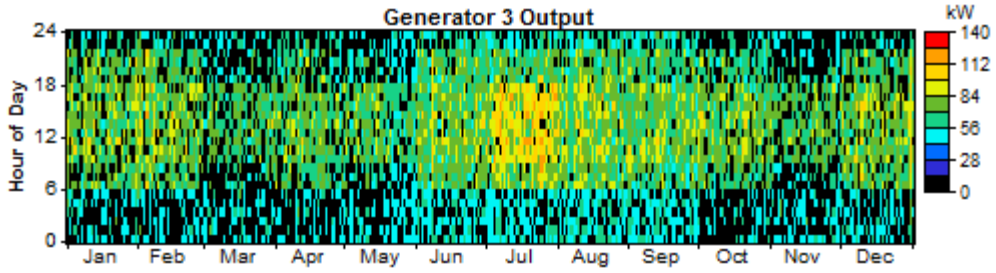
Quantity	Value	Units
Excess thermal energy	57,683	kWh/yr

Generator 3

Quantity	Value	Units
Hours of operation	5,928	hr/yr
Number of starts	1,465	starts/yr
Operational life	10.1	yr
Capacity factor	31.7	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	402,783	kWh/yr
Mean electrical output	67.9	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	230,290	kWh/yr
Mean thermal output	38.8	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	147,313	L/yr
Specific fuel consumption	0.366	L/kWh
Fuel energy input	1,449,563	kWh/yr
Mean electrical efficiency	27.8	%
Mean total efficiency	43.7	%

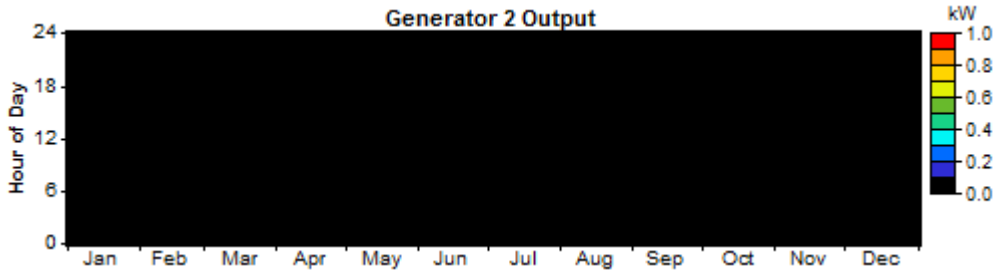


Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr
Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



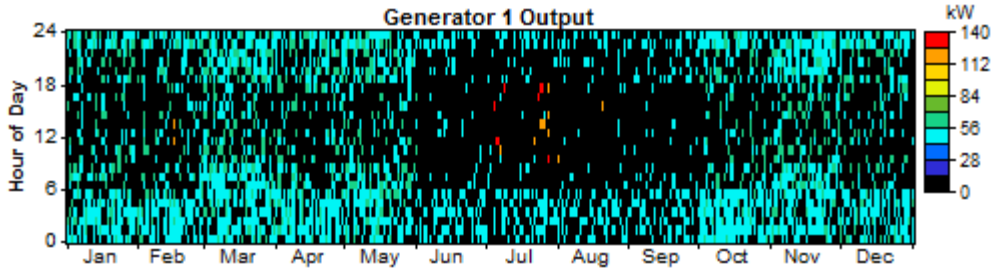
Generator 1

Quantity	Value	Units
Hours of operation	2,836	hr/yr
Number of starts	1,468	starts/yr
Operational life	21.2	yr

Capacity factor	10.7	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	150,555	kWh/yr
Mean electrical output	53.1	kW
Min. electrical output	48.0	kW
Max. electrical output	133	kW
Thermal production	99,683	kWh/yr
Mean thermal output	35.1	kW
Min. thermal output	32.9	kW
Max. thermal output	69.9	kW

Quantity	Value	Units
Fuel consumption	59,345	L/yr
Specific fuel consumption	0.394	L/kWh
Fuel energy input	583,956	kWh/yr
Mean electrical efficiency	25.8	%
Mean total efficiency	42.9	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	571,681
Carbon monoxide	1,343
Unburned hydocarbons	149
Particulate matter	101
Sulfur dioxide	1,149
Nitrogen oxides	11,986

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Appendix E
Northwind 100B/21 Economics

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Site 1
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

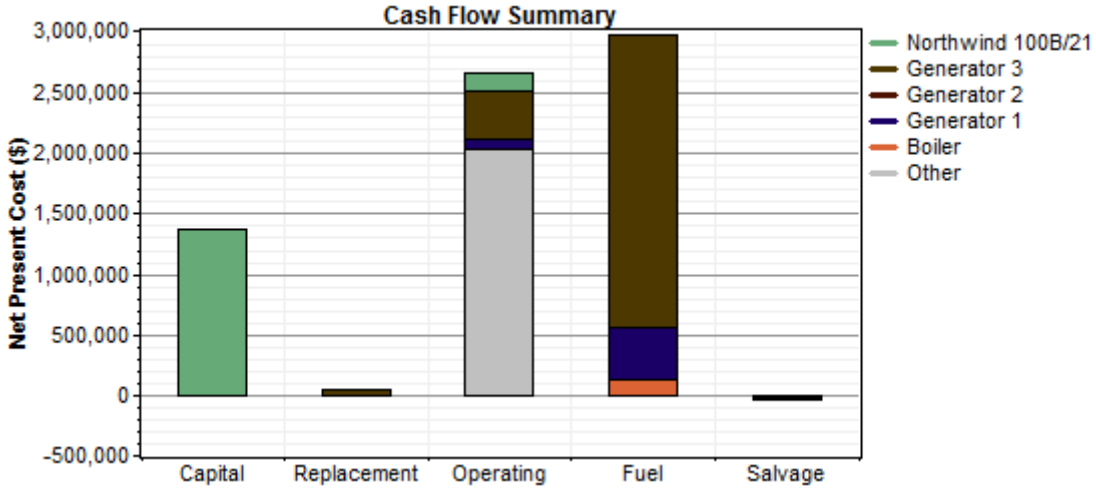
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	8	m/s
Diesel Price:	1.16	$/L
Heating Oil Price:	1.16	$/L
Northwind 100B/21 Capital Cost Multiplier:	1	
Enercon E33 Capital Cost Multiplier:	1	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,969,570
Levelized cost of energy	$ 0.751/kWh
Operating cost	$ 373,739/yr



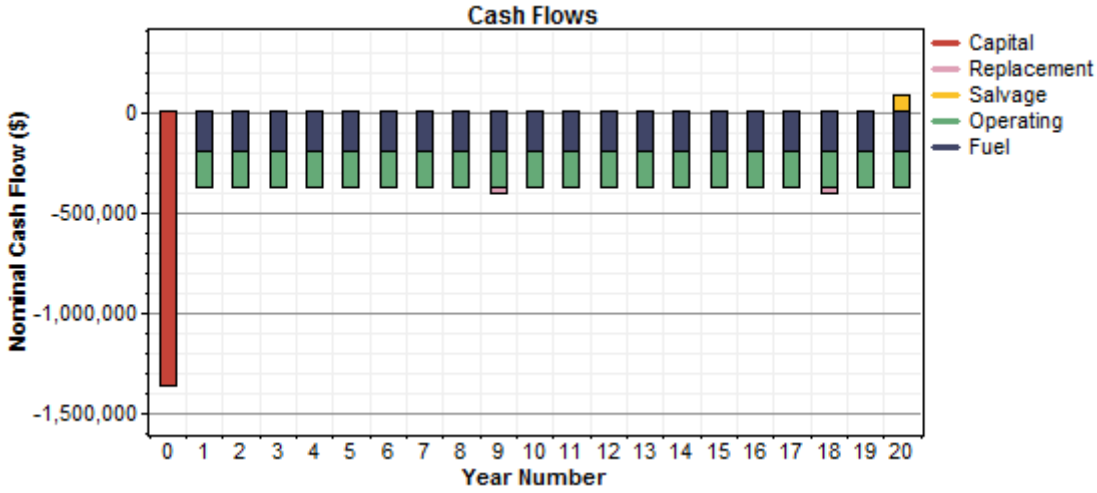
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,357,524	0	149,259	0	0	1,506,783
Generator 3	0	41,216	402,788	2,400,682	-12,950	2,831,736
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	73,758	439,075	-14,005	498,829
Boiler	0	0	0	121,663	0	121,663
Other	0	0	2,027,154	0	0	2,027,154
System	1,357,524	41,216	2,652,959	2,961,421	-43,553	6,969,568

Annualized Costs

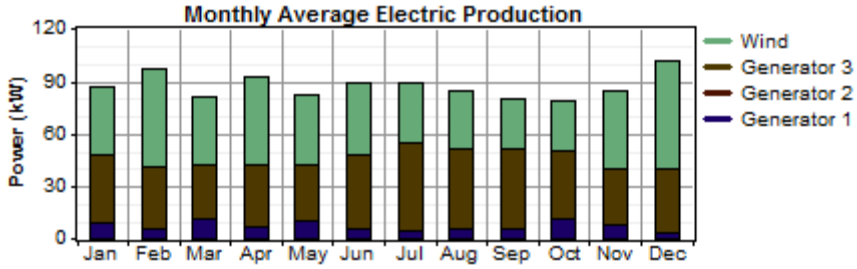
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	90,405	0	9,940	0	0	100,345
Generator 3	0	2,745	26,824	159,875	-862	188,582
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,912	29,241	-933	33,220
Boiler	0	0	0	8,102	0	8,102
Other	0	0	135,000	0	0	135,000
System	90,405	2,745	176,676	197,218	-2,900	464,144



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	361,585	47%
Generator 3	340,439	44%
Generator 2	0	0%
Generator 1	63,523	8%
Total	765,547	100%



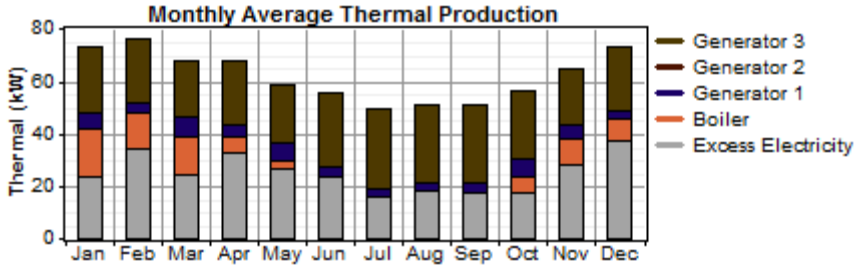
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	218,046	kWh/yr
Unmet load	0.000809	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.332	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	223,457	41%
Generator 1	42,439	8%
Boiler	58,420	11%
Excess electricity	218,046	40%
Total	542,361	100%



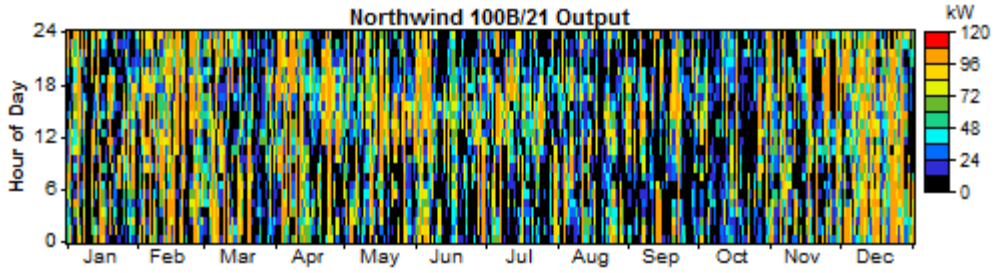
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	159,112	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	41.3	kW
Capacity factor	41.3	%
Total production	361,585	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	66.0	%
Hours of operation	7,437	hr/yr
Levelized cost	0.278	$/kWh

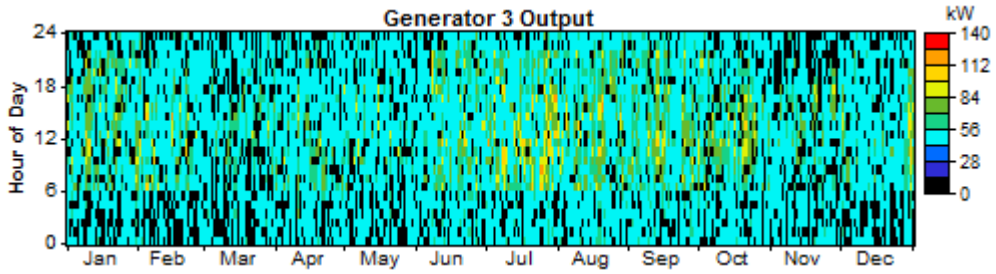


Generator 3

Quantity	Value	Units
Hours of operation	6,706	hr/yr
Number of starts	1,238	starts/yr
Operational life	8.95	yr
Capacity factor	26.8	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	340,439	kWh/yr
Mean electrical output	50.8	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	223,457	kWh/yr
Mean thermal output	33.3	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	137,824	L/yr
Specific fuel consumption	0.405	L/kWh
Fuel energy input	1,356,185	kWh/yr
Mean electrical efficiency	25.1	%
Mean total efficiency	41.6	%



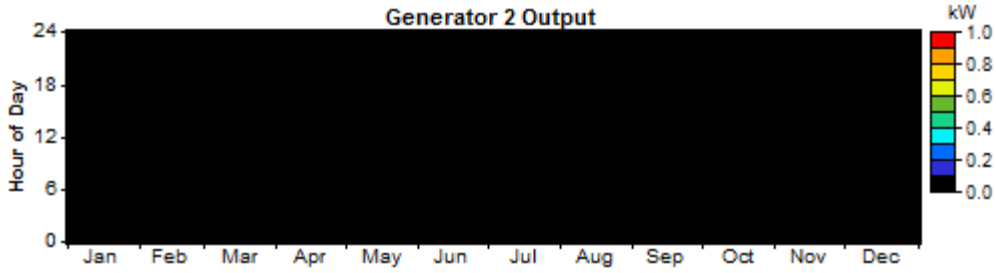
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



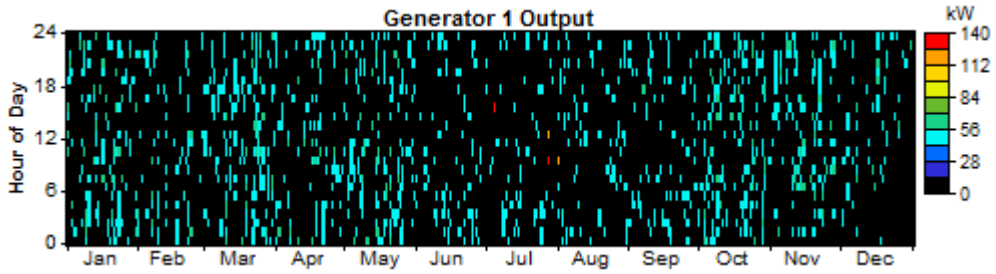
Generator 1

Quantity	Value	Units
Hours of operation	1,228	hr/yr
Number of starts	850	starts/yr
Operational life	48.9	yr
Capacity factor	4.53	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	63,523	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	128	kW
Thermal production	42,439	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	67.8	kW

Quantity	Value	Units
Fuel consumption	25,207	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	248,041	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	447,795
Carbon monoxide	1,060
Unburned hydocarbons	117
Particulate matter	79.9
Sulfur dioxide	900
Nitrogen oxides	9,456

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Site 1
Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

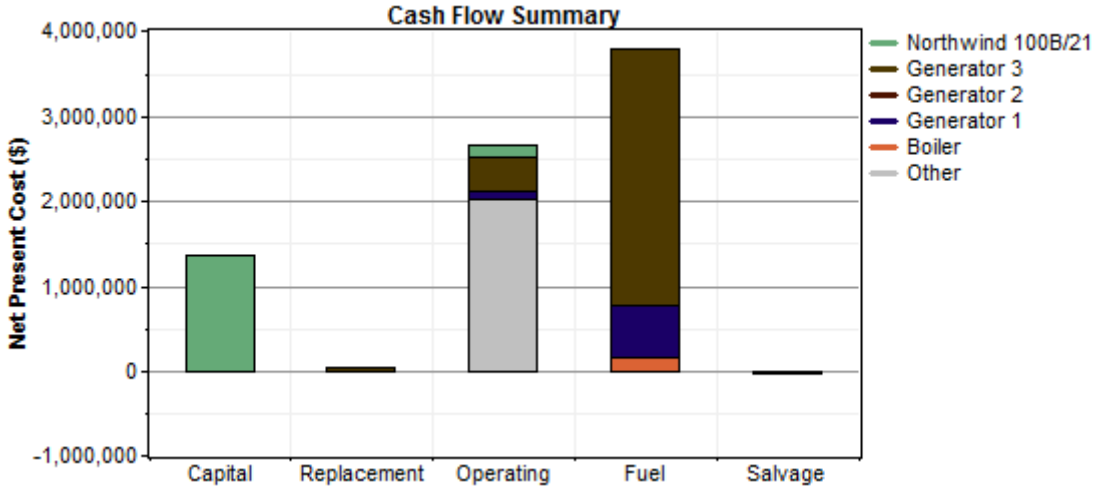
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	8	m/s
Diesel Price:	1.48	$/L
Heating Oil Price:	1.48	$/L
Northwind 100B/21 Capital Cost Multiplier:	1	
Enercon E33 Capital Cost Multiplier:	1	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,786,058
Levelized cost of energy	$ 0.823/kWh
Operating cost	$ 428,113/yr



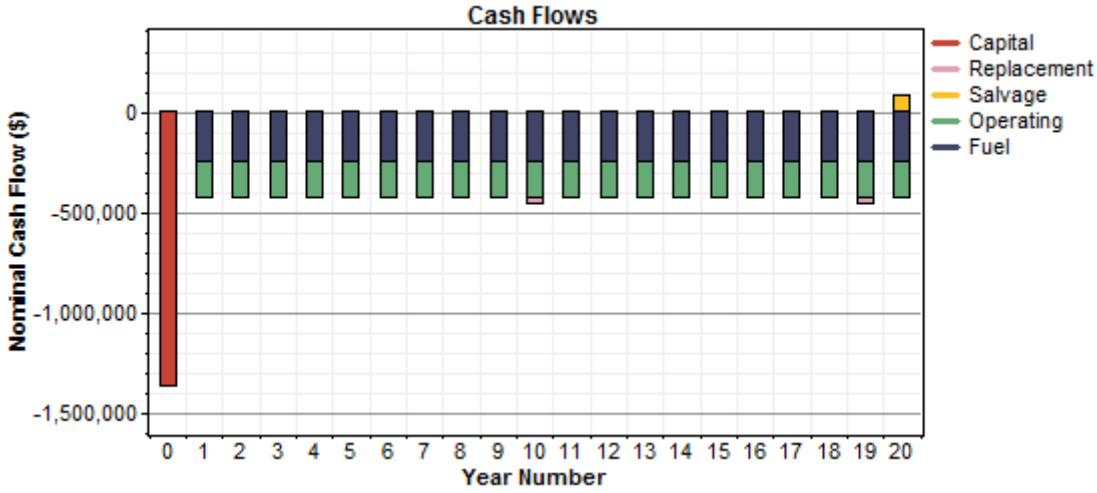
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,357,524	0	149,259	0	0	1,506,783
Generator 3	0	40,913	394,860	3,000,429	-13,696	3,422,506
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	81,687	623,019	-12,962	691,744
Boiler	0	0	0	154,465	0	154,465
Other	0	0	2,027,154	0	0	2,027,154
System	1,357,524	40,913	2,652,959	3,777,913	-43,255	7,786,054

Annualized Costs

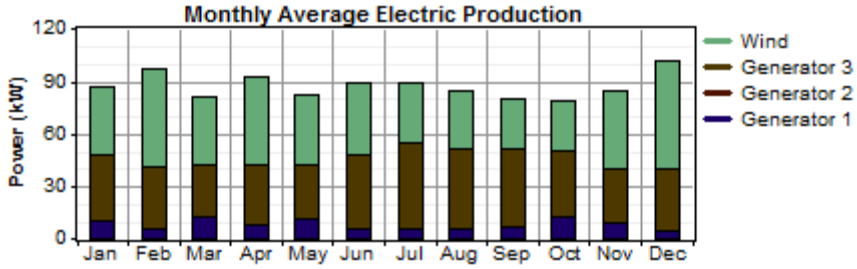
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	90,405	0	9,940	0	0	100,345
Generator 3	0	2,725	26,296	199,816	-912	227,925
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,440	41,490	-863	46,067
Boiler	0	0	0	10,287	0	10,287
Other	0	0	135,000	0	0	135,000
System	90,405	2,725	176,676	251,593	-2,881	518,519



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	361,585	47%
Generator 3	333,339	44%
Generator 2	0	0%
Generator 1	70,750	9%
Total	765,674	100%



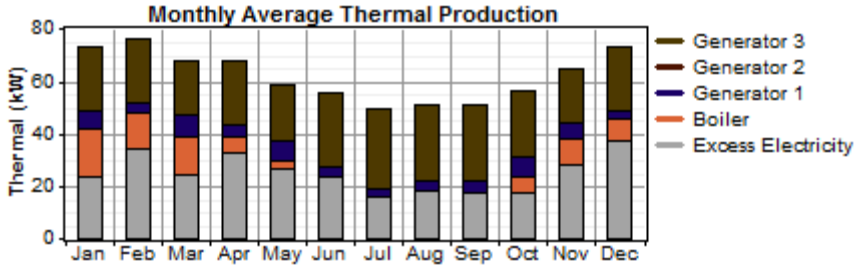
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	218,173	kWh/yr
Unmet load	0.000797	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.332	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	218,930	40%
Generator 1	47,174	9%
Boiler	58,134	11%
Excess electricity	218,173	40%
Total	542,410	100%



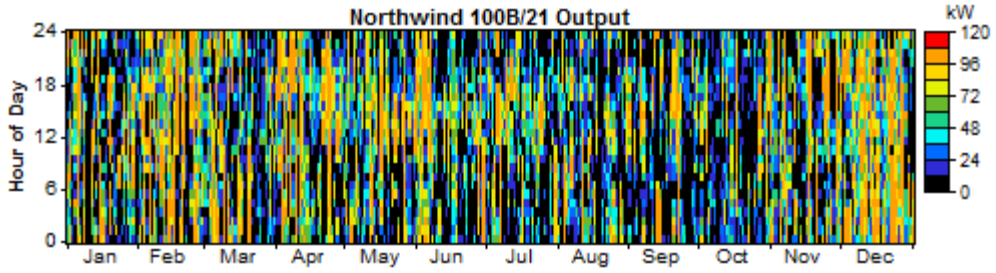
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	159,161	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	41.3	kW
Capacity factor	41.3	%
Total production	361,585	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	66.0	%
Hours of operation	7,437	hr/yr
Levelized cost	0.278	$/kWh

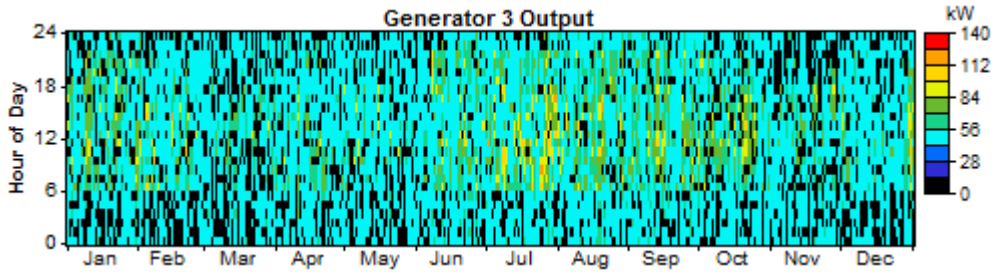


Generator 3

Quantity	Value	Units
Hours of operation	6,574	hr/yr
Number of starts	1,304	starts/yr
Operational life	9.13	yr
Capacity factor	26.2	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	333,339	kWh/yr
Mean electrical output	50.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	218,930	kWh/yr
Mean thermal output	33.3	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	135,011	L/yr
Specific fuel consumption	0.405	L/kWh
Fuel energy input	1,328,507	kWh/yr
Mean electrical efficiency	25.1	%
Mean total efficiency	41.6	%



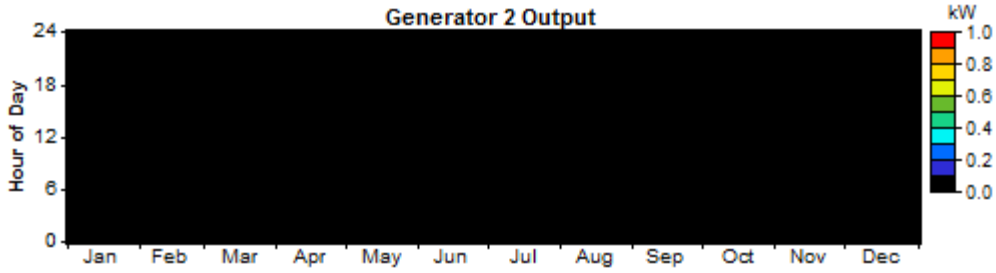
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



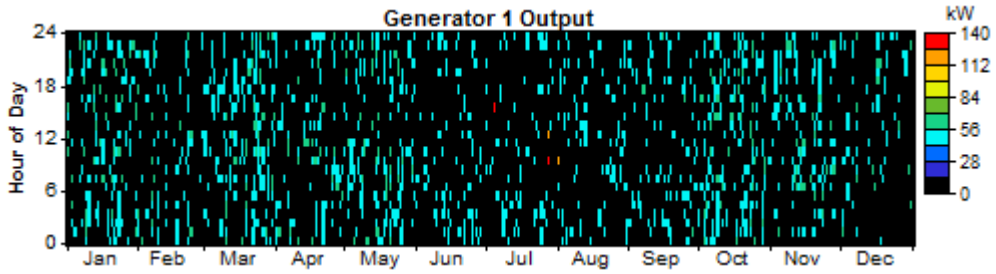
Generator 1

Quantity	Value	Units
Hours of operation	1,360	hr/yr
Number of starts	918	starts/yr
Operational life	44.1	yr
Capacity factor	5.05	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	70,750	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	128	kW
Thermal production	47,174	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	67.8	kW

Quantity	Value	Units
Fuel consumption	28,034	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	275,856	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	447,741
Carbon monoxide	1,060
Unburned hydocarbons	117
Particulate matter	79.9
Sulfur dioxide	900
Nitrogen oxides	9,457

Knight Piésold CONSULTING

Site 1
Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

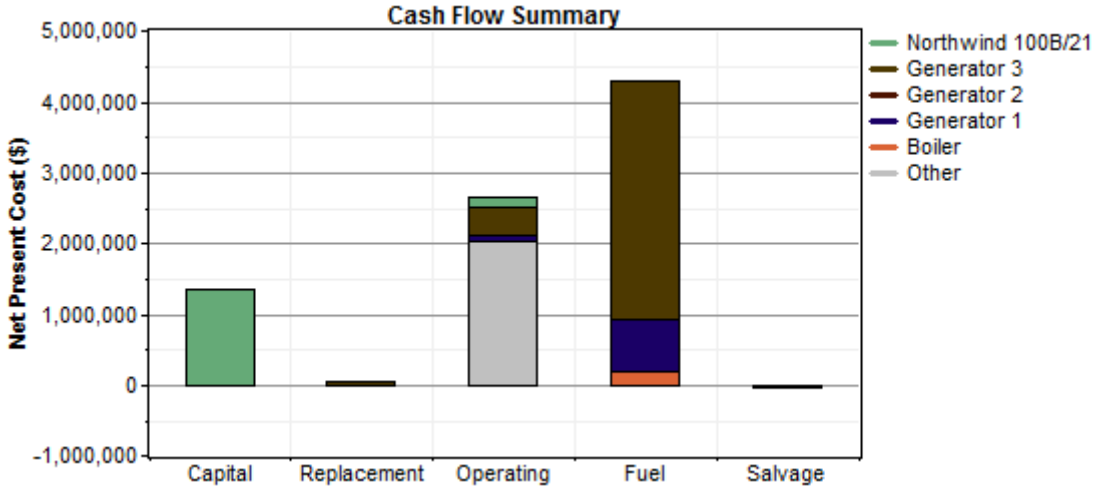
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	8	m/s
Diesel Price:	1.68	$/L
Heating Oil Price:	1.68	$/L
Northwind 100B/21 Capital Cost Multiplier:	1	
Enercon E33 Capital Cost Multiplier:	1	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 8,296,385
Levelized cost of energy	$ 0.869/kWh
Operating cost	$ 462,099/yr



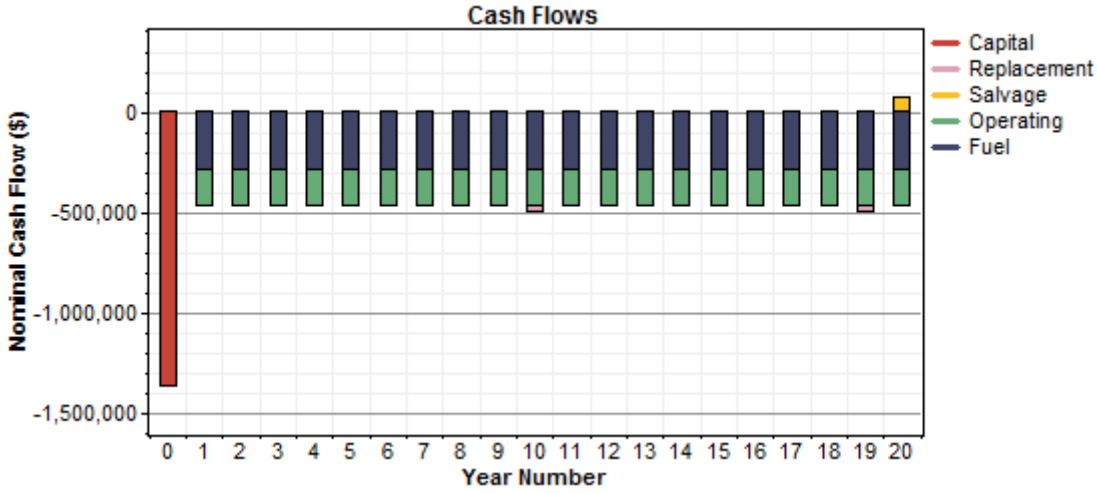
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,357,524	0	149,259	0	0	1,506,783
Generator 3	0	40,770	391,196	3,372,213	-14,040	3,790,138
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	85,351	741,049	-12,480	813,920
Boiler	0	0	0	174,984	0	174,984
Other	0	0	2,027,154	0	0	2,027,154
System	1,357,524	40,770	2,652,959	4,288,245	-43,117	8,296,382

Annualized Costs

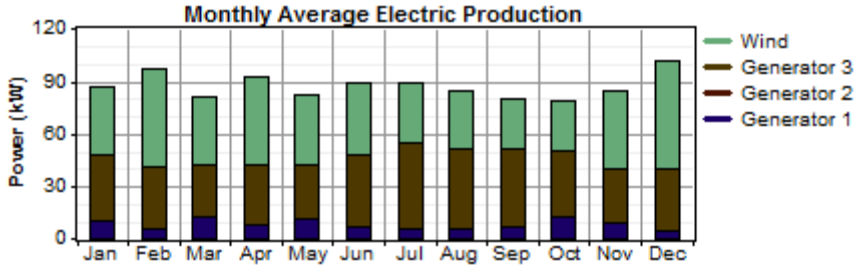
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	90,405	0	9,940	0	0	100,345
Generator 3	0	2,715	26,052	224,575	-935	252,407
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,684	49,351	-831	54,204
Boiler	0	0	0	11,653	0	11,653
Other	0	0	135,000	0	0	135,000
System	90,405	2,715	176,676	285,579	-2,871	552,504



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	361,585	47%
Generator 3	329,917	43%
Generator 2	0	0%
Generator 1	74,210	10%
Total	765,711	100%



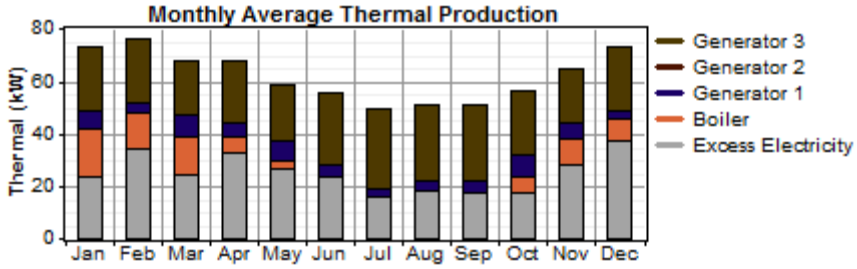
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	218,210	kWh/yr
Unmet load	0.000797	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.332	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	216,792	40%
Generator 1	49,414	9%
Boiler	58,016	11%
Excess electricity	218,210	40%
Total	542,433	100%



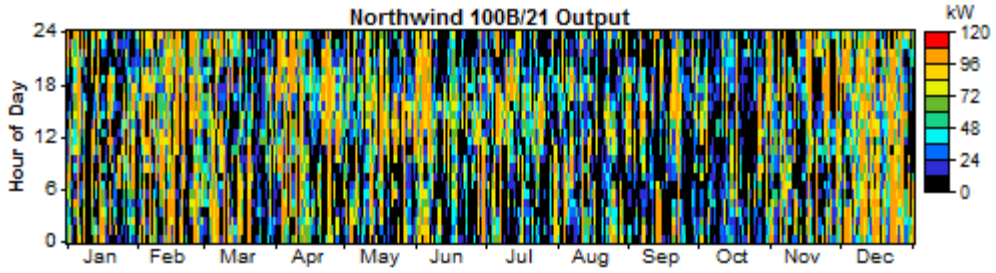
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	159,183	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	41.3	kW
Capacity factor	41.3	%
Total production	361,585	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	66.0	%
Hours of operation	7,437	hr/yr
Levelized cost	0.278	$/kWh

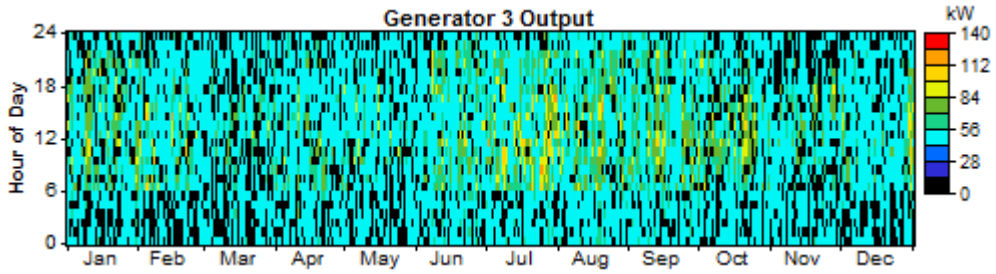


Generator 3

Quantity	Value	Units
Hours of operation	6,513	hr/yr
Number of starts	1,328	starts/yr
Operational life	9.21	yr
Capacity factor	26.0	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	329,917	kWh/yr
Mean electrical output	50.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	216,792	kWh/yr
Mean thermal output	33.3	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	133,676	L/yr
Specific fuel consumption	0.405	L/kWh
Fuel energy input	1,315,370	kWh/yr
Mean electrical efficiency	25.1	%
Mean total efficiency	41.6	%



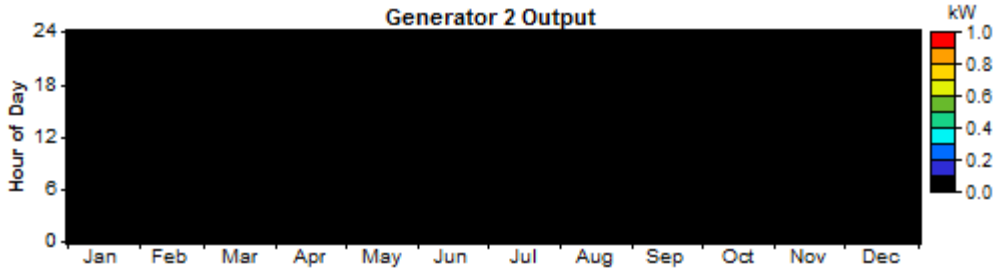
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



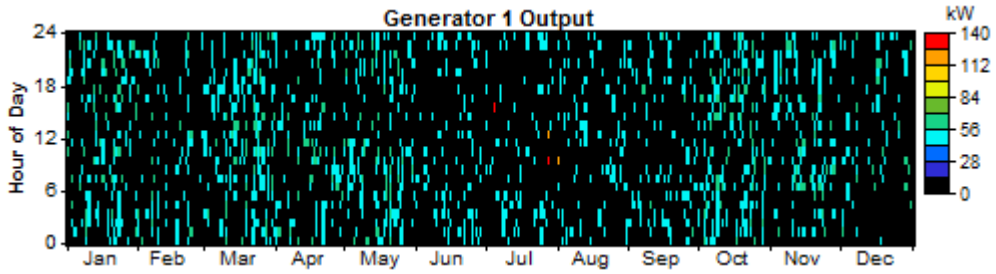
Generator 1

Quantity	Value	Units
Hours of operation	1,421	hr/yr
Number of starts	943	starts/yr
Operational life	42.2	yr
Capacity factor	5.29	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	74,210	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	128	kW
Thermal production	49,414	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	67.8	kW

Quantity	Value	Units
Fuel consumption	29,375	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	289,055	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	447,720
Carbon monoxide	1,060
Unburned hydocarbons	117
Particulate matter	79.9
Sulfur dioxide	900
Nitrogen oxides	9,457

Knight Piésold CONSULTING

Site 1
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

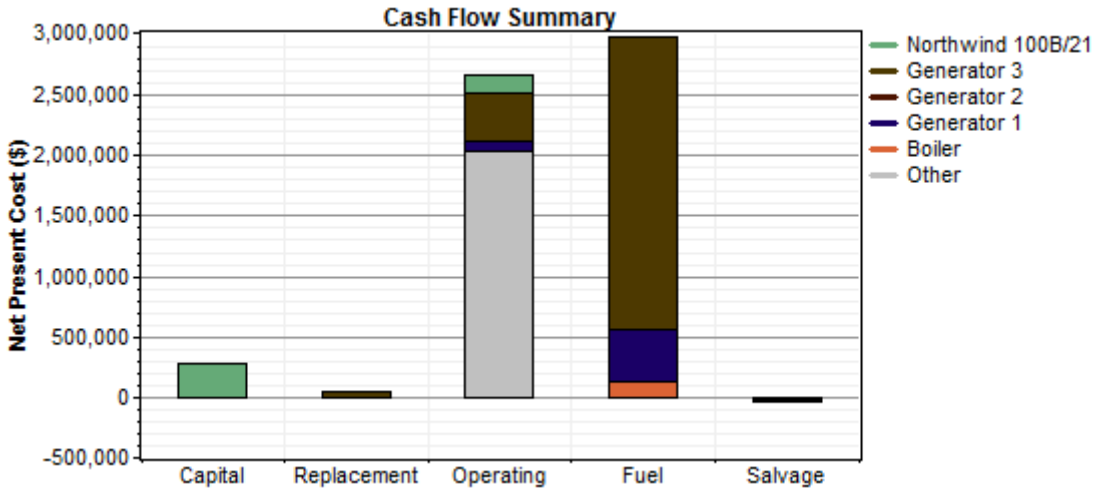
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	8	m/s
Diesel Price:	1.16	$/L
Heating Oil Price:	1.16	$/L
Northwind 100B/21 Capital Cost Multiplier:	1	
Enercon E33 Capital Cost Multiplier:	1	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,883,552
Levelized cost of energy	$ 0.619/kWh
Operating cost	$ 373,739/yr



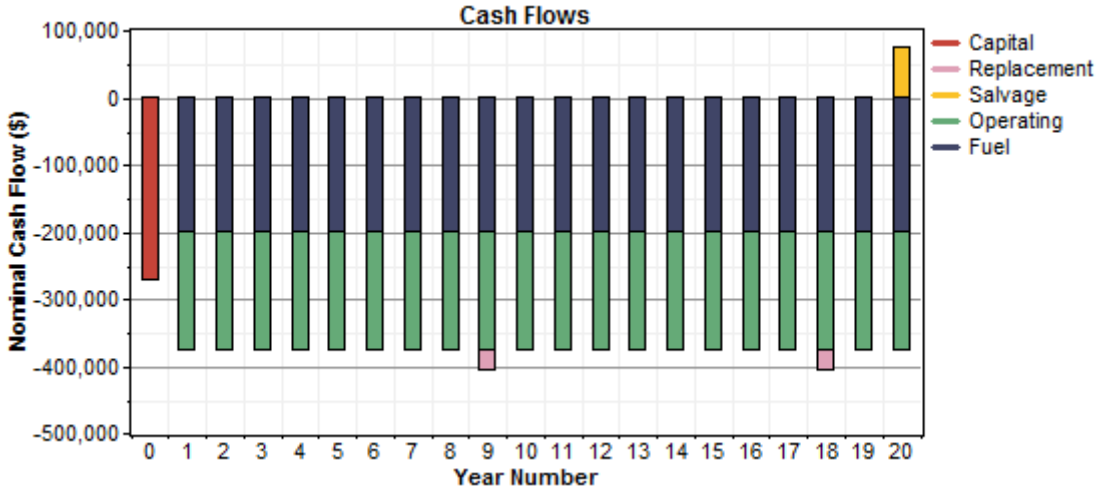
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	271,505	0	149,259	0	0	420,764
Generator 3	0	41,216	402,788	2,400,682	-12,950	2,831,736
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	73,758	439,075	-14,005	498,829
Boiler	0	0	0	121,663	0	121,663
Other	0	0	2,027,154	0	0	2,027,154
System	271,505	41,216	2,652,959	2,961,421	-43,553	5,883,549

Annualized Costs

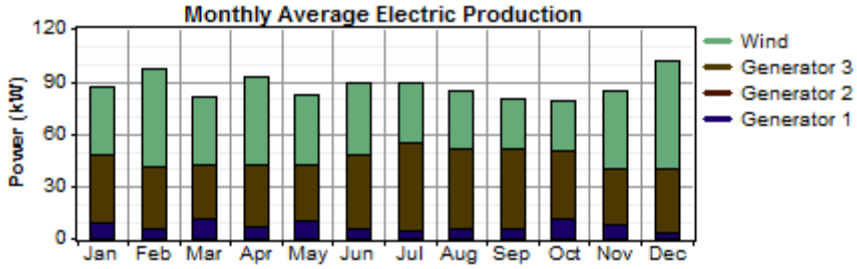
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	18,081	0	9,940	0	0	28,021
Generator 3	0	2,745	26,824	159,875	-862	188,582
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,912	29,241	-933	33,220
Boiler	0	0	0	8,102	0	8,102
Other	0	0	135,000	0	0	135,000
System	18,081	2,745	176,676	197,218	-2,900	391,820



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	361,585	47%
Generator 3	340,439	44%
Generator 2	0	0%
Generator 1	63,523	8%
Total	765,547	100%



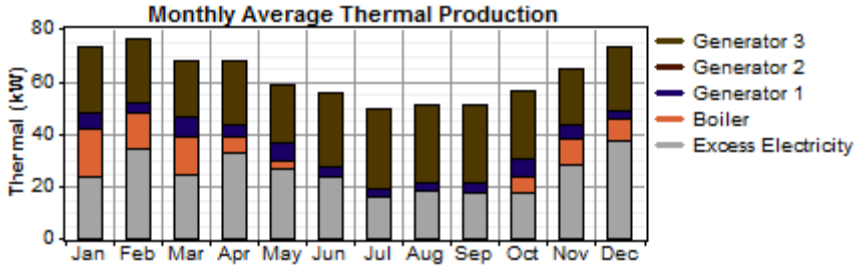
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	218,046	kWh/yr
Unmet load	0.000809	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.332	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	223,457	41%
Generator 1	42,439	8%
Boiler	58,420	11%
Excess electricity	218,046	40%
Total	542,361	100%



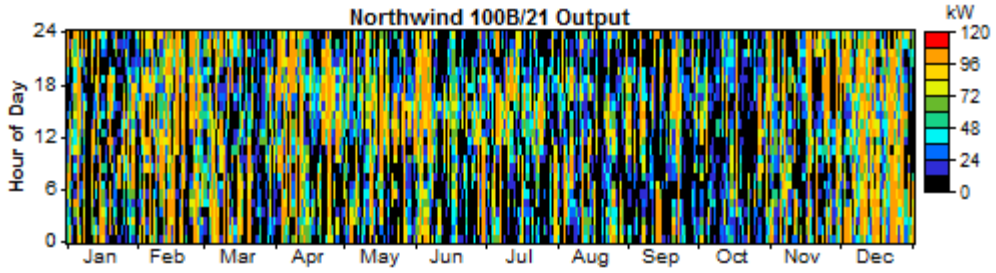
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	159,112	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	41.3	kW
Capacity factor	41.3	%
Total production	361,585	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	66.0	%
Hours of operation	7,437	hr/yr
Levelized cost	0.0775	$/kWh

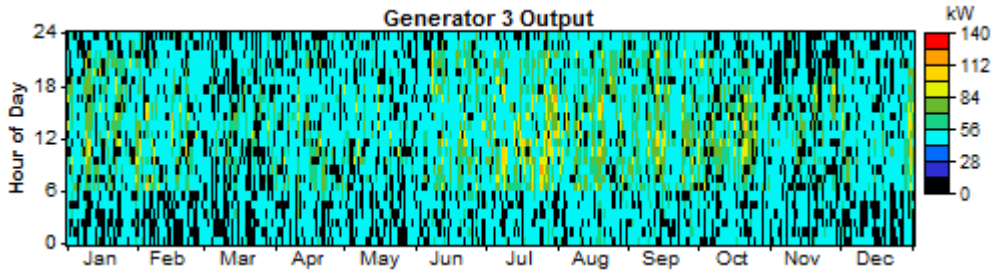


Generator 3

Quantity	Value	Units
Hours of operation	6,706	hr/yr
Number of starts	1,238	starts/yr
Operational life	8.95	yr
Capacity factor	26.8	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	340,439	kWh/yr
Mean electrical output	50.8	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	223,457	kWh/yr
Mean thermal output	33.3	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	137,824	L/yr
Specific fuel consumption	0.405	L/kWh
Fuel energy input	1,356,185	kWh/yr
Mean electrical efficiency	25.1	%
Mean total efficiency	41.6	%



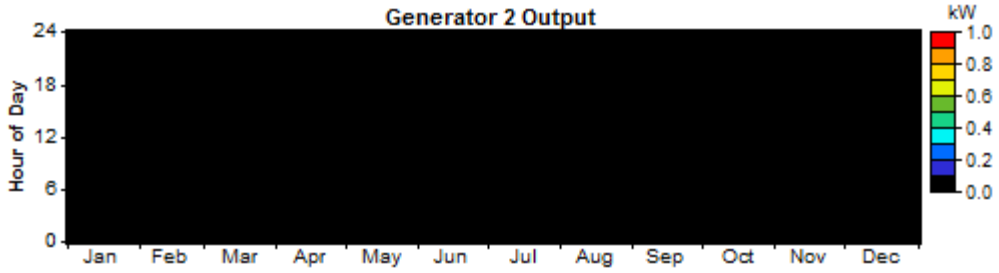
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



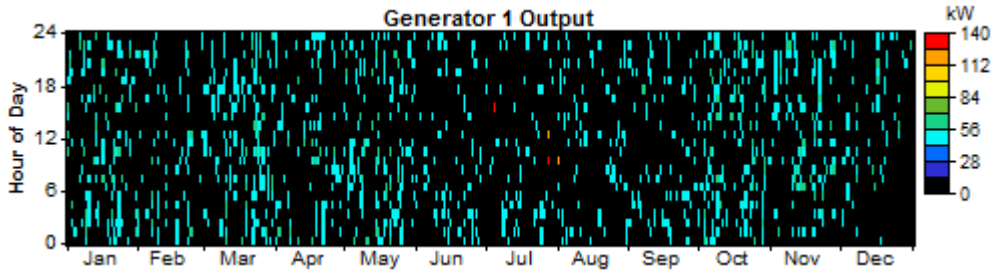
Generator 1

Quantity	Value	Units
Hours of operation	1,228	hr/yr
Number of starts	850	starts/yr
Operational life	48.9	yr
Capacity factor	4.53	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	63,523	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	128	kW
Thermal production	42,439	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	67.8	kW

Quantity	Value	Units
Fuel consumption	25,207	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	248,041	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	447,795
Carbon monoxide	1,060
Unburned hydocarbons	117
Particulate matter	79.9
Sulfur dioxide	900
Nitrogen oxides	9,456

Knight Piésold CONSULTING

Site 1
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

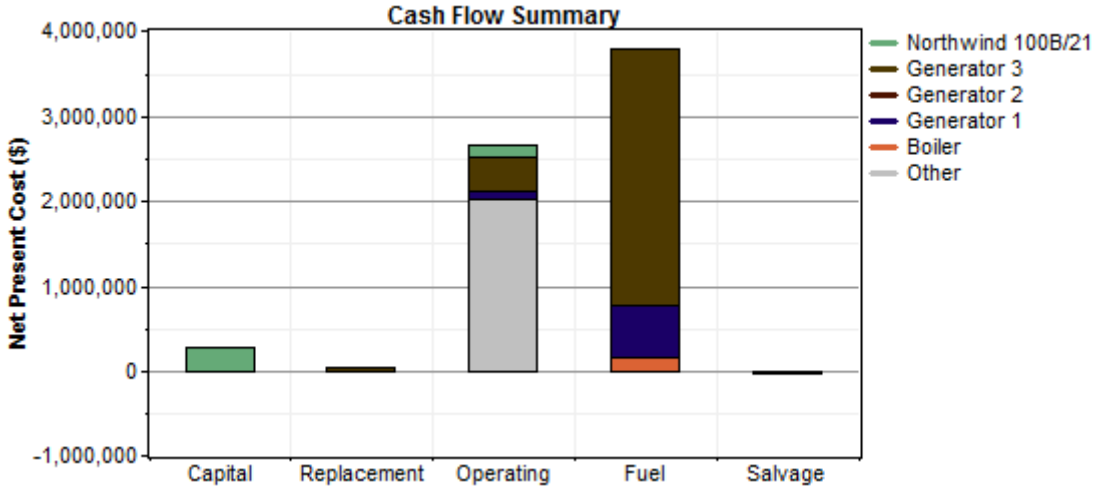
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	8	m/s
Diesel Price:	1.48	$/L
Heating Oil Price:	1.48	$/L
Northwind 100B/21 Capital Cost Multiplier:	1	
Enercon E33 Capital Cost Multiplier:	1	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,700,039
Levelized cost of energy	$ 0.691/kWh
Operating cost	$ 428,113/yr



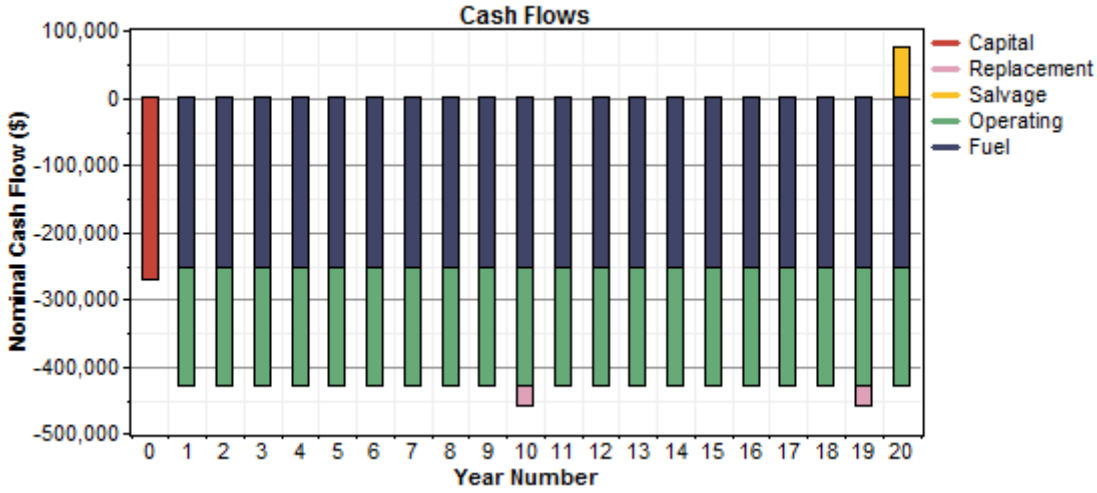
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	271,505	0	149,259	0	0	420,764
Generator 3	0	40,913	394,860	3,000,429	-13,696	3,422,506
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	81,687	623,019	-12,962	691,744
Boiler	0	0	0	154,465	0	154,465
Other	0	0	2,027,154	0	0	2,027,154
System	271,505	40,913	2,652,959	3,777,913	-43,255	6,700,036

Annualized Costs

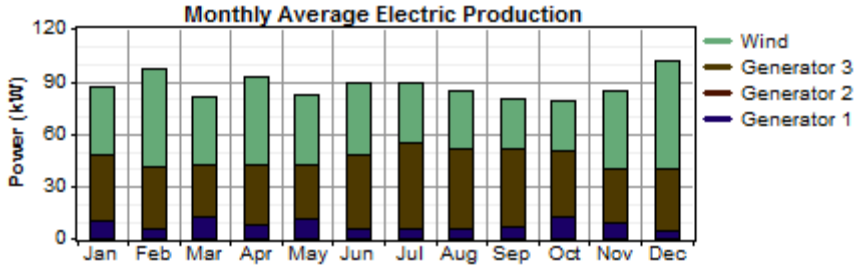
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	18,081	0	9,940	0	0	28,021
Generator 3	0	2,725	26,296	199,816	-912	227,925
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,440	41,490	-863	46,067
Boiler	0	0	0	10,287	0	10,287
Other	0	0	135,000	0	0	135,000
System	18,081	2,725	176,676	251,593	-2,881	446,194



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	361,585	47%
Generator 3	333,339	44%
Generator 2	0	0%
Generator 1	70,750	9%
Total	765,674	100%



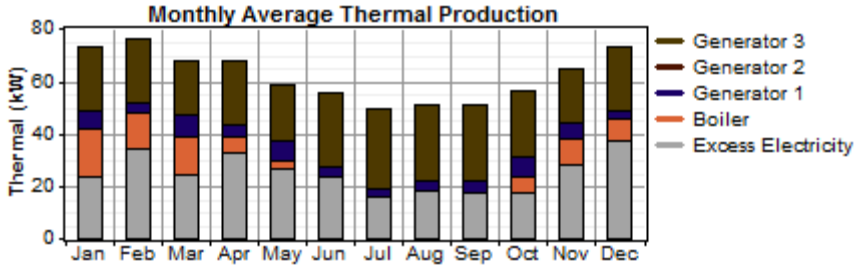
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	218,173	kWh/yr
Unmet load	0.000797	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.332	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	218,930	40%
Generator 1	47,174	9%
Boiler	58,134	11%
Excess electricity	218,173	40%
Total	542,410	100%



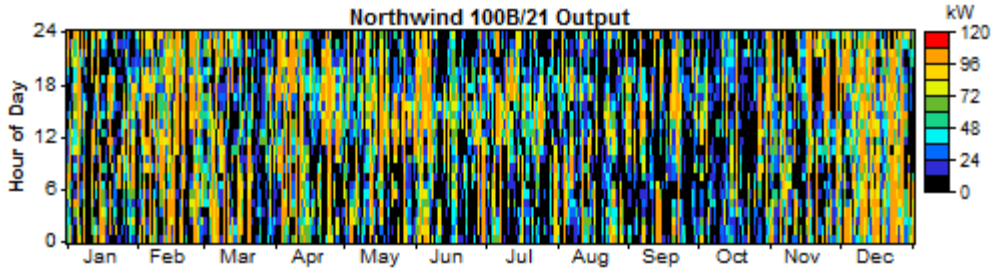
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	159,161	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	41.3	kW
Capacity factor	41.3	%
Total production	361,585	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	66.0	%
Hours of operation	7,437	hr/yr
Levelized cost	0.0775	$/kWh

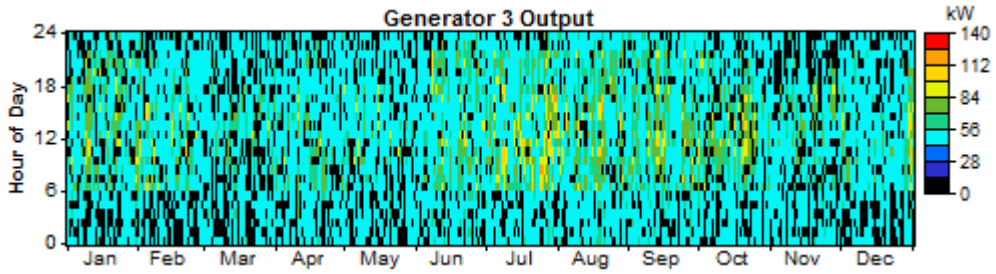


Generator 3

Quantity	Value	Units
Hours of operation	6,574	hr/yr
Number of starts	1,304	starts/yr
Operational life	9.13	yr
Capacity factor	26.2	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	333,339	kWh/yr
Mean electrical output	50.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	218,930	kWh/yr
Mean thermal output	33.3	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	135,011	L/yr
Specific fuel consumption	0.405	L/kWh
Fuel energy input	1,328,507	kWh/yr
Mean electrical efficiency	25.1	%
Mean total efficiency	41.6	%



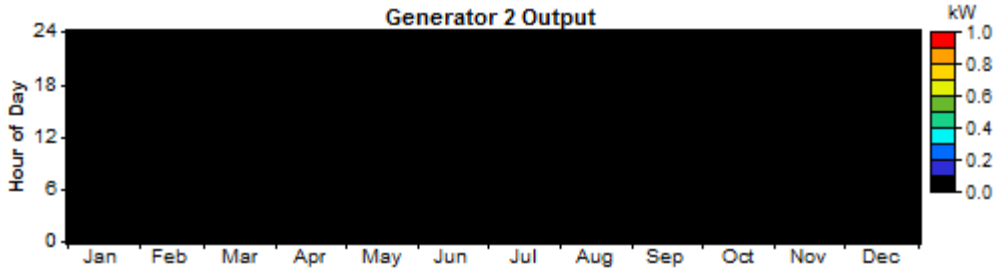
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



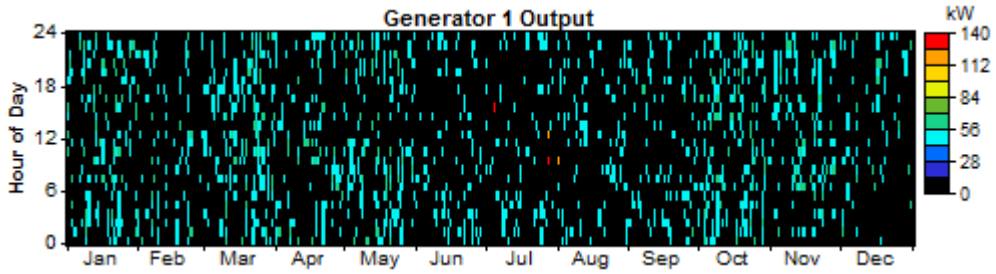
Generator 1

Quantity	Value	Units
Hours of operation	1,360	hr/yr
Number of starts	918	starts/yr
Operational life	44.1	yr
Capacity factor	5.05	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	70,750	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	128	kW
Thermal production	47,174	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	67.8	kW

Quantity	Value	Units
Fuel consumption	28,034	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	275,856	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	447,741
Carbon monoxide	1,060
Unburned hydocarbons	117
Particulate matter	79.9
Sulfur dioxide	900
Nitrogen oxides	9,457

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Site 1
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

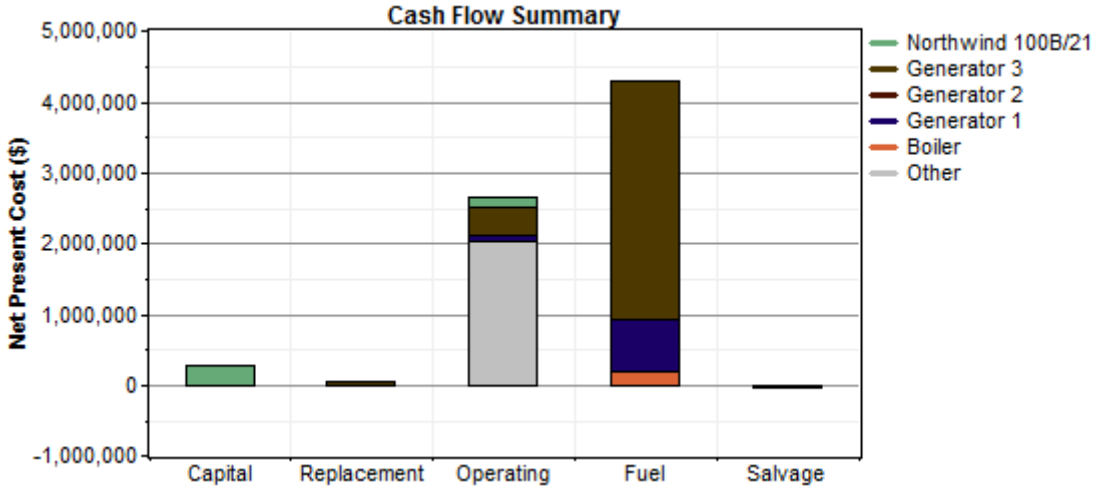
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	8	m/s
Diesel Price:	1.68	$/L
Heating Oil Price:	1.68	$/L
Northwind 100B/21 Capital Cost Multiplier:	1	
Enercon E33 Capital Cost Multiplier:	1	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,210,366
Levelized cost of energy	$ 0.736/kWh
Operating cost	$ 462,099/yr



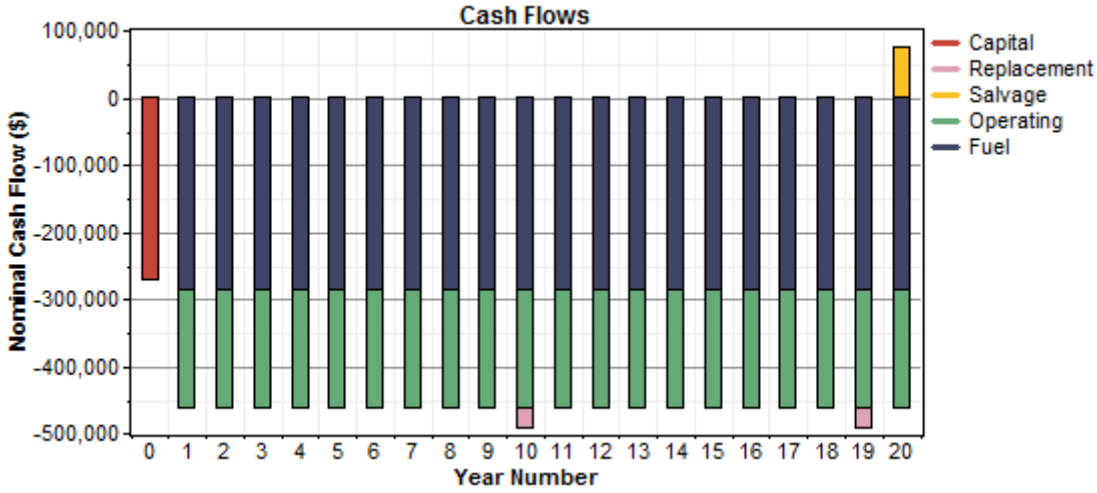
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	271,505	0	149,259	0	0	420,764
Generator 3	0	40,770	391,196	3,372,213	-14,040	3,790,138
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	85,351	741,049	-12,480	813,920
Boiler	0	0	0	174,984	0	174,984
Other	0	0	2,027,154	0	0	2,027,154
System	271,505	40,770	2,652,959	4,288,245	-43,117	7,210,363

Annualized Costs

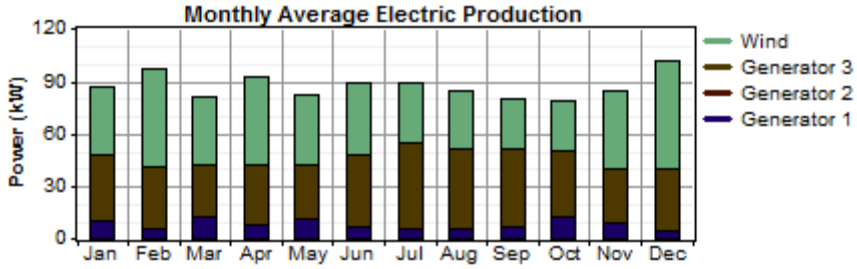
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	18,081	0	9,940	0	0	28,021
Generator 3	0	2,715	26,052	224,575	-935	252,407
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,684	49,351	-831	54,204
Boiler	0	0	0	11,653	0	11,653
Other	0	0	135,000	0	0	135,000
System	18,081	2,715	176,676	285,579	-2,871	480,180



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	361,585	47%
Generator 3	329,917	43%
Generator 2	0	0%
Generator 1	74,210	10%
Total	765,711	100%



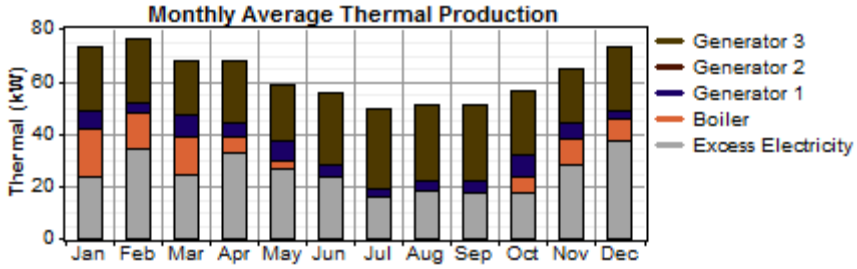
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	218,210	kWh/yr
Unmet load	0.000797	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.332	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	216,792	40%
Generator 1	49,414	9%
Boiler	58,016	11%
Excess electricity	218,210	40%
Total	542,433	100%



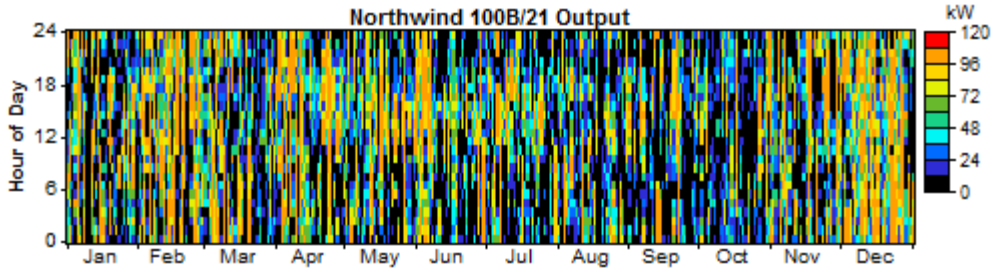
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	159,183	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	41.3	kW
Capacity factor	41.3	%
Total production	361,585	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	66.0	%
Hours of operation	7,437	hr/yr
Levelized cost	0.0775	$/kWh

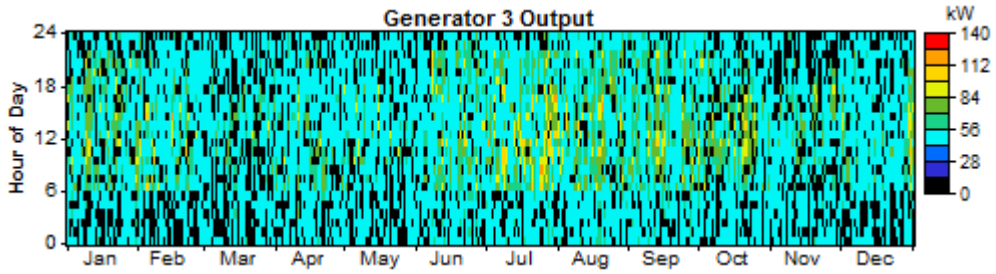


Generator 3

Quantity	Value	Units
Hours of operation	6,513	hr/yr
Number of starts	1,328	starts/yr
Operational life	9.21	yr
Capacity factor	26.0	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	329,917	kWh/yr
Mean electrical output	50.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	216,792	kWh/yr
Mean thermal output	33.3	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	133,676	L/yr
Specific fuel consumption	0.405	L/kWh
Fuel energy input	1,315,370	kWh/yr
Mean electrical efficiency	25.1	%
Mean total efficiency	41.6	%



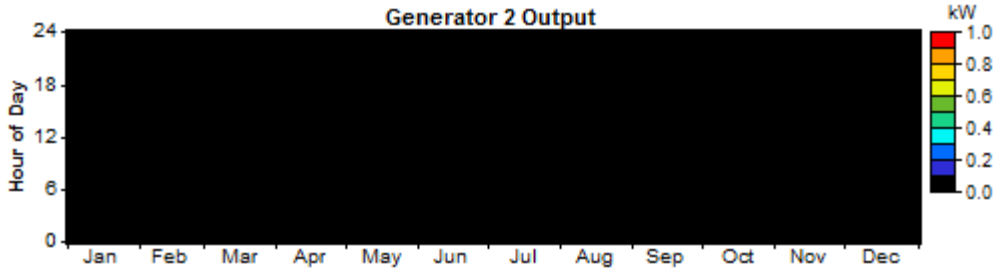
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



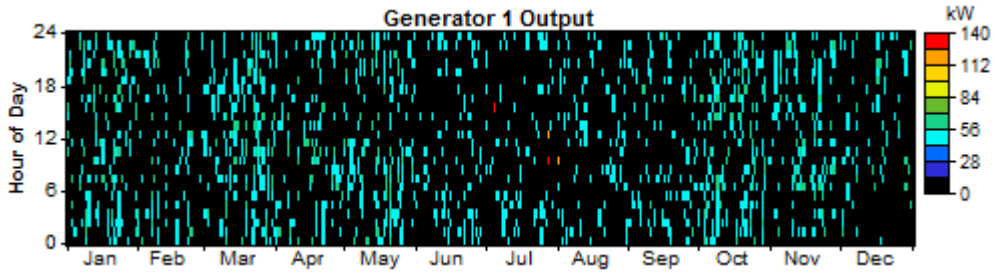
Generator 1

Quantity	Value	Units
Hours of operation	1,421	hr/yr
Number of starts	943	starts/yr
Operational life	42.2	yr
Capacity factor	5.29	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	74,210	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	128	kW
Thermal production	49,414	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	67.8	kW

Quantity	Value	Units
Fuel consumption	29,375	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	289,055	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	447,720
Carbon monoxide	1,060
Unburned hydocarbons	117
Particulate matter	79.9
Sulfur dioxide	900
Nitrogen oxides	9,457

Knight Piésold
CONSULTING

Site 2
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

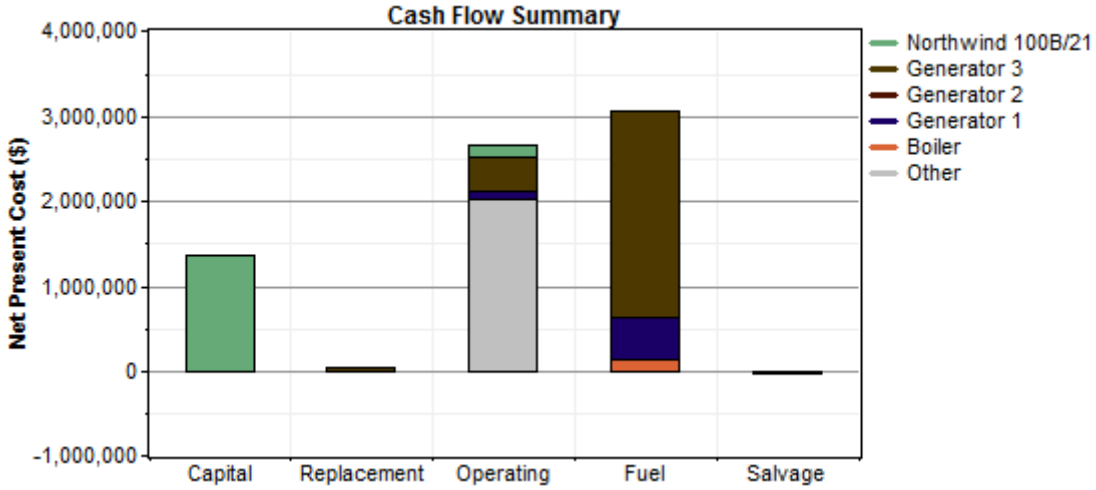
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.25 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,081,124
Levelized cost of energy	$ 0.764/kWh
Operating cost	$ 381,168/yr



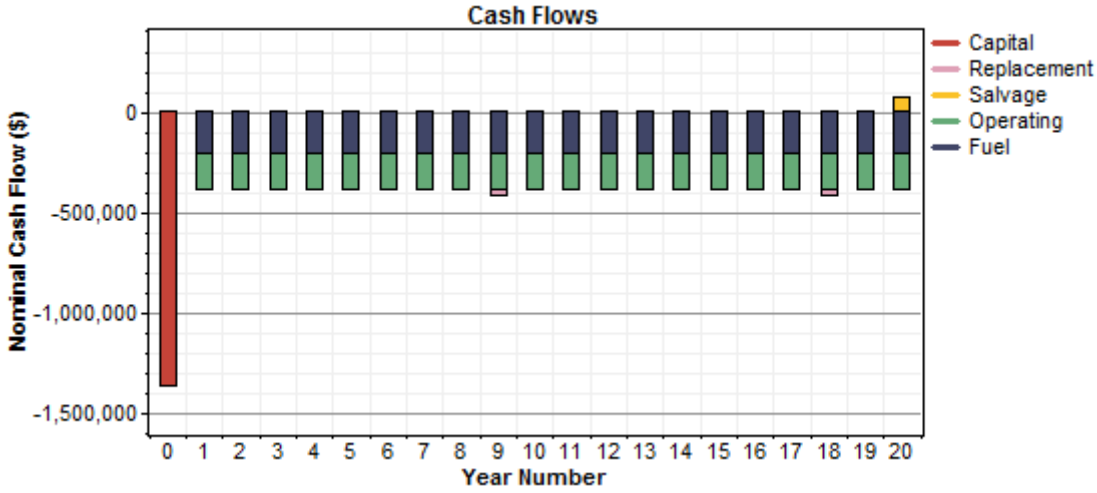
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,357,524	0	149,259	0	0	1,506,783
Generator 3	0	41,306	405,191	2,442,239	-12,725	2,876,010
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	81,927	487,755	-12,930	556,751
Boiler	0	0	0	131,020	0	131,020
Other	0	0	2,027,154	0	0	2,027,154
System	1,357,524	41,306	2,663,530	3,061,014	-42,252	7,081,122

Annualized Costs

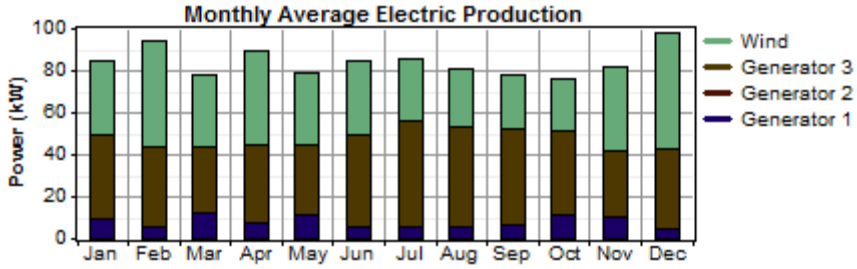
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	90,405	0	9,940	0	0	100,345
Generator 3	0	2,751	26,984	162,643	-847	191,530
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,456	32,482	-861	37,077
Boiler	0	0	0	8,725	0	8,725
Other	0	0	135,000	0	0	135,000
System	90,405	2,751	177,380	203,851	-2,814	471,573



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	318,991	43%
Generator 3	348,720	47%
Generator 2	0	0%
Generator 1	70,568	10%
Total	738,279	100%



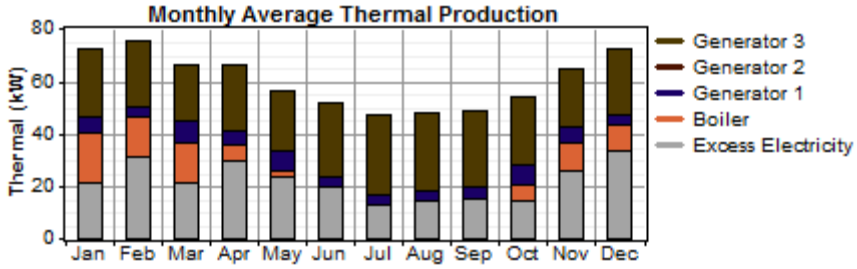
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	190,778	kWh/yr
Unmet load	0.000881	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.297	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	226,800	43%
Generator 1	47,144	9%
Boiler	62,913	12%
Excess electricity	190,778	36%
Total	527,635	100%



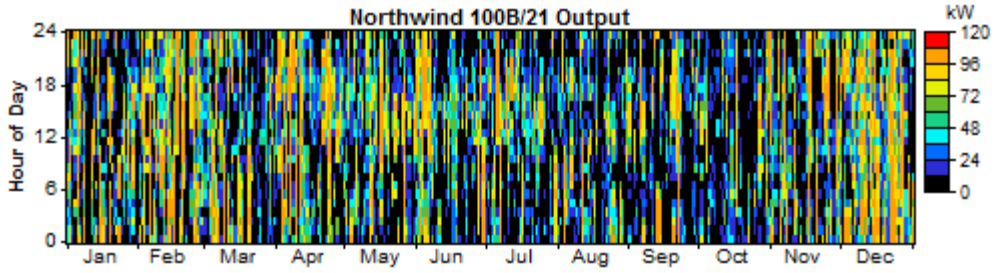
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	144,385	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	36.4	kW
Capacity factor	36.4	%
Total production	318,991	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	58.3	%
Hours of operation	7,250	hr/yr
Levelized cost	0.315	$/kWh

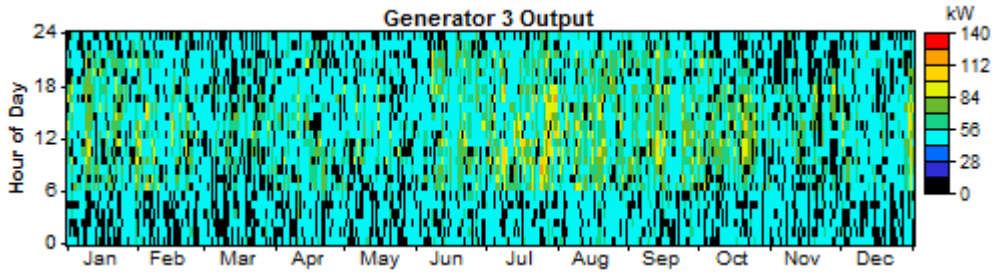


Generator 3

Quantity	Value	Units
Hours of operation	6,746	hr/yr
Number of starts	1,240	starts/yr
Operational life	8.89	yr
Capacity factor	27.5	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	348,720	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	226,800	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	140,209	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	1,379,661	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



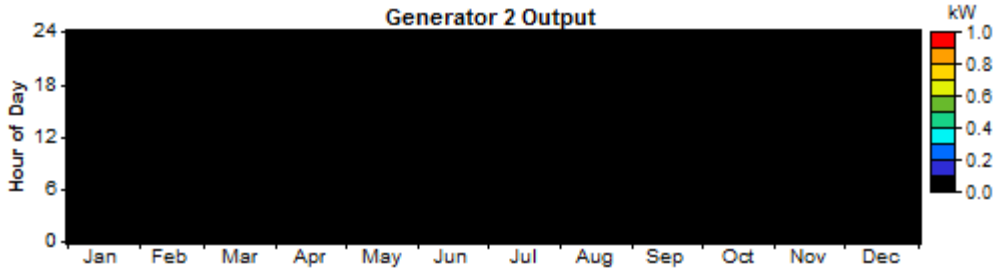
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



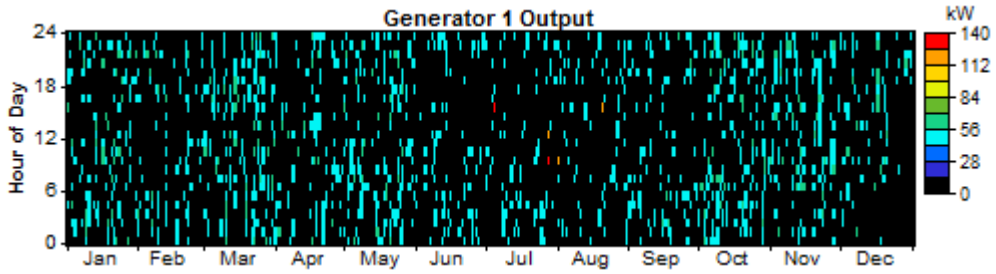
Generator 1

Quantity	Value	Units
Hours of operation	1,364	hr/yr
Number of starts	919	starts/yr
Operational life	44.0	yr
Capacity factor	5.03	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	70,568	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	47,144	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	28,002	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	275,541	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	462,858
Carbon monoxide	1,093
Unburned hydocarbons	121
Particulate matter	82.4
Sulfur dioxide	930
Nitrogen oxides	9,756

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Site 2
Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

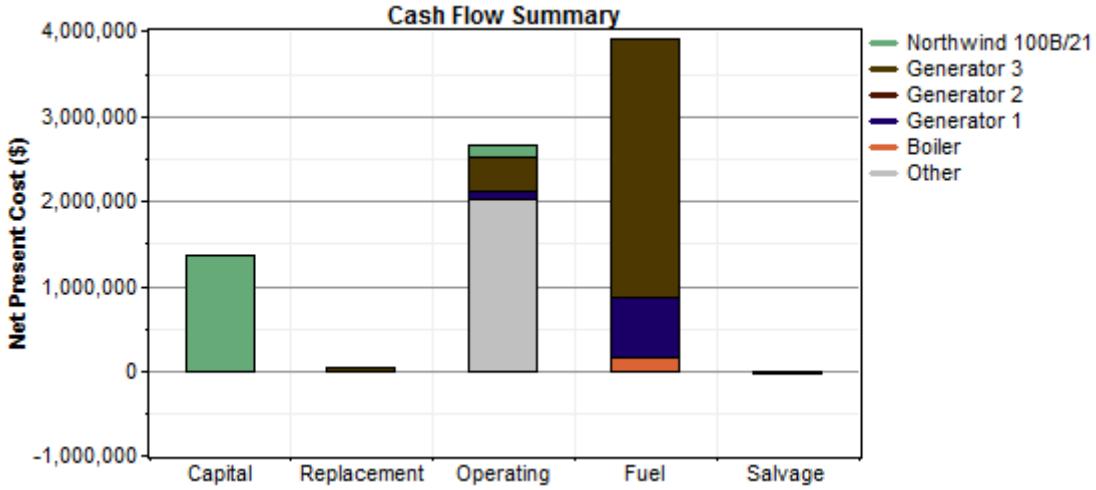
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.25 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,925,061
Levelized cost of energy	$ 0.840/kWh
Operating cost	$ 437,370/yr



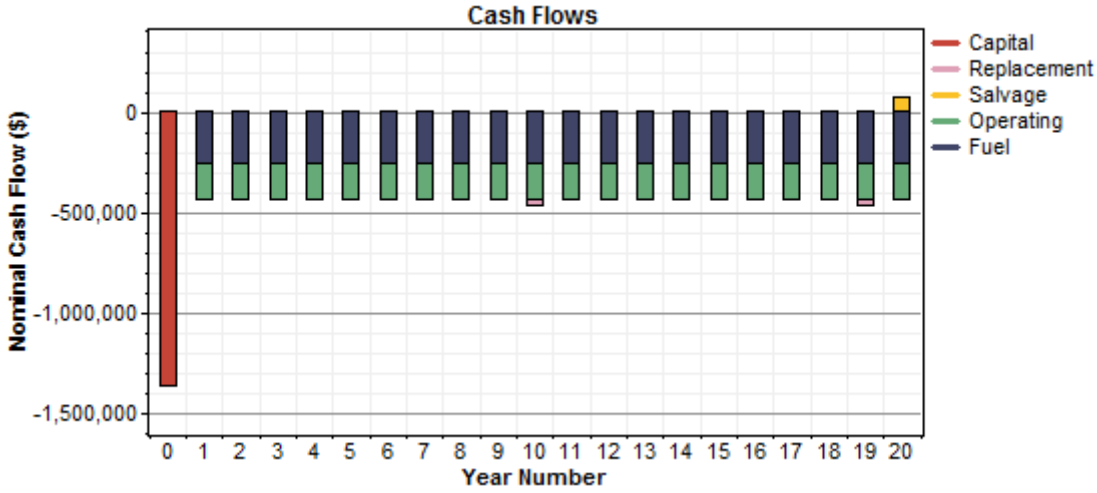
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,357,524	0	149,259	0	0	1,506,783
Generator 3	0	40,990	396,842	3,049,912	-13,509	3,474,234
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	90,276	688,731	-11,832	767,175
Boiler	0	0	0	166,309	0	166,309
Other	0	0	2,027,154	0	0	2,027,154
System	1,357,524	40,990	2,663,530	3,904,952	-41,938	7,925,057

Annualized Costs

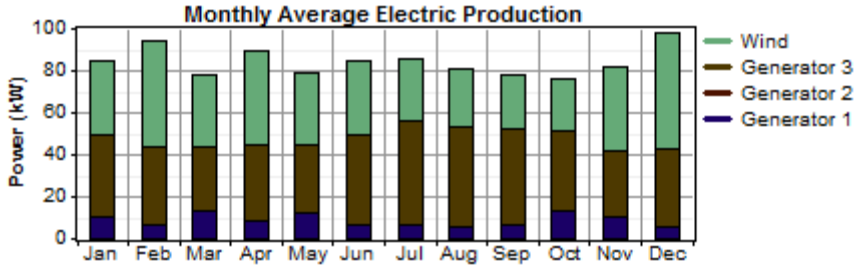
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	90,405	0	9,940	0	0	100,345
Generator 3	0	2,730	26,428	203,111	-900	231,369
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	6,012	45,867	-788	51,091
Boiler	0	0	0	11,075	0	11,075
Other	0	0	135,000	0	0	135,000
System	90,405	2,730	177,380	260,053	-2,793	527,776



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	318,991	43%
Generator 3	341,203	46%
Generator 2	0	0%
Generator 1	78,221	11%
Total	738,415	100%



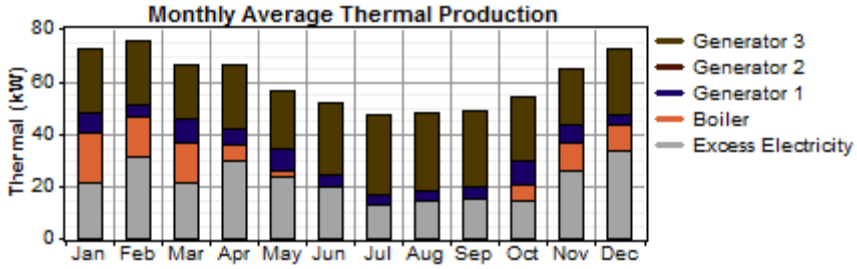
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	190,914	kWh/yr
Unmet load	0.000854	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.297	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	222,020	42%
Generator 1	52,148	10%
Boiler	62,591	12%
Excess electricity	190,914	36%
Total	527,673	100%



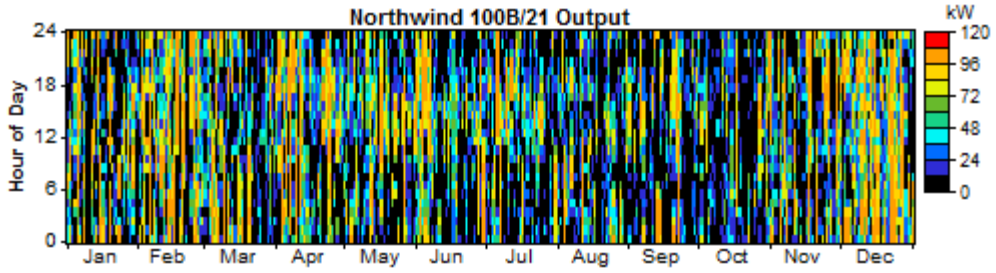
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	144,423	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	36.4	kW
Capacity factor	36.4	%
Total production	318,991	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	58.3	%
Hours of operation	7,250	hr/yr
Levelized cost	0.315	$/kWh

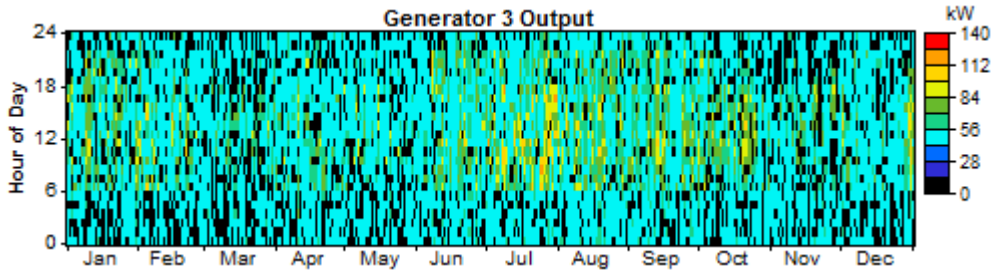


Generator 3

Quantity	Value	Units
Hours of operation	6,607	hr/yr
Number of starts	1,298	starts/yr
Operational life	9.08	yr
Capacity factor	26.9	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	341,203	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	222,020	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	137,237	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	1,350,416	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



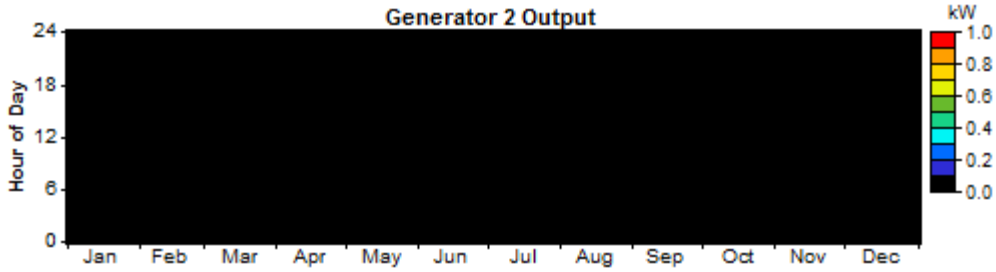
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



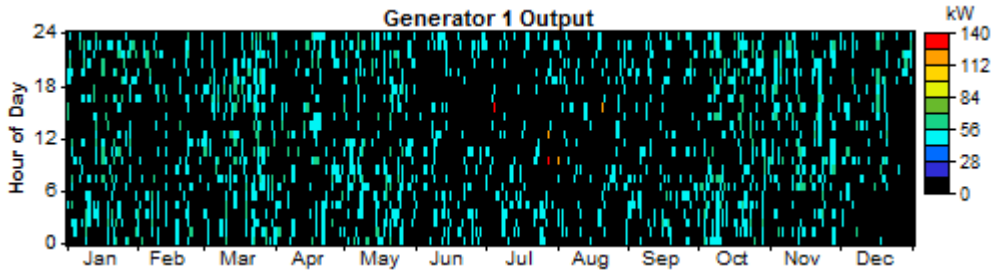
Generator 1

Quantity	Value	Units
Hours of operation	1,503	hr/yr
Number of starts	979	starts/yr
Operational life	39.9	yr
Capacity factor	5.58	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	78,221	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	52,148	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	30,991	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	304,951	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	462,801
Carbon monoxide	1,093
Unburned hydocarbons	121
Particulate matter	82.4
Sulfur dioxide	930
Nitrogen oxides	9,757

Knight Piésold
CONSULTING

Site 2
Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

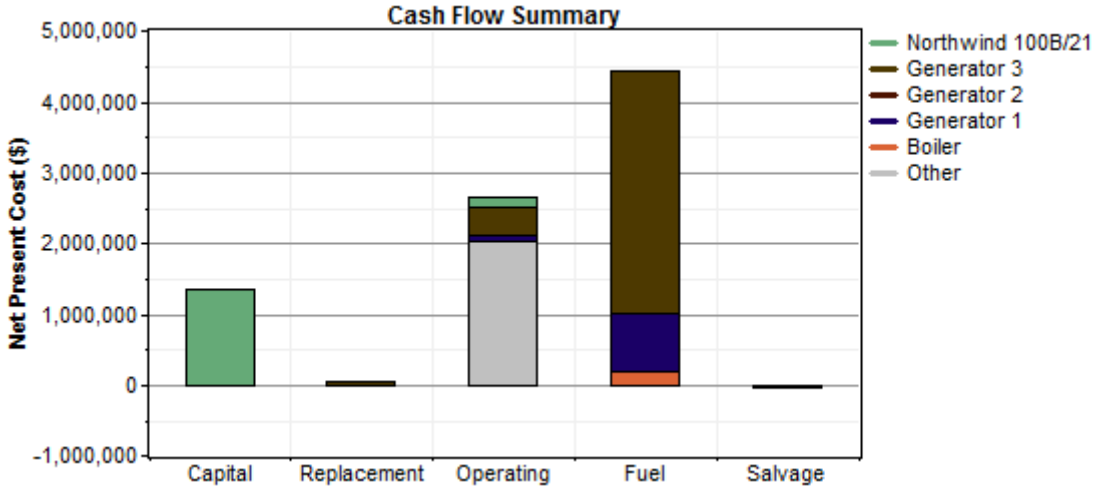
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.25 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 8,452,523
Levelized cost of energy	$ 0.888/kWh
Operating cost	$ 472,497/yr



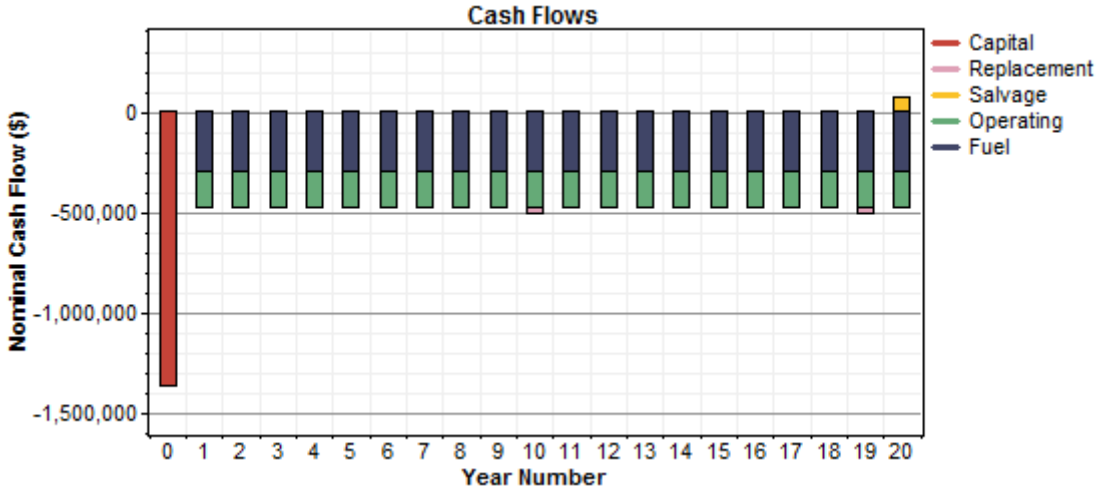
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,357,524	0	149,259	0	0	1,506,783
Generator 3	0	40,824	392,577	3,422,891	-13,910	3,842,382
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	94,540	821,157	-11,270	904,427
Boiler	0	0	0	188,372	0	188,372
Other	0	0	2,027,154	0	0	2,027,154
System	1,357,524	40,824	2,663,530	4,432,419	-41,778	8,452,521

Annualized Costs

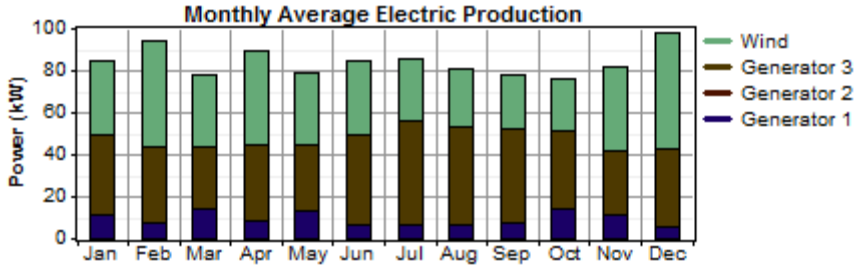
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	90,405	0	9,940	0	0	100,345
Generator 3	0	2,719	26,144	227,950	-926	255,886
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	6,296	54,686	-751	60,231
Boiler	0	0	0	12,545	0	12,545
Other	0	0	135,000	0	0	135,000
System	90,405	2,719	177,380	295,181	-2,782	562,902



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	318,991	43%
Generator 3	337,225	46%
Generator 2	0	0%
Generator 1	82,243	11%
Total	738,459	100%



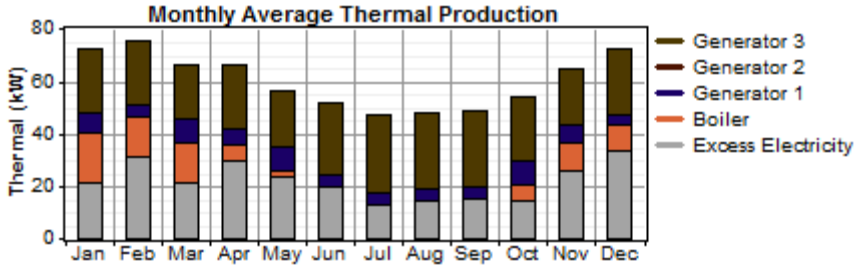
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	190,958	kWh/yr
Unmet load	0.000854	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.297	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	219,534	42%
Generator 1	54,753	10%
Boiler	62,455	12%
Excess electricity	190,958	36%
Total	527,700	100%



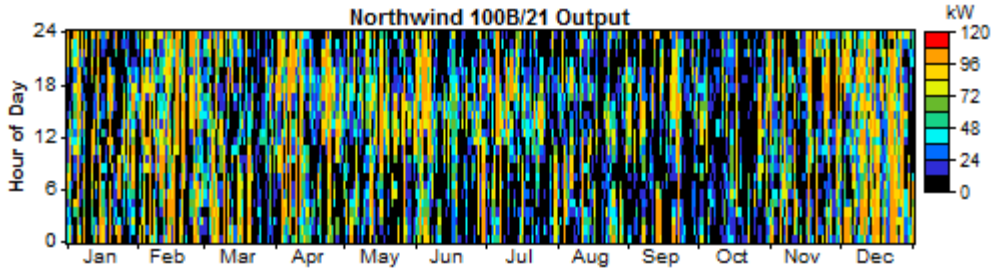
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	144,450	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	36.4	kW
Capacity factor	36.4	%
Total production	318,991	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	58.3	%
Hours of operation	7,250	hr/yr
Levelized cost	0.315	$/kWh

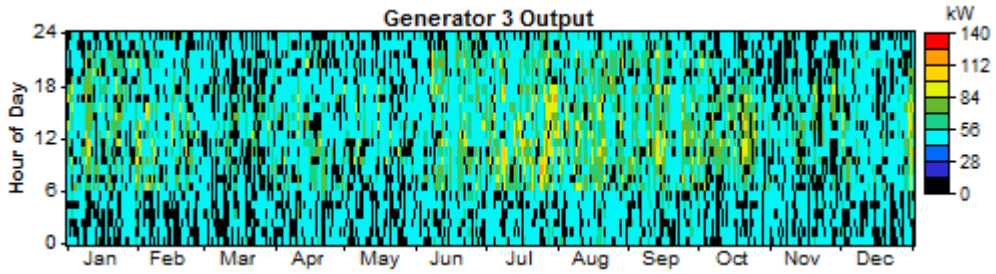


Generator 3

Quantity	Value	Units
Hours of operation	6,536	hr/yr
Number of starts	1,321	starts/yr
Operational life	9.18	yr
Capacity factor	26.5	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	337,225	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	219,534	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	135,685	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	1,335,137	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



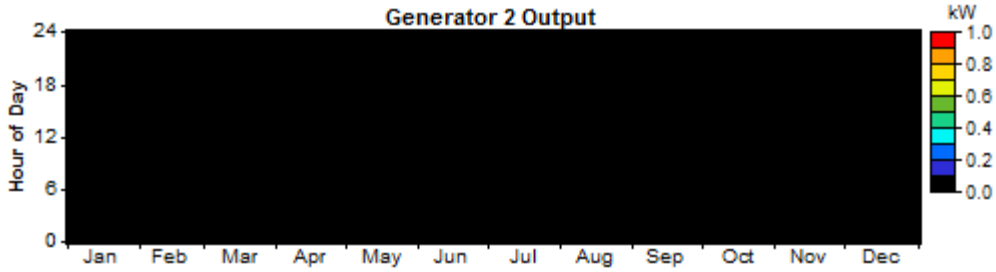
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



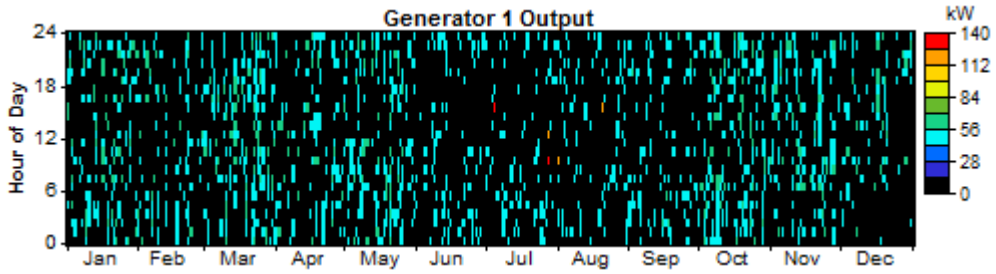
Generator 1

Quantity	Value	Units
Hours of operation	1,574	hr/yr
Number of starts	1,002	starts/yr
Operational life	38.1	yr
Capacity factor	5.87	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	82,243	kWh/yr
Mean electrical output	52.3	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	54,753	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	32,551	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	320,302	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	462,777
Carbon monoxide	1,094
Unburned hydocarbons	121
Particulate matter	82.4
Sulfur dioxide	930
Nitrogen oxides	9,758

Knight Piésold CONSULTING

Site 2
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

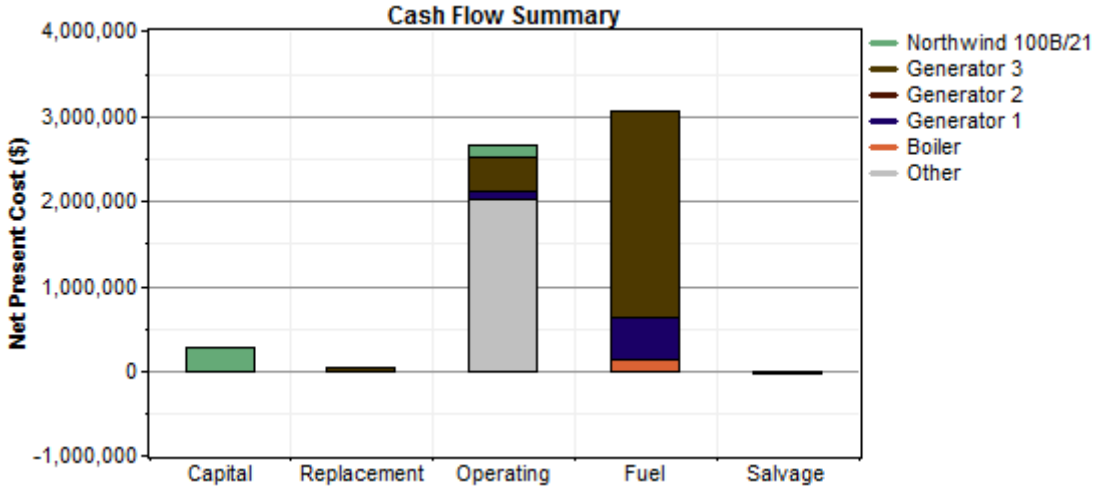
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.25 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,995,105
Levelized cost of energy	$ 0.632/kWh
Operating cost	$ 381,168/yr



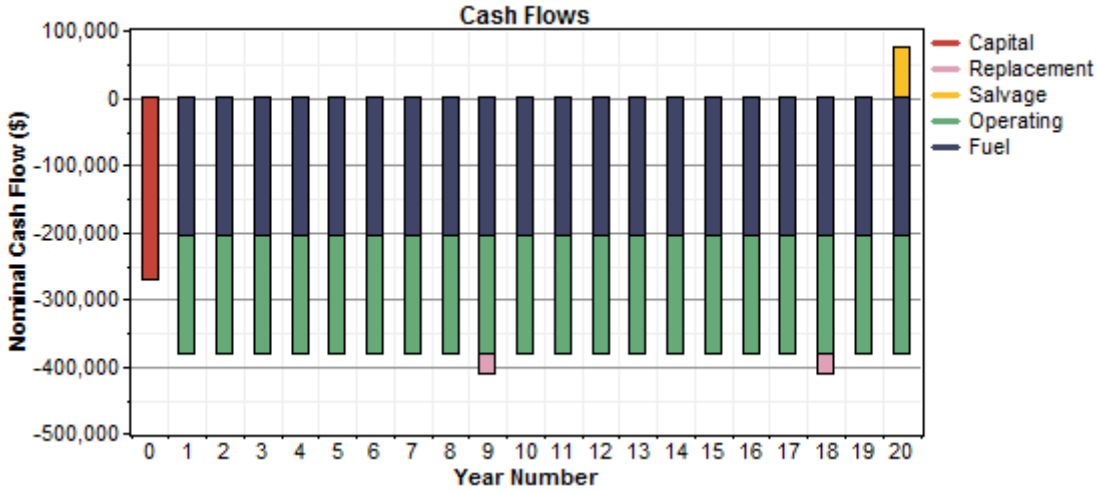
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	271,505	0	149,259	0	0	420,764
Generator 3	0	41,306	405,191	2,442,239	-12,725	2,876,010
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	81,927	487,755	-12,930	556,751
Boiler	0	0	0	131,020	0	131,020
Other	0	0	2,027,154	0	0	2,027,154
System	271,505	41,306	2,663,530	3,061,014	-42,252	5,995,103

Annualized Costs

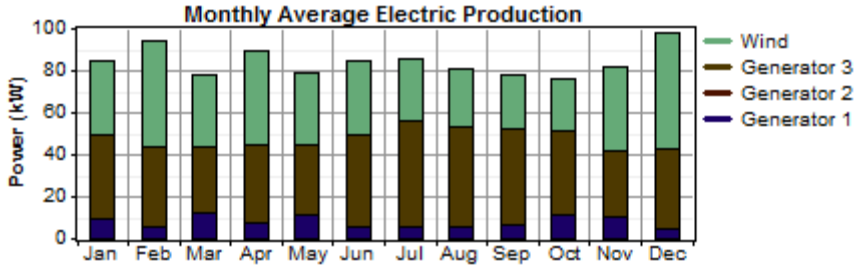
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	18,081	0	9,940	0	0	28,021
Generator 3	0	2,751	26,984	162,643	-847	191,530
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,456	32,482	-861	37,077
Boiler	0	0	0	8,725	0	8,725
Other	0	0	135,000	0	0	135,000
System	18,081	2,751	177,380	203,851	-2,814	399,249



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	318,991	43%
Generator 3	348,720	47%
Generator 2	0	0%
Generator 1	70,568	10%
Total	738,279	100%



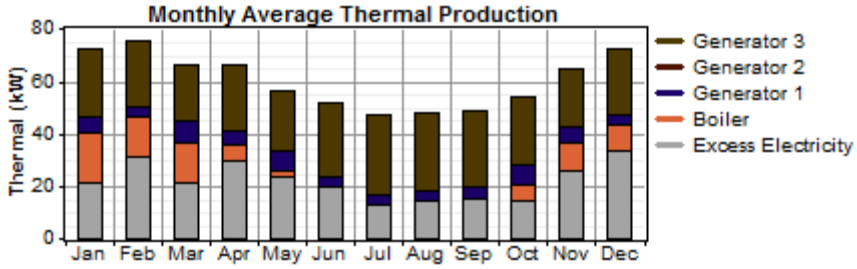
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	190,778	kWh/yr
Unmet load	0.000881	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.297	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	226,800	43%
Generator 1	47,144	9%
Boiler	62,913	12%
Excess electricity	190,778	36%
Total	527,635	100%



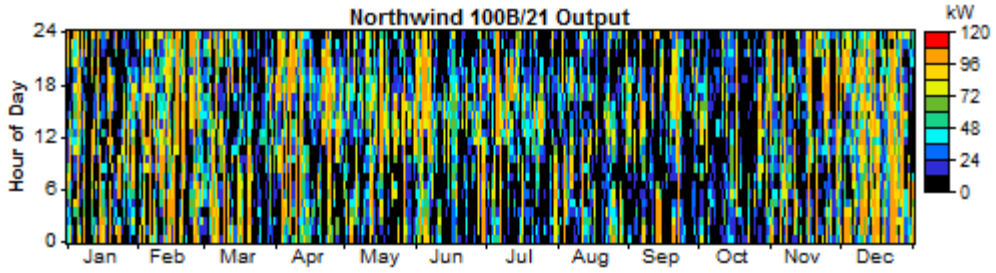
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	144,385	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	36.4	kW
Capacity factor	36.4	%
Total production	318,991	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	58.3	%
Hours of operation	7,250	hr/yr
Levelized cost	0.0878	$/kWh

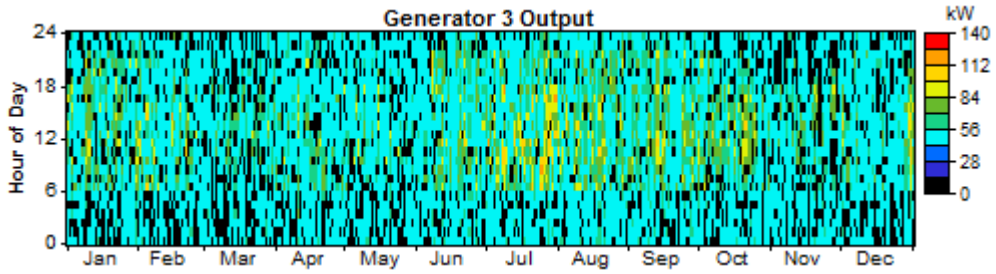


Generator 3

Quantity	Value	Units
Hours of operation	6,746	hr/yr
Number of starts	1,240	starts/yr
Operational life	8.89	yr
Capacity factor	27.5	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	348,720	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	226,800	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	140,209	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	1,379,661	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



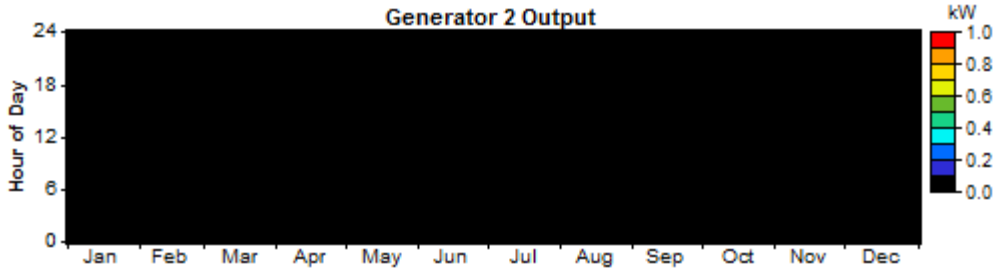
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



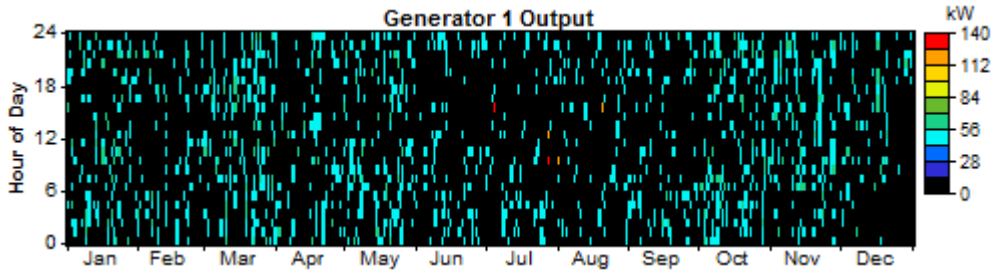
Generator 1

Quantity	Value	Units
Hours of operation	1,364	hr/yr
Number of starts	919	starts/yr
Operational life	44.0	yr
Capacity factor	5.03	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	70,568	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	47,144	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	28,002	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	275,541	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	462,858
Carbon monoxide	1,093
Unburned hydocarbons	121
Particulate matter	82.4
Sulfur dioxide	930
Nitrogen oxides	9,756

Knight Piésold CONSULTING

Site 2
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

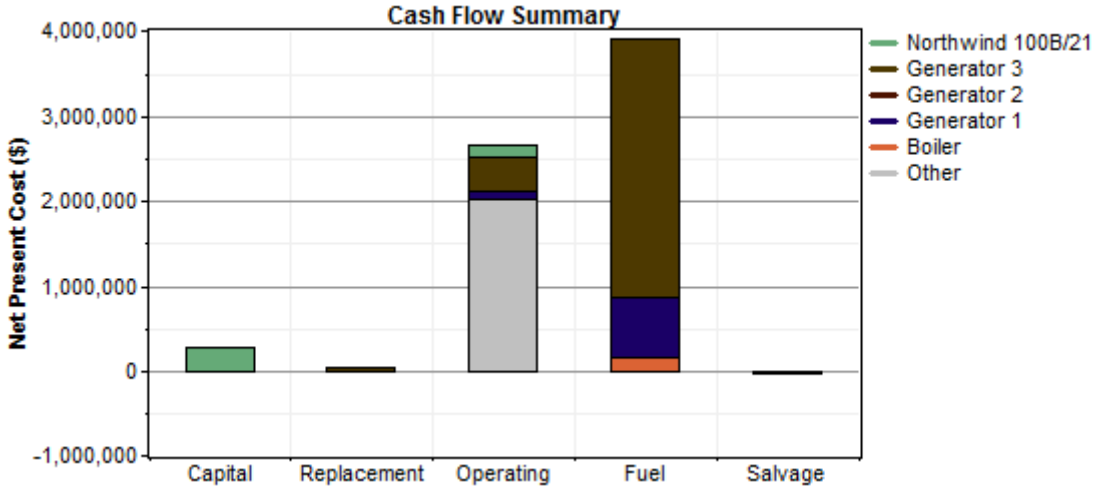
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.25 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,839,041
Levelized cost of energy	$ 0.708/kWh
Operating cost	$ 437,370/yr



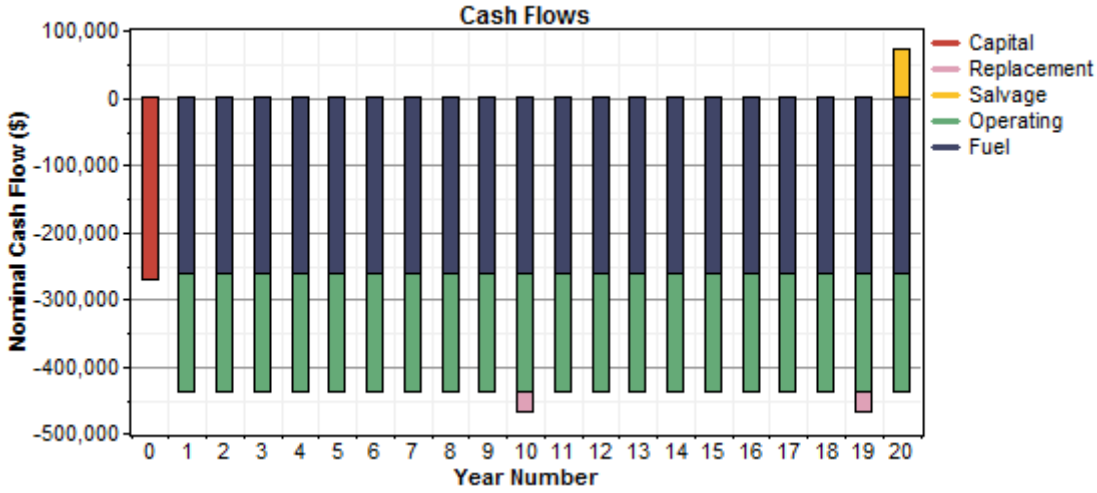
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	271,505	0	149,259	0	0	420,764
Generator 3	0	40,990	396,842	3,049,912	-13,509	3,474,234
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	90,276	688,731	-11,832	767,175
Boiler	0	0	0	166,309	0	166,309
Other	0	0	2,027,154	0	0	2,027,154
System	271,505	40,990	2,663,530	3,904,952	-41,938	6,839,038

Annualized Costs

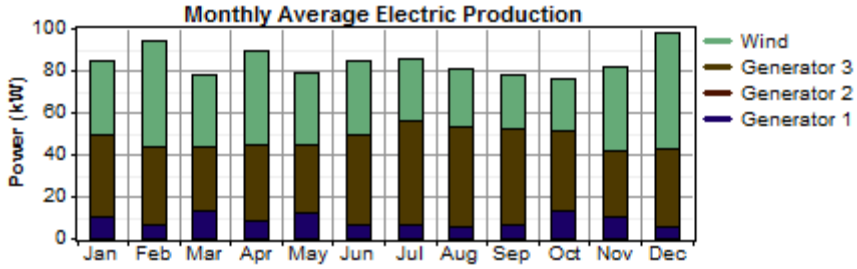
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	18,081	0	9,940	0	0	28,021
Generator 3	0	2,730	26,428	203,111	-900	231,369
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	6,012	45,867	-788	51,091
Boiler	0	0	0	11,075	0	11,075
Other	0	0	135,000	0	0	135,000
System	18,081	2,730	177,380	260,053	-2,793	455,451



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	318,991	43%
Generator 3	341,203	46%
Generator 2	0	0%
Generator 1	78,221	11%
Total	738,415	100%



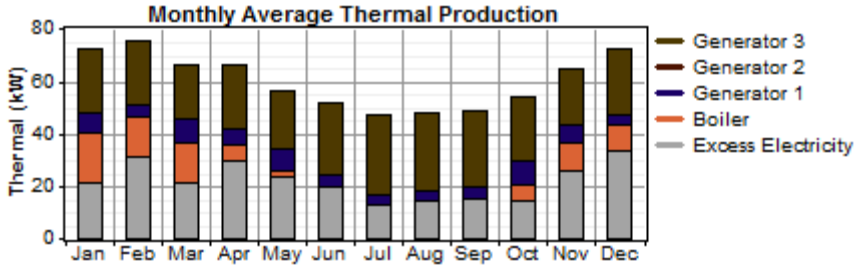
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	190,914	kWh/yr
Unmet load	0.000854	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.297	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	222,020	42%
Generator 1	52,148	10%
Boiler	62,591	12%
Excess electricity	190,914	36%
Total	527,673	100%



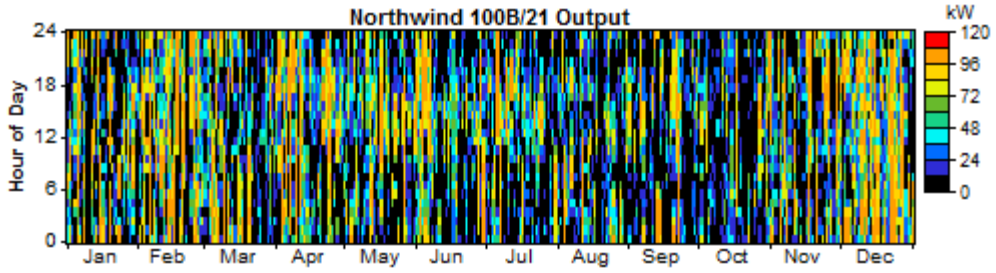
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	144,423	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	36.4	kW
Capacity factor	36.4	%
Total production	318,991	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	58.3	%
Hours of operation	7,250	hr/yr
Levelized cost	0.0878	$/kWh

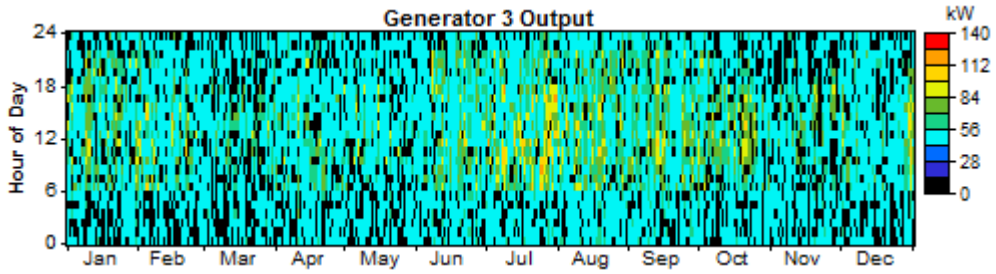


Generator 3

Quantity	Value	Units
Hours of operation	6,607	hr/yr
Number of starts	1,298	starts/yr
Operational life	9.08	yr
Capacity factor	26.9	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	341,203	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	222,020	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	137,237	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	1,350,416	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



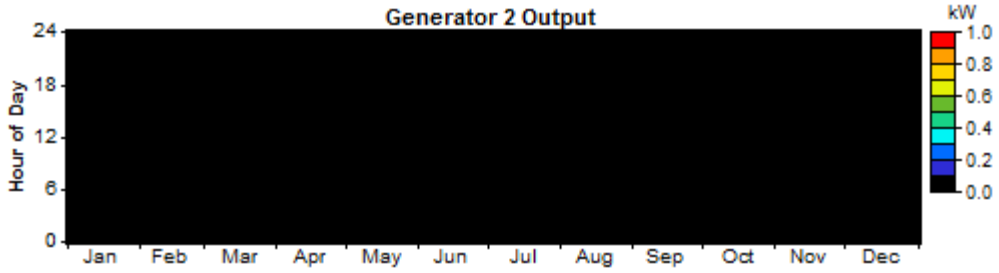
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



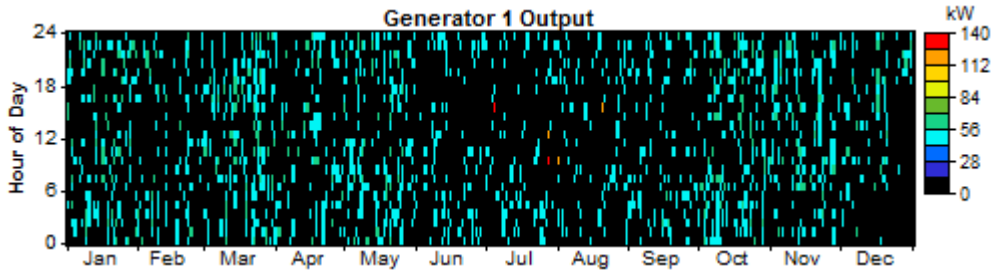
Generator 1

Quantity	Value	Units
Hours of operation	1,503	hr/yr
Number of starts	979	starts/yr
Operational life	39.9	yr
Capacity factor	5.58	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	78,221	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	52,148	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	30,991	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	304,951	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	462,801
Carbon monoxide	1,093
Unburned hydocarbons	121
Particulate matter	82.4
Sulfur dioxide	930
Nitrogen oxides	9,757

Knight Piésold CONSULTING

Site 2
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

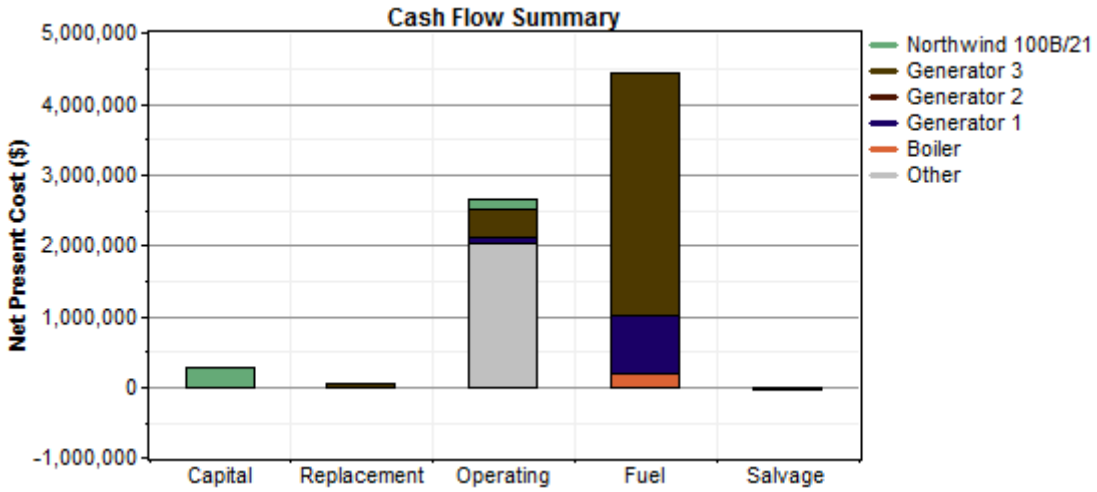
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.25 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,366,505
Levelized cost of energy	$ 0.755/kWh
Operating cost	$ 472,497/yr



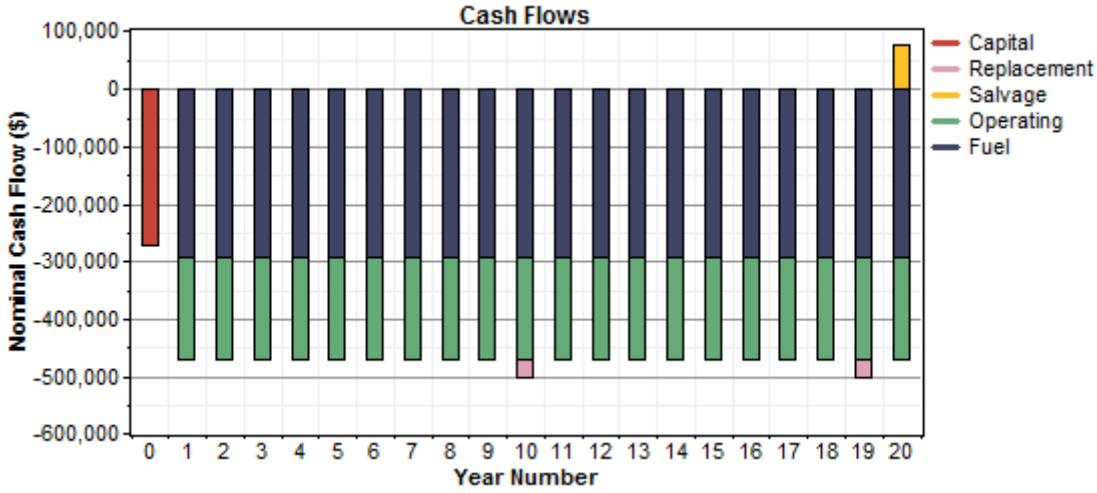
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	271,505	0	149,259	0	0	420,764
Generator 3	0	40,824	392,577	3,422,891	-13,910	3,842,382
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	94,540	821,157	-11,270	904,427
Boiler	0	0	0	188,372	0	188,372
Other	0	0	2,027,154	0	0	2,027,154
System	271,505	40,824	2,663,530	4,432,419	-41,778	7,366,503

Annualized Costs

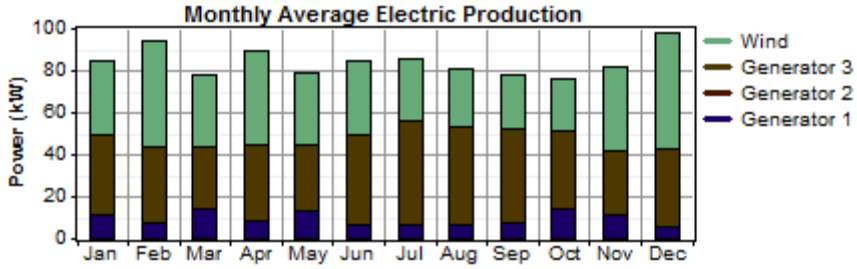
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	18,081	0	9,940	0	0	28,021
Generator 3	0	2,719	26,144	227,950	-926	255,886
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	6,296	54,686	-751	60,231
Boiler	0	0	0	12,545	0	12,545
Other	0	0	135,000	0	0	135,000
System	18,081	2,719	177,380	295,181	-2,782	490,578



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	318,991	43%
Generator 3	337,225	46%
Generator 2	0	0%
Generator 1	82,243	11%
Total	738,459	100%



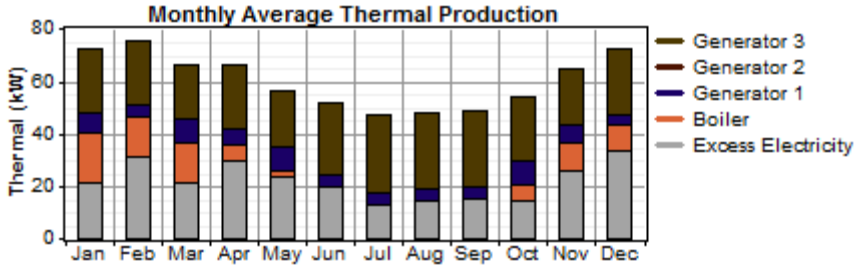
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	190,958	kWh/yr
Unmet load	0.000854	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.297	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	219,534	42%
Generator 1	54,753	10%
Boiler	62,455	12%
Excess electricity	190,958	36%
Total	527,700	100%



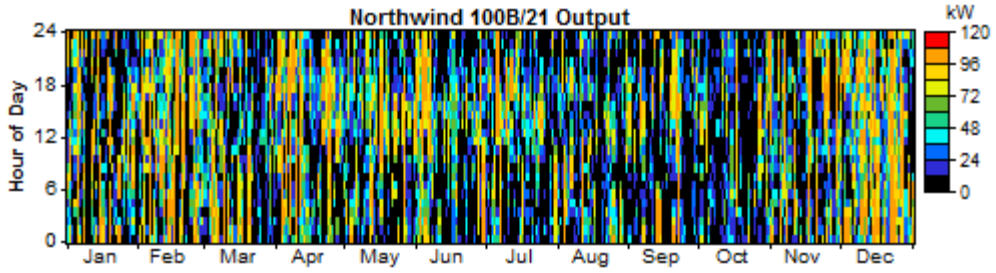
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	144,450	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	36.4	kW
Capacity factor	36.4	%
Total production	318,991	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	58.3	%
Hours of operation	7,250	hr/yr
Levelized cost	0.0878	$/kWh

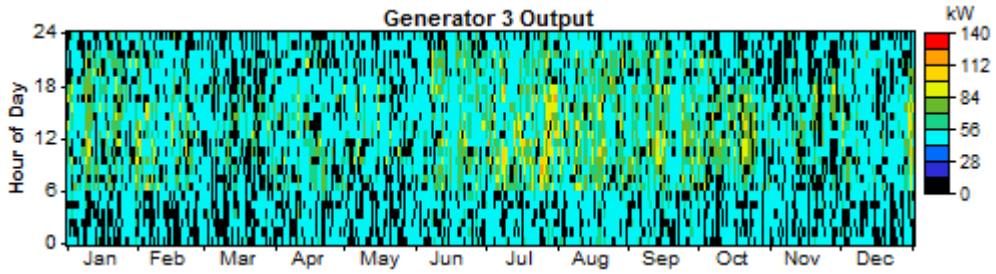


Generator 3

Quantity	Value	Units
Hours of operation	6,536	hr/yr
Number of starts	1,321	starts/yr
Operational life	9.18	yr
Capacity factor	26.5	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	337,225	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	219,534	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	135,685	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	1,335,137	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



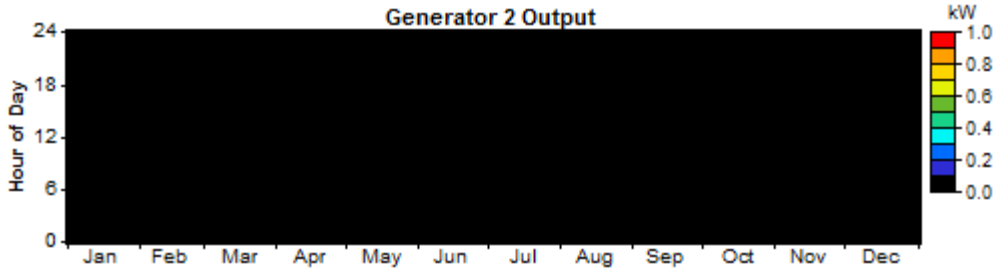
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



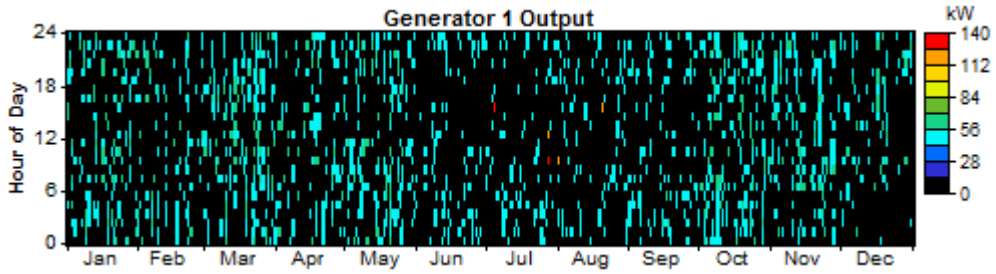
Generator 1

Quantity	Value	Units
Hours of operation	1,574	hr/yr
Number of starts	1,002	starts/yr
Operational life	38.1	yr
Capacity factor	5.87	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	82,243	kWh/yr
Mean electrical output	52.3	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	54,753	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	32,551	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	320,302	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	462,777
Carbon monoxide	1,094
Unburned hydocarbons	121
Particulate matter	82.4
Sulfur dioxide	930
Nitrogen oxides	9,758

Knight Piésold CONSULTING

Site 3
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

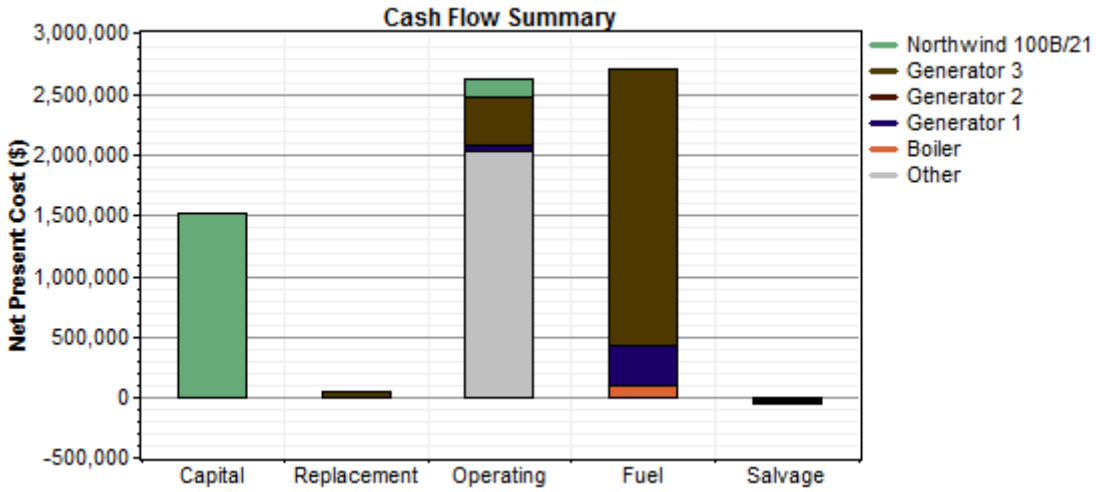
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	11	m/s
Diesel Price:	1.16	$/L
Heating Oil Price:	1.16	$/L
Northwind 100B/21 Capital Cost Multiplier:	1.11	
Enercon E33 Capital Cost Multiplier:	1.07	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,836,137
Levelized cost of energy	$ 0.734/kWh
Operating cost	$ 354,908/yr



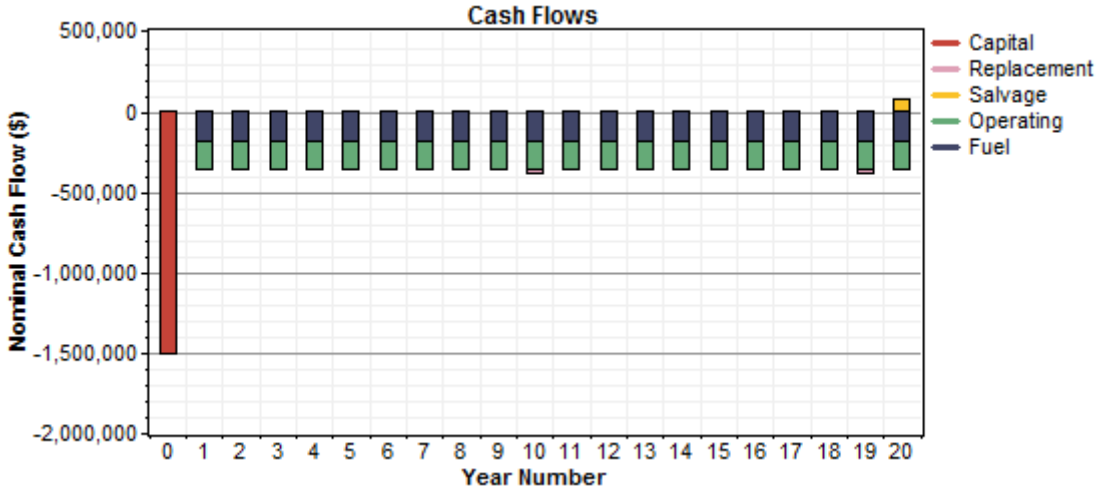
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,506,852	0	149,259	0	0	1,656,110
Generator 3	0	40,899	394,499	2,294,248	-13,730	2,715,917
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	53,457	318,070	-16,676	354,850
Boiler	0	0	0	98,700	0	98,700
Other	0	0	2,027,154	0	0	2,027,154
System	1,506,852	40,899	2,624,369	2,711,018	-47,003	6,836,134

Annualized Costs

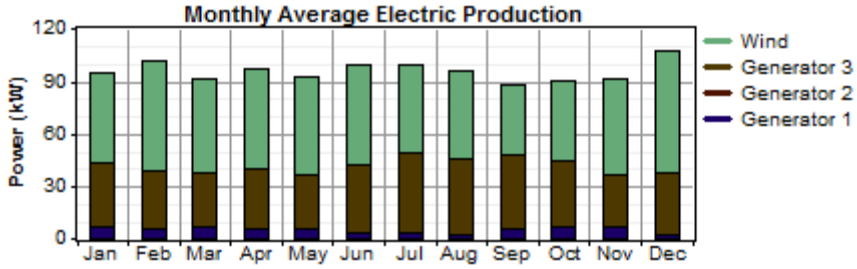
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	100,350	0	9,940	0	0	110,290
Generator 3	0	2,724	26,272	152,787	-914	180,869
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,560	21,182	-1,111	23,632
Boiler	0	0	0	6,573	0	6,573
Other	0	0	135,000	0	0	135,000
System	100,350	2,724	174,772	180,542	-3,130	455,258



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	473,299	56%
Generator 3	320,347	38%
Generator 2	0	0%
Generator 1	46,009	5%
Total	839,654	100%



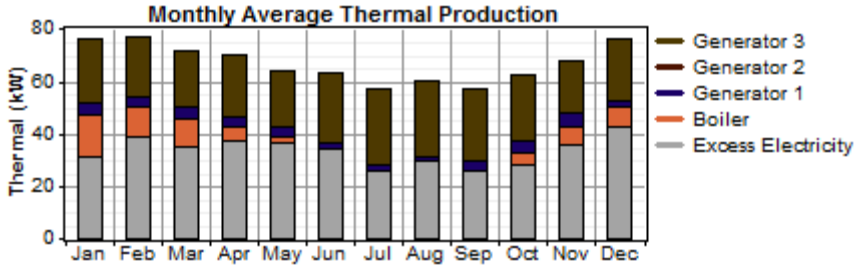
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	292,154	kWh/yr
Unmet load	0.000534	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.418	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	214,649	37%
Generator 1	30,745	5%
Boiler	47,394	8%
Excess electricity	292,154	50%
Total	584,941	100%



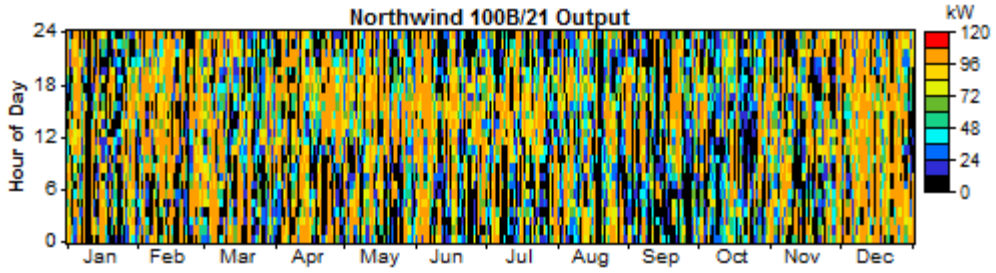
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	201,692	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	54.0	kW
Capacity factor	54.0	%
Total production	473,299	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	86.4	%
Hours of operation	7,722	hr/yr
Levelized cost	0.233	$/kWh

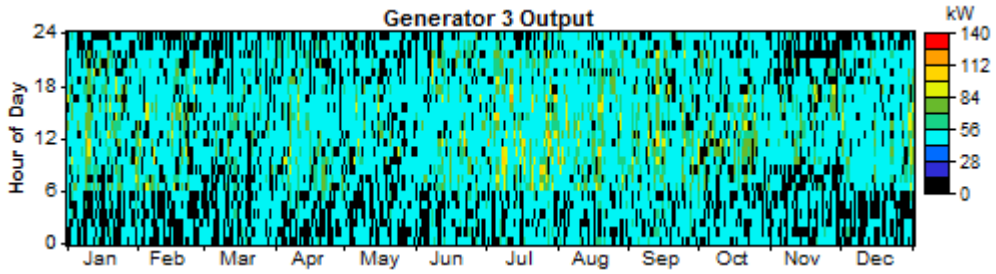


Generator 3

Quantity	Value	Units
Hours of operation	6,568	hr/yr
Number of starts	1,237	starts/yr
Operational life	9.14	yr
Capacity factor	25.2	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	320,347	kWh/yr
Mean electrical output	48.8	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	214,649	kWh/yr
Mean thermal output	32.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	131,713	L/yr
Specific fuel consumption	0.411	L/kWh
Fuel energy input	1,296,058	kWh/yr
Mean electrical efficiency	24.7	%
Mean total efficiency	41.3	%



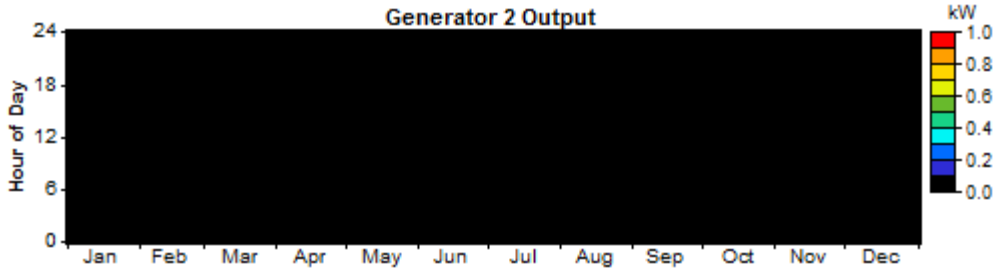
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



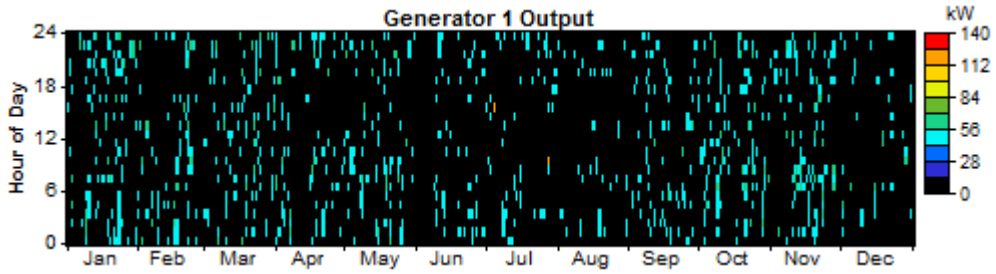
Generator 1

Quantity	Value	Units
Hours of operation	890	hr/yr
Number of starts	652	starts/yr
Operational life	67.4	yr
Capacity factor	3.28	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	46,009	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	30,745	kWh/yr
Mean thermal output	34.5	kW
Min. thermal output	32.9	kW

Max. thermal output	65.4	kW

Quantity	Value	Units
Fuel consumption	18,260	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	179,683	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	409,923
Carbon monoxide	975
Unburned hydocarbons	108
Particulate matter	73.5
Sulfur dioxide	824
Nitrogen oxides	8,698

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Site 3
Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

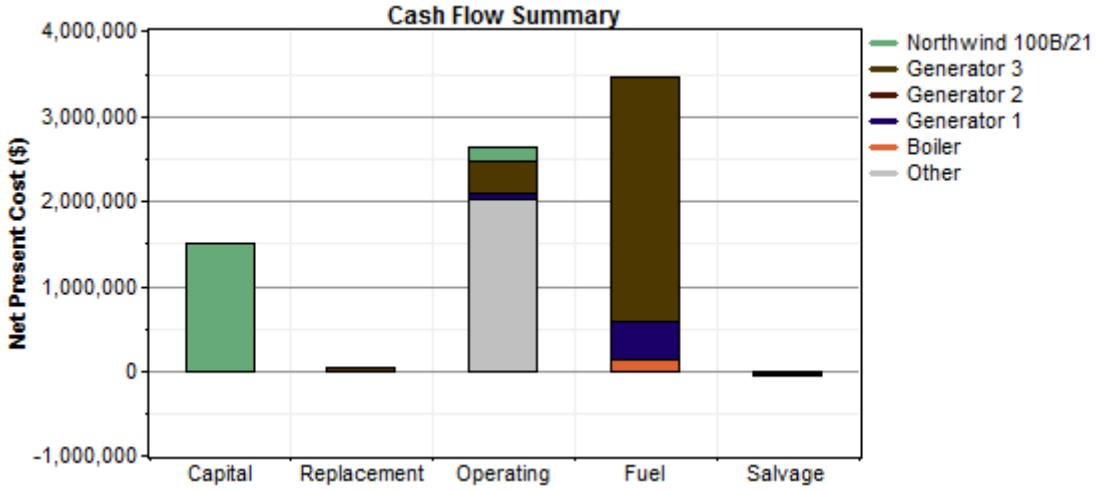
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	11	m/s
Diesel Price:	1.48	$/L
Heating Oil Price:	1.48	$/L
Northwind 100B/21 Capital Cost Multiplier:	1.11	
Enercon E33 Capital Cost Multiplier:	1.07	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,583,713
Levelized cost of energy	$ 0.799/kWh
Operating cost	$ 404,693/yr



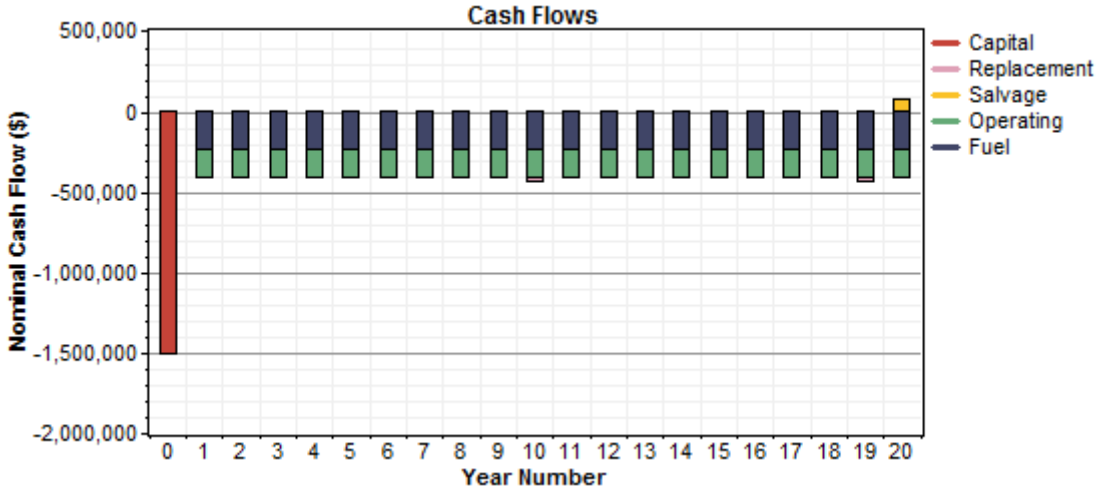
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,506,852	0	149,259	0	0	1,656,110
Generator 3	0	40,706	389,574	2,888,154	-14,192	3,304,242
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	58,382	444,980	-16,028	487,333
Boiler	0	0	0	125,469	0	125,469
Other	0	0	2,027,154	0	0	2,027,154
System	1,506,852	40,706	2,624,369	3,458,602	-46,818	7,583,710

Annualized Costs

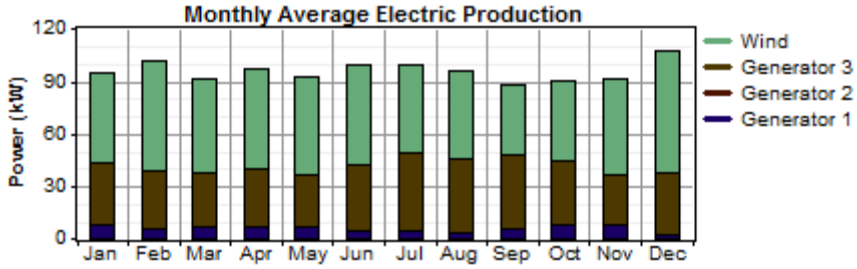
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	100,350	0	9,940	0	0	110,290
Generator 3	0	2,711	25,944	192,339	-945	220,049
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,888	29,634	-1,067	32,454
Boiler	0	0	0	8,356	0	8,356
Other	0	0	135,000	0	0	135,000
System	100,350	2,711	174,772	230,328	-3,118	505,043



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	473,299	56%
Generator 3	315,908	38%
Generator 2	0	0%
Generator 1	50,520	6%
Total	839,727	100%



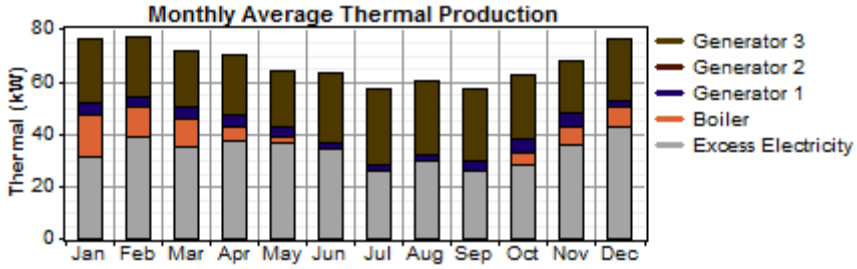
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	292,226	kWh/yr
Unmet load	0.000519	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.418	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	211,828	36%
Generator 1	33,696	6%
Boiler	47,221	8%
Excess electricity	292,226	50%
Total	584,970	100%



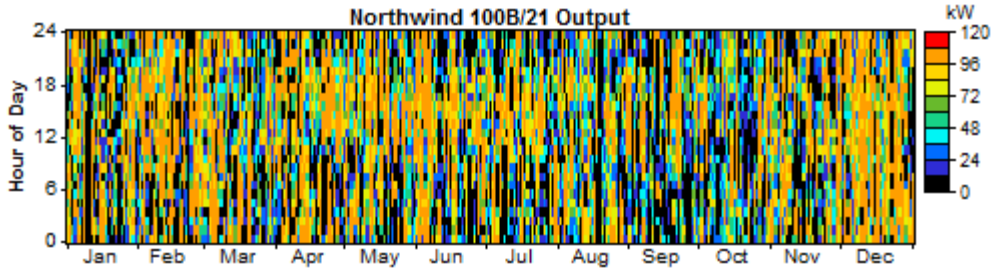
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	201,721	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	54.0	kW
Capacity factor	54.0	%
Total production	473,299	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	86.4	%
Hours of operation	7,722	hr/yr
Levelized cost	0.233	$/kWh

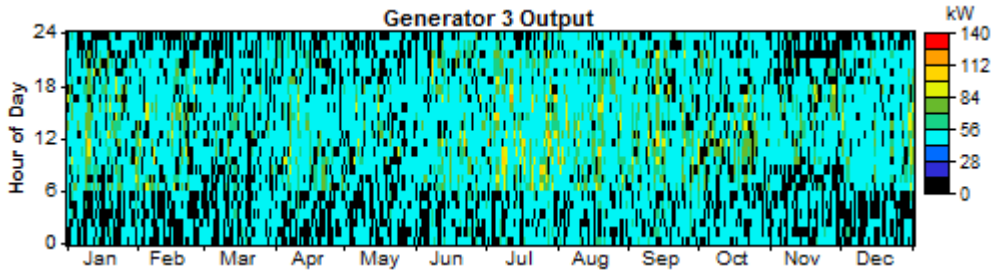


Generator 3

Quantity	Value	Units
Hours of operation	6,486	hr/yr
Number of starts	1,277	starts/yr
Operational life	9.25	yr
Capacity factor	24.9	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	315,908	kWh/yr
Mean electrical output	48.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	211,828	kWh/yr
Mean thermal output	32.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	129,959	L/yr
Specific fuel consumption	0.411	L/kWh
Fuel energy input	1,278,795	kWh/yr
Mean electrical efficiency	24.7	%
Mean total efficiency	41.3	%



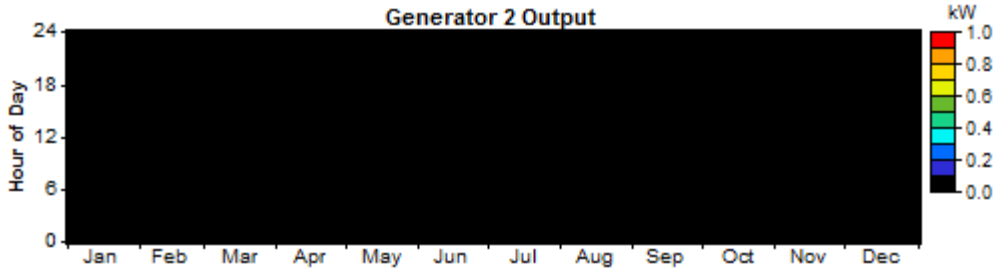
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



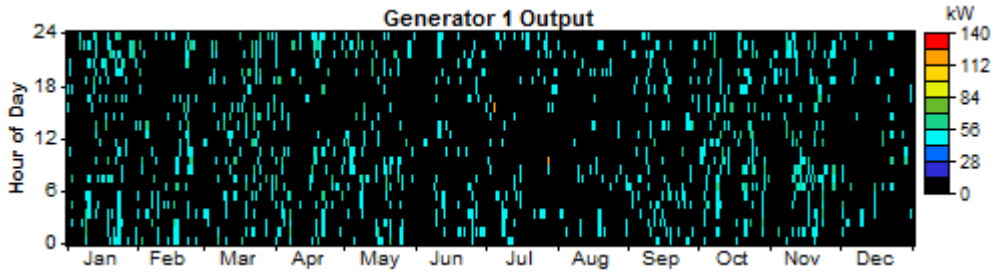
Generator 1

Quantity	Value	Units
Hours of operation	972	hr/yr
Number of starts	698	starts/yr
Operational life	61.7	yr
Capacity factor	3.60	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	50,520	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	33,696	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	65.4	kW

Quantity	Value	Units
Fuel consumption	20,023	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	197,025	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	409,889
Carbon monoxide	975
Unburned hydocarbons	108
Particulate matter	73.5
Sulfur dioxide	824
Nitrogen oxides	8,699

Knight Piésold
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Site 3
Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

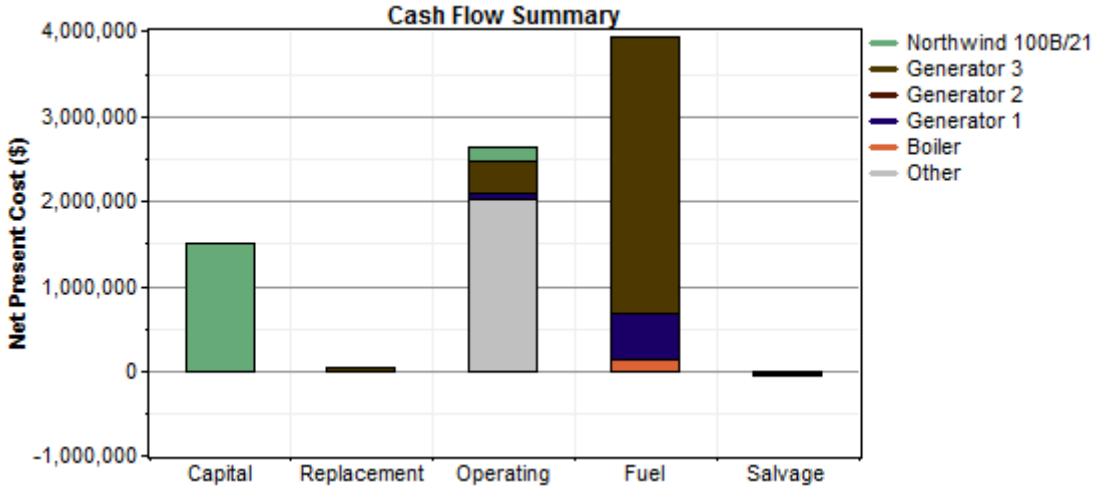
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	11	m/s
Diesel Price:	1.68	$/L
Heating Oil Price:	1.68	$/L
Northwind 100B/21 Capital Cost Multiplier:	1.11	
Enercon E33 Capital Cost Multiplier:	1.07	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 8,050,949
Levelized cost of energy	$ 0.839/kWh
Operating cost	$ 435,809/yr



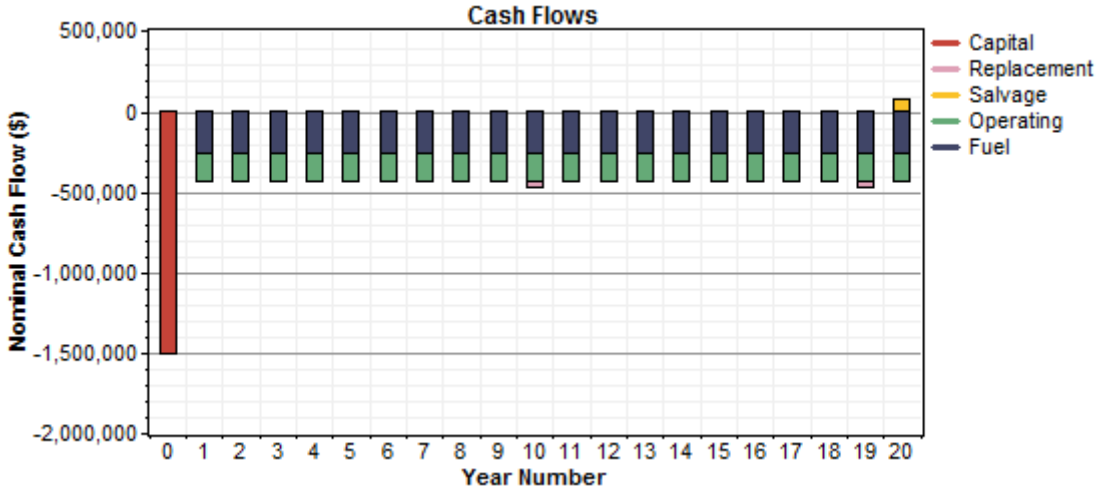
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	1,506,852	0	149,259	0	0	1,656,110
Generator 3	0	40,603	386,991	3,254,729	-14,435	3,667,888
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	60,965	528,950	-15,688	574,226
Boiler	0	0	0	142,164	0	142,164
Other	0	0	2,027,154	0	0	2,027,154
System	1,506,852	40,603	2,624,369	3,925,844	-46,721	8,050,946

Annualized Costs

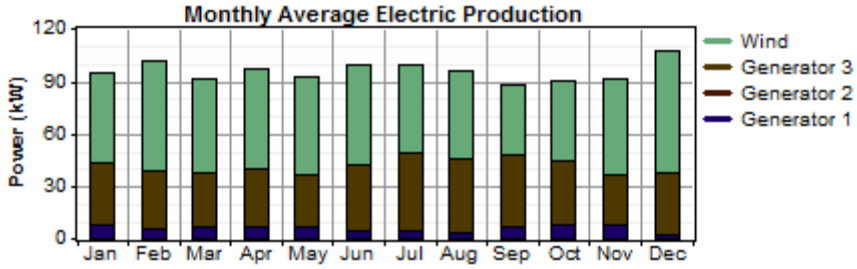
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	100,350	0	9,940	0	0	110,290
Generator 3	0	2,704	25,772	216,751	-961	244,266
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,060	35,226	-1,045	38,241
Boiler	0	0	0	9,468	0	9,468
Other	0	0	135,000	0	0	135,000
System	100,350	2,704	174,772	261,445	-3,111	536,159



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	473,299	56%
Generator 3	313,499	37%
Generator 2	0	0%
Generator 1	52,957	6%
Total	839,755	100%



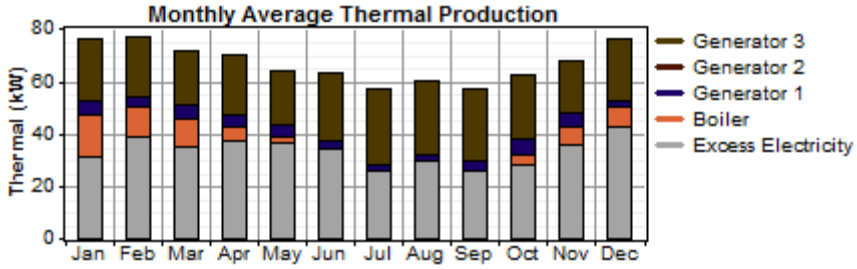
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	292,254	kWh/yr
Unmet load	0.000519	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.418	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	210,322	36%
Generator 1	35,274	6%
Boiler	47,135	8%
Excess electricity	292,254	50%
Total	584,985	100%



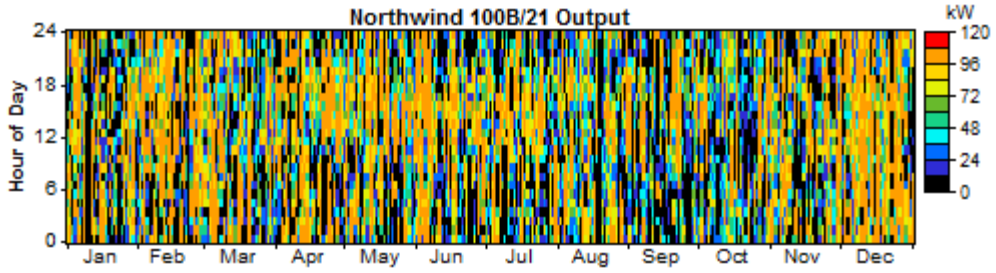
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	201,736	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	54.0	kW
Capacity factor	54.0	%
Total production	473,299	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	86.4	%
Hours of operation	7,722	hr/yr
Levelized cost	0.233	$/kWh

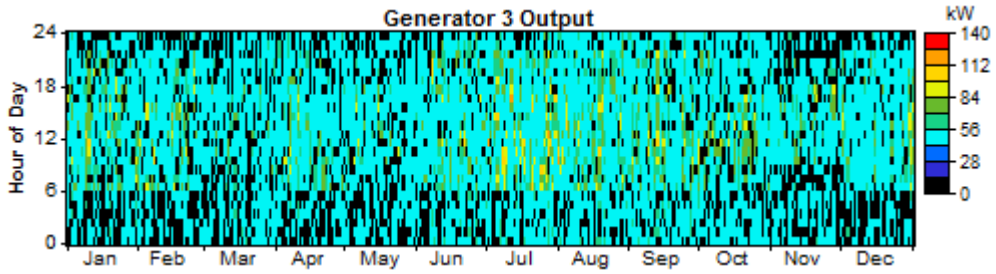


Generator 3

Quantity	Value	Units
Hours of operation	6,443	hr/yr
Number of starts	1,303	starts/yr
Operational life	9.31	yr
Capacity factor	24.7	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	313,499	kWh/yr
Mean electrical output	48.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	210,322	kWh/yr
Mean thermal output	32.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	129,019	L/yr
Specific fuel consumption	0.412	L/kWh
Fuel energy input	1,269,544	kWh/yr
Mean electrical efficiency	24.7	%
Mean total efficiency	41.3	%



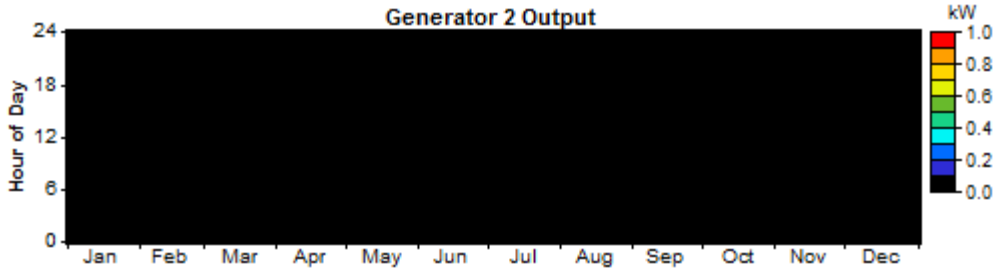
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



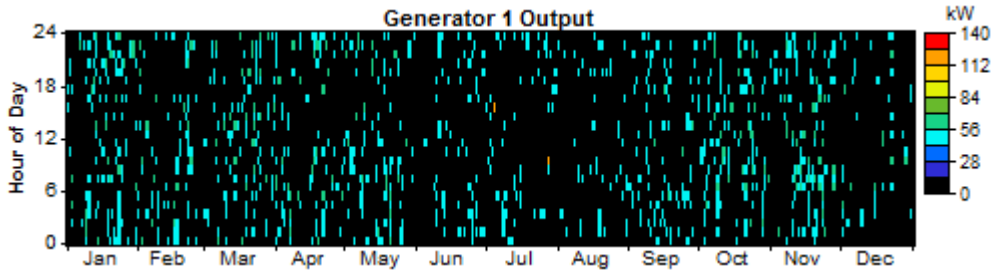
Generator 1

Quantity	Value	Units
Hours of operation	1,015	hr/yr
Number of starts	726	starts/yr
Operational life	59.1	yr
Capacity factor	3.78	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	52,957	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	35,274	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	65.4	kW

Quantity	Value	Units
Fuel consumption	20,968	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	206,323	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	409,874
Carbon monoxide	975
Unburned hydocarbons	108
Particulate matter	73.5
Sulfur dioxide	824
Nitrogen oxides	8,699

Knight Piésold CONSULTING

Site 3
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

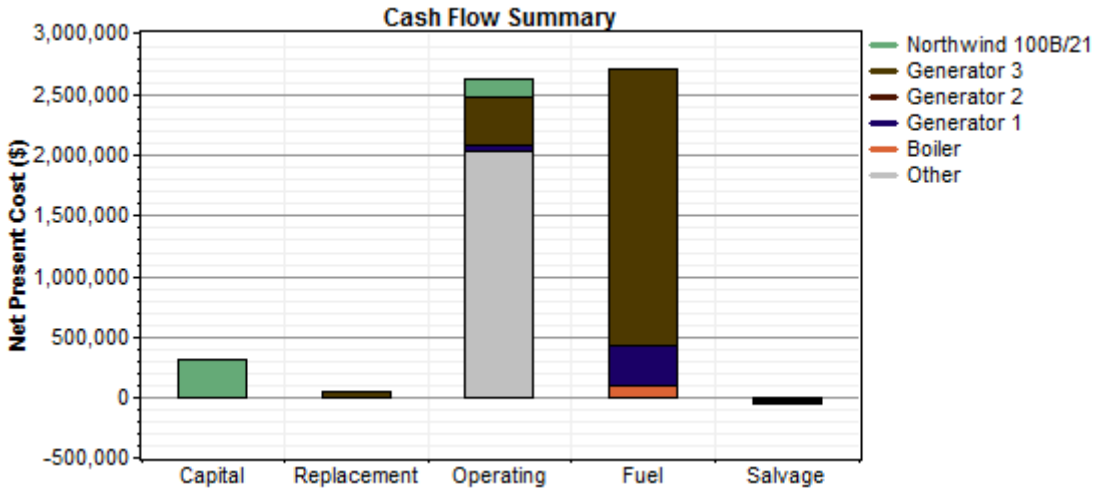
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	11	m/s
Diesel Price:	1.16	$/L
Heating Oil Price:	1.16	$/L
Northwind 100B/21 Capital Cost Multiplier:	1.11	
Enercon E33 Capital Cost Multiplier:	1.07	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,630,656
Levelized cost of energy	$ 0.588/kWh
Operating cost	$ 354,908/yr



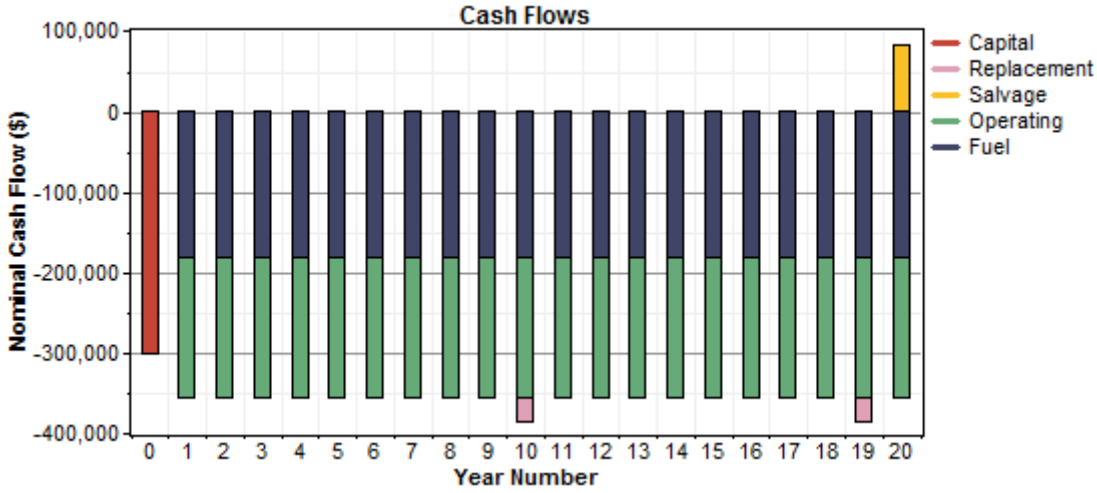
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	301,371	0	149,259	0	0	450,629
Generator 3	0	40,899	394,499	2,294,248	-13,730	2,715,917
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	53,457	318,070	-16,676	354,850
Boiler	0	0	0	98,700	0	98,700
Other	0	0	2,027,154	0	0	2,027,154
System	301,371	40,899	2,624,369	2,711,018	-47,003	5,630,653

Annualized Costs

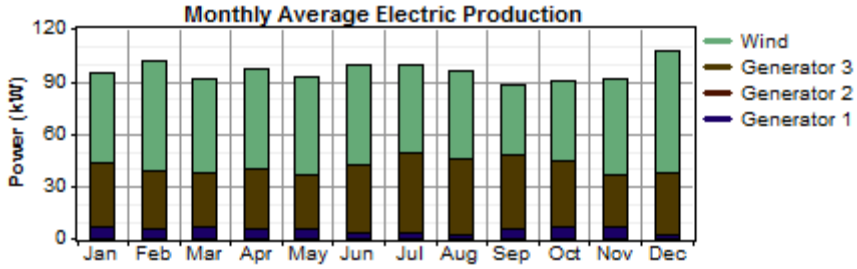
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	20,070	0	9,940	0	0	30,010
Generator 3	0	2,724	26,272	152,787	-914	180,869
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,560	21,182	-1,111	23,632
Boiler	0	0	0	6,573	0	6,573
Other	0	0	135,000	0	0	135,000
System	20,070	2,724	174,772	180,542	-3,130	374,978



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	473,299	56%
Generator 3	320,347	38%
Generator 2	0	0%
Generator 1	46,009	5%
Total	839,654	100%



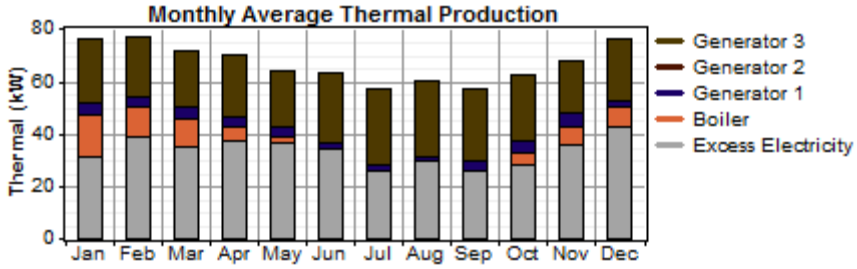
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	292,154	kWh/yr
Unmet load	0.000534	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.418	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	214,649	37%
Generator 1	30,745	5%
Boiler	47,394	8%
Excess electricity	292,154	50%
Total	584,941	100%



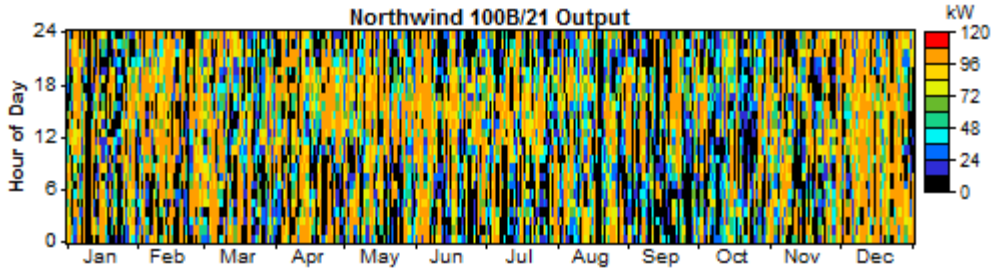
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	201,692	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	54.0	kW
Capacity factor	54.0	%
Total production	473,299	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	86.4	%
Hours of operation	7,722	hr/yr
Levelized cost	0.0634	$/kWh

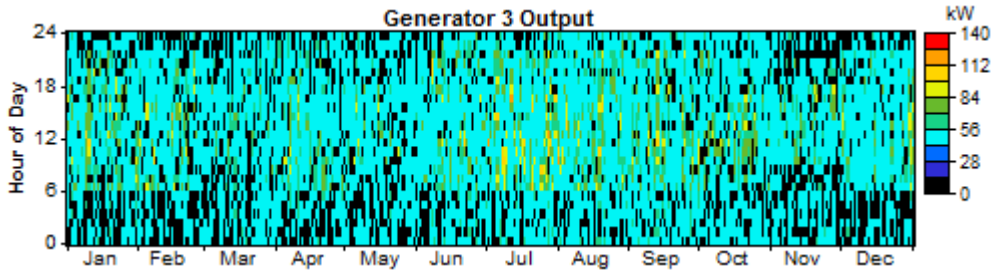


Generator 3

Quantity	Value	Units
Hours of operation	6,568	hr/yr
Number of starts	1,237	starts/yr
Operational life	9.14	yr
Capacity factor	25.2	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	320,347	kWh/yr
Mean electrical output	48.8	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	214,649	kWh/yr
Mean thermal output	32.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	131,713	L/yr
Specific fuel consumption	0.411	L/kWh
Fuel energy input	1,296,058	kWh/yr
Mean electrical efficiency	24.7	%
Mean total efficiency	41.3	%



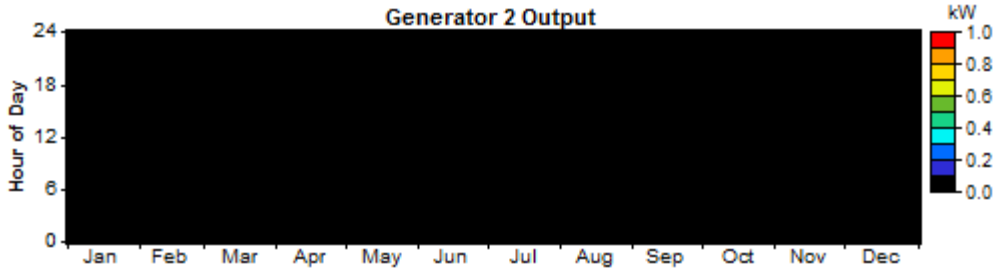
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



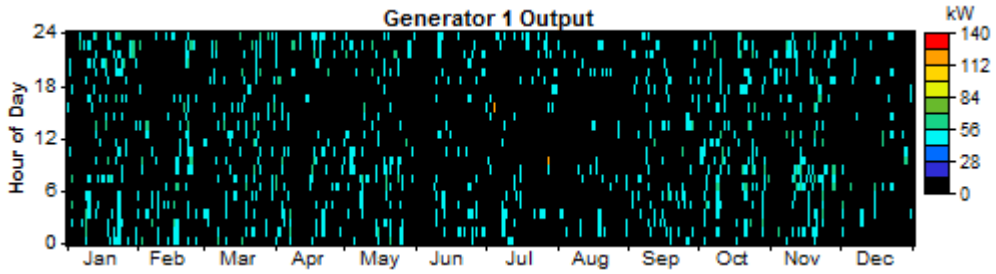
Generator 1

Quantity	Value	Units
Hours of operation	890	hr/yr
Number of starts	652	starts/yr
Operational life	67.4	yr
Capacity factor	3.28	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	46,009	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	30,745	kWh/yr
Mean thermal output	34.5	kW
Min. thermal output	32.9	kW

Max. thermal output	65.4	kW

Quantity	Value	Units
Fuel consumption	18,260	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	179,683	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	409,923
Carbon monoxide	975
Unburned hydocarbons	108
Particulate matter	73.5
Sulfur dioxide	824
Nitrogen oxides	8,698

Knight Piésold CONSULTING

Site 3
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

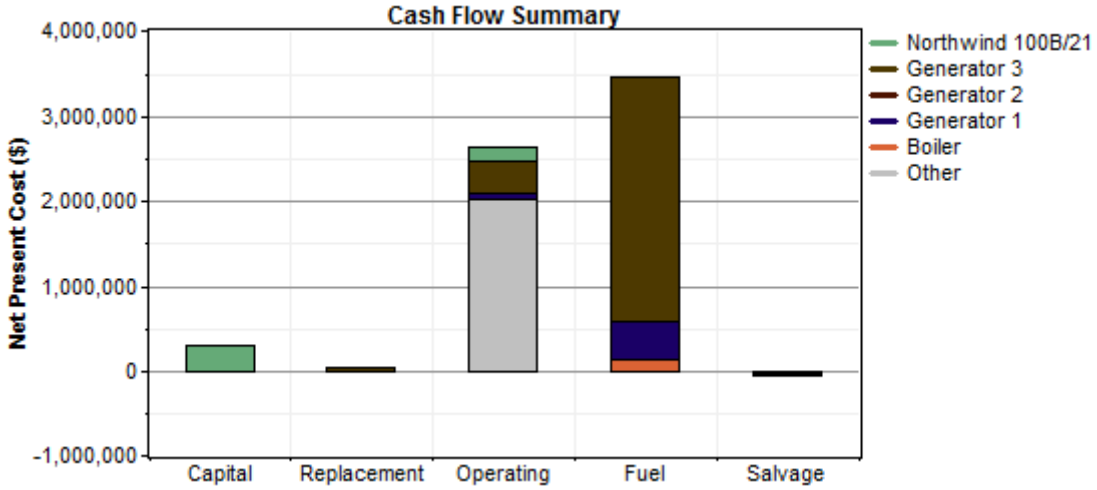
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	11	m/s
Diesel Price:	1.48	$/L
Heating Oil Price:	1.48	$/L
Northwind 100B/21 Capital Cost Multiplier:	1.11	
Enercon E33 Capital Cost Multiplier:	1.07	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,378,233
Levelized cost of energy	$ 0.652/kWh
Operating cost	$ 404,694/yr



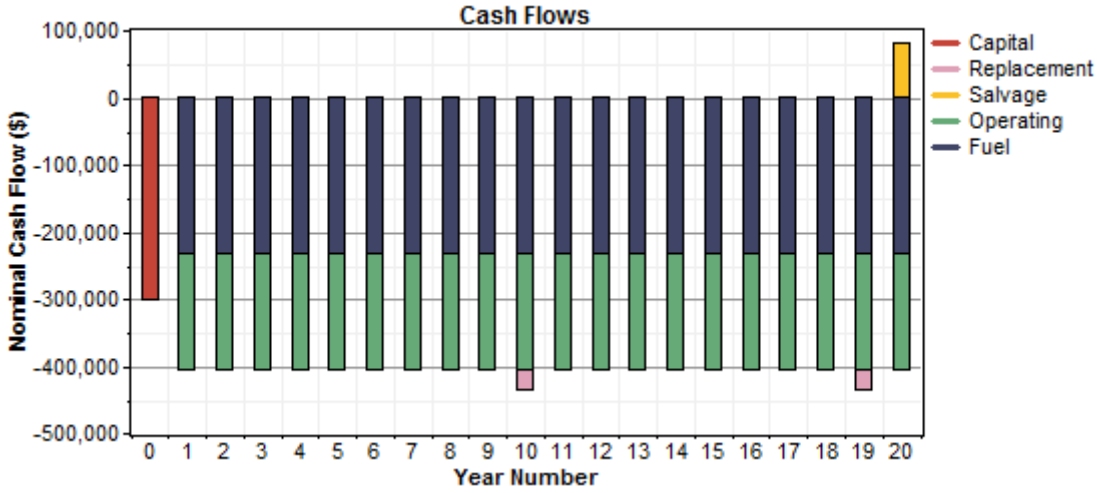
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	301,371	0	149,259	0	0	450,629
Generator 3	0	40,706	389,574	2,888,154	-14,192	3,304,242
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	58,382	444,980	-16,028	487,333
Boiler	0	0	0	125,469	0	125,469
Other	0	0	2,027,154	0	0	2,027,154
System	301,371	40,706	2,624,369	3,458,602	-46,818	6,378,229

Annualized Costs

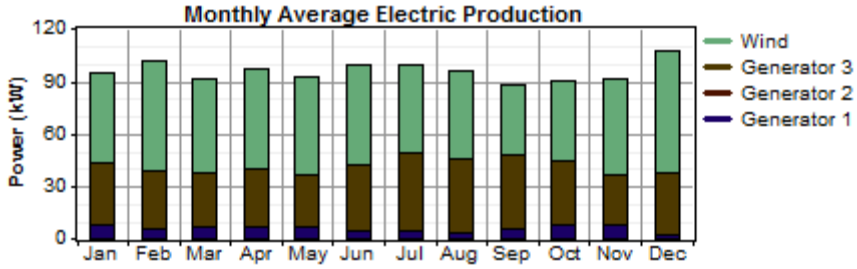
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	20,070	0	9,940	0	0	30,010
Generator 3	0	2,711	25,944	192,339	-945	220,049
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,888	29,634	-1,067	32,454
Boiler	0	0	0	8,356	0	8,356
Other	0	0	135,000	0	0	135,000
System	20,070	2,711	174,772	230,328	-3,118	424,763



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	473,299	56%
Generator 3	315,908	38%
Generator 2	0	0%
Generator 1	50,520	6%
Total	839,727	100%



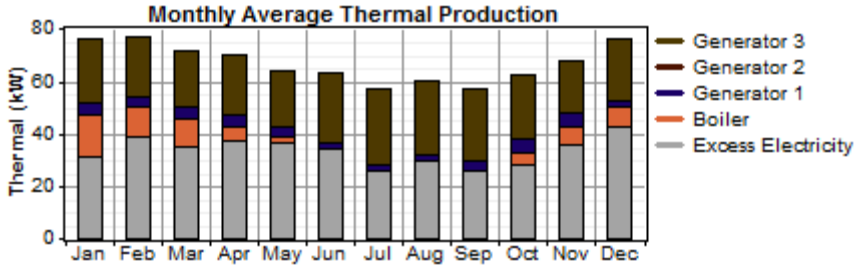
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	292,226	kWh/yr
Unmet load	0.000519	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.418	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	211,828	36%
Generator 1	33,696	6%
Boiler	47,221	8%
Excess electricity	292,226	50%
Total	584,970	100%



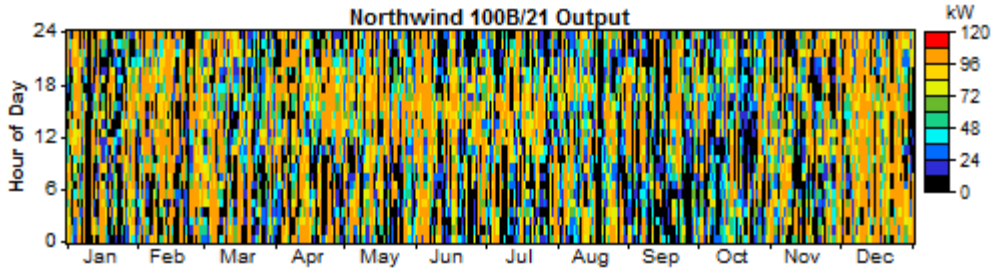
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	201,721	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	54.0	kW
Capacity factor	54.0	%
Total production	473,299	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	86.4	%
Hours of operation	7,722	hr/yr
Levelized cost	0.0634	$/kWh

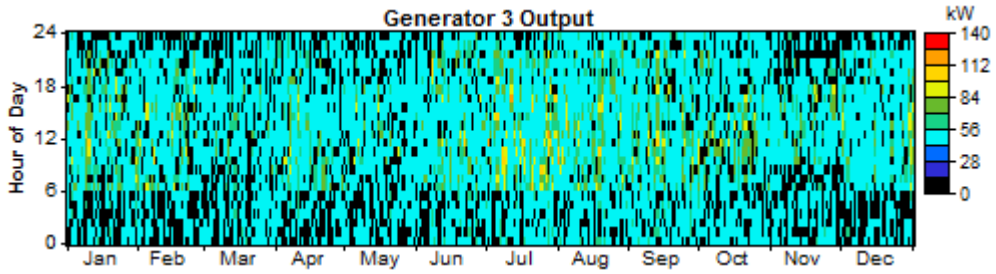


Generator 3

Quantity	Value	Units
Hours of operation	6,486	hr/yr
Number of starts	1,277	starts/yr
Operational life	9.25	yr
Capacity factor	24.9	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	315,908	kWh/yr
Mean electrical output	48.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	211,828	kWh/yr
Mean thermal output	32.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	129,959	L/yr
Specific fuel consumption	0.411	L/kWh
Fuel energy input	1,278,795	kWh/yr
Mean electrical efficiency	24.7	%
Mean total efficiency	41.3	%



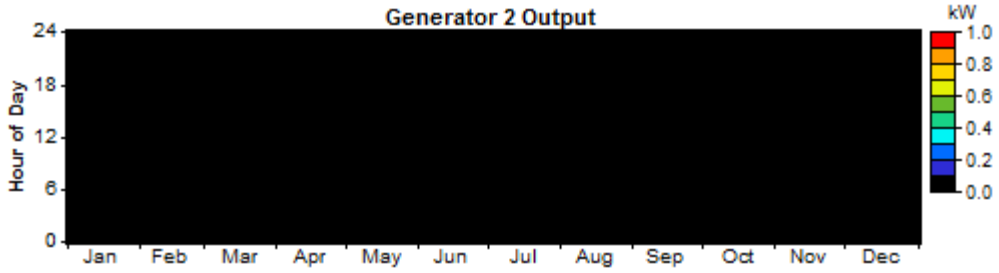
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



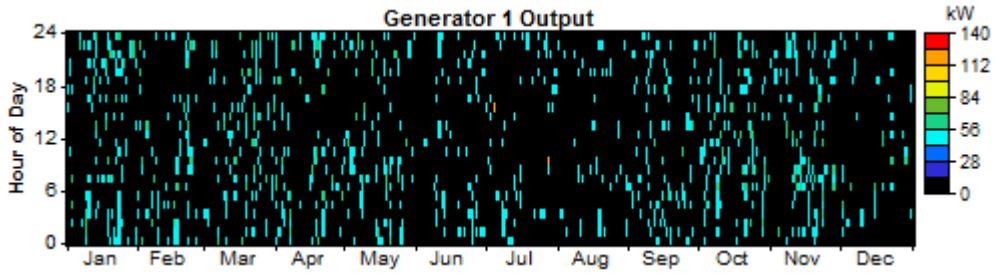
Generator 1

Quantity	Value	Units
Hours of operation	972	hr/yr
Number of starts	698	starts/yr
Operational life	61.7	yr
Capacity factor	3.60	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	50,520	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	33,696	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	65.4	kW

Quantity	Value	Units
Fuel consumption	20,023	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	197,025	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	409,889
Carbon monoxide	975
Unburned hydocarbons	108
Particulate matter	73.5
Sulfur dioxide	824
Nitrogen oxides	8,699

Knight Piésold CONSULTING

Site 3
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

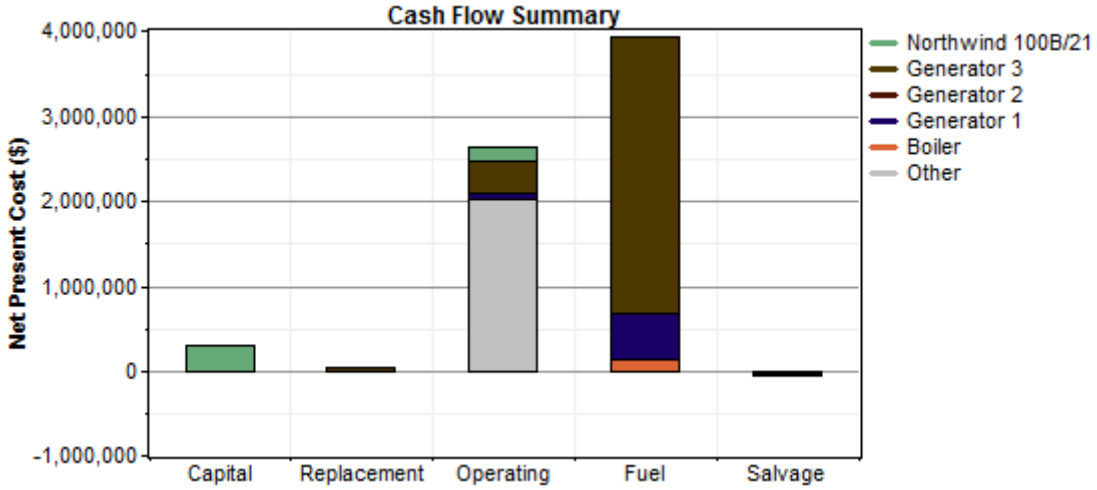
Thermal Load 1 Scaled Average:	1,050	kWh/d
Wind Data Scaled Average:	11	m/s
Diesel Price:	1.68	$/L
Heating Oil Price:	1.68	$/L
Northwind 100B/21 Capital Cost Multiplier:	1.11	
Enercon E33 Capital Cost Multiplier:	1.07	

System architecture

Wind turbine 1 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,845,468
Levelized cost of energy	$ 0.692/kWh
Operating cost	$ 435,809/yr



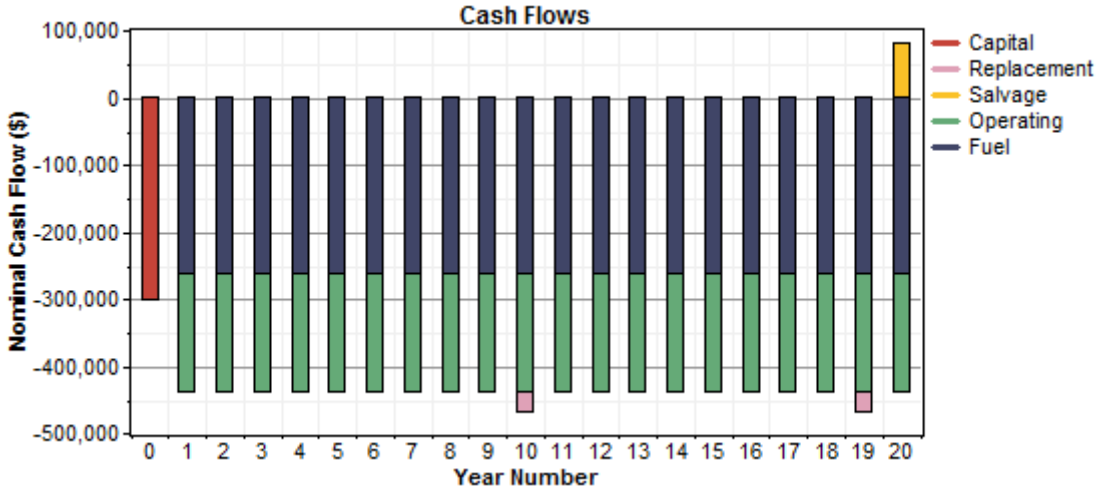
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	301,371	0	149,259	0	0	450,629
Generator 3	0	40,603	386,991	3,254,729	-14,435	3,667,888
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	60,965	528,950	-15,688	574,226
Boiler	0	0	0	142,164	0	142,164
Other	0	0	2,027,154	0	0	2,027,154
System	301,371	40,603	2,624,369	3,925,844	-46,721	6,845,465

Annualized Costs

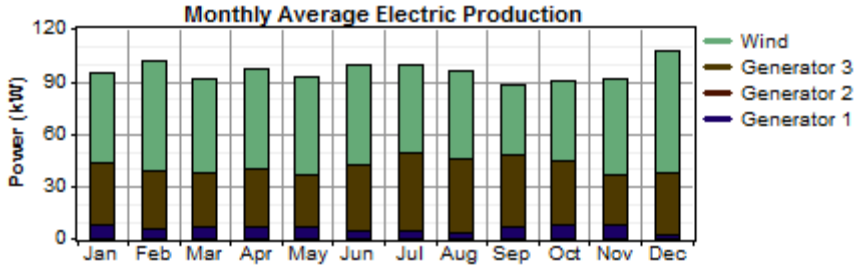
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	20,070	0	9,940	0	0	30,010
Generator 3	0	2,704	25,772	216,751	-961	244,266
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,060	35,226	-1,045	38,241
Boiler	0	0	0	9,468	0	9,468
Other	0	0	135,000	0	0	135,000
System	20,070	2,704	174,772	261,445	-3,111	455,879



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	473,299	56%
Generator 3	313,499	37%
Generator 2	0	0%
Generator 1	52,957	6%
Total	839,755	100%



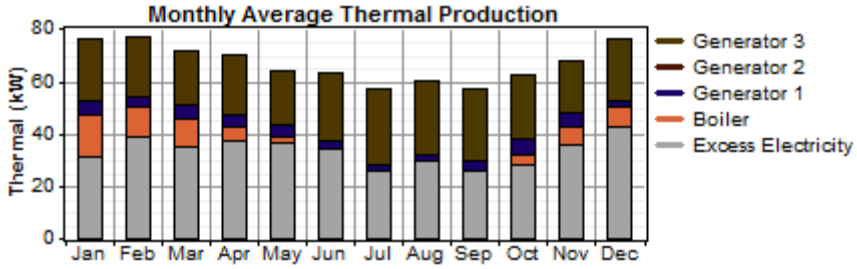
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	292,254	kWh/yr
Unmet load	0.000519	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.418	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	210,322	36%
Generator 1	35,274	6%
Boiler	47,135	8%
Excess electricity	292,254	50%
Total	584,985	100%



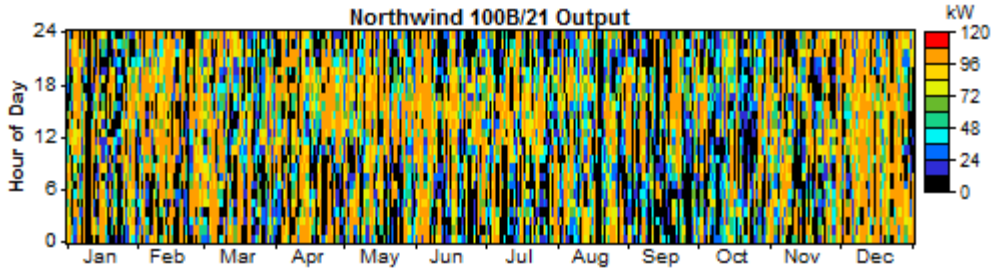
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	201,736	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	100	kW
Mean output	54.0	kW
Capacity factor	54.0	%
Total production	473,299	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	101	kW
Wind penetration	86.4	%
Hours of operation	7,722	hr/yr
Levelized cost	0.0634	$/kWh

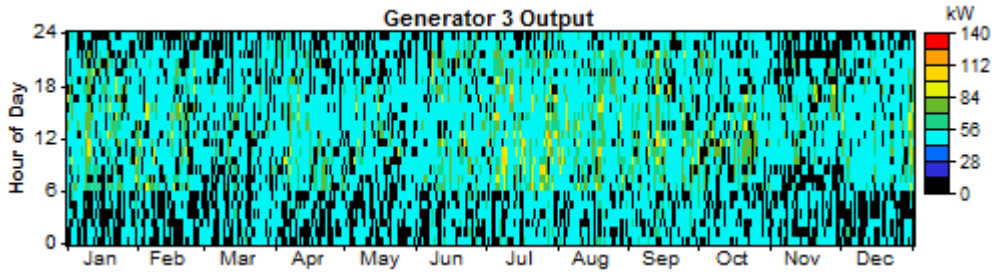


Generator 3

Quantity	Value	Units
Hours of operation	6,443	hr/yr
Number of starts	1,303	starts/yr
Operational life	9.31	yr
Capacity factor	24.7	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	313,499	kWh/yr
Mean electrical output	48.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	210,322	kWh/yr
Mean thermal output	32.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	129,019	L/yr
Specific fuel consumption	0.412	L/kWh
Fuel energy input	1,269,544	kWh/yr
Mean electrical efficiency	24.7	%
Mean total efficiency	41.3	%



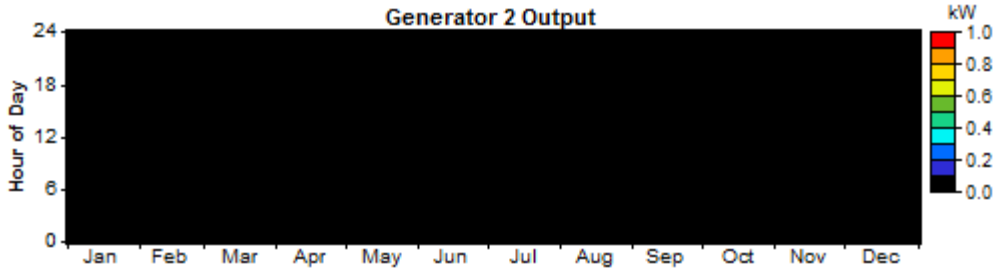
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



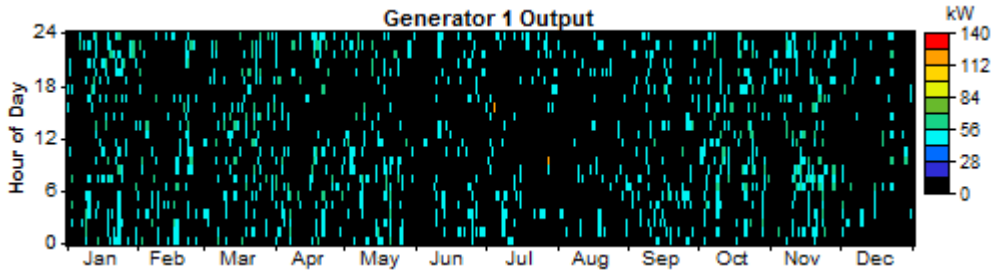
Generator 1

Quantity	Value	Units
Hours of operation	1,015	hr/yr
Number of starts	726	starts/yr
Operational life	59.1	yr
Capacity factor	3.78	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	52,957	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	35,274	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	65.4	kW

Quantity	Value	Units
Fuel consumption	20,968	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	206,323	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	409,874
Carbon monoxide	975
Unburned hydocarbons	108
Particulate matter	73.5
Sulfur dioxide	824
Nitrogen oxides	8,699

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Appendix F
Enercon E33 Economics

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Site 1
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

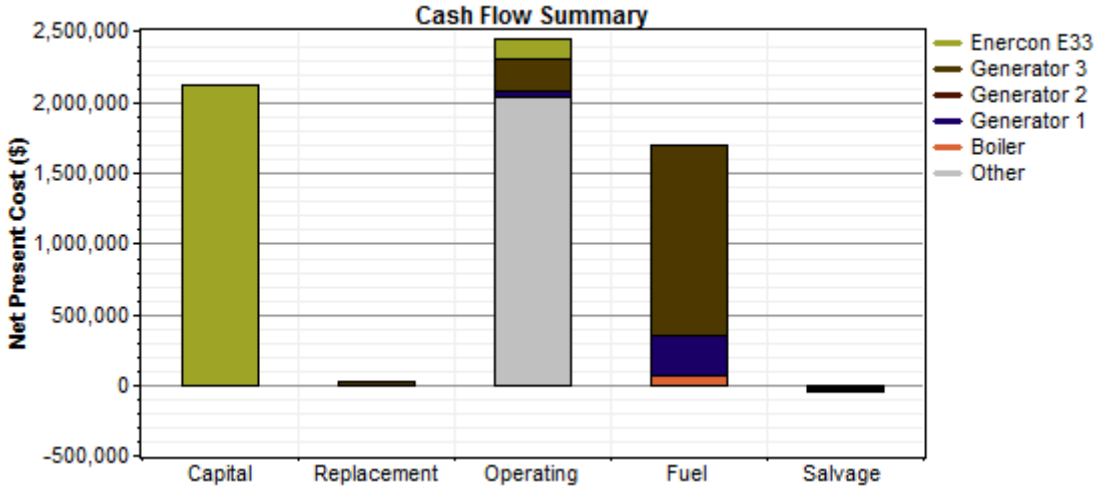
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.97 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,231,279
Levelized cost of energy	$ 0.661/kWh
Operating cost	$ 273,981/yr



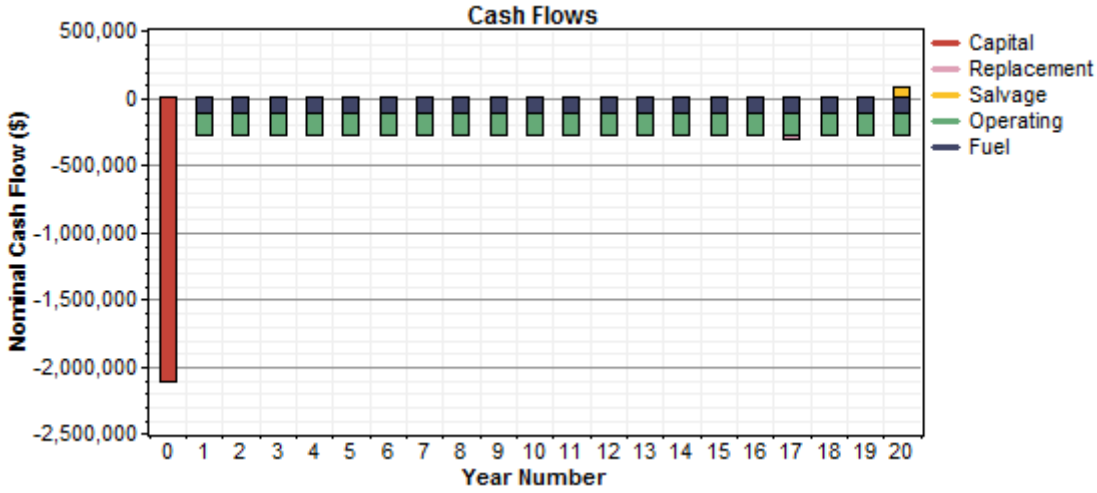
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,117,184	0	149,259	0	0	2,266,443
Generator 3	0	18,916	223,377	1,344,740	-12,877	1,574,156
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	47,030	279,545	-17,522	309,053
Boiler	0	0	0	71,069	0	71,069
Other	0	0	2,027,154	0	0	2,027,154
System	2,117,184	18,916	2,446,820	1,695,354	-46,997	6,231,277

Annualized Costs

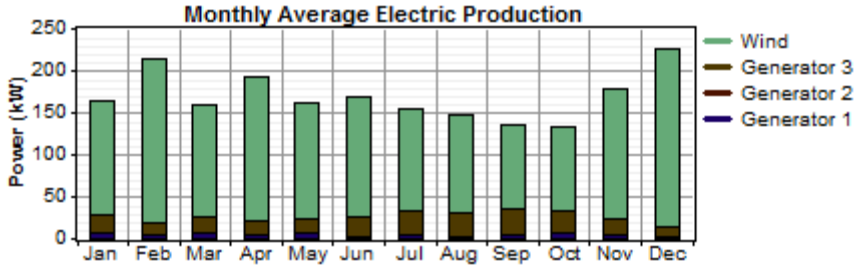
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	140,996	0	9,940	0	0	150,936
Generator 3	0	1,260	14,876	89,554	-858	104,832
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,132	18,617	-1,167	20,582
Boiler	0	0	0	4,733	0	4,733
Other	0	0	135,000	0	0	135,000
System	140,996	1,260	162,948	112,903	-3,130	414,977



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,252,957	84%
Generator 3	191,870	13%
Generator 2	0	0%
Generator 1	40,422	3%
Total	1,485,248	100%



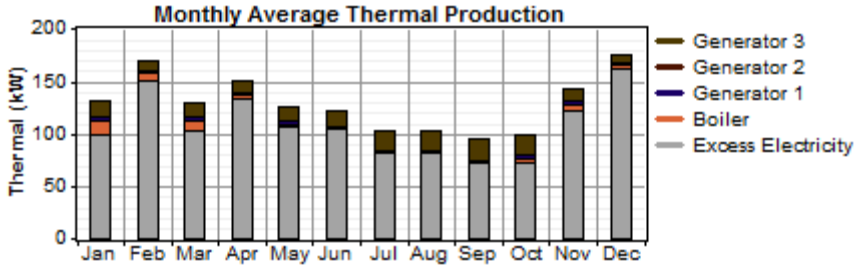
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	937,753	kWh/yr
Unmet load	0.000534	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.750	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	124,912	11%
Generator 1	27,025	2%
Boiler	34,126	3%
Excess electricity	937,753	83%
Total	1,123,815	100%



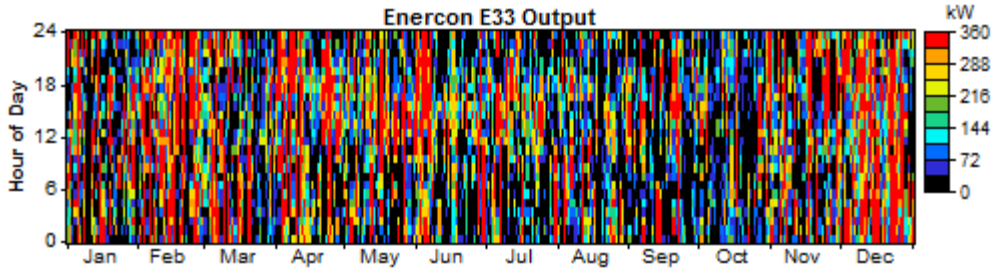
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	740,566	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	143	kW
Capacity factor	43.3	%
Total production	1,252,957	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	229	%
Hours of operation	8,053	hr/yr
Levelized cost	0.120	$/kWh

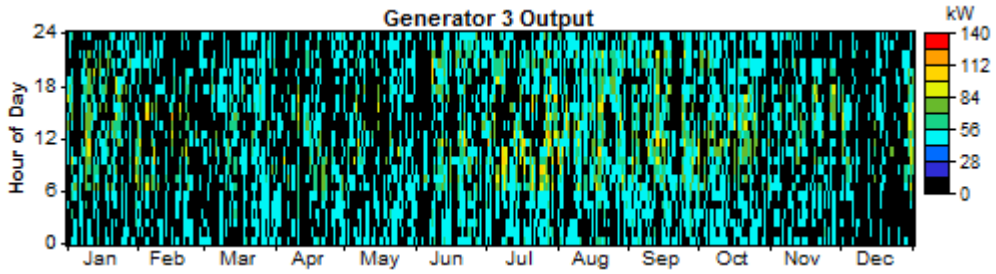


Generator 3

Quantity	Value	Units
Hours of operation	3,719	hr/yr
Number of starts	1,207	starts/yr
Operational life	16.1	yr
Capacity factor	15.1	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	191,870	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	124,912	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	77,202	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	759,666	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



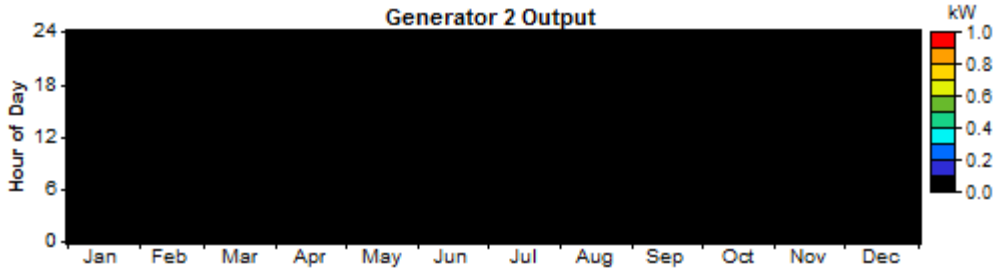
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



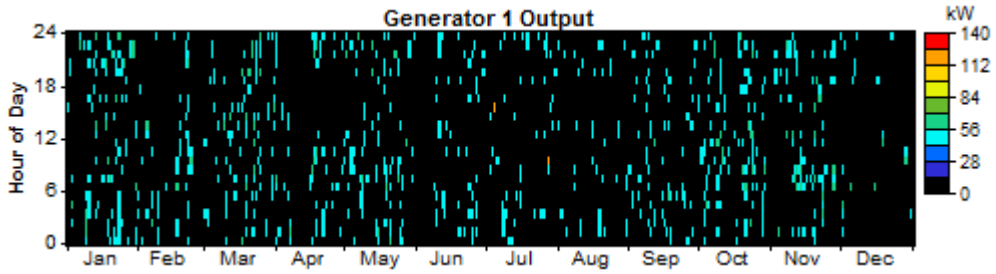
Generator 1

Quantity	Value	Units
Hours of operation	783	hr/yr
Number of starts	575	starts/yr
Operational life	76.6	yr
Capacity factor	2.88	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	40,422	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	27,025	kWh/yr
Mean thermal output	34.5	kW
Min. thermal output	32.9	kW

Max. thermal output	65.3	kW

Quantity	Value	Units
Fuel consumption	16,049	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	157,920	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	256,355
Carbon monoxide	606
Unburned hydocarbons	67.1
Particulate matter	45.7
Sulfur dioxide	515
Nitrogen oxides	5,409

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Site 1
Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

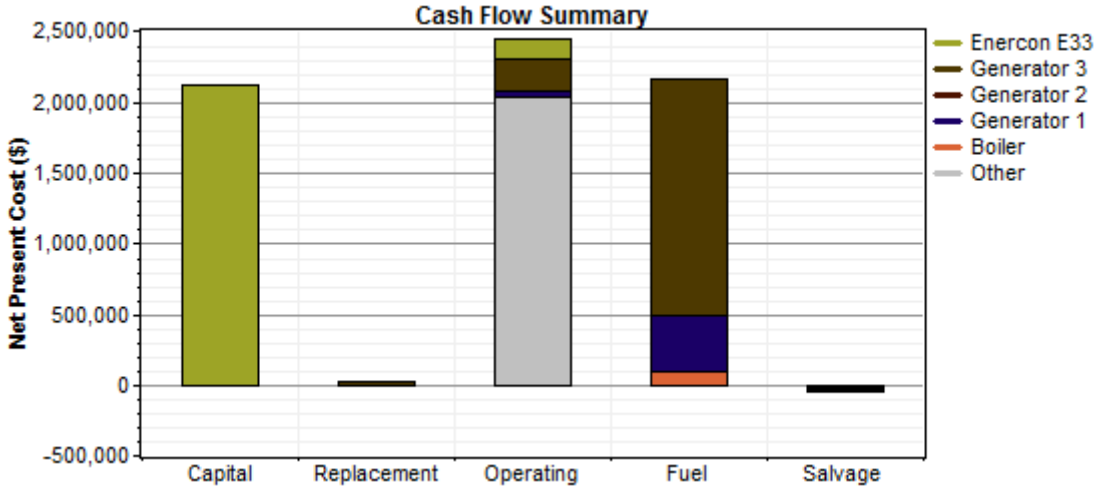
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.97 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,698,693
Levelized cost of energy	$ 0.691/kWh
Operating cost	$ 305,109/yr



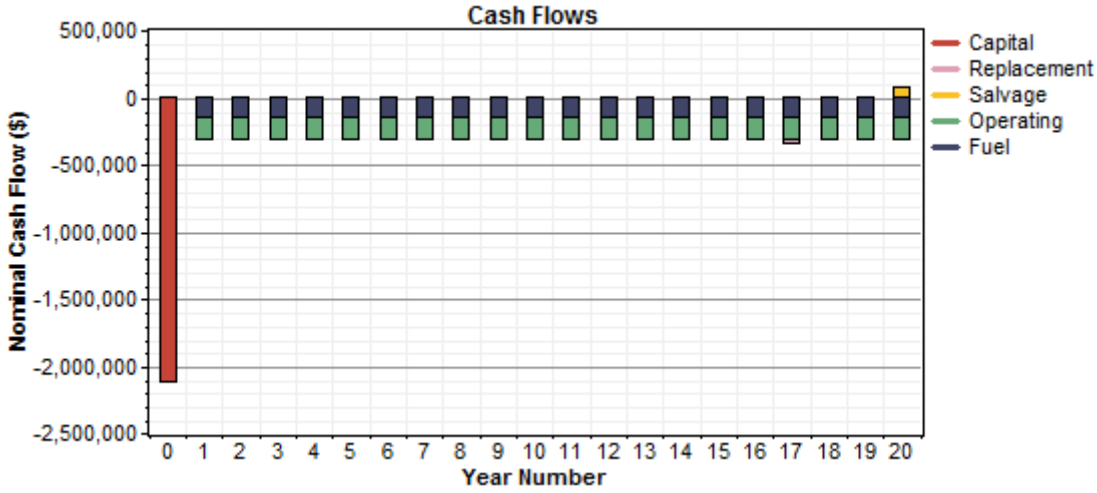
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,117,184	0	149,259	0	0	2,266,443
Generator 3	0	18,734	218,812	1,679,170	-13,306	1,903,411
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	51,595	393,275	-16,921	427,949
Boiler	0	0	0	90,331	0	90,331
Other	0	0	2,027,154	0	0	2,027,154
System	2,117,184	18,734	2,446,820	2,162,777	-46,825	6,698,691

Annualized Costs

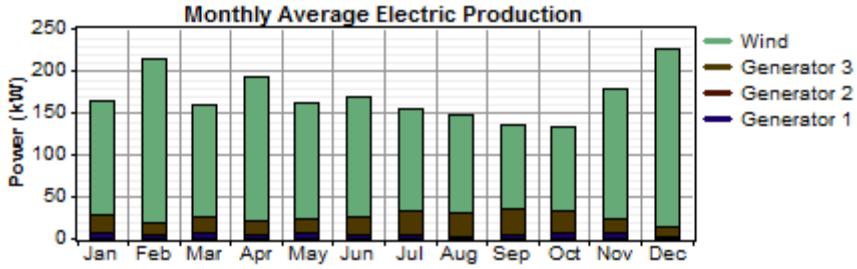
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	140,996	0	9,940	0	0	150,936
Generator 3	0	1,248	14,572	111,826	-886	126,759
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,436	26,190	-1,127	28,500
Boiler	0	0	0	6,016	0	6,016
Other	0	0	135,000	0	0	135,000
System	140,996	1,248	162,948	144,032	-3,118	446,105



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,252,957	84%
Generator 3	187,684	13%
Generator 2	0	0%
Generator 1	44,651	3%
Total	1,485,292	100%



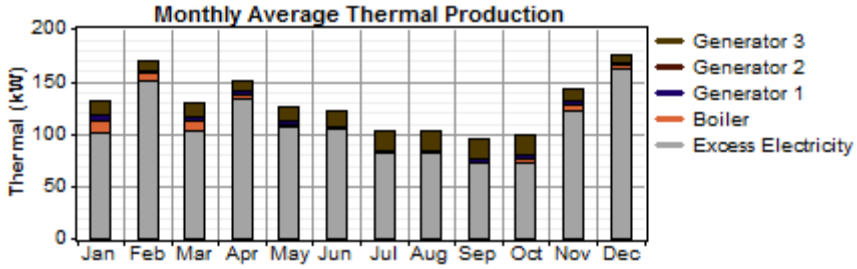
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	937,797	kWh/yr
Unmet load	0.000542	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.750	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	122,274	11%
Generator 1	29,780	3%
Boiler	33,997	3%
Excess electricity	937,797	83%
Total	1,123,848	100%



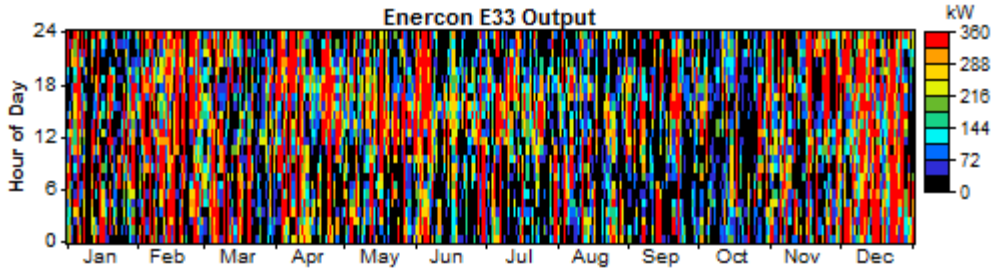
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	740,599	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	143	kW
Capacity factor	43.3	%
Total production	1,252,957	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	229	%
Hours of operation	8,053	hr/yr
Levelized cost	0.120	$/kWh

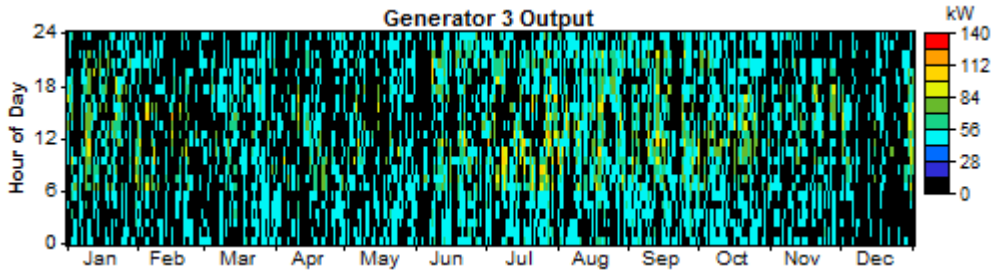


Generator 3

Quantity	Value	Units
Hours of operation	3,643	hr/yr
Number of starts	1,249	starts/yr
Operational life	16.5	yr
Capacity factor	14.8	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	187,684	kWh/yr
Mean electrical output	51.5	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	122,274	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	75,558	L/yr
Specific fuel consumption	0.403	L/kWh
Fuel energy input	743,490	kWh/yr
Mean electrical efficiency	25.2	%
Mean total efficiency	41.7	%



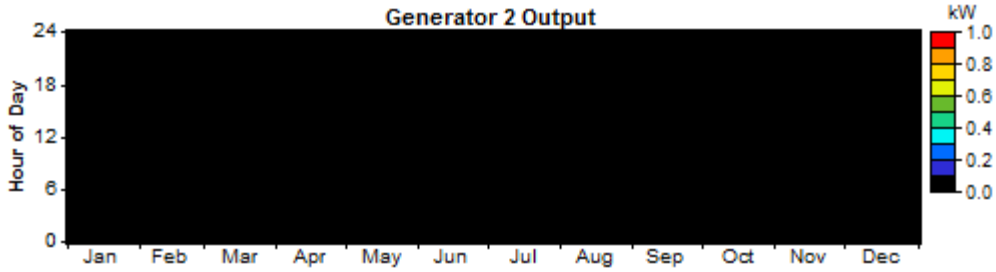
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



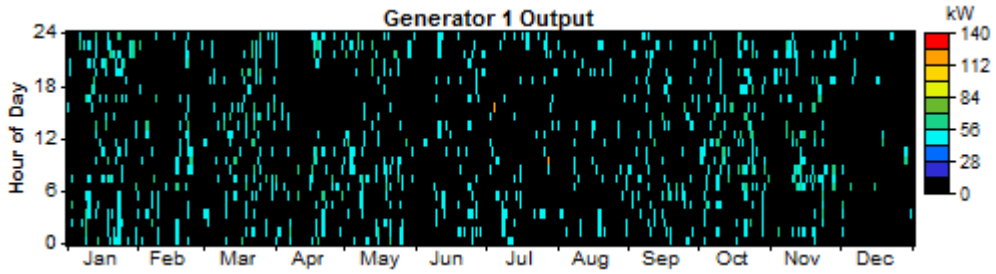
Generator 1

Quantity	Value	Units
Hours of operation	859	hr/yr
Number of starts	625	starts/yr
Operational life	69.8	yr
Capacity factor	3.19	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	44,651	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	29,780	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	65.3	kW

Quantity	Value	Units
Fuel consumption	17,696	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	174,131	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	256,324
Carbon monoxide	606
Unburned hydocarbons	67.1
Particulate matter	45.7
Sulfur dioxide	515
Nitrogen oxides	5,409

Knight Piésold CONSULTING

Site 1
Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

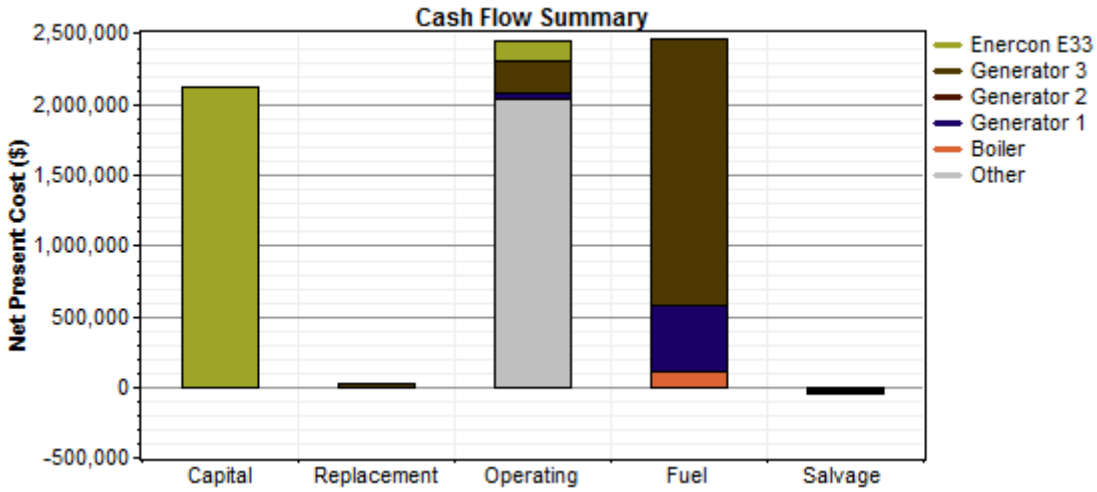
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.97 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,990,835
Levelized cost of energy	$ 0.710/kWh
Operating cost	$ 324,565/yr



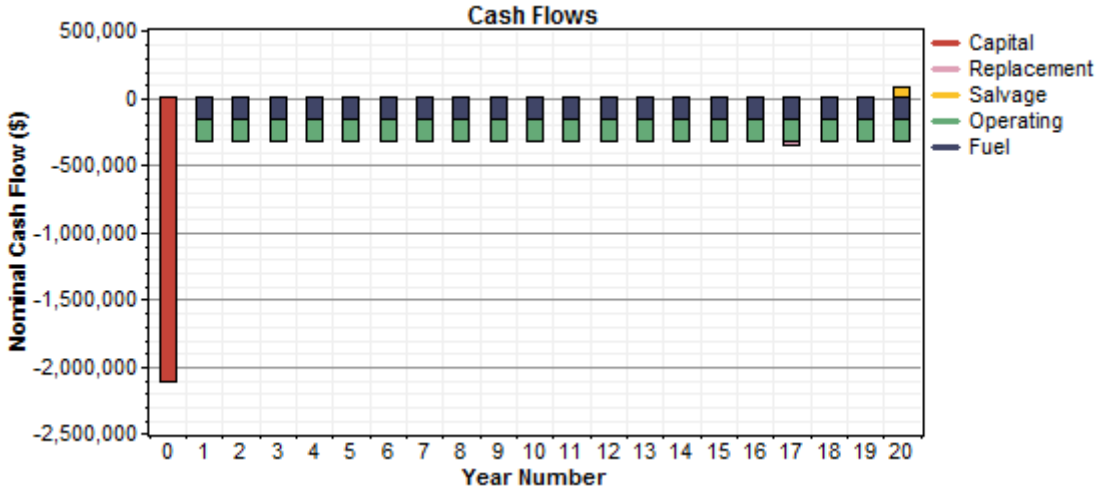
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,117,184	0	149,259	0	0	2,266,443
Generator 3	0	18,644	216,590	1,885,883	-13,515	2,107,603
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	53,817	466,732	-16,629	503,920
Boiler	0	0	0	102,311	0	102,311
Other	0	0	2,027,154	0	0	2,027,154
System	2,117,184	18,644	2,446,820	2,454,926	-46,741	6,990,833

Annualized Costs

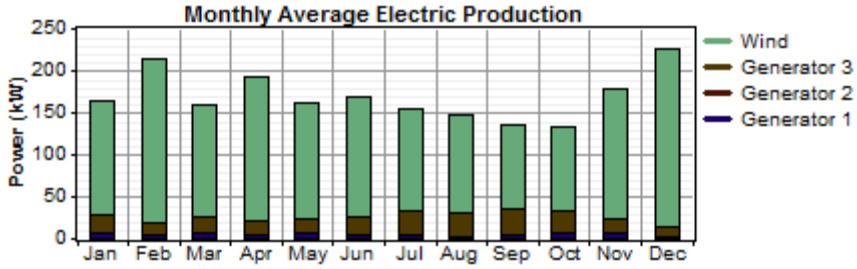
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	140,996	0	9,940	0	0	150,936
Generator 3	0	1,242	14,424	125,592	-900	140,358
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,584	31,082	-1,107	33,559
Boiler	0	0	0	6,813	0	6,813
Other	0	0	135,000	0	0	135,000
System	140,996	1,242	162,948	163,488	-3,113	465,560



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,252,957	84%
Generator 3	185,644	12%
Generator 2	0	0%
Generator 1	46,721	3%
Total	1,485,322	100%



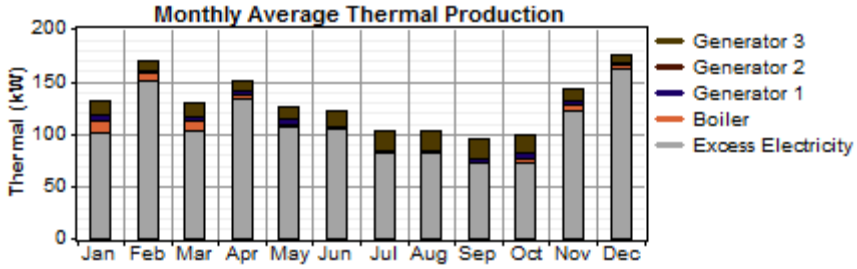
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	937,827	kWh/yr
Unmet load	0.000542	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.750	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	120,989	11%
Generator 1	31,127	3%
Boiler	33,921	3%
Excess electricity	937,827	83%
Total	1,123,864	100%



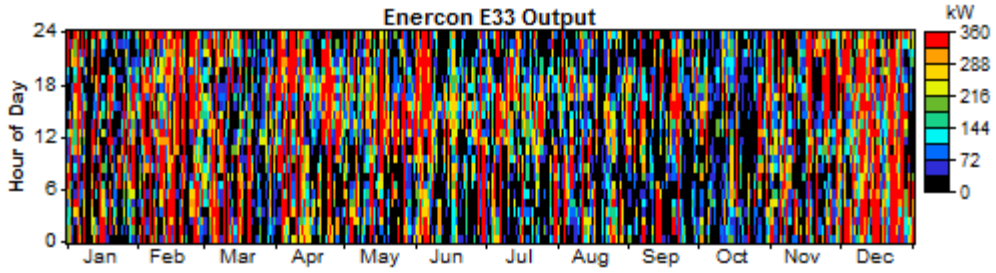
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	740,614	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	143	kW
Capacity factor	43.3	%
Total production	1,252,957	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	229	%
Hours of operation	8,053	hr/yr
Levelized cost	0.120	$/kWh

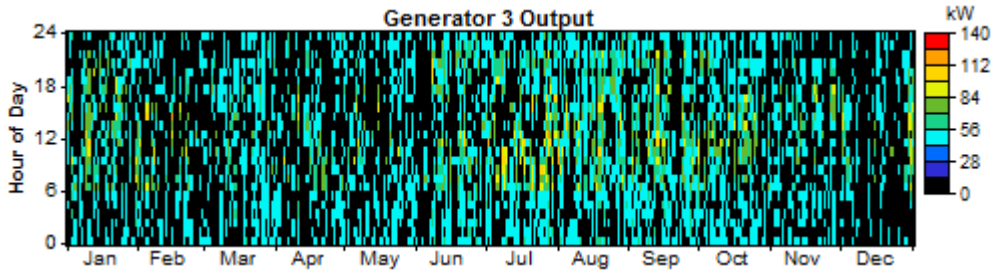


Generator 3

Quantity	Value	Units
Hours of operation	3,606	hr/yr
Number of starts	1,256	starts/yr
Operational life	16.6	yr
Capacity factor	14.6	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	185,644	kWh/yr
Mean electrical output	51.5	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	120,989	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	74,757	L/yr
Specific fuel consumption	0.403	L/kWh
Fuel energy input	735,610	kWh/yr
Mean electrical efficiency	25.2	%
Mean total efficiency	41.7	%



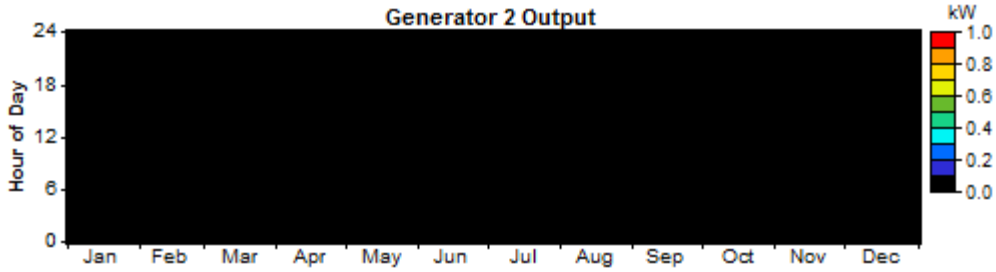
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



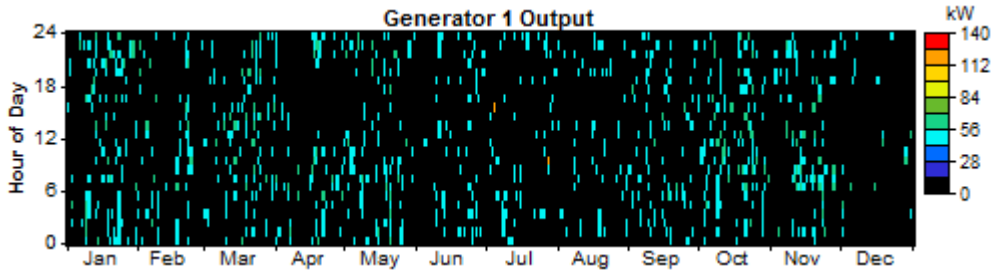
Generator 1

Quantity	Value	Units
Hours of operation	896	hr/yr
Number of starts	636	starts/yr
Operational life	67.0	yr
Capacity factor	3.33	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	46,721	kWh/yr
Mean electrical output	52.1	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	31,127	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	65.3	kW

Quantity	Value	Units
Fuel consumption	18,501	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	182,054	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	256,311
Carbon monoxide	606
Unburned hydocarbons	67.1
Particulate matter	45.7
Sulfur dioxide	515
Nitrogen oxides	5,409

Knight Piésold CONSULTING

Site 1
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

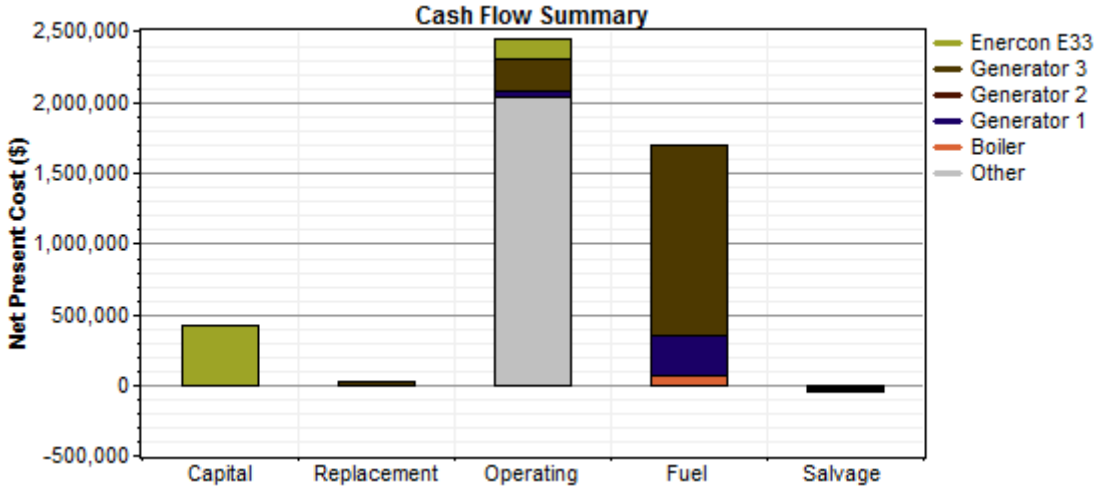
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.97 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 4,537,532
Levelized cost of energy	$ 0.455/kWh
Operating cost	$ 273,981/yr



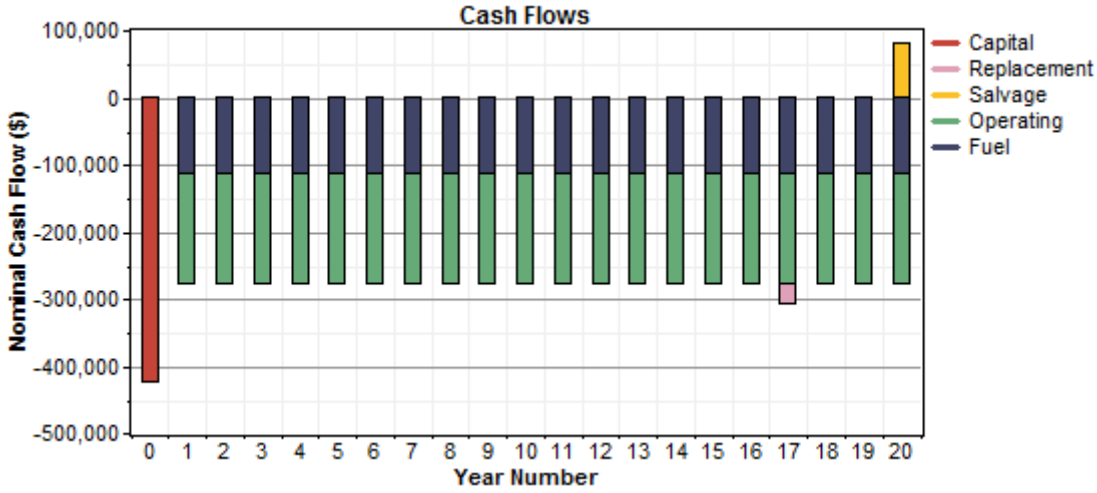
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	423,437	0	149,259	0	0	572,696
Generator 3	0	18,916	223,377	1,344,740	-12,877	1,574,156
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	47,030	279,545	-17,522	309,053
Boiler	0	0	0	71,069	0	71,069
Other	0	0	2,027,154	0	0	2,027,154
System	423,437	18,916	2,446,820	1,695,354	-46,997	4,537,530

Annualized Costs

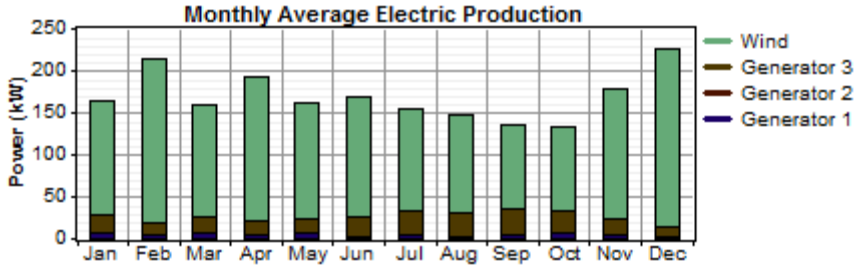
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	28,199	0	9,940	0	0	38,139
Generator 3	0	1,260	14,876	89,554	-858	104,832
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,132	18,617	-1,167	20,582
Boiler	0	0	0	4,733	0	4,733
Other	0	0	135,000	0	0	135,000
System	28,199	1,260	162,948	112,903	-3,130	302,180



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,252,957	84%
Generator 3	191,870	13%
Generator 2	0	0%
Generator 1	40,422	3%
Total	1,485,248	100%



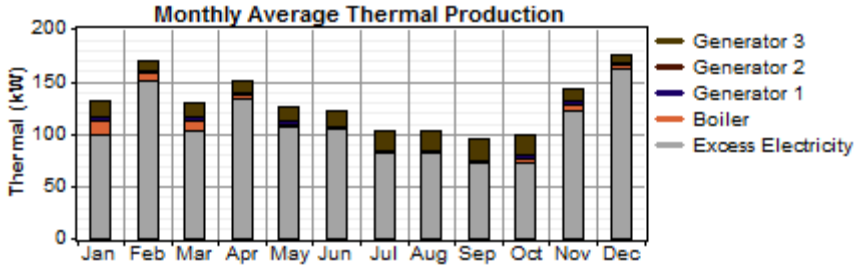
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	937,753	kWh/yr
Unmet load	0.000534	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.750	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	124,912	11%
Generator 1	27,025	2%
Boiler	34,126	3%
Excess electricity	937,753	83%
Total	1,123,815	100%



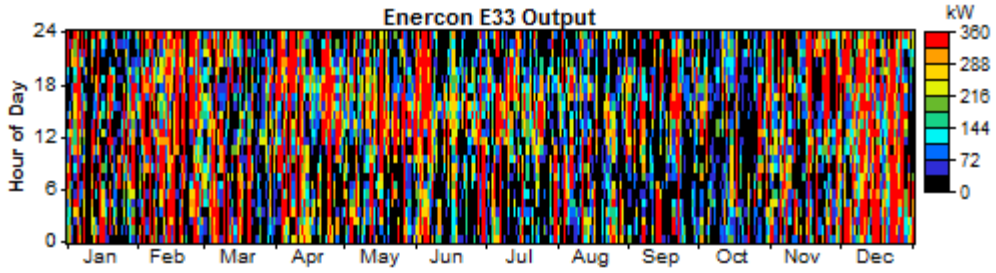
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	740,566	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	143	kW
Capacity factor	43.3	%
Total production	1,252,957	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	229	%
Hours of operation	8,053	hr/yr
Levelized cost	0.0304	$/kWh

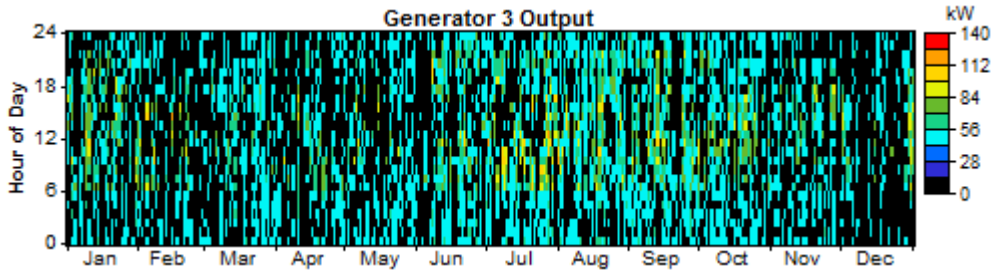


Generator 3

Quantity	Value	Units
Hours of operation	3,719	hr/yr
Number of starts	1,207	starts/yr
Operational life	16.1	yr
Capacity factor	15.1	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	191,870	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	124,912	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	77,202	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	759,666	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



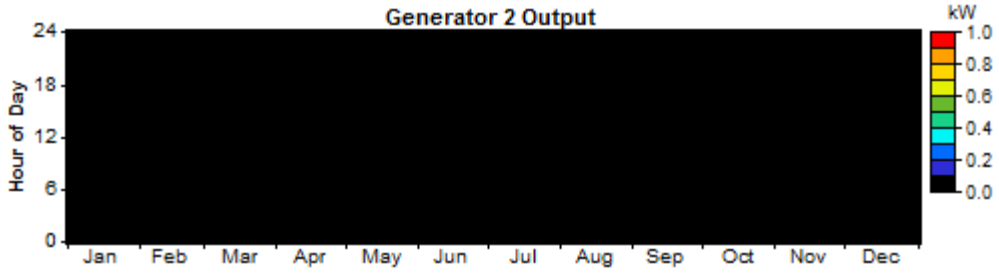
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



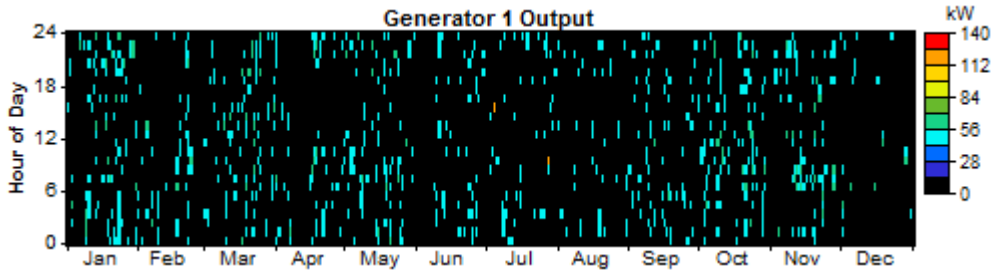
Generator 1

Quantity	Value	Units
Hours of operation	783	hr/yr
Number of starts	575	starts/yr
Operational life	76.6	yr
Capacity factor	2.88	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	40,422	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	27,025	kWh/yr
Mean thermal output	34.5	kW
Min. thermal output	32.9	kW

Max. thermal output	65.3	kW

Quantity	Value	Units
Fuel consumption	16,049	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	157,920	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	256,355
Carbon monoxide	606
Unburned hydocarbons	67.1
Particulate matter	45.7
Sulfur dioxide	515
Nitrogen oxides	5,409

Knight Piésold CONSULTING

Site 1
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

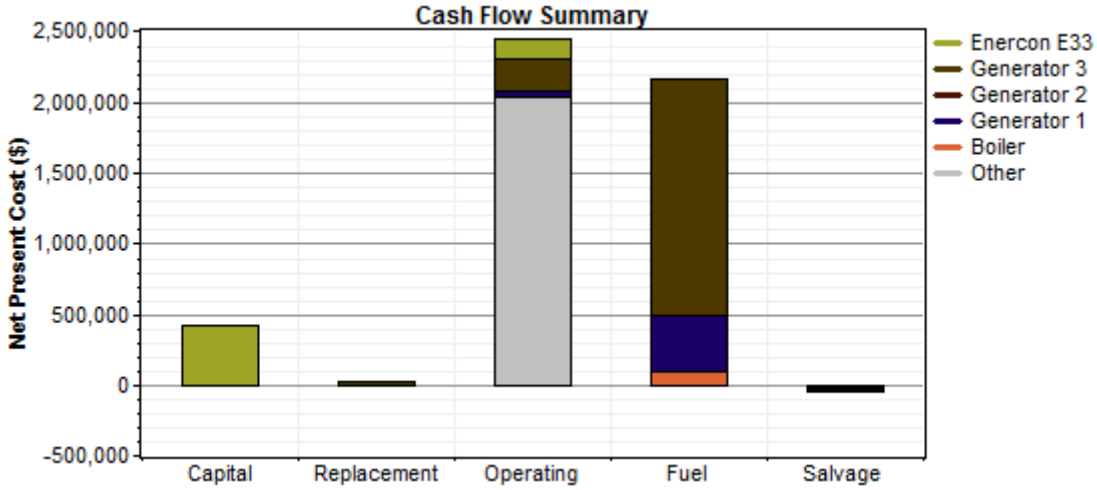
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.97 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,004,946
Levelized cost of energy	$ 0.485/kWh
Operating cost	$ 305,109/yr



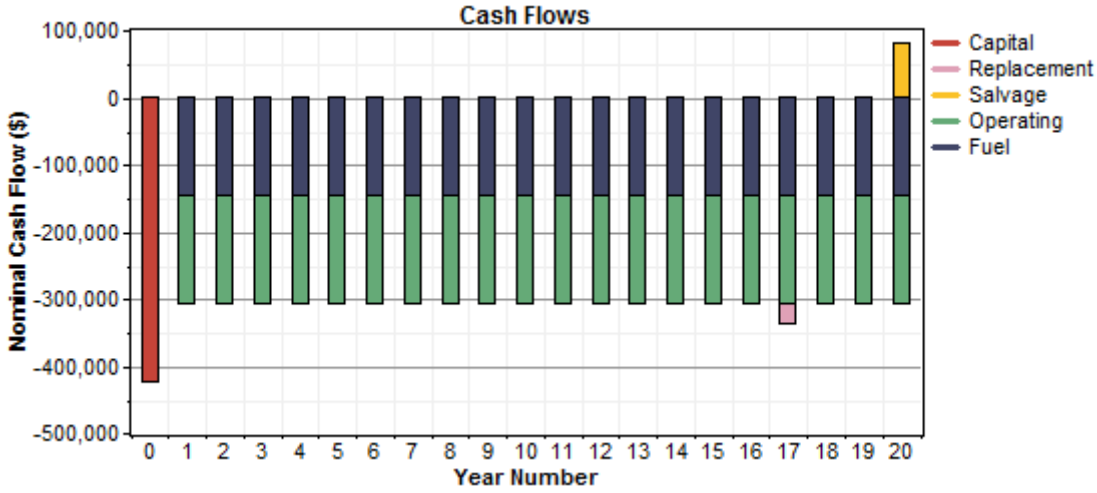
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	423,437	0	149,259	0	0	572,696
Generator 3	0	18,734	218,812	1,679,170	-13,306	1,903,411
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	51,595	393,275	-16,921	427,949
Boiler	0	0	0	90,331	0	90,331
Other	0	0	2,027,154	0	0	2,027,154
System	423,437	18,734	2,446,820	2,162,777	-46,825	5,004,944

Annualized Costs

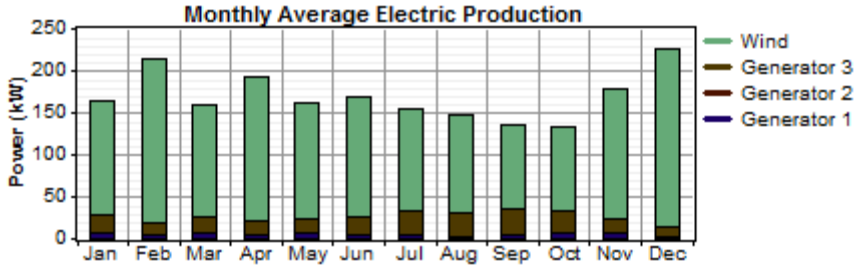
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	28,199	0	9,940	0	0	38,139
Generator 3	0	1,248	14,572	111,826	-886	126,759
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,436	26,190	-1,127	28,500
Boiler	0	0	0	6,016	0	6,016
Other	0	0	135,000	0	0	135,000
System	28,199	1,248	162,948	144,032	-3,118	333,308



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,252,957	84%
Generator 3	187,684	13%
Generator 2	0	0%
Generator 1	44,651	3%
Total	1,485,292	100%



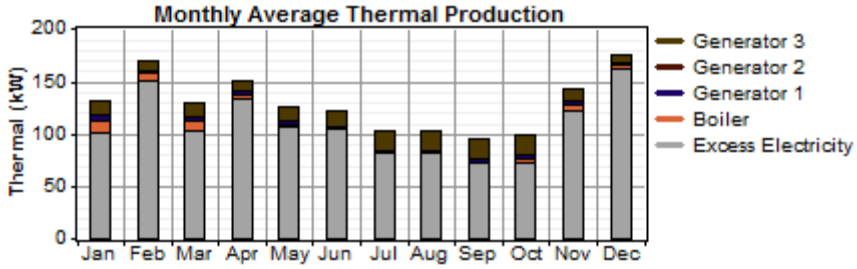
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	937,797	kWh/yr
Unmet load	0.000542	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.750	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	122,274	11%
Generator 1	29,780	3%
Boiler	33,997	3%
Excess electricity	937,797	83%
Total	1,123,848	100%



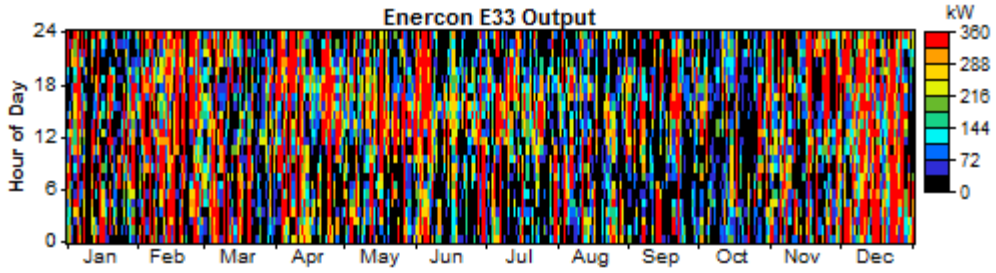
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	740,599	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	143	kW
Capacity factor	43.3	%
Total production	1,252,957	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	229	%
Hours of operation	8,053	hr/yr
Levelized cost	0.0304	$/kWh

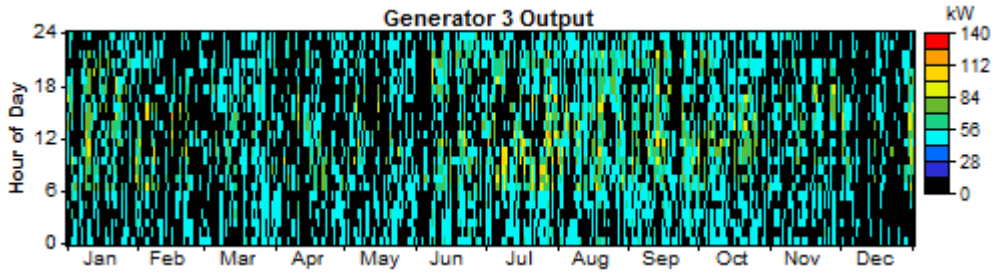


Generator 3

Quantity	Value	Units
Hours of operation	3,643	hr/yr
Number of starts	1,249	starts/yr
Operational life	16.5	yr
Capacity factor	14.8	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	187,684	kWh/yr
Mean electrical output	51.5	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	122,274	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	75,558	L/yr
Specific fuel consumption	0.403	L/kWh
Fuel energy input	743,490	kWh/yr
Mean electrical efficiency	25.2	%
Mean total efficiency	41.7	%



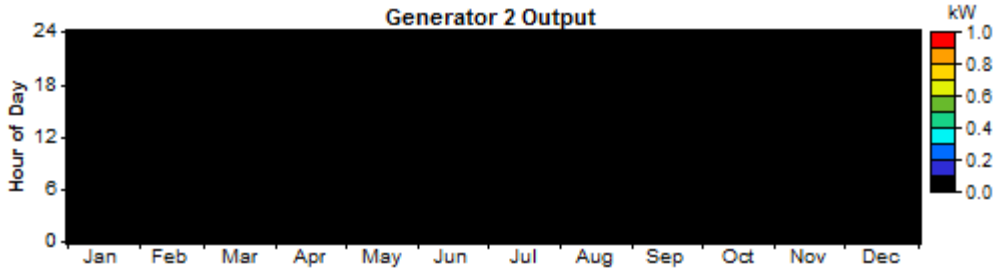
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



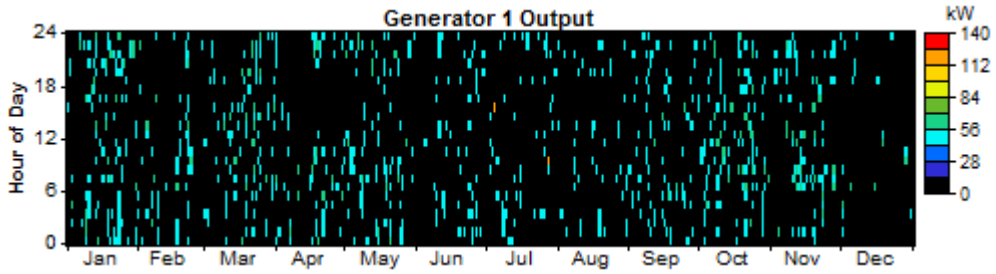
Generator 1

Quantity	Value	Units
Hours of operation	859	hr/yr
Number of starts	625	starts/yr
Operational life	69.8	yr
Capacity factor	3.19	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	44,651	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	29,780	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	65.3	kW

Quantity	Value	Units
Fuel consumption	17,696	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	174,131	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	256,324
Carbon monoxide	606
Unburned hydocarbons	67.1
Particulate matter	45.7
Sulfur dioxide	515
Nitrogen oxides	5,409

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Site 1
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

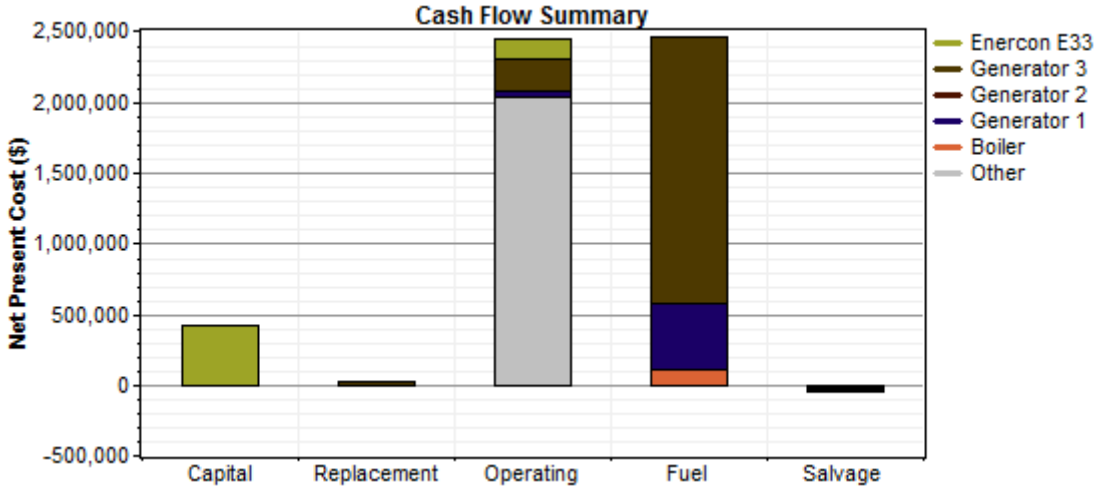
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.97 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,297,088
Levelized cost of energy	$ 0.504/kWh
Operating cost	$ 324,565/yr



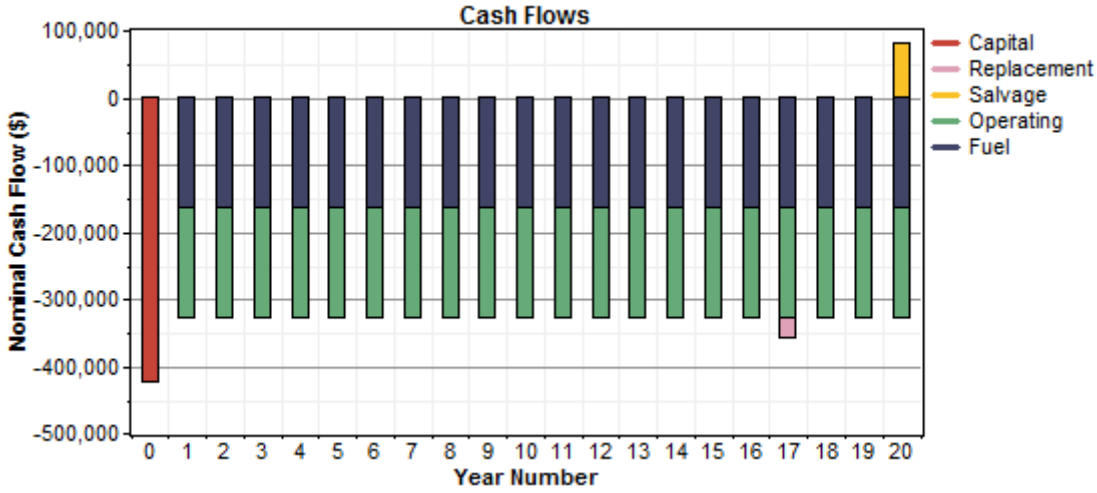
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	423,437	0	149,259	0	0	572,696
Generator 3	0	18,644	216,590	1,885,883	-13,515	2,107,603
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	53,817	466,732	-16,629	503,920
Boiler	0	0	0	102,311	0	102,311
Other	0	0	2,027,154	0	0	2,027,154
System	423,437	18,644	2,446,820	2,454,926	-46,741	5,297,086

Annualized Costs

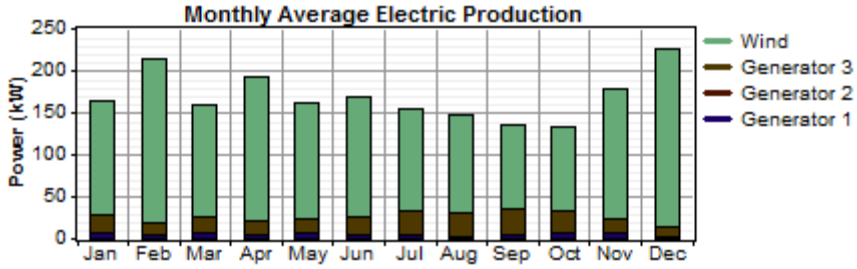
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	28,199	0	9,940	0	0	38,139
Generator 3	0	1,242	14,424	125,592	-900	140,358
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,584	31,082	-1,107	33,559
Boiler	0	0	0	6,813	0	6,813
Other	0	0	135,000	0	0	135,000
System	28,199	1,242	162,948	163,488	-3,113	352,764



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,252,957	84%
Generator 3	185,644	12%
Generator 2	0	0%
Generator 1	46,721	3%
Total	1,485,322	100%



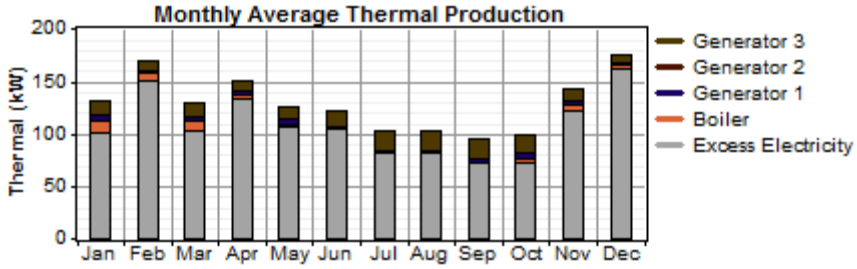
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	937,827	kWh/yr
Unmet load	0.000542	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.750	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	120,989	11%
Generator 1	31,127	3%
Boiler	33,921	3%
Excess electricity	937,827	83%
Total	1,123,864	100%



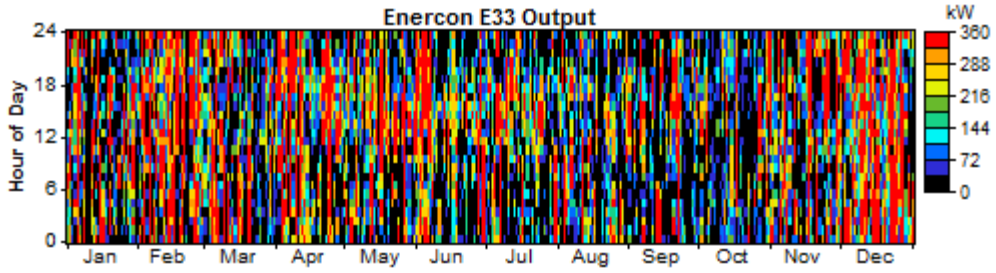
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	740,614	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	143	kW
Capacity factor	43.3	%
Total production	1,252,957	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	229	%
Hours of operation	8,053	hr/yr
Levelized cost	0.0304	$/kWh

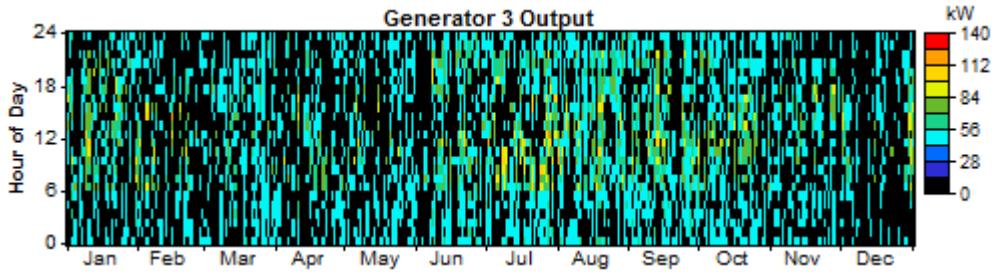


Generator 3

Quantity	Value	Units
Hours of operation	3,606	hr/yr
Number of starts	1,256	starts/yr
Operational life	16.6	yr
Capacity factor	14.6	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	185,644	kWh/yr
Mean electrical output	51.5	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	120,989	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	74,757	L/yr
Specific fuel consumption	0.403	L/kWh
Fuel energy input	735,610	kWh/yr
Mean electrical efficiency	25.2	%
Mean total efficiency	41.7	%



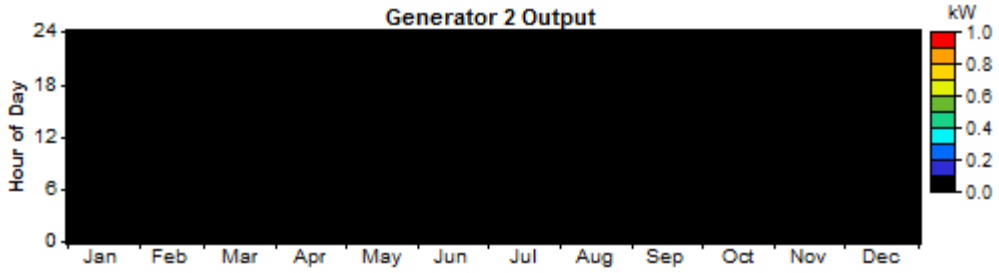
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



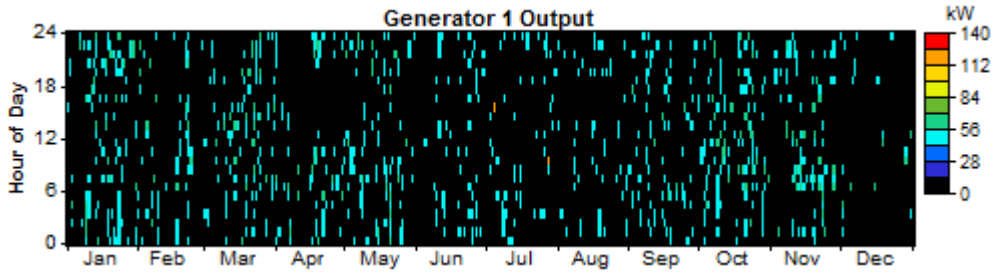
Generator 1

Quantity	Value	Units
Hours of operation	896	hr/yr
Number of starts	636	starts/yr
Operational life	67.0	yr
Capacity factor	3.33	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	46,721	kWh/yr
Mean electrical output	52.1	kW
Min. electrical output	48.0	kW
Max. electrical output	123	kW
Thermal production	31,127	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	65.3	kW

Quantity	Value	Units
Fuel consumption	18,501	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	182,054	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	256,311
Carbon monoxide	606
Unburned hydocarbons	67.1
Particulate matter	45.7
Sulfur dioxide	515
Nitrogen oxides	5,409

Knight Piésold
CONSULTING

Site 2
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

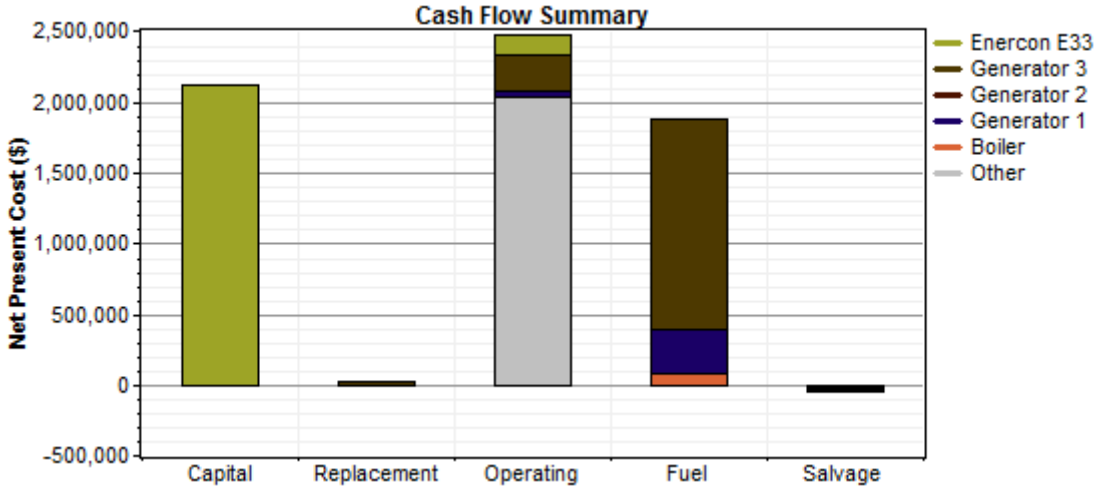
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,444,906
Levelized cost of energy	$ 0.687/kWh
Operating cost	$ 288,208/yr



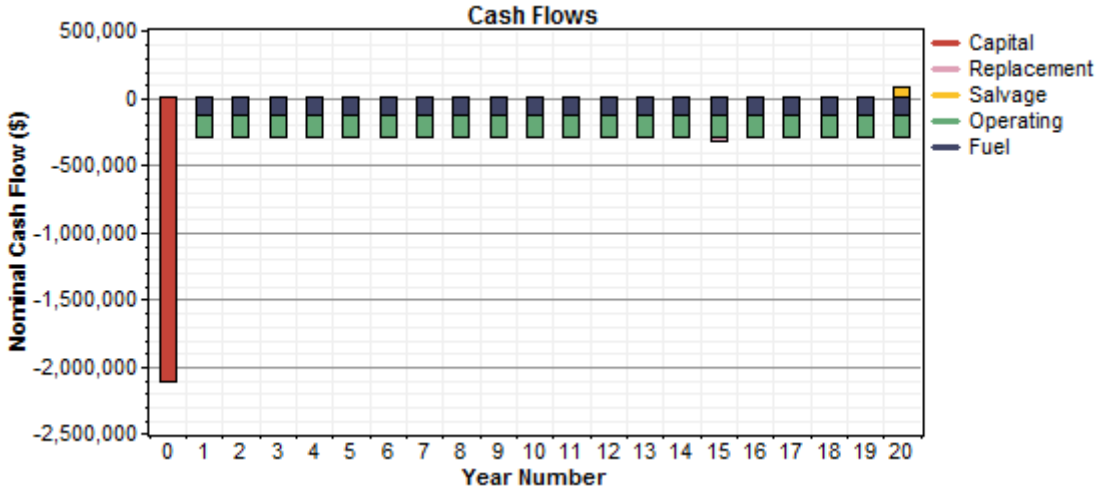
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,117,184	0	149,259	0	0	2,266,443
Generator 3	0	19,701	245,000	1,482,305	-10,845	1,736,162
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	52,976	314,491	-16,740	350,728
Boiler	0	0	0	81,015	0	81,015
Other	0	0	2,027,154	0	0	2,027,154
System	2,117,184	19,701	2,474,389	1,877,811	-44,182	6,444,904

Annualized Costs

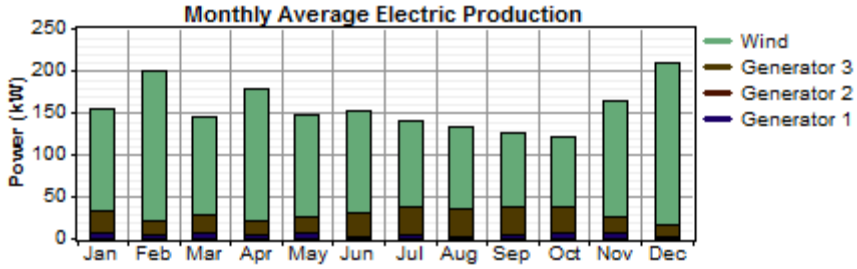
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	140,996	0	9,940	0	0	150,936
Generator 3	0	1,312	16,316	98,715	-722	115,621
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,528	20,944	-1,115	23,357
Boiler	0	0	0	5,395	0	5,395
Other	0	0	135,000	0	0	135,000
System	140,996	1,312	164,784	125,054	-2,942	429,204



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,106,151	81%
Generator 3	212,139	16%
Generator 2	0	0%
Generator 1	45,454	3%
Total	1,363,744	100%



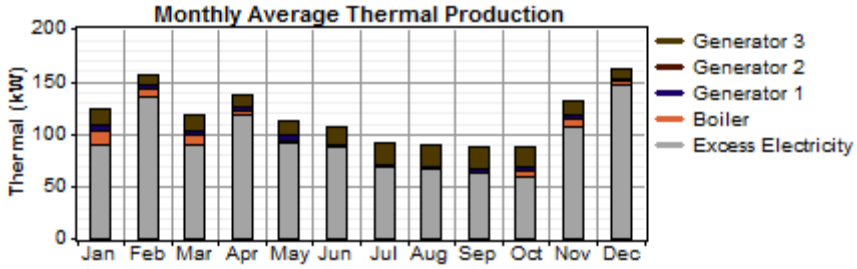
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	816,241	kWh/yr
Unmet load	0.000465	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.704	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	137,549	13%
Generator 1	30,408	3%
Boiler	38,902	4%
Excess electricity	816,241	80%
Total	1,023,099	100%



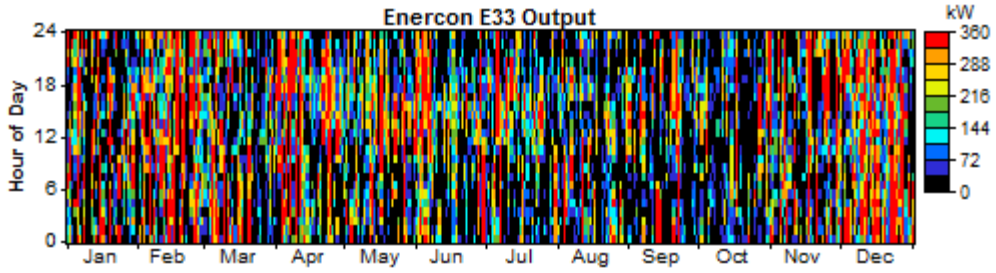
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	639,849	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	126	kW
Capacity factor	38.3	%
Total production	1,106,151	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	202	%
Hours of operation	7,967	hr/yr
Levelized cost	0.136	$/kWh

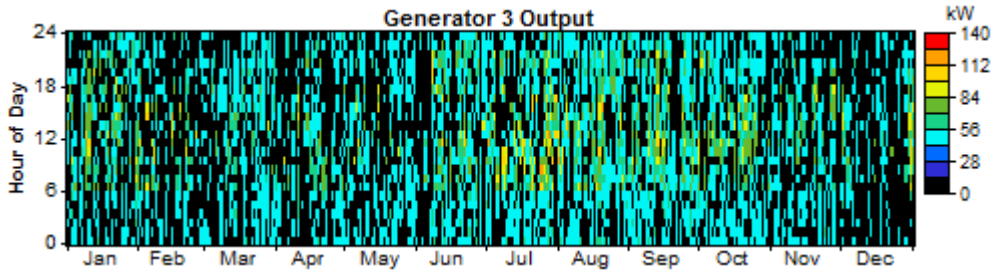


Generator 3

Quantity	Value	Units
Hours of operation	4,079	hr/yr
Number of starts	1,245	starts/yr
Operational life	14.7	yr
Capacity factor	16.7	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	212,139	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	137,549	kWh/yr
Mean thermal output	33.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	85,099	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	837,378	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.8	%



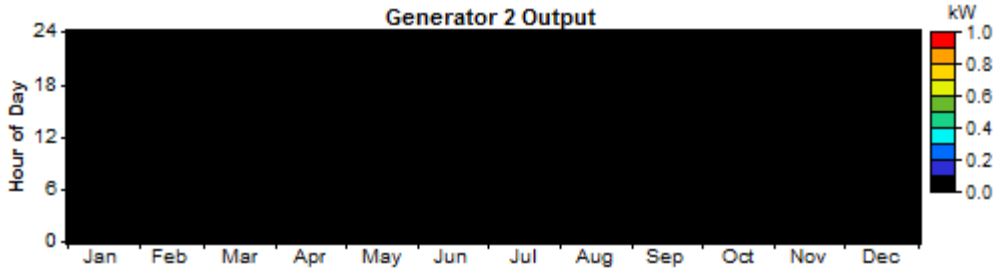
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



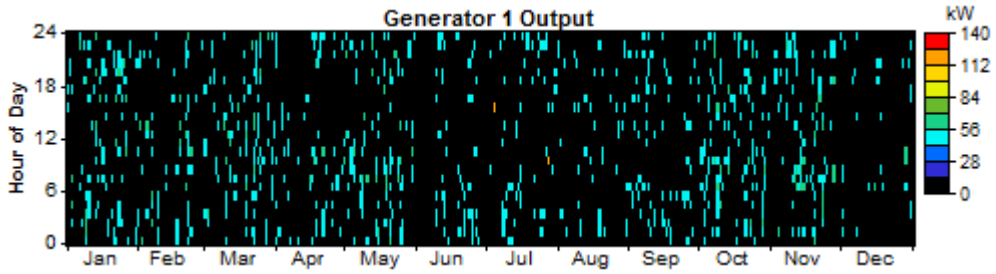
Generator 1

Quantity	Value	Units
Hours of operation	882	hr/yr
Number of starts	647	starts/yr
Operational life	68.0	yr
Capacity factor	3.24	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	45,454	kWh/yr
Mean electrical output	51.5	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	30,408	kWh/yr
Mean thermal output	34.5	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	18,055	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	177,661	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	283,946
Carbon monoxide	671
Unburned hydocarbons	74.3
Particulate matter	50.5
Sulfur dioxide	571
Nitrogen oxides	5,983

Knight Piésold CONSULTING

Site 2
Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

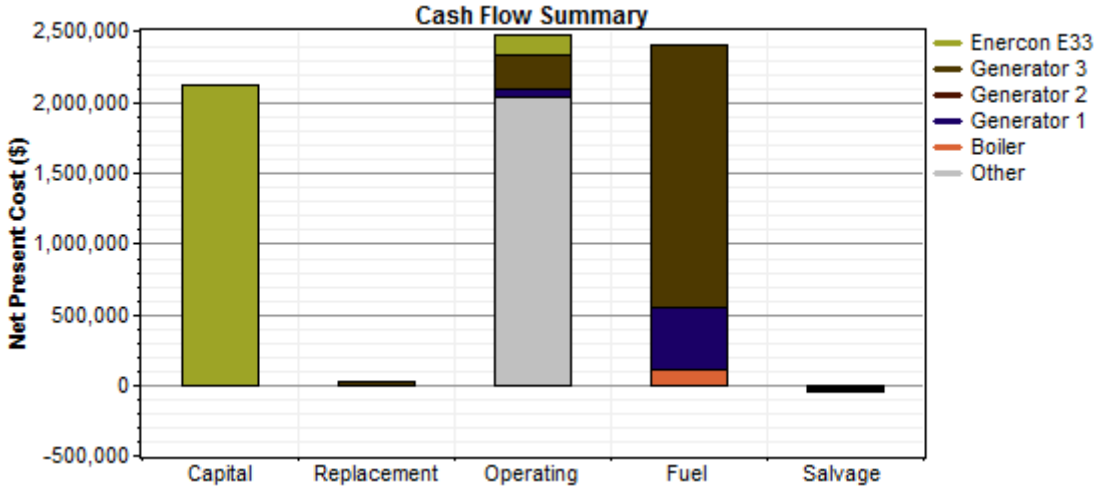
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,962,633
Levelized cost of energy	$ 0.723/kWh
Operating cost	$ 322,687/yr



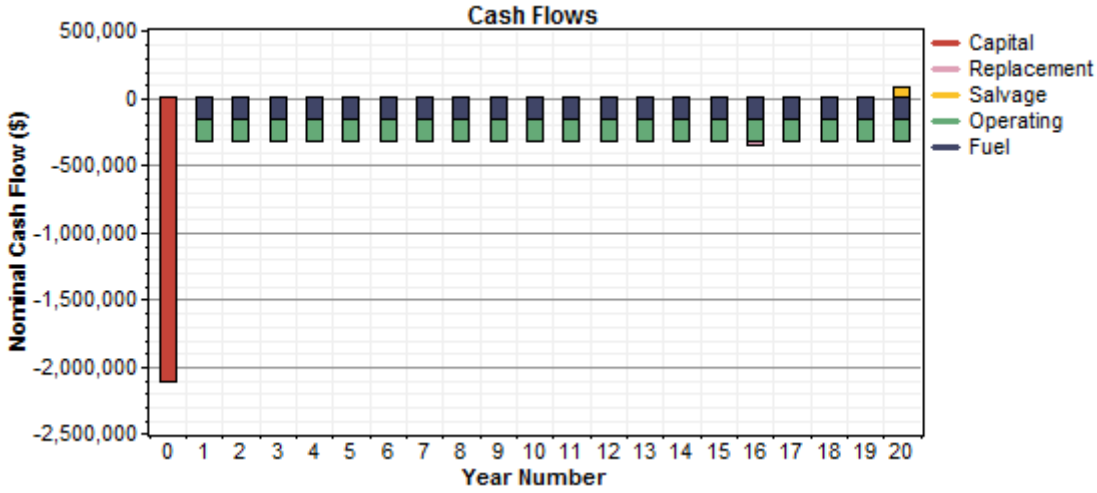
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,117,184	0	149,259	0	0	2,266,443
Generator 3	0	19,520	239,715	1,849,299	-11,342	2,097,192
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	58,262	443,329	-16,044	485,547
Boiler	0	0	0	102,892	0	102,892
Other	0	0	2,027,154	0	0	2,027,154
System	2,117,184	19,520	2,474,389	2,395,520	-43,983	6,962,630

Annualized Costs

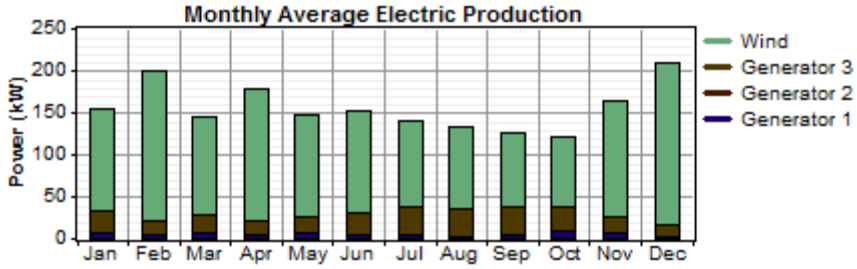
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	140,996	0	9,940	0	0	150,936
Generator 3	0	1,300	15,964	123,156	-755	139,664
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,880	29,524	-1,068	32,335
Boiler	0	0	0	6,852	0	6,852
Other	0	0	135,000	0	0	135,000
System	140,996	1,300	164,784	159,532	-2,929	463,682



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,106,151	81%
Generator 3	207,361	15%
Generator 2	0	0%
Generator 1	50,304	4%
Total	1,363,816	100%



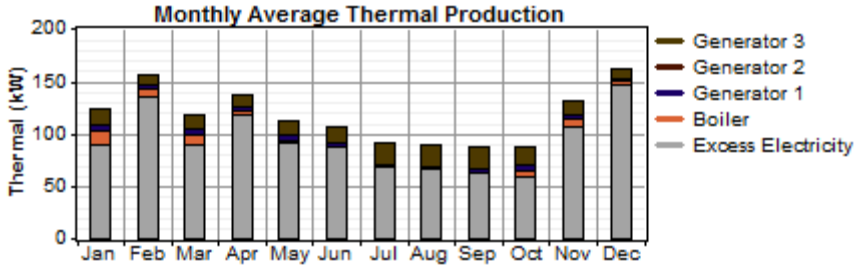
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	816,313	kWh/yr
Unmet load	0.000469	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.704	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	134,517	13%
Generator 1	33,578	3%
Boiler	38,724	4%
Excess electricity	816,313	80%
Total	1,023,131	100%



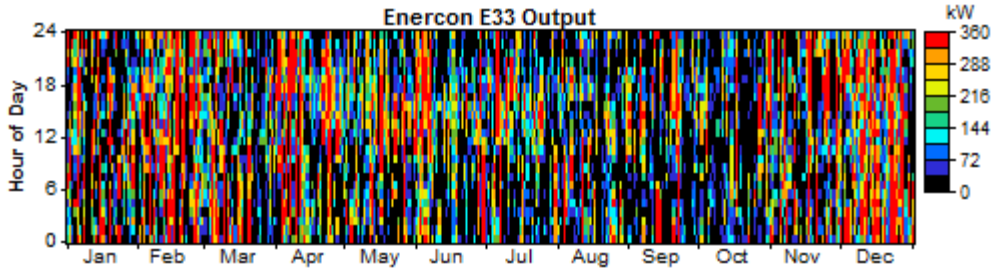
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	639,882	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	126	kW
Capacity factor	38.3	%
Total production	1,106,151	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	202	%
Hours of operation	7,967	hr/yr
Levelized cost	0.136	$/kWh

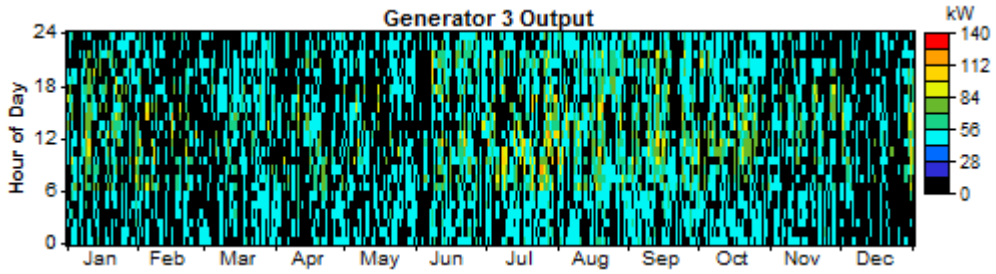


Generator 3

Quantity	Value	Units
Hours of operation	3,991	hr/yr
Number of starts	1,281	starts/yr
Operational life	15.0	yr
Capacity factor	16.3	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	207,361	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	134,517	kWh/yr
Mean thermal output	33.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	83,213	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	818,819	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.8	%



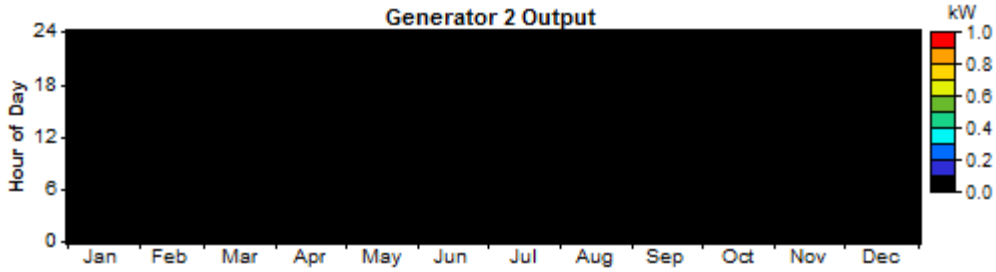
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



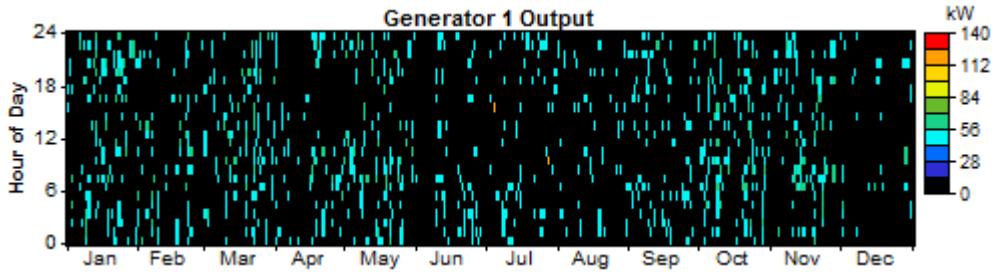
Generator 1

Quantity	Value	Units
Hours of operation	970	hr/yr
Number of starts	695	starts/yr
Operational life	61.9	yr
Capacity factor	3.59	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	50,304	kWh/yr
Mean electrical output	51.9	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	33,578	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	19,949	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	196,294	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	283,909
Carbon monoxide	671
Unburned hydocarbons	74.3
Particulate matter	50.5
Sulfur dioxide	571
Nitrogen oxides	5,983

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Site 2
Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

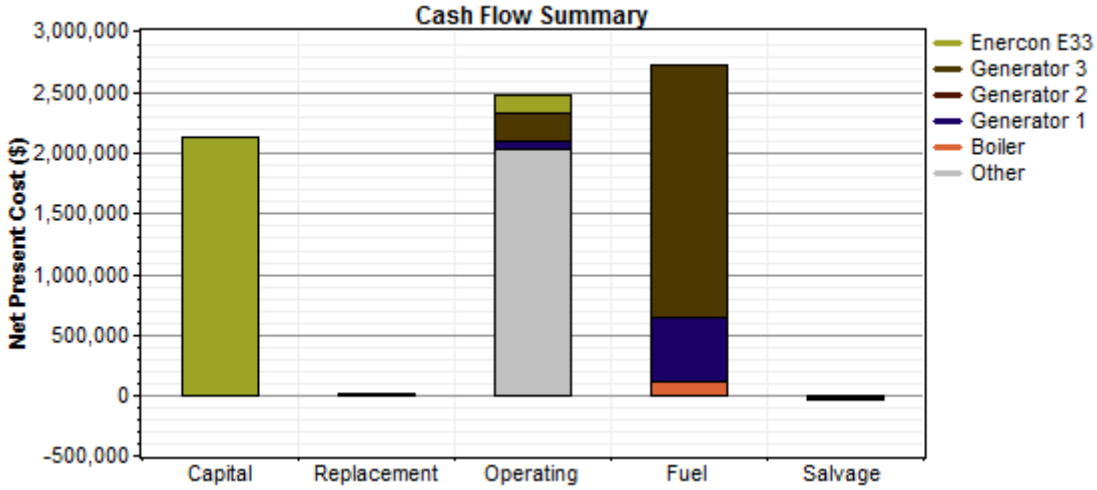
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,286,239
Levelized cost of energy	$ 0.746/kWh
Operating cost	$ 344,237/yr



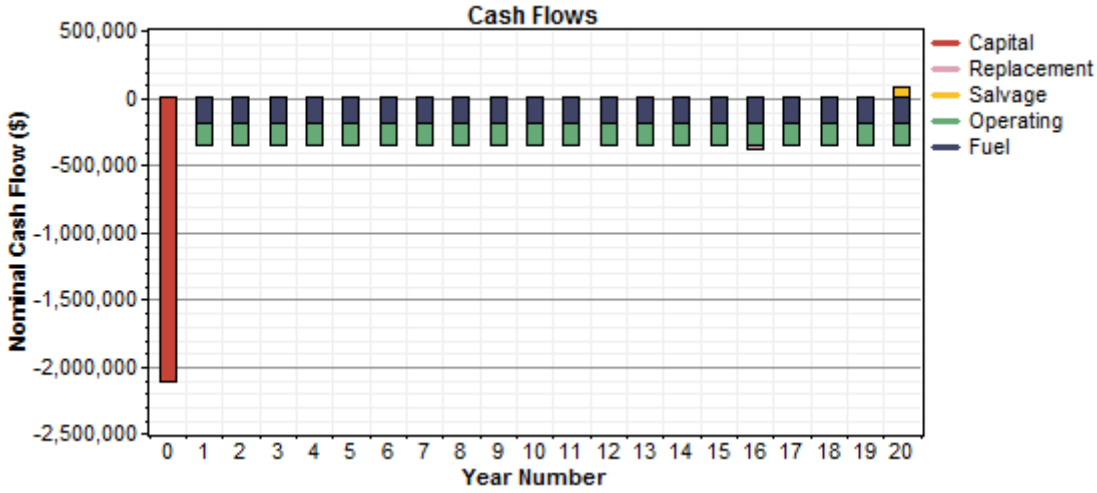
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,117,184	0	149,259	0	0	2,266,443
Generator 3	0	19,441	237,492	2,078,758	-11,550	2,324,141
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	60,484	523,771	-15,752	568,504
Boiler	0	0	0	116,591	0	116,591
Other	0	0	2,027,154	0	0	2,027,154
System	2,117,184	19,441	2,474,389	2,719,121	-43,899	7,286,235

Annualized Costs

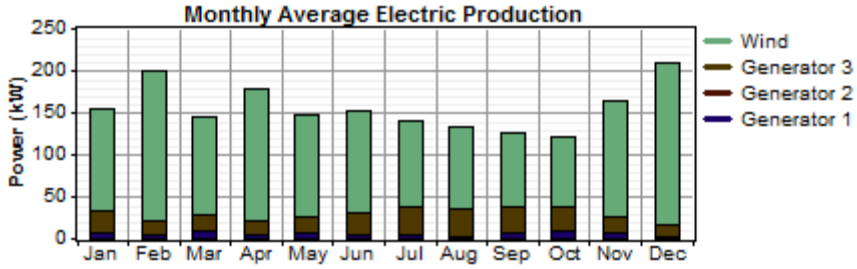
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	140,996	0	9,940	0	0	150,936
Generator 3	0	1,295	15,816	138,437	-769	154,778
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,028	34,881	-1,049	37,860
Boiler	0	0	0	7,764	0	7,764
Other	0	0	135,000	0	0	135,000
System	140,996	1,295	164,784	181,082	-2,924	485,233



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,106,151	81%
Generator 3	205,283	15%
Generator 2	0	0%
Generator 1	52,403	4%
Total	1,363,837	100%



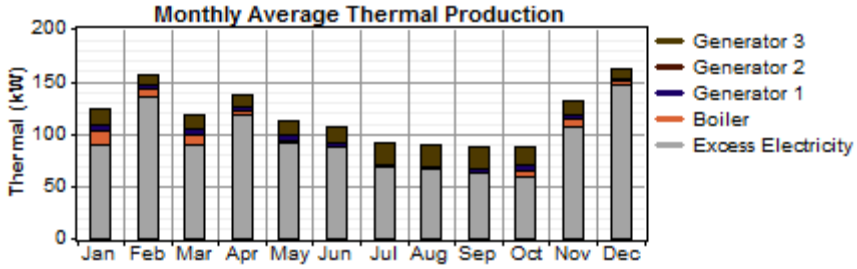
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	816,334	kWh/yr
Unmet load	0.000469	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.704	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	133,220	13%
Generator 1	34,937	3%
Boiler	38,656	4%
Excess electricity	816,334	80%
Total	1,023,146	100%



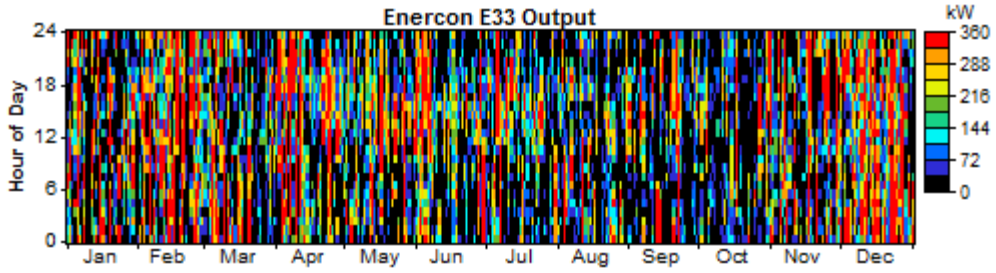
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	639,897	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	126	kW
Capacity factor	38.3	%
Total production	1,106,151	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	202	%
Hours of operation	7,967	hr/yr
Levelized cost	0.136	$/kWh

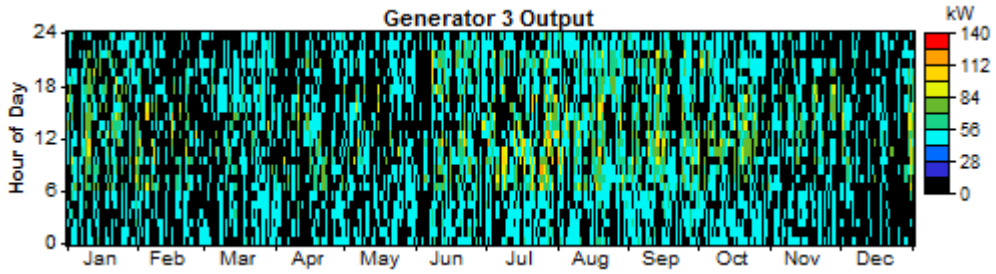


Generator 3

Quantity	Value	Units
Hours of operation	3,954	hr/yr
Number of starts	1,296	starts/yr
Operational life	15.2	yr
Capacity factor	16.2	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	205,283	kWh/yr
Mean electrical output	51.9	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	133,220	kWh/yr
Mean thermal output	33.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	82,403	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	810,843	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



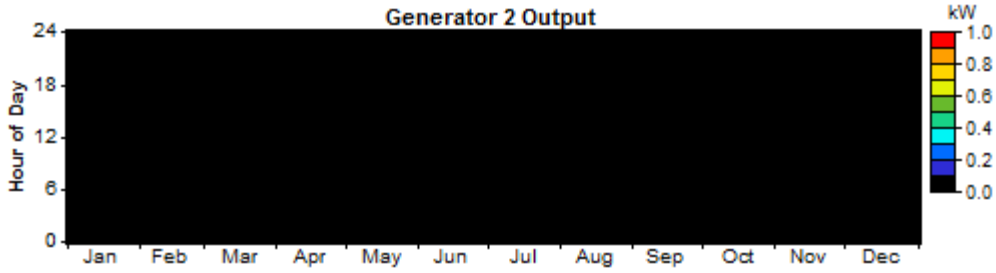
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



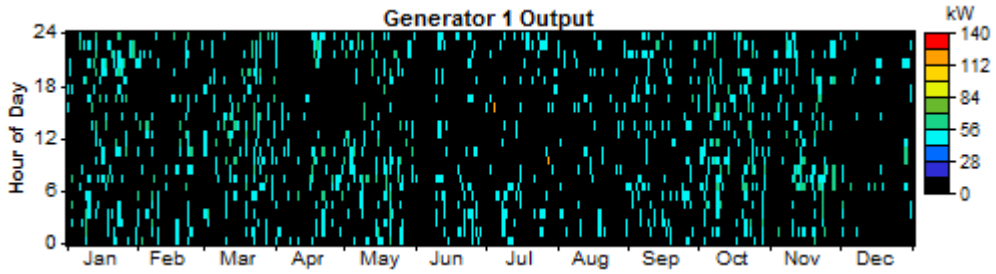
Generator 1

Quantity	Value	Units
Hours of operation	1,007	hr/yr
Number of starts	714	starts/yr
Operational life	59.6	yr
Capacity factor	3.74	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	52,403	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	34,937	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	20,762	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	204,303	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	283,897
Carbon monoxide	671
Unburned hydocarbons	74.3
Particulate matter	50.6
Sulfur dioxide	571
Nitrogen oxides	5,984

Knight Piésold CONSULTING

Site 2
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

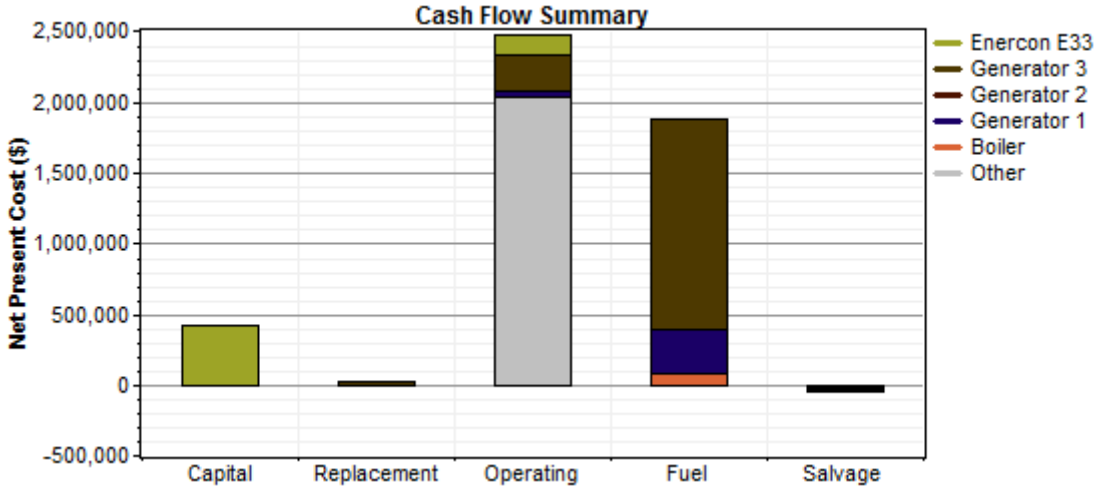
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 4,751,159
Levelized cost of energy	$ 0.481/kWh
Operating cost	$ 288,208/yr



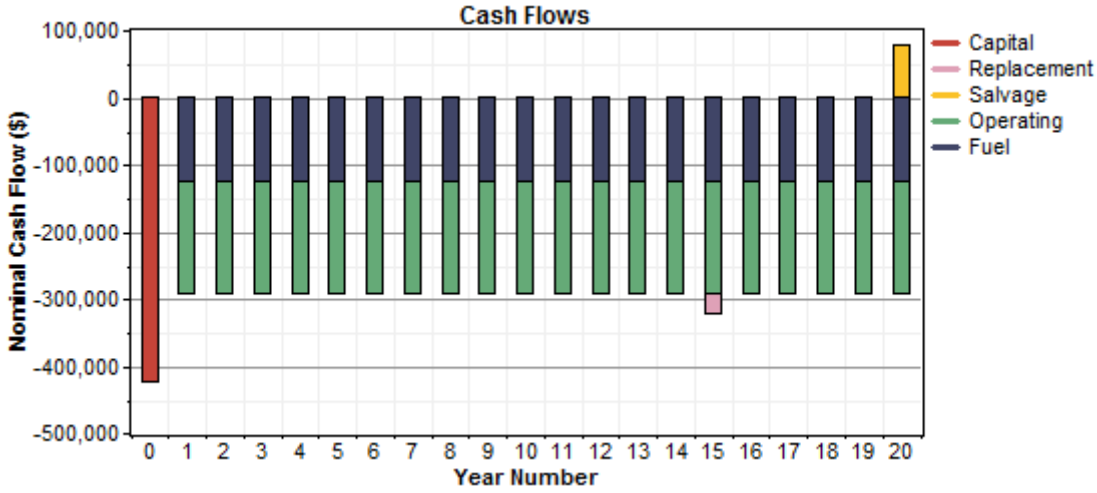
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	423,437	0	149,259	0	0	572,696
Generator 3	0	19,701	245,000	1,482,305	-10,845	1,736,162
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	52,976	314,491	-16,740	350,728
Boiler	0	0	0	81,015	0	81,015
Other	0	0	2,027,154	0	0	2,027,154
System	423,437	19,701	2,474,389	1,877,811	-44,182	4,751,157

Annualized Costs

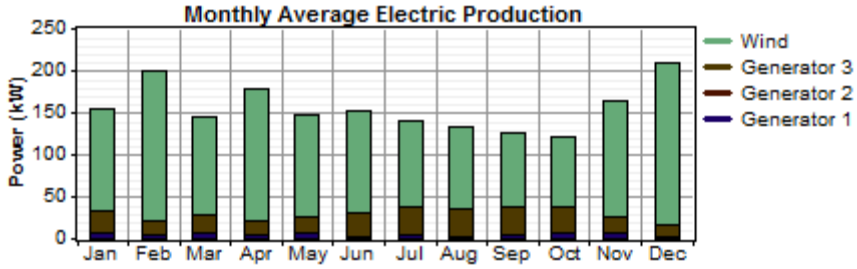
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	28,199	0	9,940	0	0	38,139
Generator 3	0	1,312	16,316	98,715	-722	115,621
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,528	20,944	-1,115	23,357
Boiler	0	0	0	5,395	0	5,395
Other	0	0	135,000	0	0	135,000
System	28,199	1,312	164,784	125,054	-2,942	316,407



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,106,151	81%
Generator 3	212,139	16%
Generator 2	0	0%
Generator 1	45,454	3%
Total	1,363,744	100%



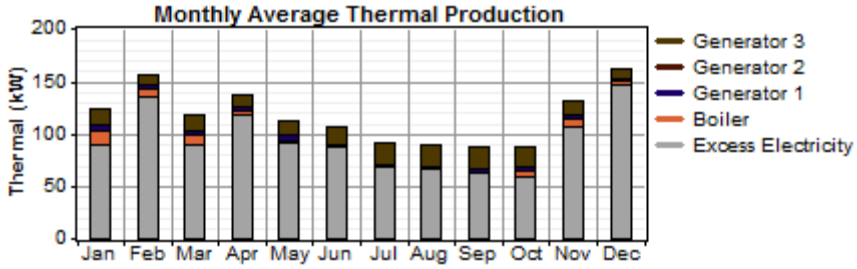
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	816,241	kWh/yr
Unmet load	0.000465	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.704	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	137,549	13%
Generator 1	30,408	3%
Boiler	38,902	4%
Excess electricity	816,241	80%
Total	1,023,099	100%



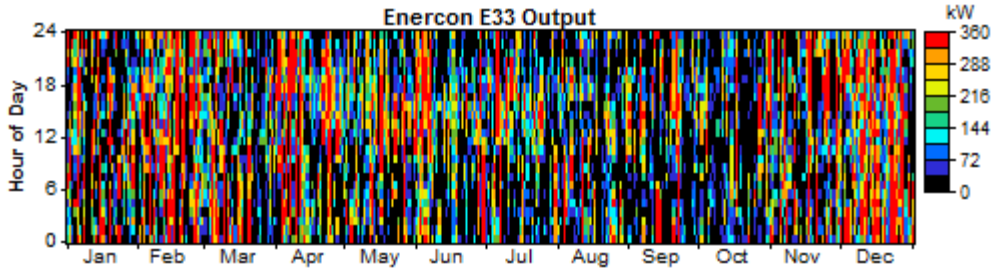
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	639,849	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	126	kW
Capacity factor	38.3	%
Total production	1,106,151	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	202	%
Hours of operation	7,967	hr/yr
Levelized cost	0.0345	$/kWh

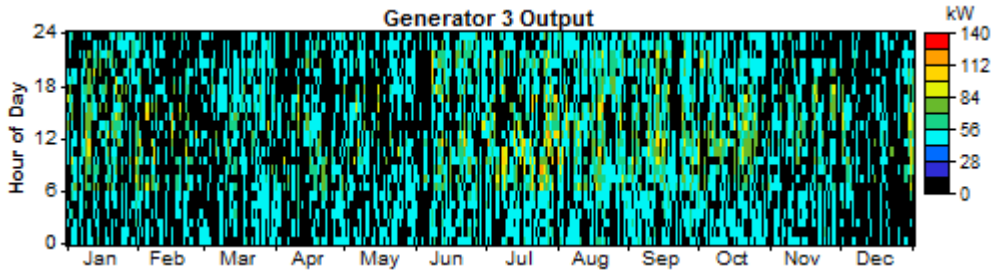


Generator 3

Quantity	Value	Units
Hours of operation	4,079	hr/yr
Number of starts	1,245	starts/yr
Operational life	14.7	yr
Capacity factor	16.7	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	212,139	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	137,549	kWh/yr
Mean thermal output	33.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	85,099	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	837,378	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.8	%



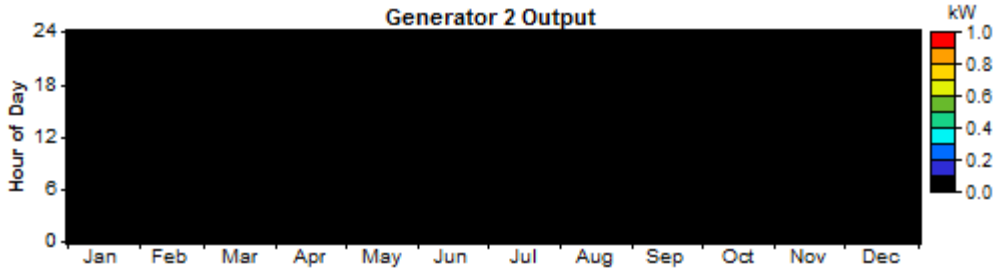
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



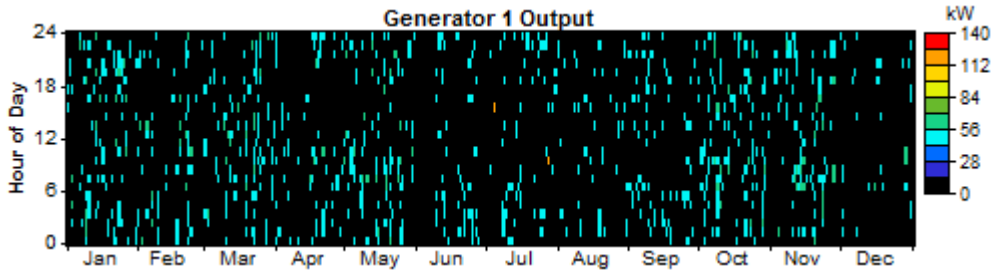
Generator 1

Quantity	Value	Units
Hours of operation	882	hr/yr
Number of starts	647	starts/yr
Operational life	68.0	yr
Capacity factor	3.24	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	45,454	kWh/yr
Mean electrical output	51.5	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	30,408	kWh/yr
Mean thermal output	34.5	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	18,055	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	177,661	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	283,946
Carbon monoxide	671
Unburned hydocarbons	74.3
Particulate matter	50.5
Sulfur dioxide	571
Nitrogen oxides	5,983

Knight Piésold CONSULTING

Site 2
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

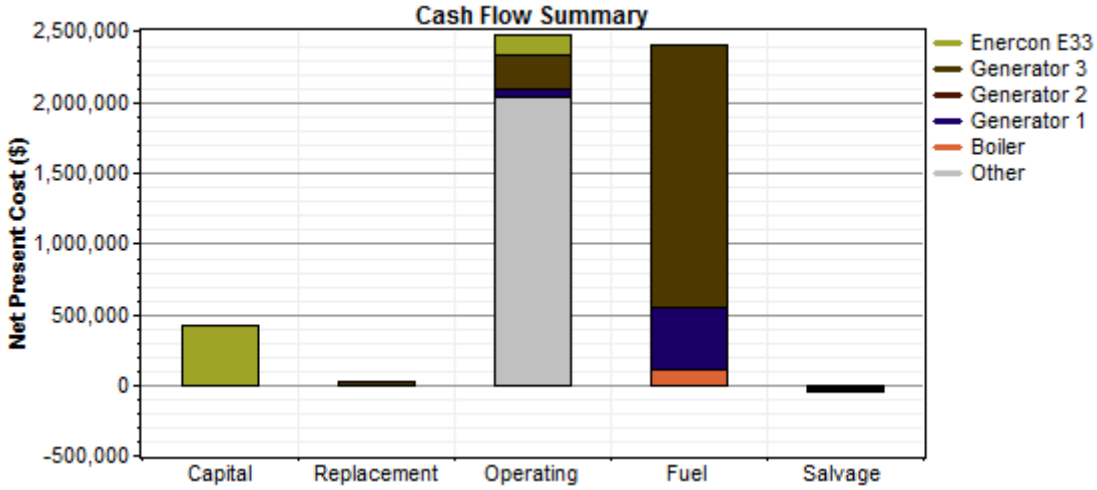
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,268,885
Levelized cost of energy	$ 0.517/kWh
Operating cost	$ 322,687/yr



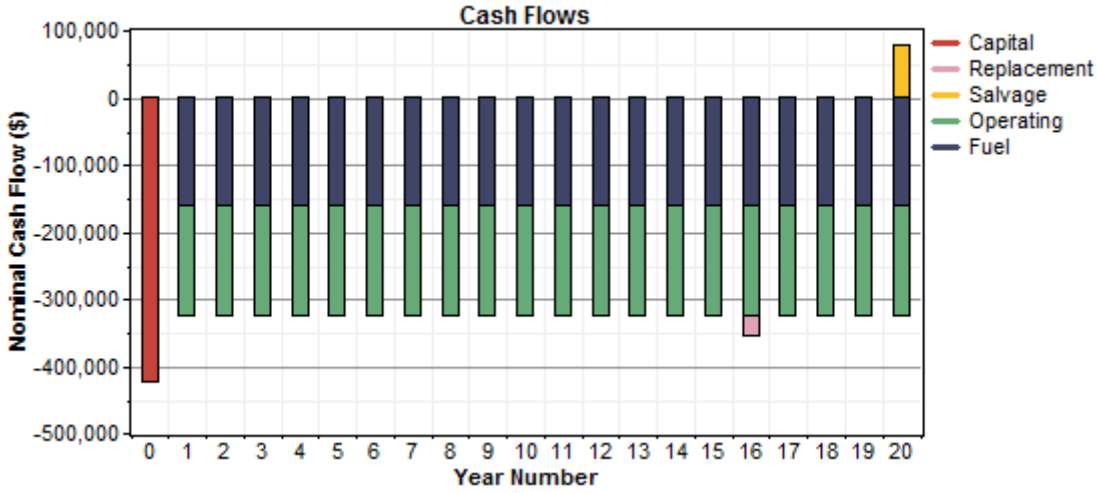
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	423,437	0	149,259	0	0	572,696
Generator 3	0	19,520	239,715	1,849,299	-11,342	2,097,192
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	58,262	443,329	-16,044	485,547
Boiler	0	0	0	102,892	0	102,892
Other	0	0	2,027,154	0	0	2,027,154
System	423,437	19,520	2,474,389	2,395,520	-43,983	5,268,883

Annualized Costs

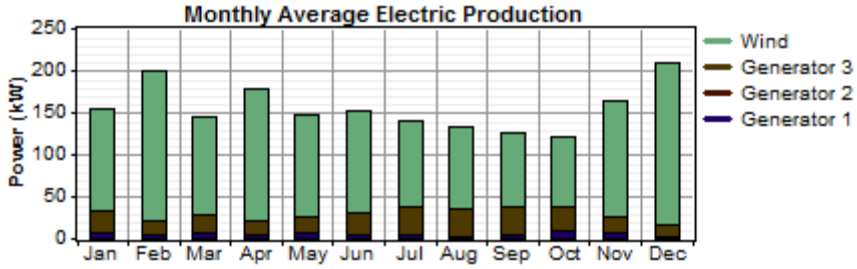
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	28,199	0	9,940	0	0	38,139
Generator 3	0	1,300	15,964	123,156	-755	139,664
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,880	29,524	-1,068	32,335
Boiler	0	0	0	6,852	0	6,852
Other	0	0	135,000	0	0	135,000
System	28,199	1,300	164,784	159,532	-2,929	350,885



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,106,151	81%
Generator 3	207,361	15%
Generator 2	0	0%
Generator 1	50,304	4%
Total	1,363,816	100%



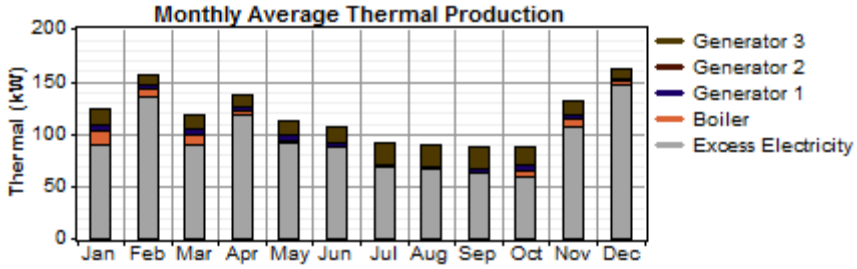
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	816,313	kWh/yr
Unmet load	0.000469	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.704	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	134,517	13%
Generator 1	33,578	3%
Boiler	38,724	4%
Excess electricity	816,313	80%
Total	1,023,131	100%



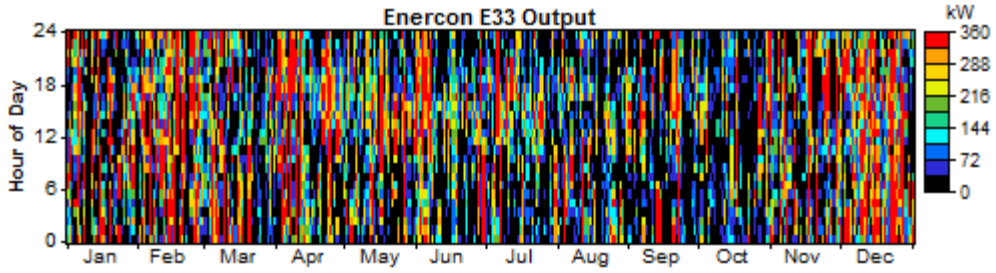
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	639,882	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	126	kW
Capacity factor	38.3	%
Total production	1,106,151	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	202	%
Hours of operation	7,967	hr/yr
Levelized cost	0.0345	$/kWh

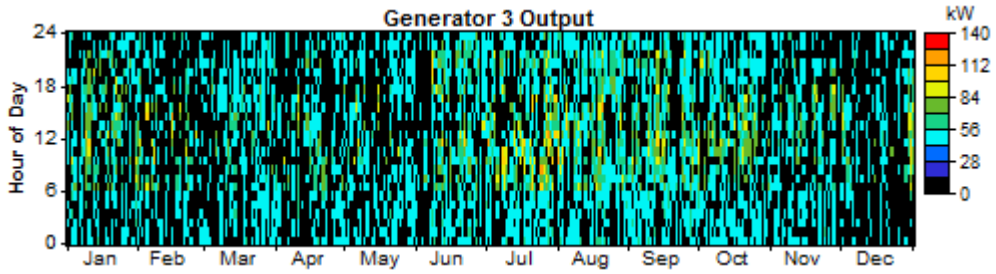


Generator 3

Quantity	Value	Units
Hours of operation	3,991	hr/yr
Number of starts	1,281	starts/yr
Operational life	15.0	yr
Capacity factor	16.3	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	207,361	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	134,517	kWh/yr
Mean thermal output	33.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	83,213	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	818,819	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.8	%



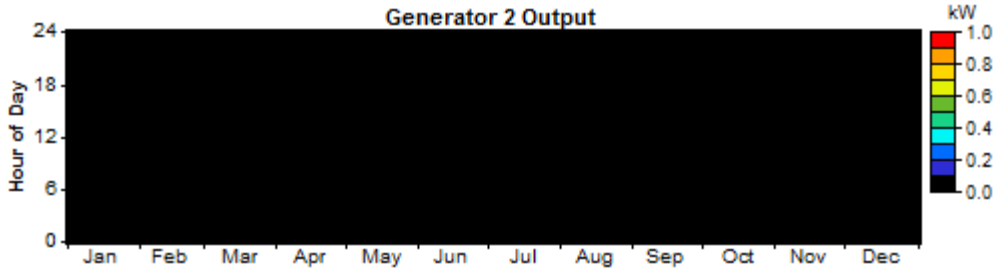
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



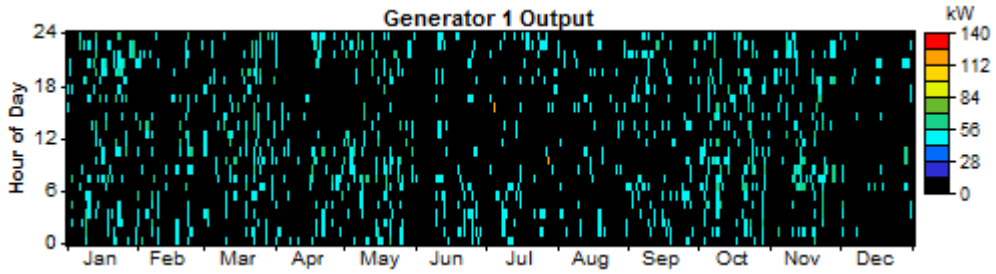
Generator 1

Quantity	Value	Units
Hours of operation	970	hr/yr
Number of starts	695	starts/yr
Operational life	61.9	yr
Capacity factor	3.59	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	50,304	kWh/yr
Mean electrical output	51.9	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	33,578	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	19,949	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	196,294	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	283,909
Carbon monoxide	671
Unburned hydocarbons	74.3
Particulate matter	50.5
Sulfur dioxide	571
Nitrogen oxides	5,983

Knight Piésold CONSULTING

Site 2
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

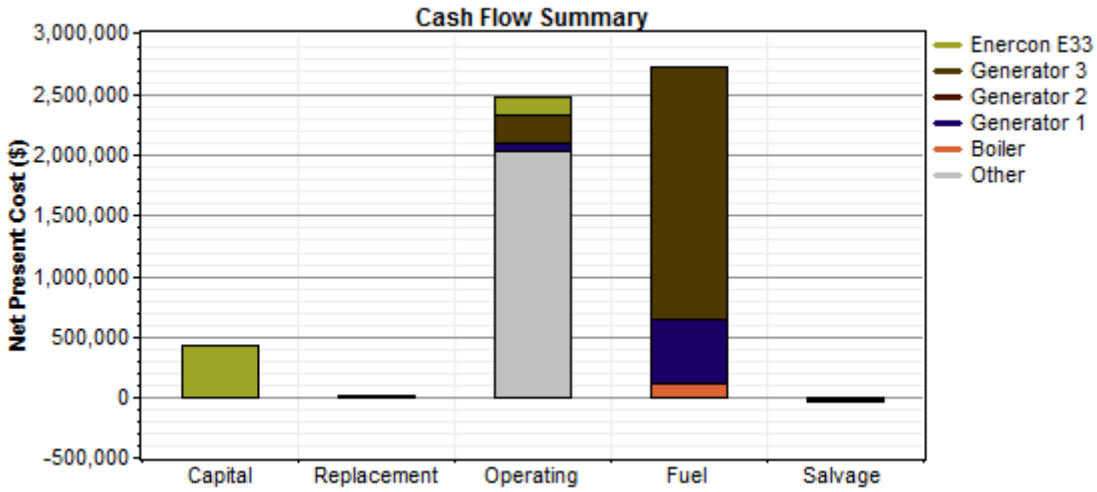
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,592,491
Levelized cost of energy	$ 0.540/kWh
Operating cost	$ 344,237/yr



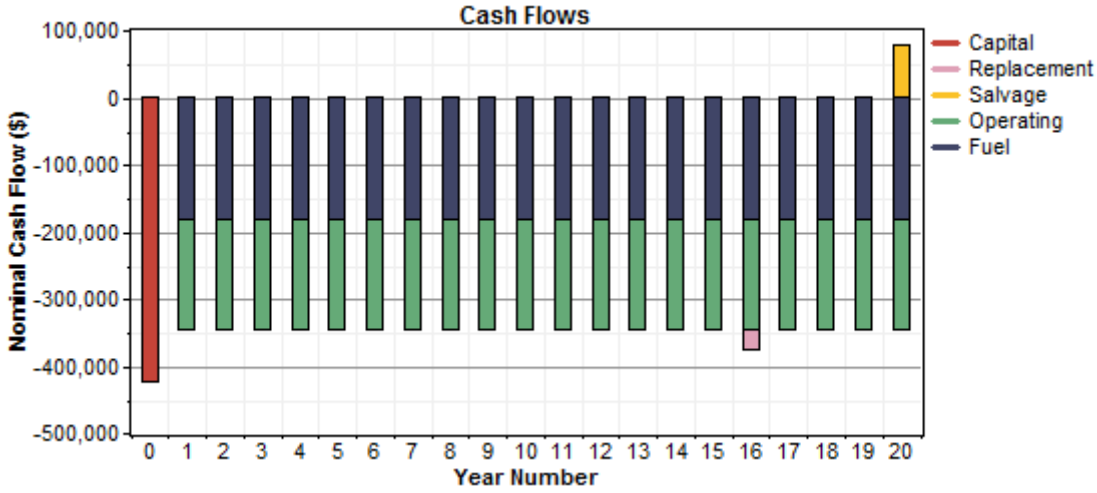
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	423,437	0	149,259	0	0	572,696
Generator 3	0	19,441	237,492	2,078,758	-11,550	2,324,141
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	60,484	523,771	-15,752	568,504
Boiler	0	0	0	116,591	0	116,591
Other	0	0	2,027,154	0	0	2,027,154
System	423,437	19,441	2,474,389	2,719,121	-43,899	5,592,489

Annualized Costs

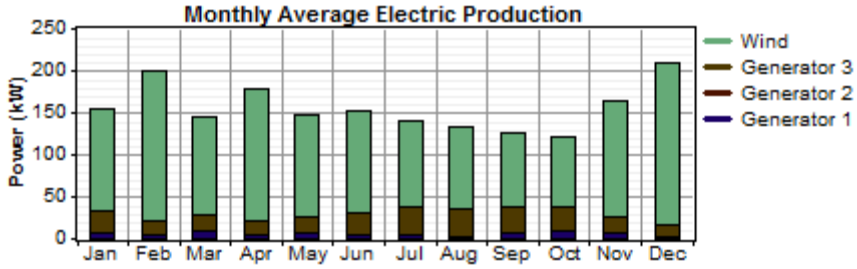
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	28,199	0	9,940	0	0	38,139
Generator 3	0	1,295	15,816	138,437	-769	154,778
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,028	34,881	-1,049	37,860
Boiler	0	0	0	7,764	0	7,764
Other	0	0	135,000	0	0	135,000
System	28,199	1,295	164,784	181,082	-2,924	372,436



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,106,151	81%
Generator 3	205,283	15%
Generator 2	0	0%
Generator 1	52,403	4%
Total	1,363,837	100%



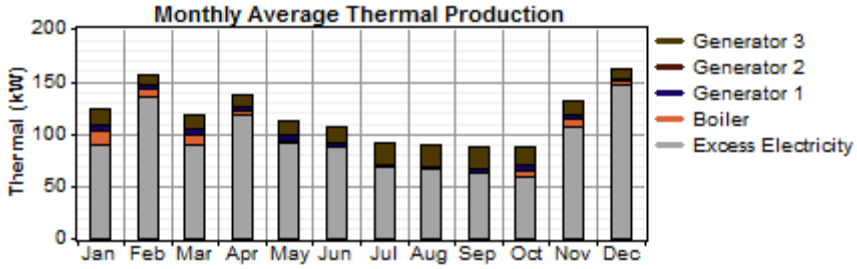
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	816,334	kWh/yr
Unmet load	0.000469	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.704	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	133,220	13%
Generator 1	34,937	3%
Boiler	38,656	4%
Excess electricity	816,334	80%
Total	1,023,146	100%



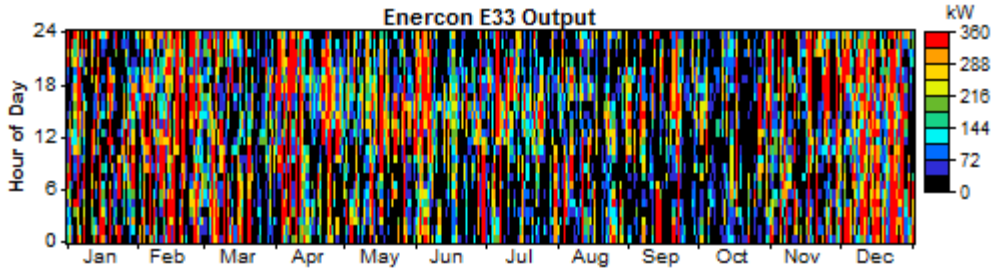
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	639,897	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	126	kW
Capacity factor	38.3	%
Total production	1,106,151	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	202	%
Hours of operation	7,967	hr/yr
Levelized cost	0.0345	$/kWh

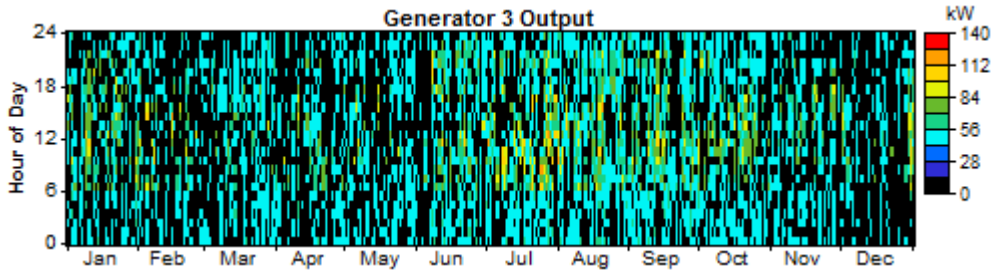


Generator 3

Quantity	Value	Units
Hours of operation	3,954	hr/yr
Number of starts	1,296	starts/yr
Operational life	15.2	yr
Capacity factor	16.2	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	205,283	kWh/yr
Mean electrical output	51.9	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	133,220	kWh/yr
Mean thermal output	33.7	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	82,403	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	810,843	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



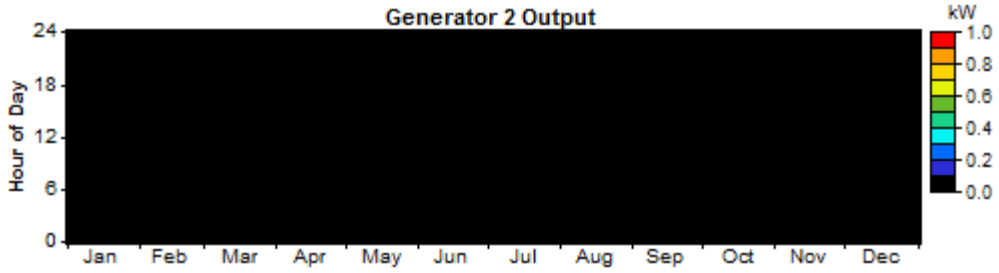
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



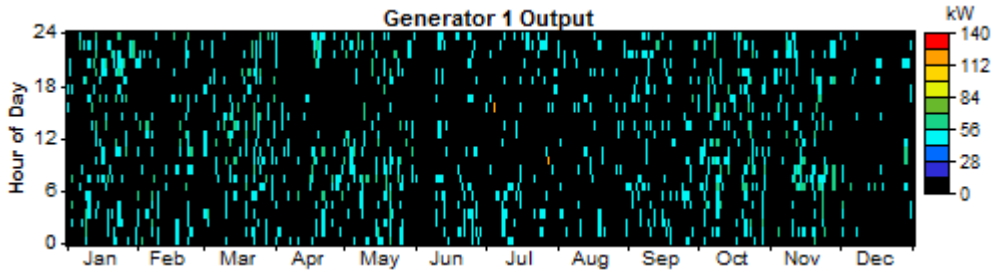
Generator 1

Quantity	Value	Units
Hours of operation	1,007	hr/yr
Number of starts	714	starts/yr
Operational life	59.6	yr
Capacity factor	3.74	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	52,403	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	34,937	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	20,762	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	204,303	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	283,897
Carbon monoxide	671
Unburned hydocarbons	74.3
Particulate matter	50.6
Sulfur dioxide	571
Nitrogen oxides	5,984

Knight Piésold CONSULTING

Site 3
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

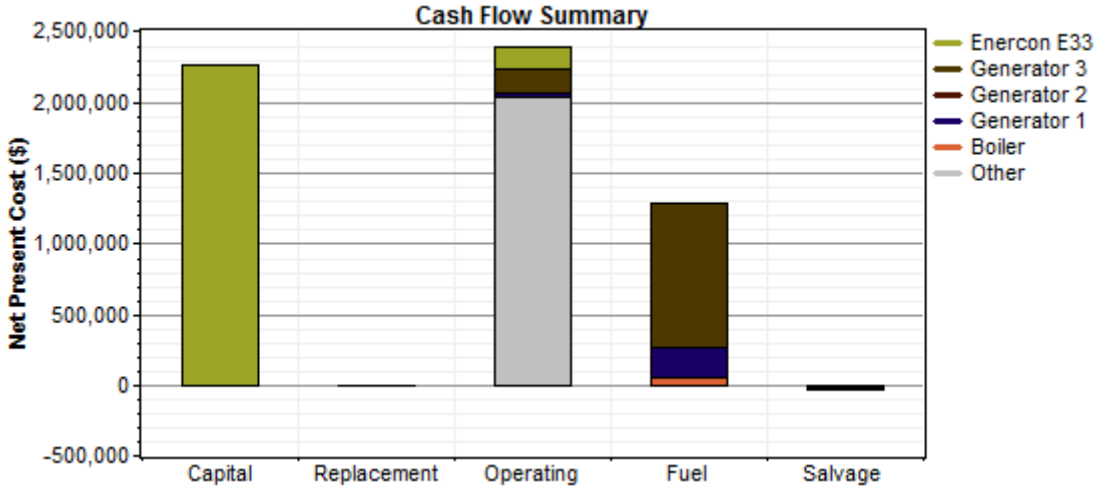
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	10.8 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1.11
Enercon E33 Capital Cost Multiplier:	1.07

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,887,515
Levelized cost of energy	$ 0.619/kWh
Operating cost	$ 241,218/yr



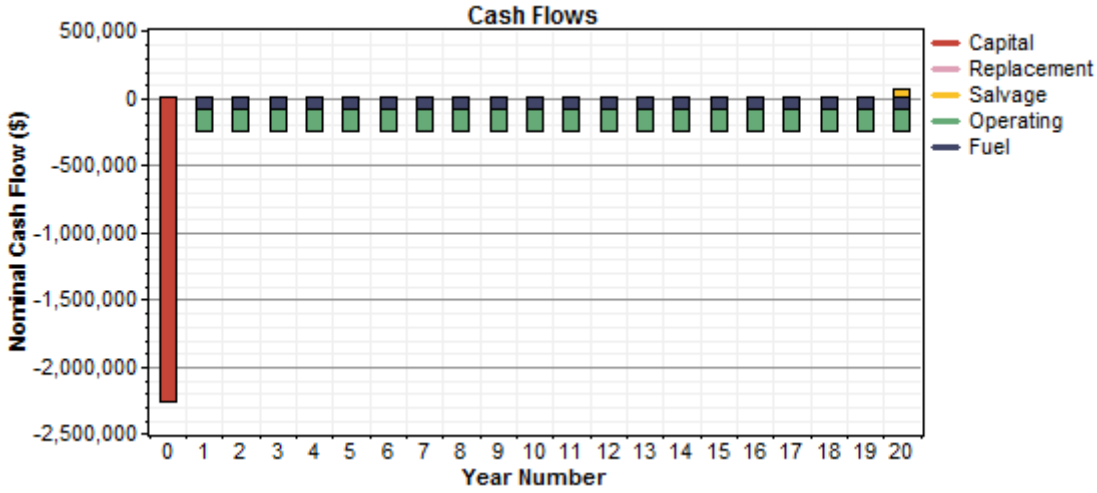
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,265,387	0	149,259	0	0	2,414,646
Generator 3	0	0	167,458	1,008,909	-1,197	1,175,170
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	35,858	213,347	-18,992	230,213
Boiler	0	0	0	56,927	0	56,927
Other	0	0	2,027,154	0	0	2,027,154
System	2,265,387	0	2,379,729	1,279,183	-36,786	5,887,513

Annualized Costs

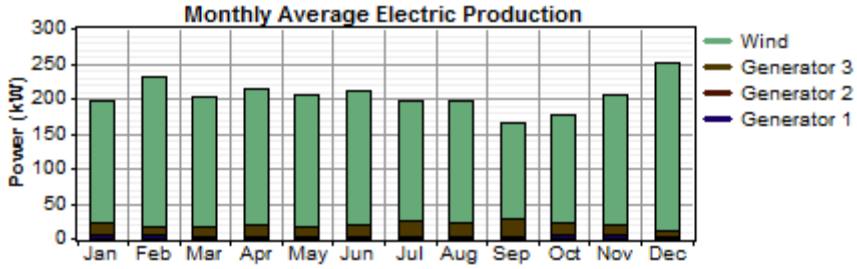
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	150,865	0	9,940	0	0	160,805
Generator 3	0	0	11,152	67,189	-80	78,261
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	2,388	14,208	-1,265	15,331
Boiler	0	0	0	3,791	0	3,791
Other	0	0	135,000	0	0	135,000
System	150,865	0	158,480	85,188	-2,450	392,084



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,617,282	90%
Generator 3	144,023	8%
Generator 2	0	0%
Generator 1	30,860	2%
Total	1,792,165	100%



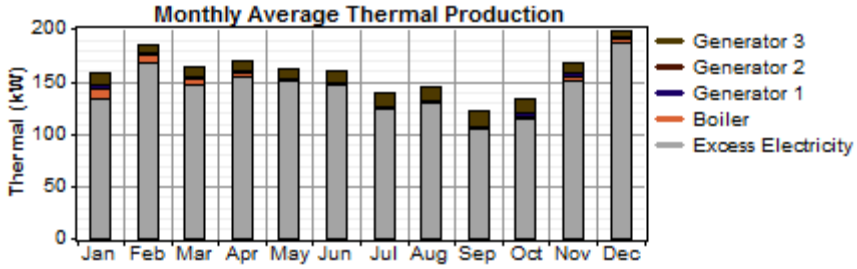
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	1,244,694	kWh/yr
Unmet load	0.000340	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.836	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	93,702	7%
Generator 1	20,623	1%
Boiler	27,335	2%
Excess electricity	1,244,694	90%
Total	1,386,354	100%



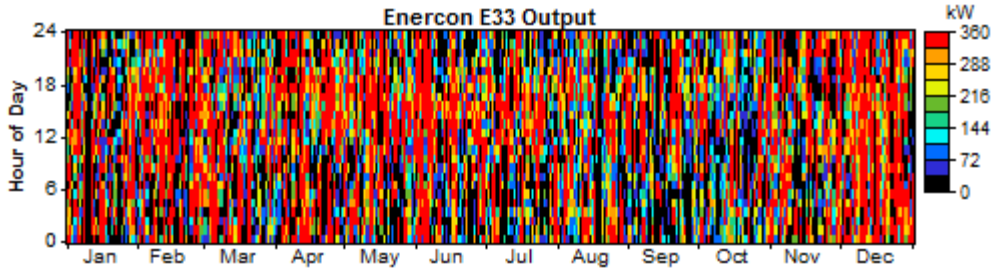
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	1,003,104	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	185	kW
Capacity factor	55.9	%
Total production	1,617,282	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	295	%
Hours of operation	8,089	hr/yr
Levelized cost	0.0994	$/kWh

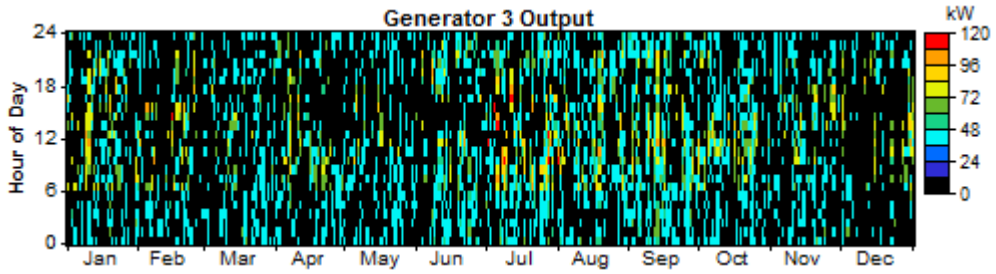


Generator 3

Quantity	Value	Units
Hours of operation	2,788	hr/yr
Number of starts	1,129	starts/yr
Operational life	21.5	yr
Capacity factor	11.3	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	144,023	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	43.5	kW
Max. electrical output	118	kW
Thermal production	93,702	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	54.9	kW

Quantity	Value	Units
Fuel consumption	57,922	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	569,949	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



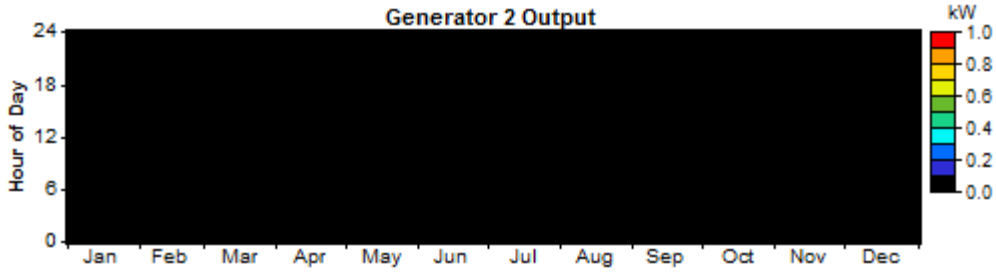
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



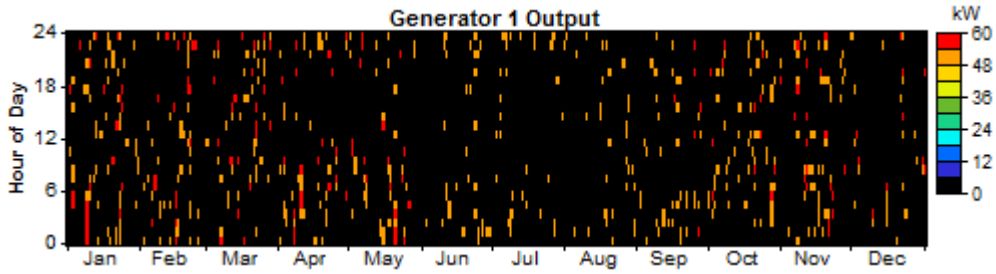
Generator 1

Quantity	Value	Units
Hours of operation	597	hr/yr
Number of starts	445	starts/yr
Operational life	101	yr
Capacity factor	2.20	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	30,860	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	58.6	kW
Thermal production	20,623	kWh/yr
Mean thermal output	34.5	kW
Min. thermal output	32.9	kW

Max. thermal output	37.5	kW

Quantity	Value	Units
Fuel consumption	12,248	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	120,523	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	193,428
Carbon monoxide	456
Unburned hydocarbons	50.5
Particulate matter	34.4
Sulfur dioxide	389
Nitrogen oxides	4,070

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Site 3
Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

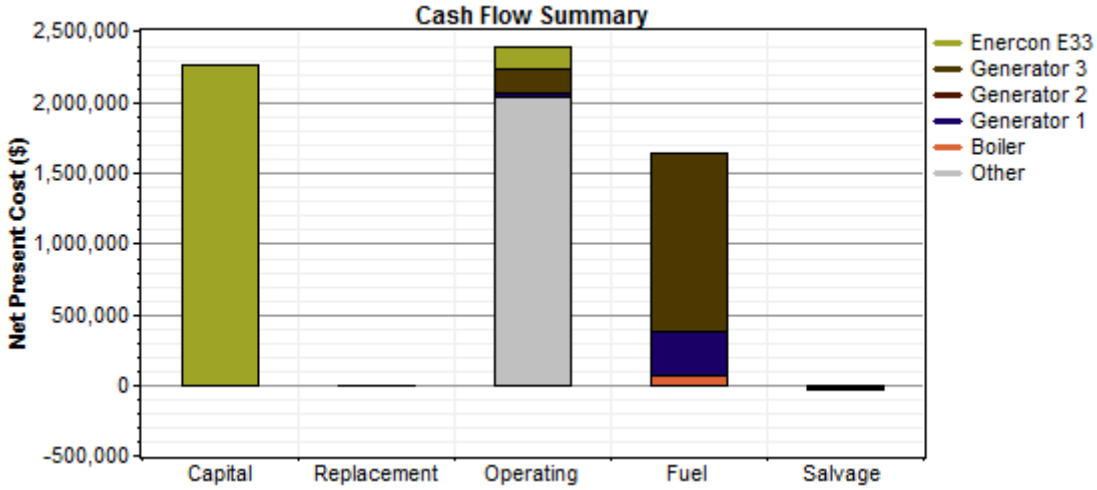
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	10.8 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1.11
Enercon E33 Capital Cost Multiplier:	1.07

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,240,326
Levelized cost of energy	$ 0.635/kWh
Operating cost	$ 264,714/yr



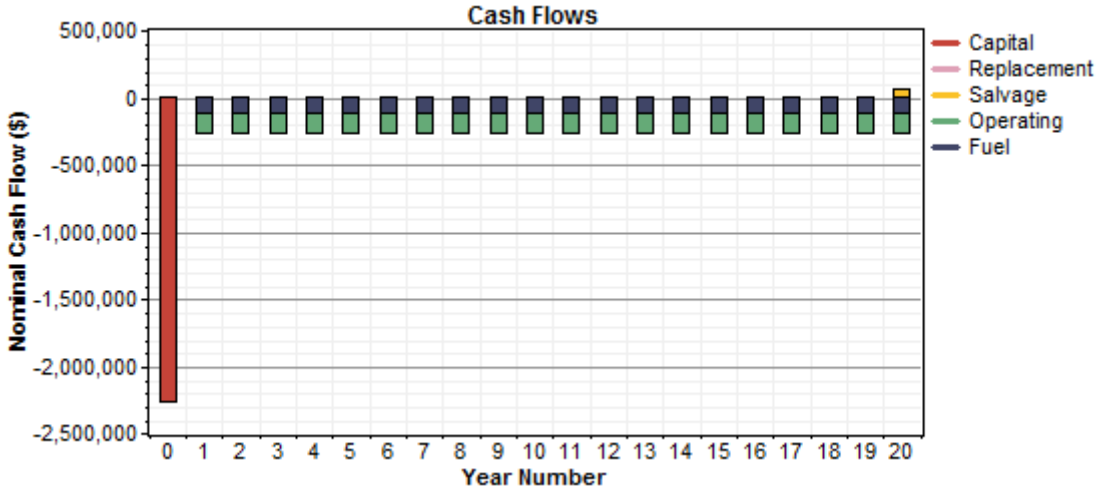
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,265,387	0	149,259	0	0	2,414,646
Generator 3	0	0	164,094	1,260,663	-1,513	1,423,244
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	39,222	298,899	-18,550	319,571
Boiler	0	0	0	72,306	0	72,306
Other	0	0	2,027,154	0	0	2,027,154
System	2,265,387	0	2,379,729	1,631,868	-36,660	6,240,324

Annualized Costs

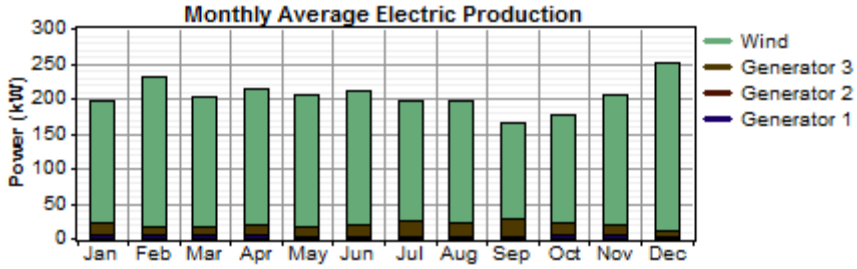
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	150,865	0	9,940	0	0	160,805
Generator 3	0	0	10,928	83,955	-101	94,782
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	2,612	19,905	-1,235	21,282
Boiler	0	0	0	4,815	0	4,815
Other	0	0	135,000	0	0	135,000
System	150,865	0	158,480	108,676	-2,441	415,579



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,617,282	90%
Generator 3	141,002	8%
Generator 2	0	0%
Generator 1	33,933	2%
Total	1,792,218	100%



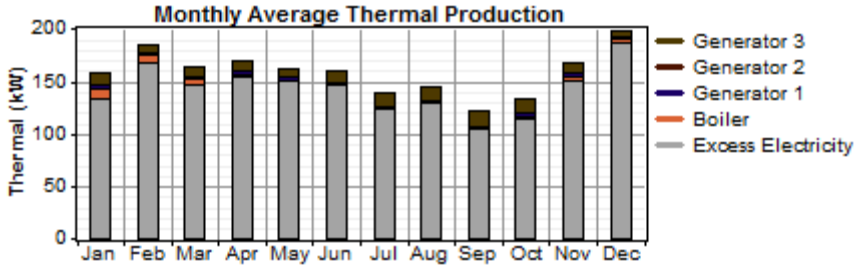
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	1,244,747	kWh/yr
Unmet load	0.000347	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.836	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	91,779	7%
Generator 1	22,634	2%
Boiler	27,213	2%
Excess electricity	1,244,747	90%
Total	1,386,373	100%



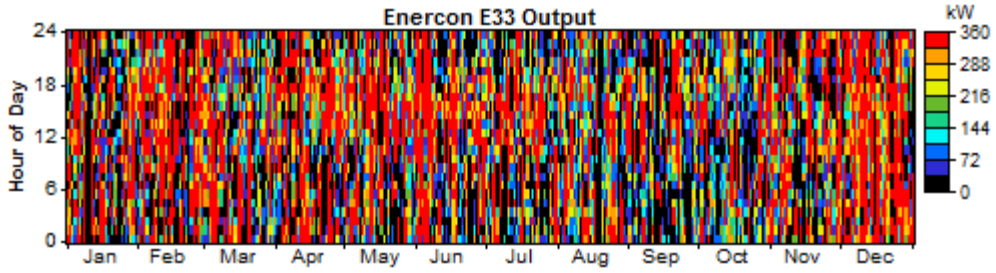
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	1,003,123	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	185	kW
Capacity factor	55.9	%
Total production	1,617,282	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	295	%
Hours of operation	8,089	hr/yr
Levelized cost	0.0994	$/kWh

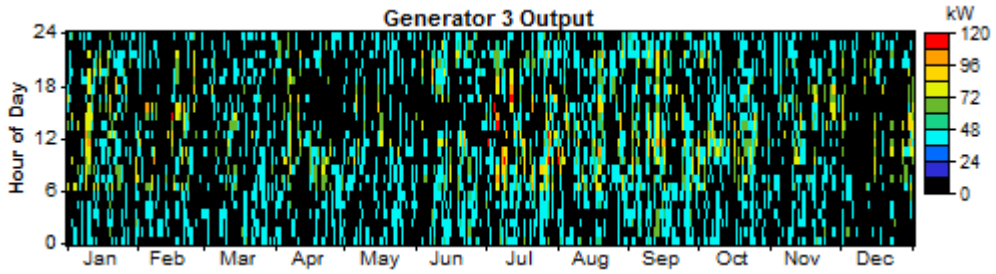


Generator 3

Quantity	Value	Units
Hours of operation	2,732	hr/yr
Number of starts	1,140	starts/yr
Operational life	22.0	yr
Capacity factor	11.1	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	141,002	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	118	kW
Thermal production	91,779	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	54.9	kW

Quantity	Value	Units
Fuel consumption	56,726	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	558,187	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



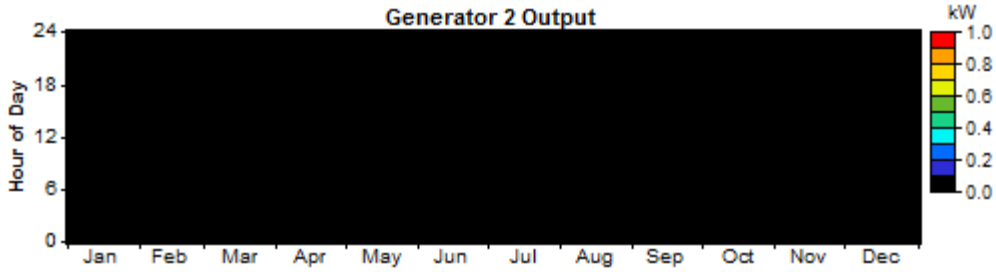
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



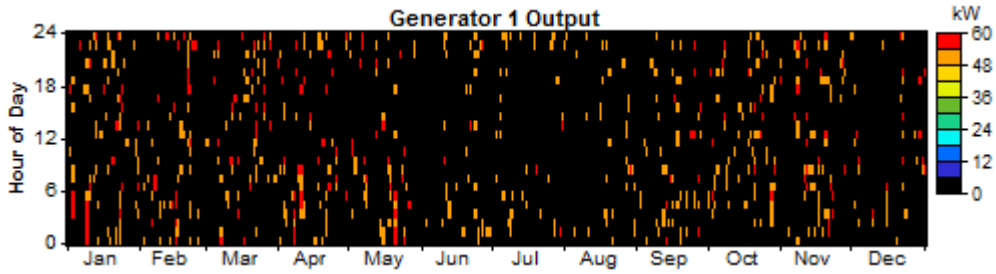
Generator 1

Quantity	Value	Units
Hours of operation	653	hr/yr
Number of starts	481	starts/yr
Operational life	91.9	yr
Capacity factor	2.42	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	33,933	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	59.9	kW
Thermal production	22,634	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	38.1	kW

Quantity	Value	Units
Fuel consumption	13,450	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	132,344	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	193,405
Carbon monoxide	456
Unburned hydocarbons	50.5
Particulate matter	34.4
Sulfur dioxide	389
Nitrogen oxides	4,070

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Site 3
Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_NW_Enercon.hmr

Sensitivity case

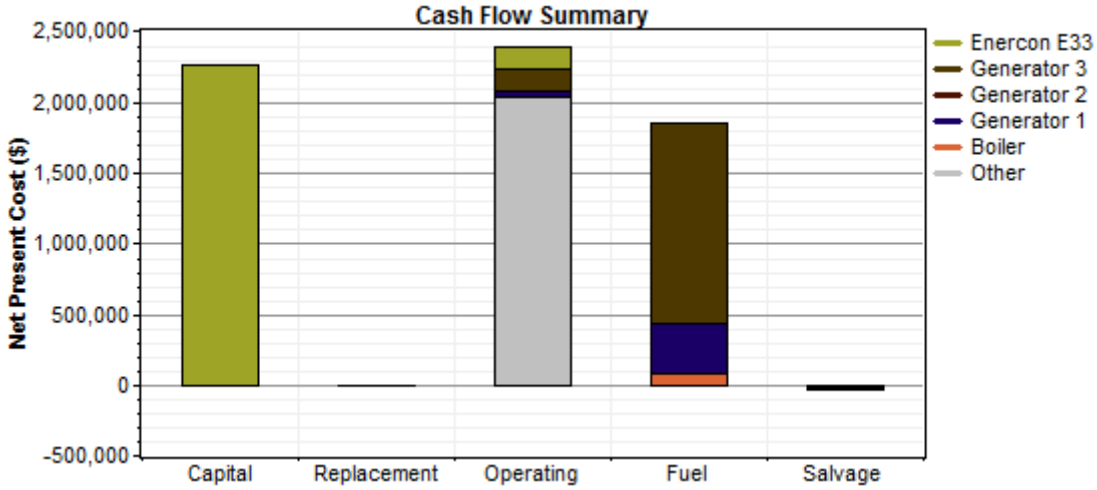
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	10.8 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1.11
Enercon E33 Capital Cost Multiplier:	1.07

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,460,816
Levelized cost of energy	$ 0.645/kWh
Operating cost	$ 279,398/yr



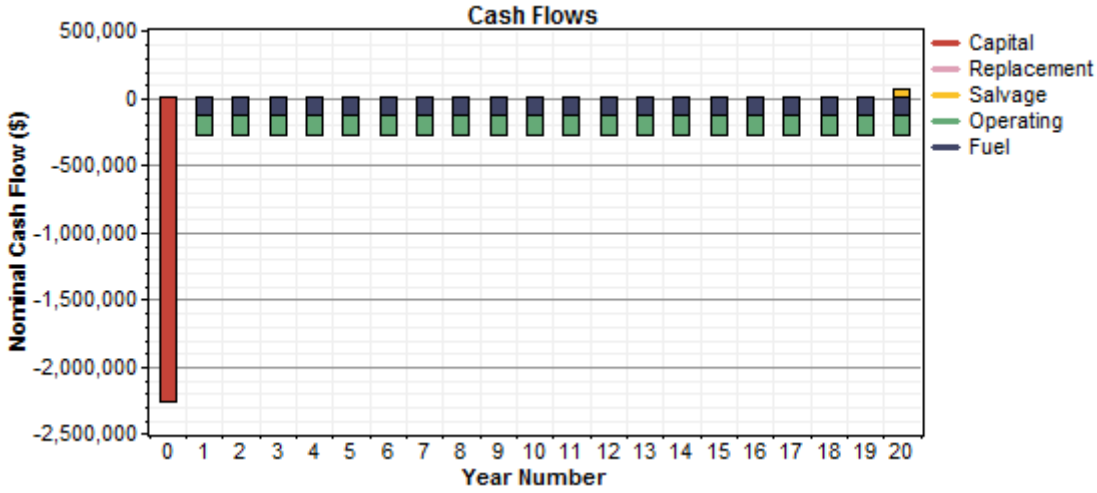
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	2,265,387	0	149,259	0	0	2,414,646
Generator 3	0	0	161,992	1,411,783	-1,711	1,572,064
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	41,324	358,573	-18,273	381,624
Boiler	0	0	0	81,924	0	81,924
Other	0	0	2,027,154	0	0	2,027,154
System	2,265,387	0	2,379,729	1,852,279	-36,581	6,460,814

Annualized Costs

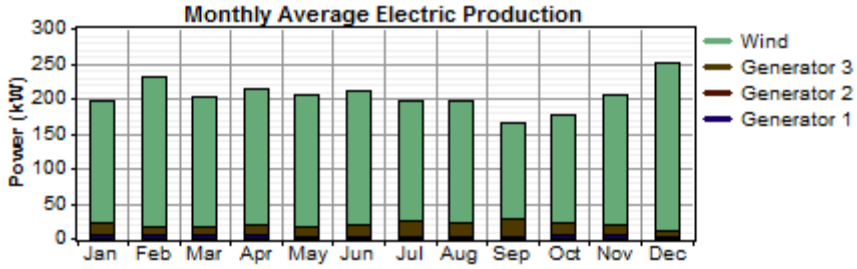
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	150,865	0	9,940	0	0	160,805
Generator 3	0	0	10,788	94,019	-114	104,693
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	2,752	23,879	-1,217	25,415
Boiler	0	0	0	5,456	0	5,456
Other	0	0	135,000	0	0	135,000
System	150,865	0	158,480	123,354	-2,436	430,263



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,617,282	90%
Generator 3	139,052	8%
Generator 2	0	0%
Generator 1	35,900	2%
Total	1,792,235	100%



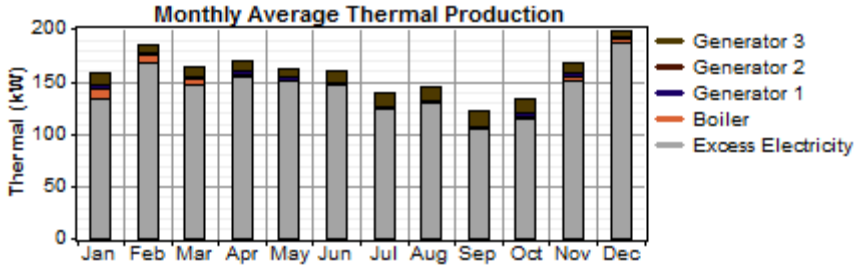
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	1,244,764	kWh/yr
Unmet load	0.000347	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.836	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	90,557	7%
Generator 1	23,912	2%
Boiler	27,162	2%
Excess electricity	1,244,764	90%
Total	1,386,394	100%



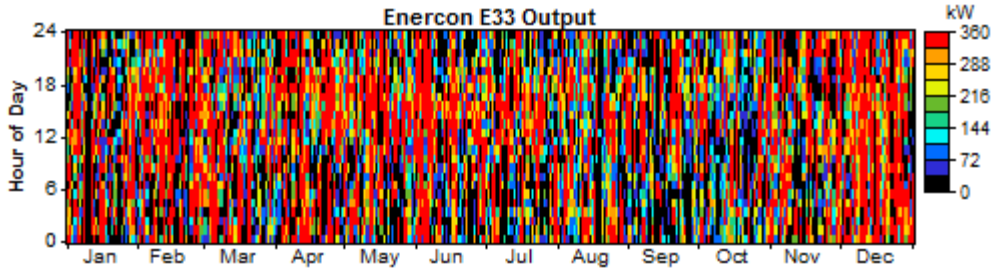
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	1,003,145	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	185	kW
Capacity factor	55.9	%
Total production	1,617,282	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	295	%
Hours of operation	8,089	hr/yr
Levelized cost	0.0994	$/kWh

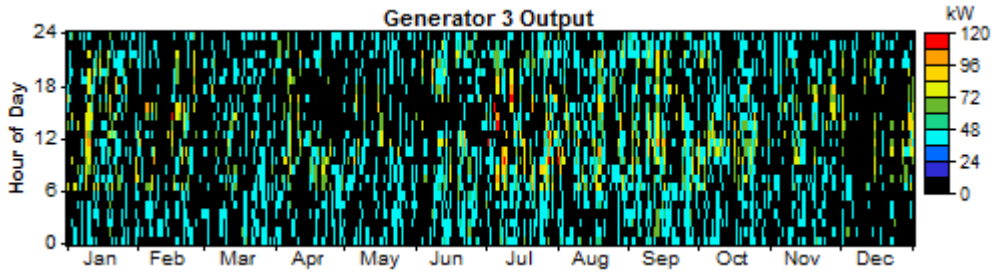


Generator 3

Quantity	Value	Units
Hours of operation	2,697	hr/yr
Number of starts	1,156	starts/yr
Operational life	22.2	yr
Capacity factor	10.9	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	139,052	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	118	kW
Thermal production	90,557	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	54.9	kW

Quantity	Value	Units
Fuel consumption	55,964	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	550,682	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



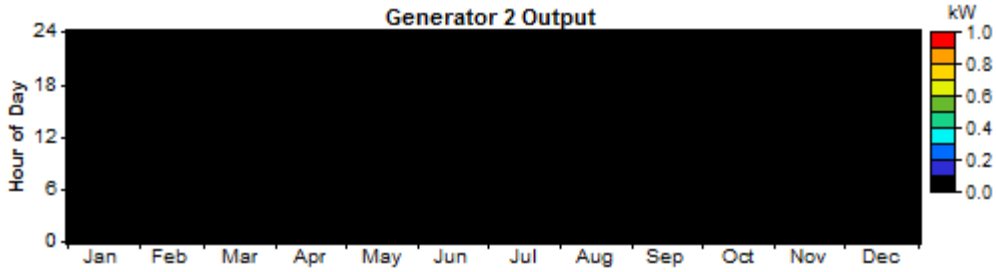
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



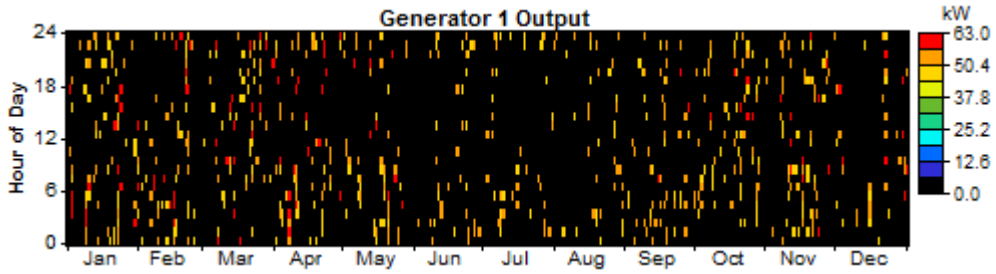
Generator 1

Quantity	Value	Units
Hours of operation	688	hr/yr
Number of starts	509	starts/yr
Operational life	87.2	yr
Capacity factor	2.56	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	35,900	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	60.4	kW
Thermal production	23,912	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	38.3	kW

Quantity	Value	Units
Fuel consumption	14,214	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	139,865	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	193,393
Carbon monoxide	456
Unburned hydocarbons	50.5
Particulate matter	34.4
Sulfur dioxide	389
Nitrogen oxides	4,070

Knight Piésold CONSULTING

Site 3
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

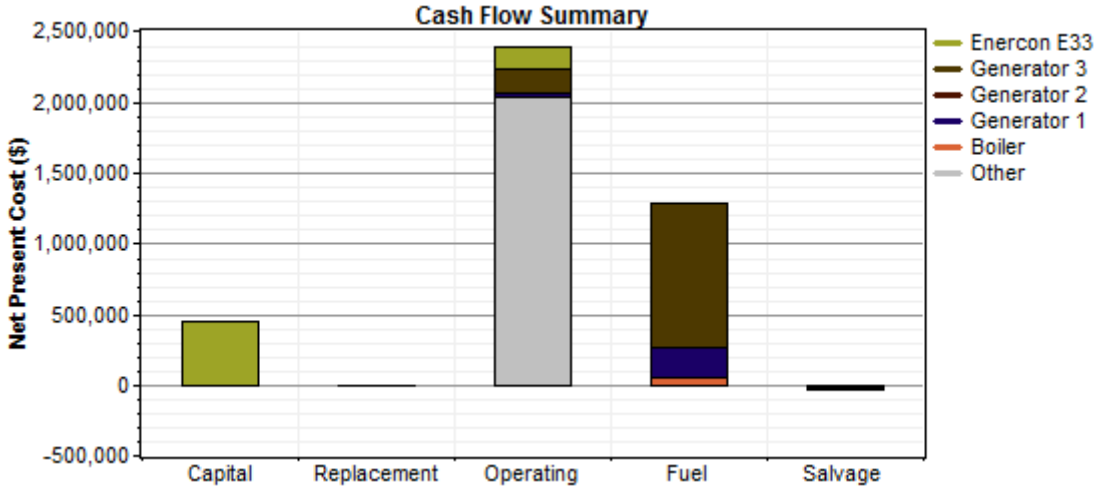
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	10.8 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1.11
Enercon E33 Capital Cost Multiplier:	1.07

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 4,075,205
Levelized cost of energy	$ 0.399/kWh
Operating cost	$ 241,218/yr



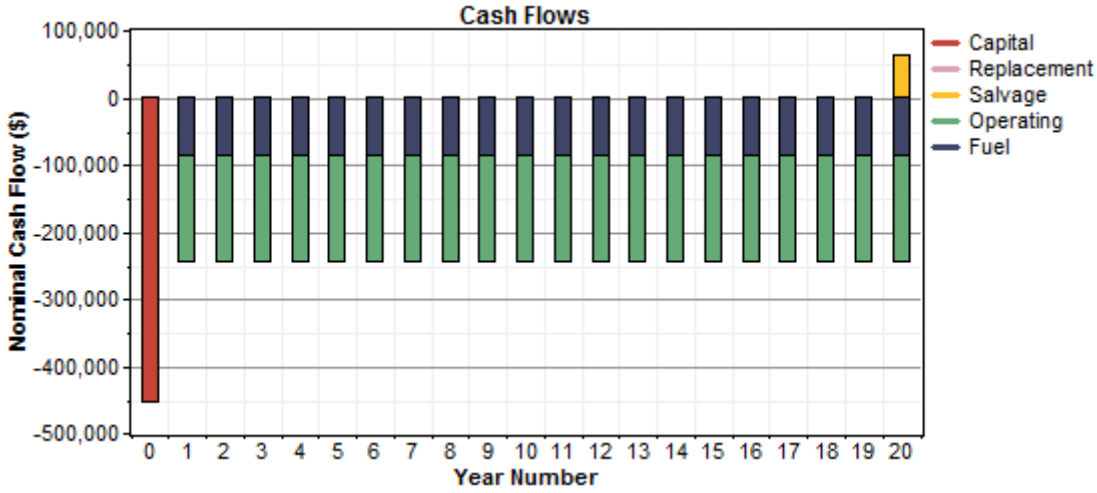
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	453,078	0	149,259	0	0	602,336
Generator 3	0	0	167,458	1,008,909	-1,197	1,175,170
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	35,858	213,347	-18,992	230,213
Boiler	0	0	0	56,927	0	56,927
Other	0	0	2,027,154	0	0	2,027,154
System	453,078	0	2,379,729	1,279,183	-36,786	4,075,203

Annualized Costs

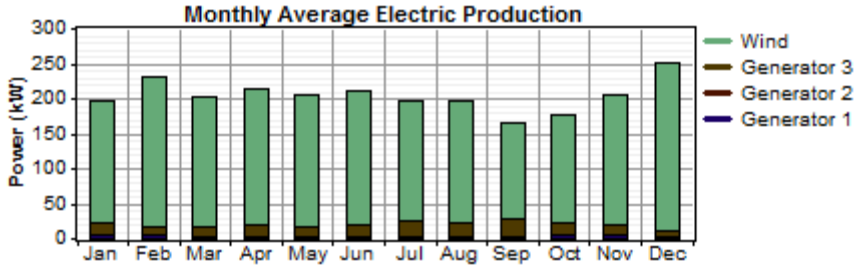
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	30,173	0	9,940	0	0	40,113
Generator 3	0	0	11,152	67,189	-80	78,261
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	2,388	14,208	-1,265	15,331
Boiler	0	0	0	3,791	0	3,791
Other	0	0	135,000	0	0	135,000
System	30,173	0	158,480	85,188	-2,450	271,391



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,617,282	90%
Generator 3	144,023	8%
Generator 2	0	0%
Generator 1	30,860	2%
Total	1,792,165	100%



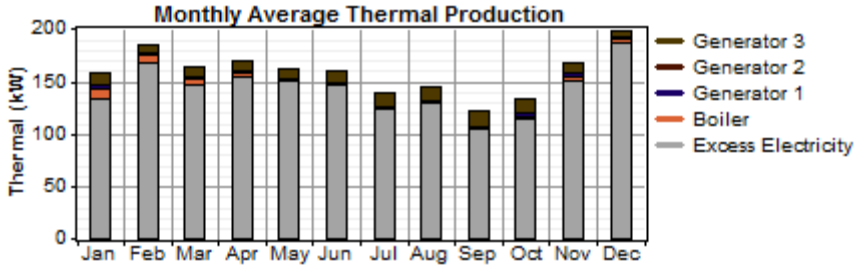
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	1,244,694	kWh/yr
Unmet load	0.000340	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.836	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	93,702	7%
Generator 1	20,623	1%
Boiler	27,335	2%
Excess electricity	1,244,694	90%
Total	1,386,354	100%



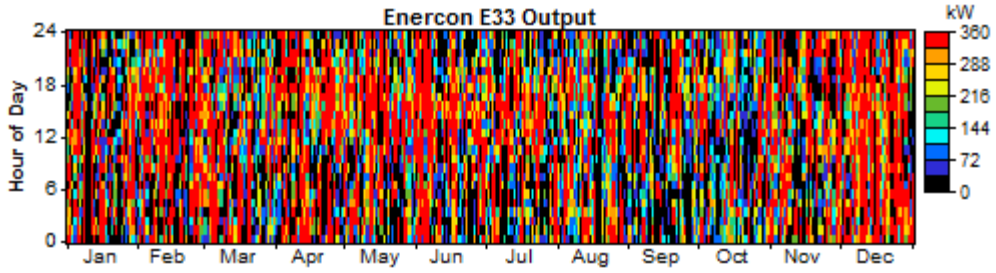
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	1,003,104	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	185	kW
Capacity factor	55.9	%
Total production	1,617,282	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	295	%
Hours of operation	8,089	hr/yr
Levelized cost	0.0248	$/kWh

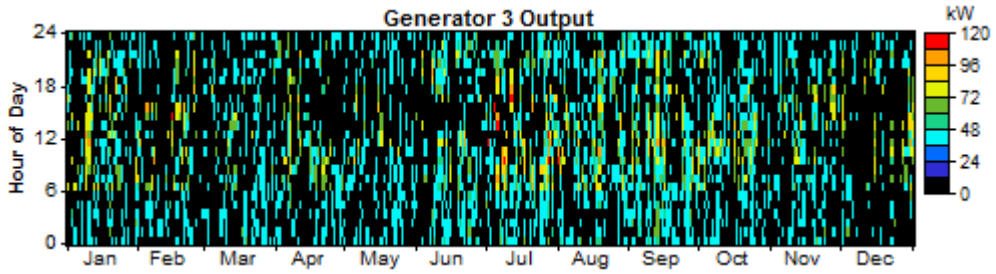


Generator 3

Quantity	Value	Units
Hours of operation	2,788	hr/yr
Number of starts	1,129	starts/yr
Operational life	21.5	yr
Capacity factor	11.3	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	144,023	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	43.5	kW
Max. electrical output	118	kW
Thermal production	93,702	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	54.9	kW

Quantity	Value	Units
Fuel consumption	57,922	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	569,949	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



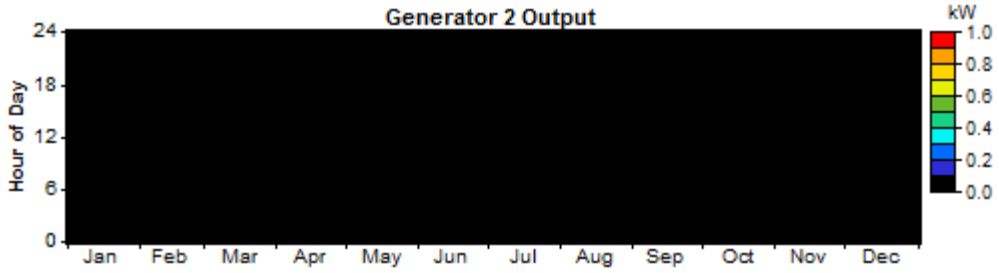
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



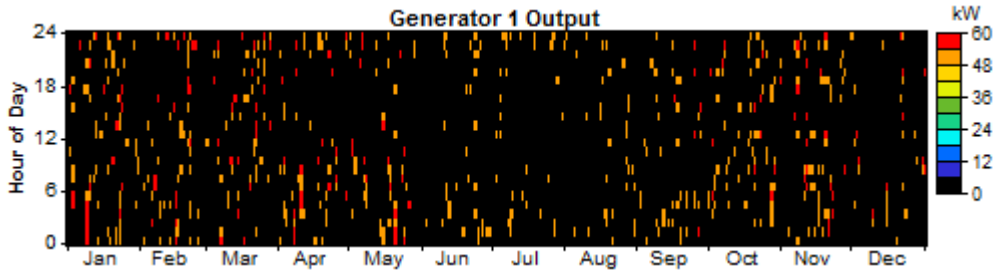
Generator 1

Quantity	Value	Units
Hours of operation	597	hr/yr
Number of starts	445	starts/yr
Operational life	101	yr
Capacity factor	2.20	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	30,860	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	58.6	kW
Thermal production	20,623	kWh/yr
Mean thermal output	34.5	kW
Min. thermal output	32.9	kW

Max. thermal output	37.5	kW

Quantity	Value	Units
Fuel consumption	12,248	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	120,523	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	193,428
Carbon monoxide	456
Unburned hydocarbons	50.5
Particulate matter	34.4
Sulfur dioxide	389
Nitrogen oxides	4,070

Knight Piésold CONSULTING

Site 3
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

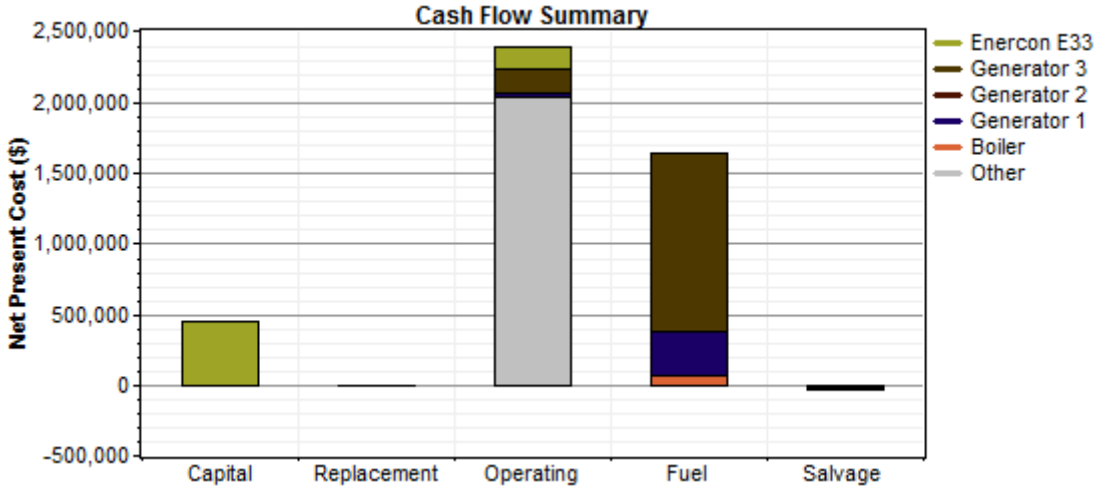
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	10.8 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1.11
Enercon E33 Capital Cost Multiplier:	1.07

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 4,428,016
Levelized cost of energy	$ 0.415/kWh
Operating cost	$ 264,714/yr



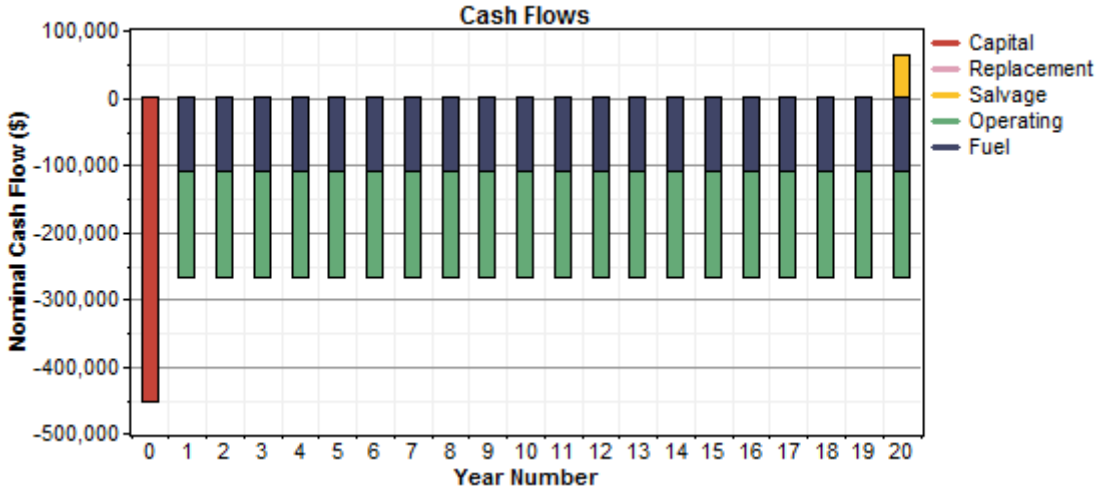
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	453,078	0	149,259	0	0	602,336
Generator 3	0	0	164,094	1,260,663	-1,513	1,423,244
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	39,222	298,899	-18,550	319,571
Boiler	0	0	0	72,306	0	72,306
Other	0	0	2,027,154	0	0	2,027,154
System	453,078	0	2,379,729	1,631,868	-36,660	4,428,014

Annualized Costs

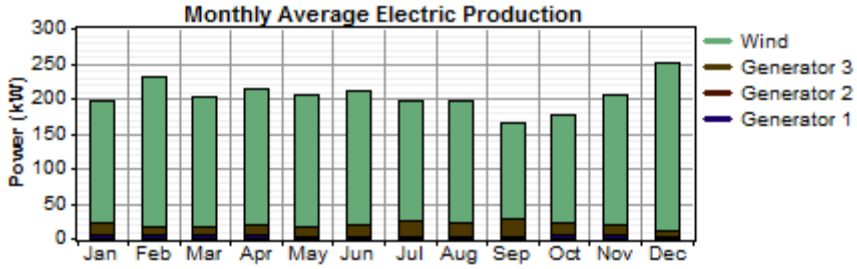
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	30,173	0	9,940	0	0	40,113
Generator 3	0	0	10,928	83,955	-101	94,782
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	2,612	19,905	-1,235	21,282
Boiler	0	0	0	4,815	0	4,815
Other	0	0	135,000	0	0	135,000
System	30,173	0	158,480	108,676	-2,441	294,887



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,617,282	90%
Generator 3	141,002	8%
Generator 2	0	0%
Generator 1	33,933	2%
Total	1,792,218	100%



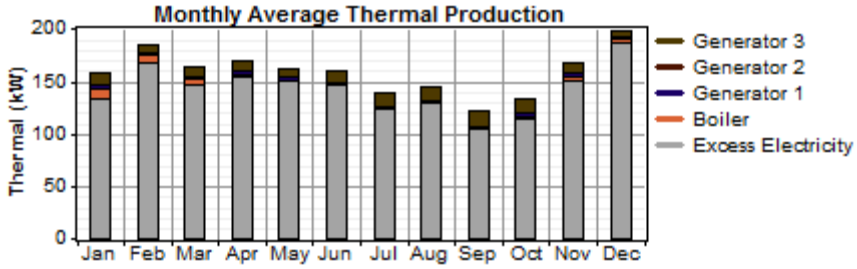
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	1,244,747	kWh/yr
Unmet load	0.000347	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.836	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	91,779	7%
Generator 1	22,634	2%
Boiler	27,213	2%
Excess electricity	1,244,747	90%
Total	1,386,373	100%



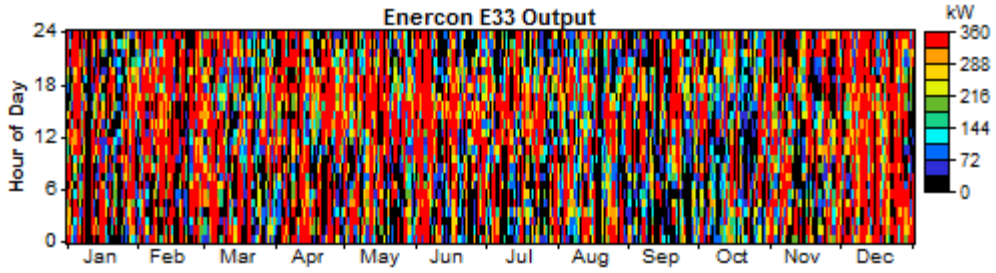
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	1,003,123	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	185	kW
Capacity factor	55.9	%
Total production	1,617,282	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	295	%
Hours of operation	8,089	hr/yr
Levelized cost	0.0248	$/kWh

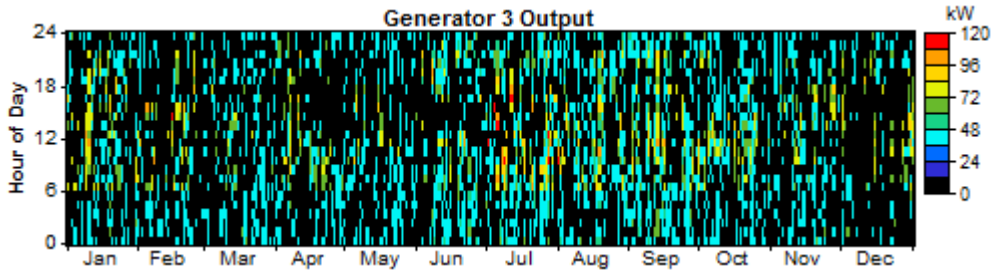


Generator 3

Quantity	Value	Units
Hours of operation	2,732	hr/yr
Number of starts	1,140	starts/yr
Operational life	22.0	yr
Capacity factor	11.1	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	141,002	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	118	kW
Thermal production	91,779	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	54.9	kW

Quantity	Value	Units
Fuel consumption	56,726	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	558,187	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



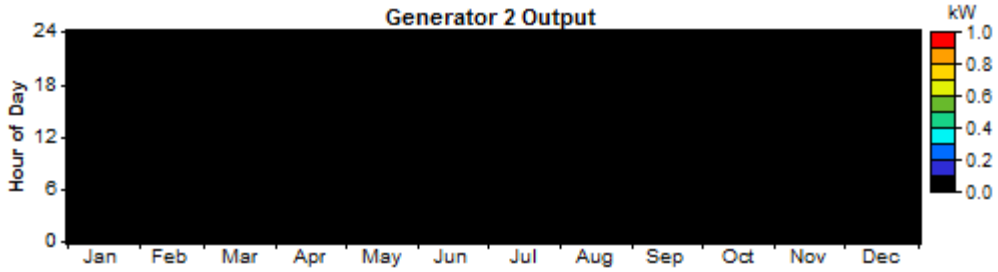
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



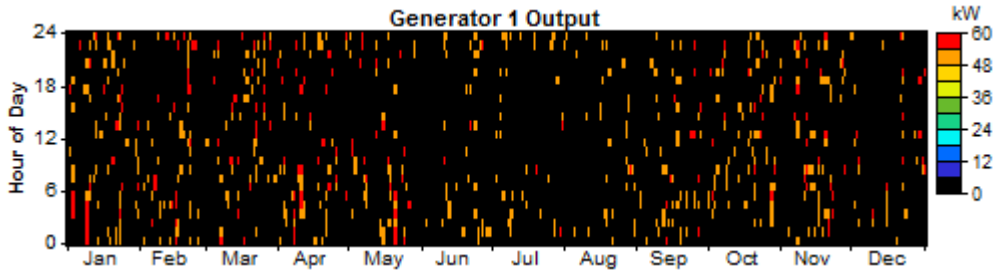
Generator 1

Quantity	Value	Units
Hours of operation	653	hr/yr
Number of starts	481	starts/yr
Operational life	91.9	yr
Capacity factor	2.42	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	33,933	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	59.9	kW
Thermal production	22,634	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	38.1	kW

Quantity	Value	Units
Fuel consumption	13,450	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	132,344	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	193,405
Carbon monoxide	456
Unburned hydocarbons	50.5
Particulate matter	34.4
Sulfur dioxide	389
Nitrogen oxides	4,070

Knight Piésold CONSULTING

Site 3
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

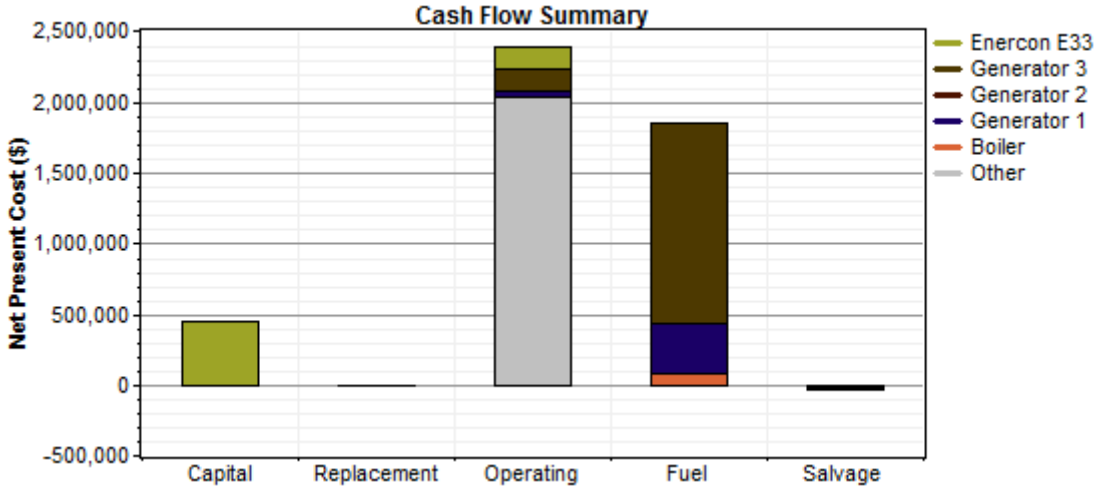
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	10.8 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1.11
Enercon E33 Capital Cost Multiplier:	1.07

System architecture

Wind turbine 1 Enercon E33
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 4,648,507
Levelized cost of energy	$ 0.425/kWh
Operating cost	$ 279,398/yr



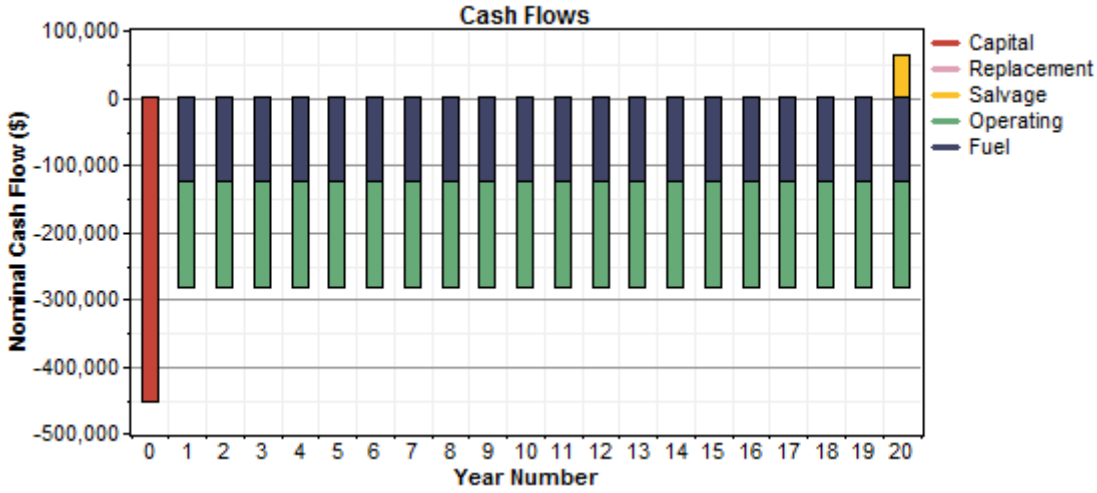
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Enercon E33	453,078	0	149,259	0	0	602,336
Generator 3	0	0	161,992	1,411,783	-1,711	1,572,064
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	41,324	358,573	-18,273	381,624
Boiler	0	0	0	81,924	0	81,924
Other	0	0	2,027,154	0	0	2,027,154
System	453,078	0	2,379,729	1,852,279	-36,581	4,648,505

Annualized Costs

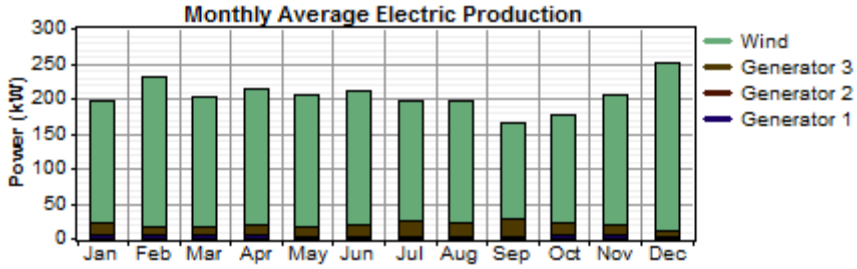
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Enercon E33	30,173	0	9,940	0	0	40,113
Generator 3	0	0	10,788	94,019	-114	104,693
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	2,752	23,879	-1,217	25,415
Boiler	0	0	0	5,456	0	5,456
Other	0	0	135,000	0	0	135,000
System	30,173	0	158,480	123,354	-2,436	309,571



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,617,282	90%
Generator 3	139,052	8%
Generator 2	0	0%
Generator 1	35,900	2%
Total	1,792,235	100%



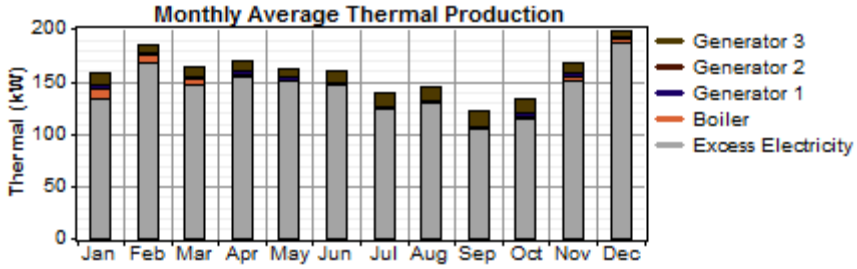
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	1,244,764	kWh/yr
Unmet load	0.000347	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.836	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	90,557	7%
Generator 1	23,912	2%
Boiler	27,162	2%
Excess electricity	1,244,764	90%
Total	1,386,394	100%



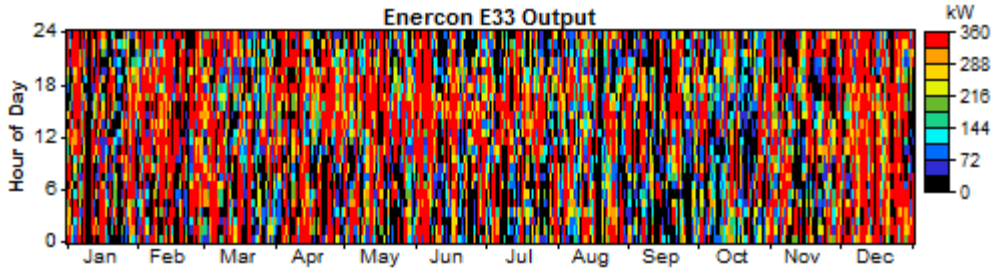
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	1,003,145	kWh/yr

AC Wind Turbine: Enercon E33

Variable	Value	Units
Total rated capacity	330	kW
Mean output	185	kW
Capacity factor	55.9	%
Total production	1,617,282	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	335	kW
Wind penetration	295	%
Hours of operation	8,089	hr/yr
Levelized cost	0.0248	$/kWh

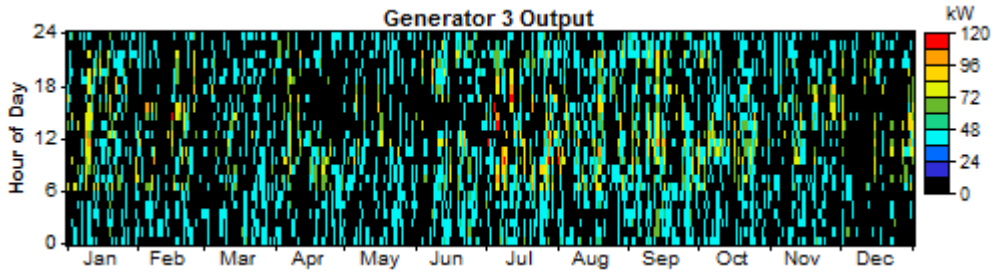


Generator 3

Quantity	Value	Units
Hours of operation	2,697	hr/yr
Number of starts	1,156	starts/yr
Operational life	22.2	yr
Capacity factor	10.9	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	139,052	kWh/yr
Mean electrical output	51.6	kW
Min. electrical output	43.5	kW
Max. electrical output	118	kW
Thermal production	90,557	kWh/yr
Mean thermal output	33.6	kW
Min. thermal output	31.0	kW
Max. thermal output	54.9	kW

Quantity	Value	Units
Fuel consumption	55,964	L/yr
Specific fuel consumption	0.402	L/kWh
Fuel energy input	550,682	kWh/yr
Mean electrical efficiency	25.3	%
Mean total efficiency	41.7	%



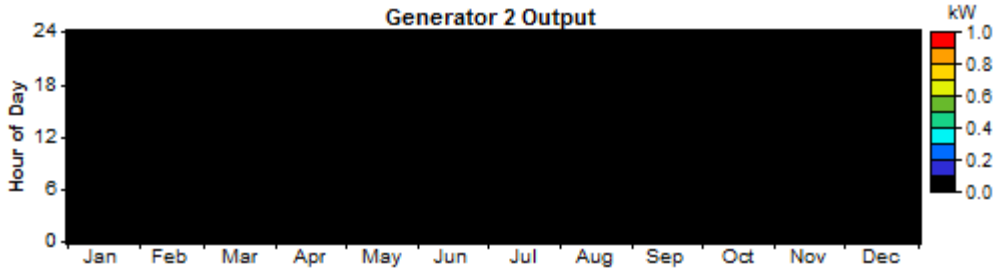
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



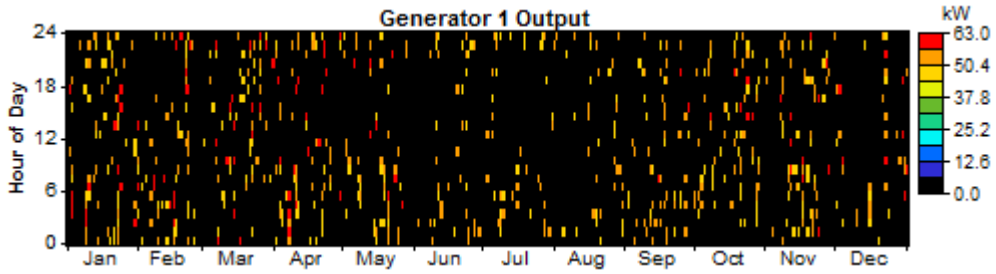
Generator 1

Quantity	Value	Units
Hours of operation	688	hr/yr
Number of starts	509	starts/yr
Operational life	87.2	yr
Capacity factor	2.56	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	35,900	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	60.4	kW
Thermal production	23,912	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	38.3	kW

Quantity	Value	Units
Fuel consumption	14,214	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	139,865	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	193,393
Carbon monoxide	456
Unburned hydocarbons	50.5
Particulate matter	34.4
Sulfur dioxide	389
Nitrogen oxides	4,070

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Appendix G
Aeronautica 29-225 Economics

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Site 1
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_Vestas_Aeronautica.hmr

Sensitivity case

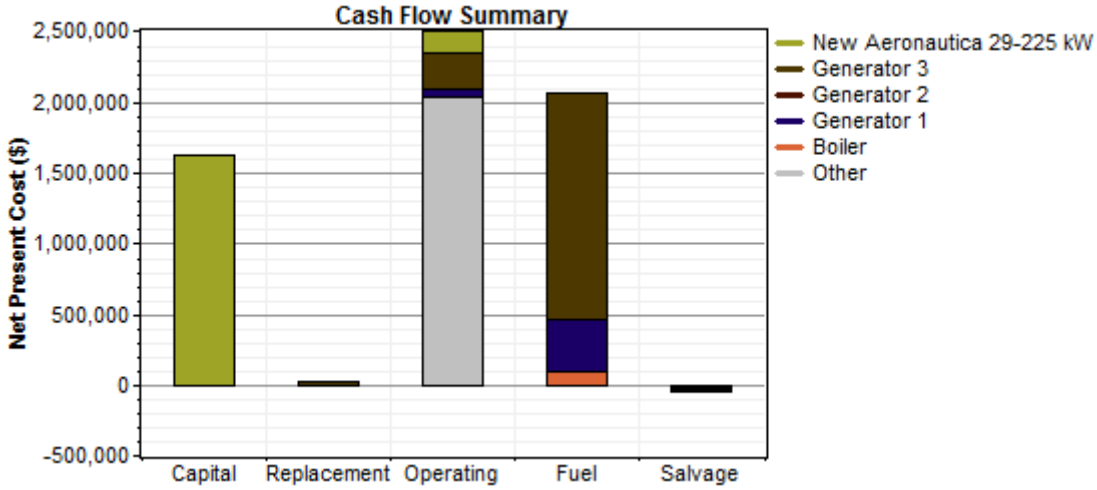
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	8.05 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,160,455
Levelized cost of energy	$ 0.652/kWh
Operating cost	$ 302,098/yr



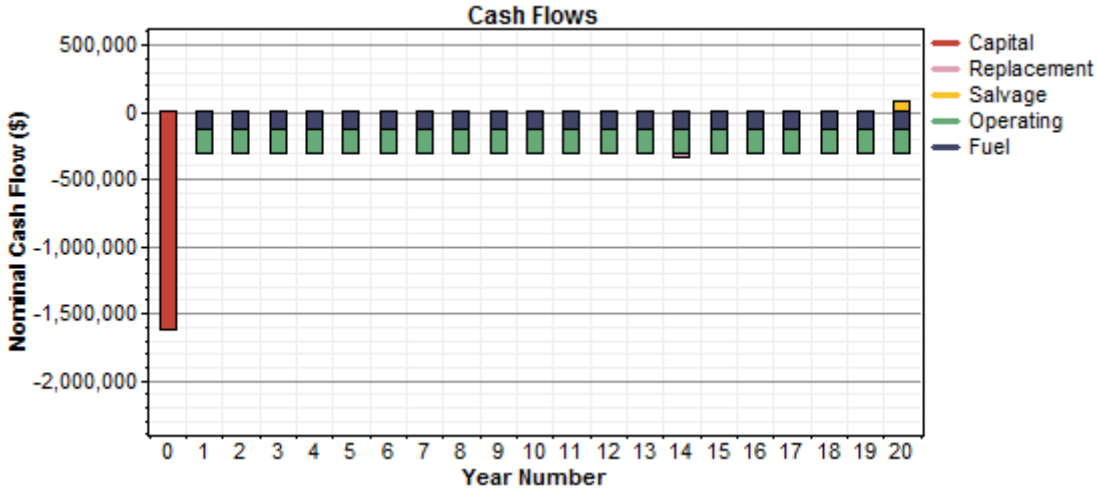
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,624,164	0	149,259	0	0	1,773,423
Generator 3	0	20,119	257,854	1,600,015	-9,637	1,868,351
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	62,346	372,134	-15,507	418,974
Boiler	0	0	0	89,148	0	89,148
Other	0	0	2,027,154	0	0	2,027,154
System	1,624,164	20,119	2,496,613	2,061,298	-41,741	6,160,452

Annualized Costs

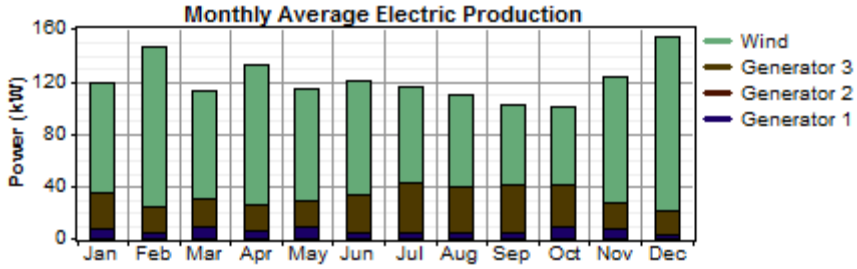
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	108,163	0	9,940	0	0	118,103
Generator 3	0	1,340	17,172	106,554	-642	124,424
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,152	24,783	-1,033	27,902
Boiler	0	0	0	5,937	0	5,937
Other	0	0	135,000	0	0	135,000
System	108,163	1,340	166,264	137,274	-2,780	410,260



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	771,961	73%
Generator 3	232,434	22%
Generator 2	0	0%
Generator 1	53,889	5%
Total	1,058,284	100%



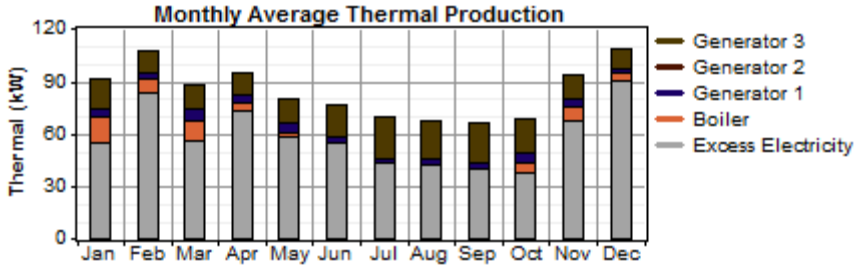
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	510,789	kWh/yr
Unmet load	0.000702	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.601	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	147,713	20%
Generator 1	35,957	5%
Boiler	42,807	6%
Excess electricity	510,789	69%
Total	737,266	100%



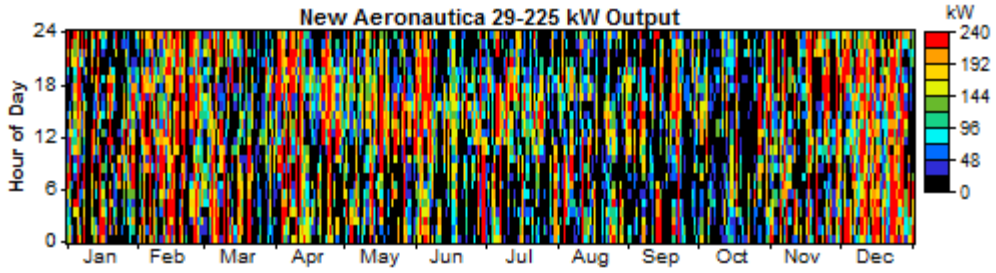
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	354,017	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	88.1	kW
Capacity factor	39.2	%
Total production	771,961	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	141	%
Hours of operation	7,109	hr/yr
Levelized cost	0.153	$/kWh

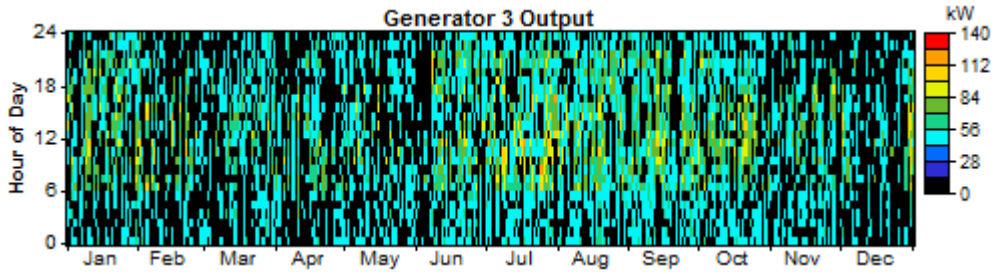


Generator 3

Quantity	Value	Units
Hours of operation	4,293	hr/yr
Number of starts	1,280	starts/yr
Operational life	14.0	yr
Capacity factor	18.3	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	232,434	kWh/yr
Mean electrical output	54.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	147,713	kWh/yr
Mean thermal output	34.4	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	91,857	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	903,875	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.1	%



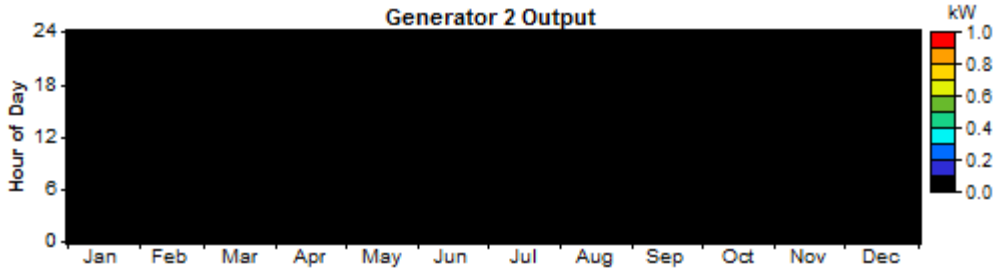
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



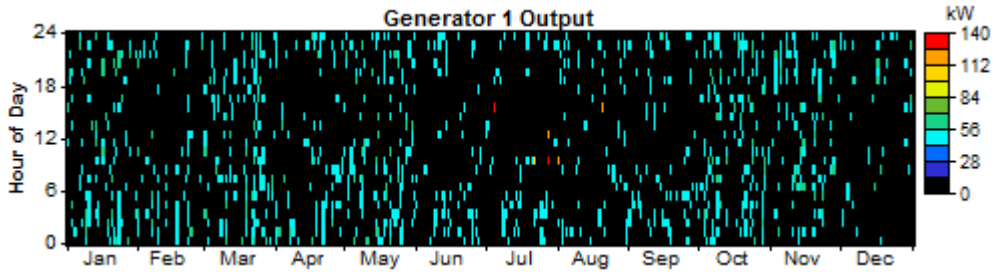
Generator 1

Quantity	Value	Units
Hours of operation	1,038	hr/yr
Number of starts	708	starts/yr
Operational life	57.8	yr
Capacity factor	3.84	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	53,889	kWh/yr
Mean electrical output	51.9	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	35,957	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	21,364	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	210,225	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	311,691
Carbon monoxide	736
Unburned hydocarbons	81.5
Particulate matter	55.5
Sulfur dioxide	626
Nitrogen oxides	6,567

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Site 1
Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_Vestas_Aeronautica.hmr

Sensitivity case

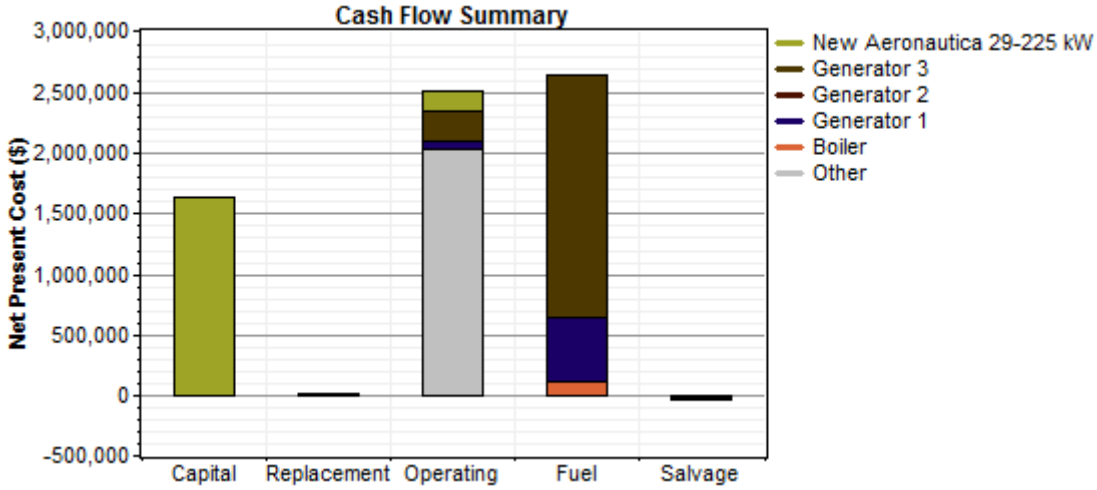
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	8.05 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,728,757
Levelized cost of energy	$ 0.695/kWh
Operating cost	$ 339,944/yr



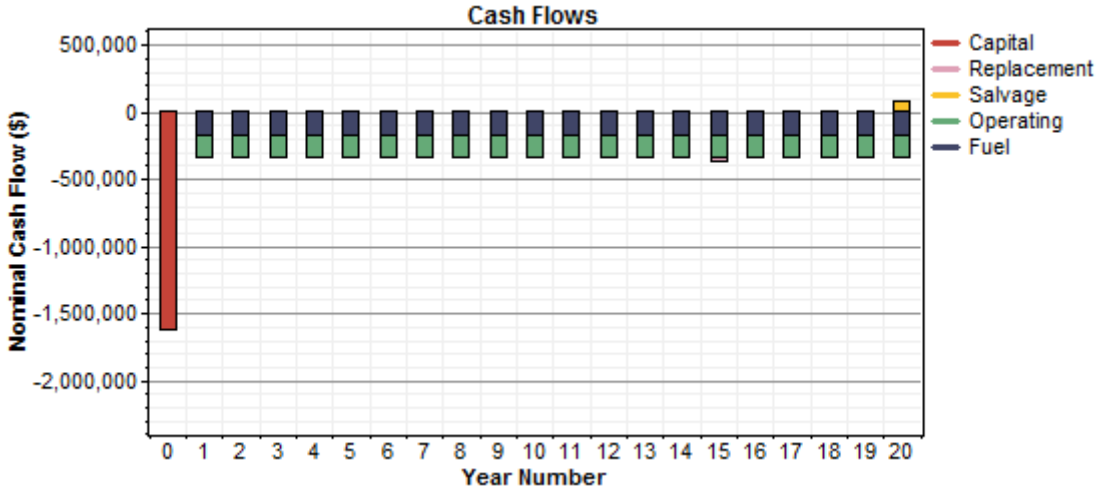
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,624,164	0	149,259	0	0	1,773,423
Generator 3	0	19,914	251,427	1,990,370	-10,241	2,251,471
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	68,773	526,058	-14,661	580,170
Boiler	0	0	0	113,135	0	113,135
Other	0	0	2,027,154	0	0	2,027,154
System	1,624,164	19,914	2,496,613	2,629,563	-41,499	6,728,755

Annualized Costs

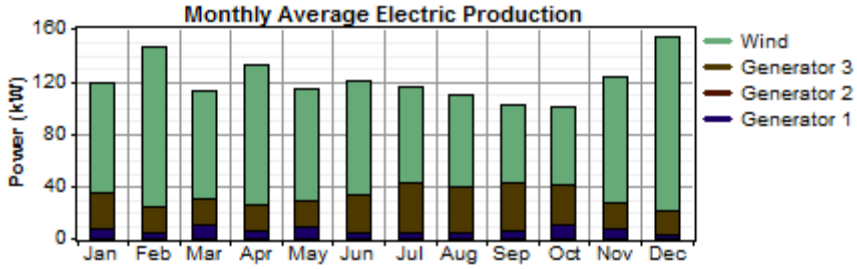
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	108,163	0	9,940	0	0	118,103
Generator 3	0	1,326	16,744	132,550	-682	149,939
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,580	35,033	-976	38,637
Boiler	0	0	0	7,534	0	7,534
Other	0	0	135,000	0	0	135,000
System	108,163	1,326	166,264	175,118	-2,764	448,107



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	771,961	73%
Generator 3	226,614	21%
Generator 2	0	0%
Generator 1	59,800	6%
Total	1,058,376	100%



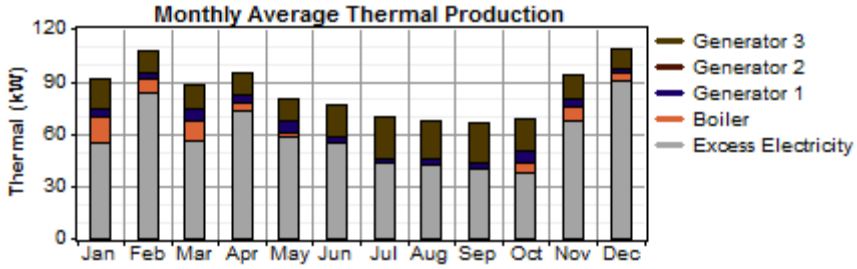
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	510,880	kWh/yr
Unmet load	0.000710	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.601	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	144,023	20%
Generator 1	39,818	5%
Boiler	42,579	6%
Excess electricity	510,880	69%
Total	737,301	100%



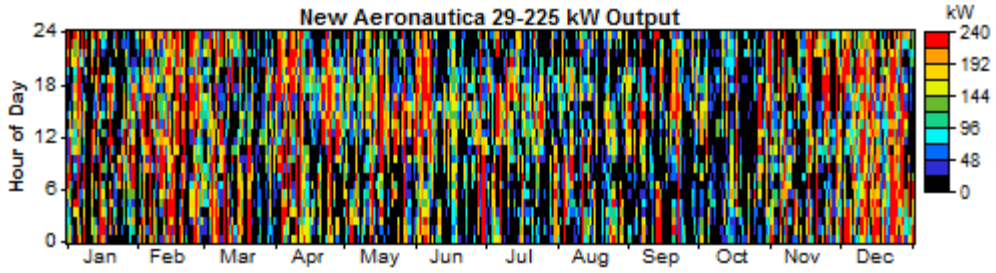
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	354,051	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	88.1	kW
Capacity factor	39.2	%
Total production	771,961	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	141	%
Hours of operation	7,109	hr/yr
Levelized cost	0.153	$/kWh

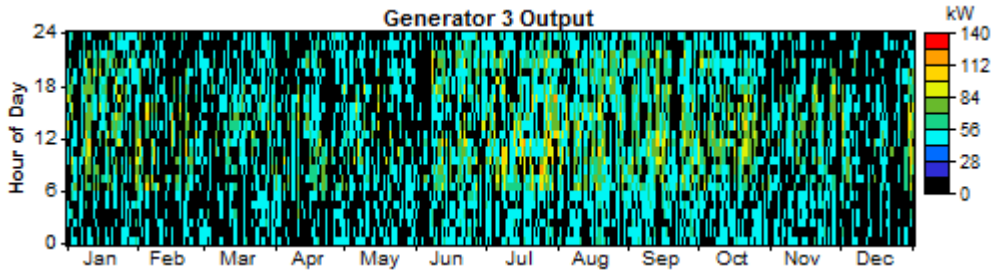


Generator 3

Quantity	Value	Units
Hours of operation	4,186	hr/yr
Number of starts	1,318	starts/yr
Operational life	14.3	yr
Capacity factor	17.8	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	226,614	kWh/yr
Mean electrical output	54.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	144,023	kWh/yr
Mean thermal output	34.4	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	89,561	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	881,281	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.1	%



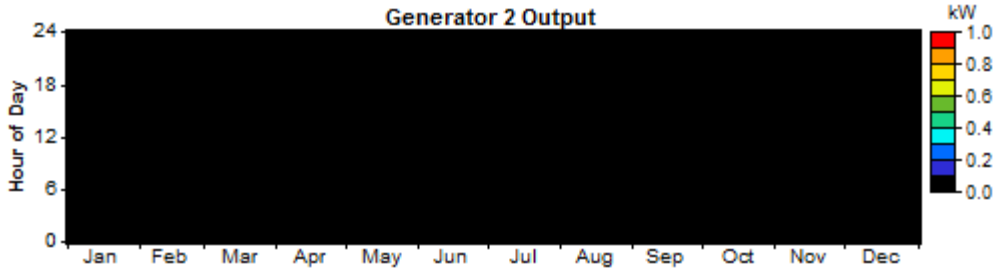
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



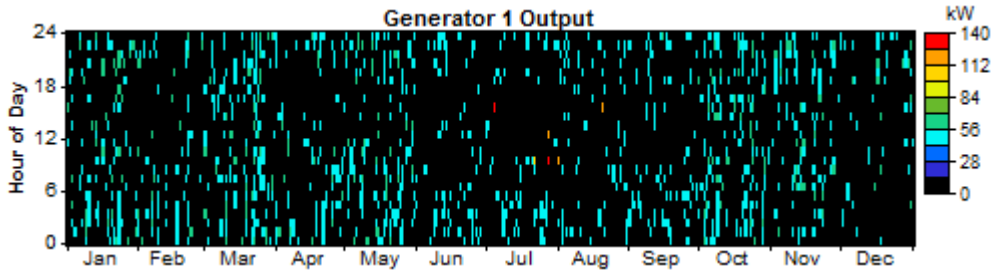
Generator 1

Quantity	Value	Units
Hours of operation	1,145	hr/yr
Number of starts	757	starts/yr
Operational life	52.4	yr
Capacity factor	4.27	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	59,800	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	39,818	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	23,671	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	232,924	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	311,647
Carbon monoxide	736
Unburned hydocarbons	81.5
Particulate matter	55.5
Sulfur dioxide	626
Nitrogen oxides	6,567

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Site 1
Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_Vestas_Aeronautica.hmr

Sensitivity case

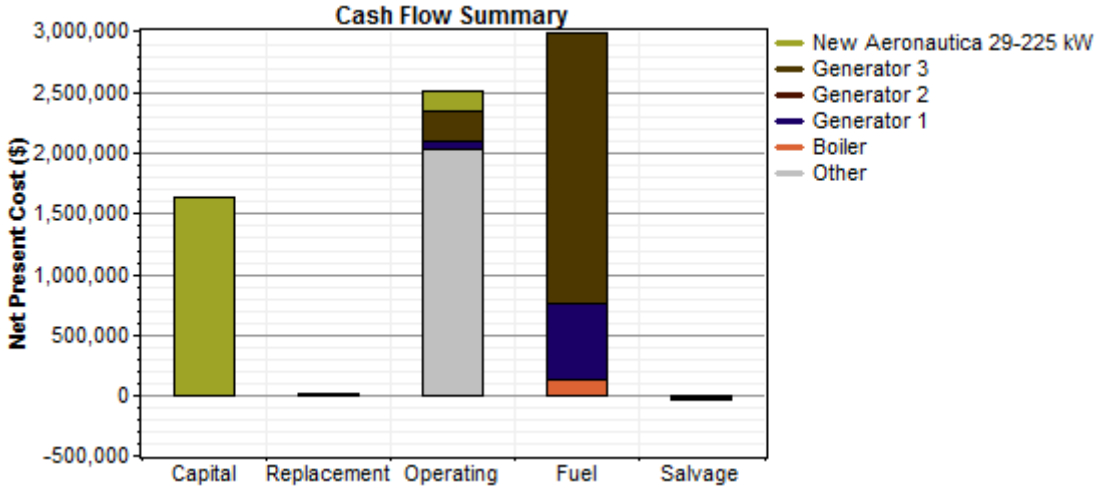
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	8.05 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,083,940
Levelized cost of energy	$ 0.721/kWh
Operating cost	$ 363,598/yr



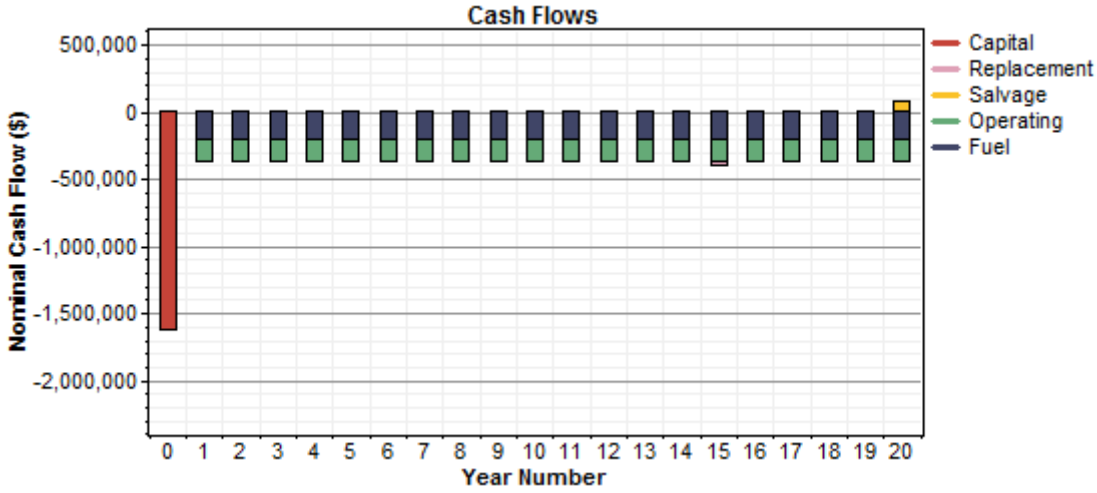
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,624,164	0	149,259	0	0	1,773,423
Generator 3	0	19,804	248,064	2,228,667	-10,557	2,485,977
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	72,137	628,044	-14,218	685,962
Boiler	0	0	0	128,019	0	128,019
Other	0	0	2,027,154	0	0	2,027,154
System	1,624,164	19,804	2,496,613	2,984,730	-41,373	7,083,938

Annualized Costs

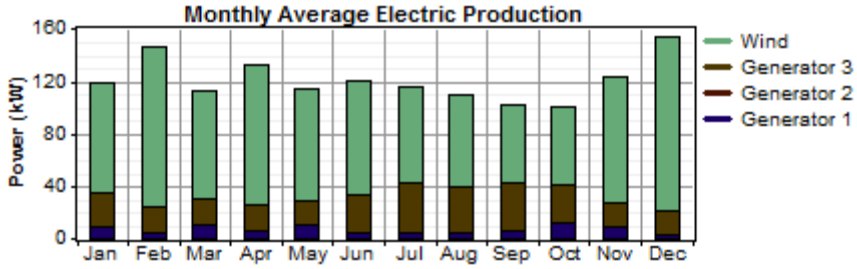
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	108,163	0	9,940	0	0	118,103
Generator 3	0	1,319	16,520	148,420	-703	165,556
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,804	41,825	-947	45,682
Boiler	0	0	0	8,526	0	8,526
Other	0	0	135,000	0	0	135,000
System	108,163	1,319	166,264	198,770	-2,755	471,761



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	771,961	73%
Generator 3	223,512	21%
Generator 2	0	0%
Generator 1	62,954	6%
Total	1,058,427	100%



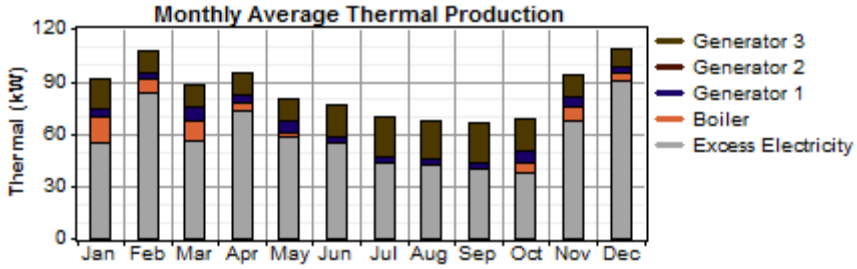
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	510,931	kWh/yr
Unmet load	0.000698	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.601	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	142,074	19%
Generator 1	41,865	6%
Boiler	42,445	6%
Excess electricity	510,931	69%
Total	737,315	100%



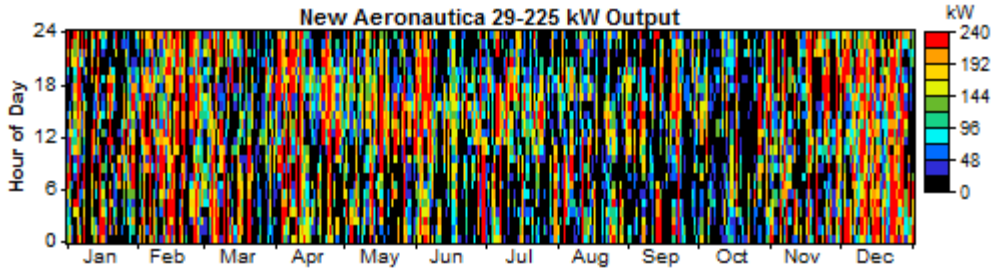
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	354,065	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	88.1	kW
Capacity factor	39.2	%
Total production	771,961	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	141	%
Hours of operation	7,109	hr/yr
Levelized cost	0.153	$/kWh

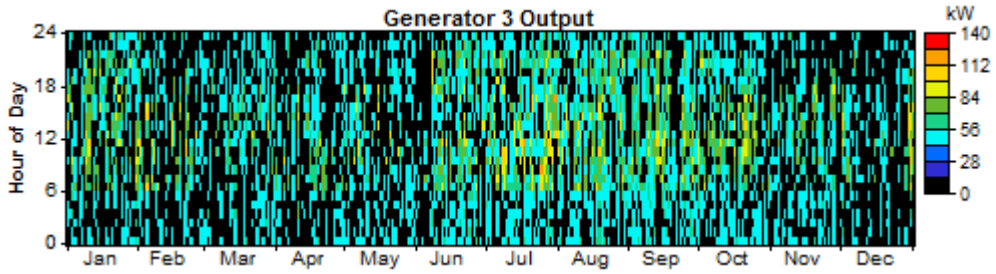


Generator 3

Quantity	Value	Units
Hours of operation	4,130	hr/yr
Number of starts	1,334	starts/yr
Operational life	14.5	yr
Capacity factor	17.6	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	223,512	kWh/yr
Mean electrical output	54.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	142,074	kWh/yr
Mean thermal output	34.4	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	88,345	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	869,317	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.1	%



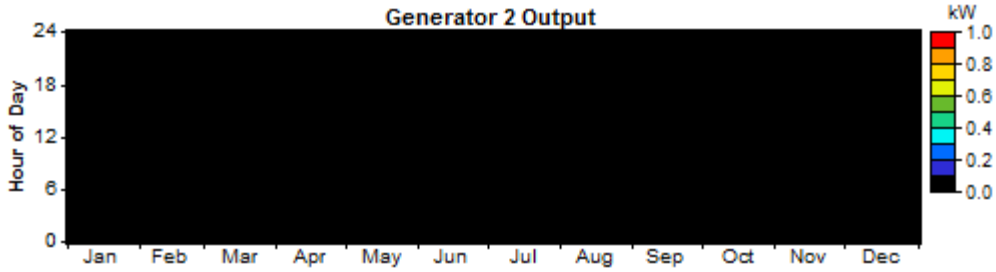
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



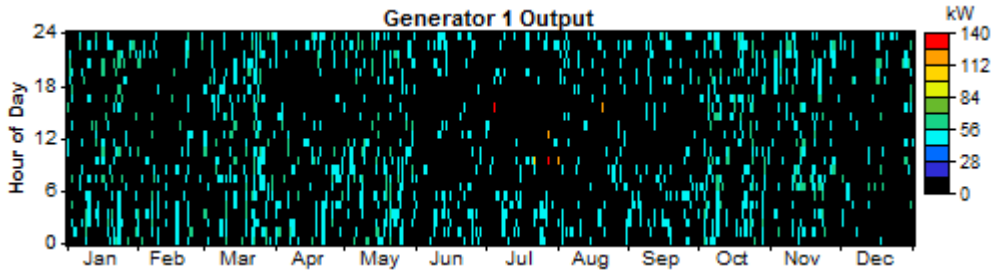
Generator 1

Quantity	Value	Units
Hours of operation	1,201	hr/yr
Number of starts	785	starts/yr
Operational life	50.0	yr
Capacity factor	4.49	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	62,954	kWh/yr
Mean electrical output	52.4	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	41,865	kWh/yr
Mean thermal output	34.9	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	24,896	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	244,976	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	311,628
Carbon monoxide	736
Unburned hydocarbons	81.5
Particulate matter	55.5
Sulfur dioxide	626
Nitrogen oxides	6,568

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Site 1
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

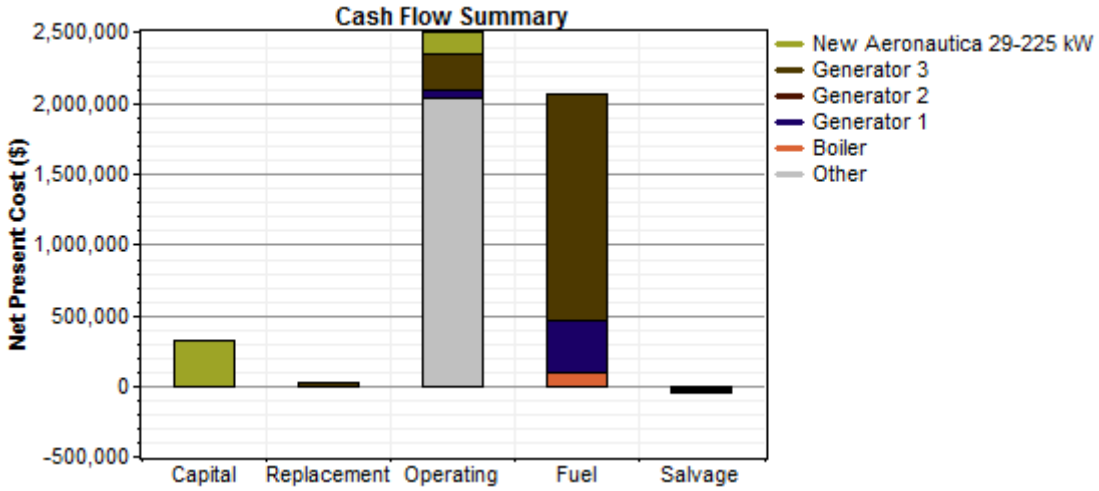
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	8.05 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 4,861,124
Levelized cost of energy	$ 0.494/kWh
Operating cost	$ 302,098/yr



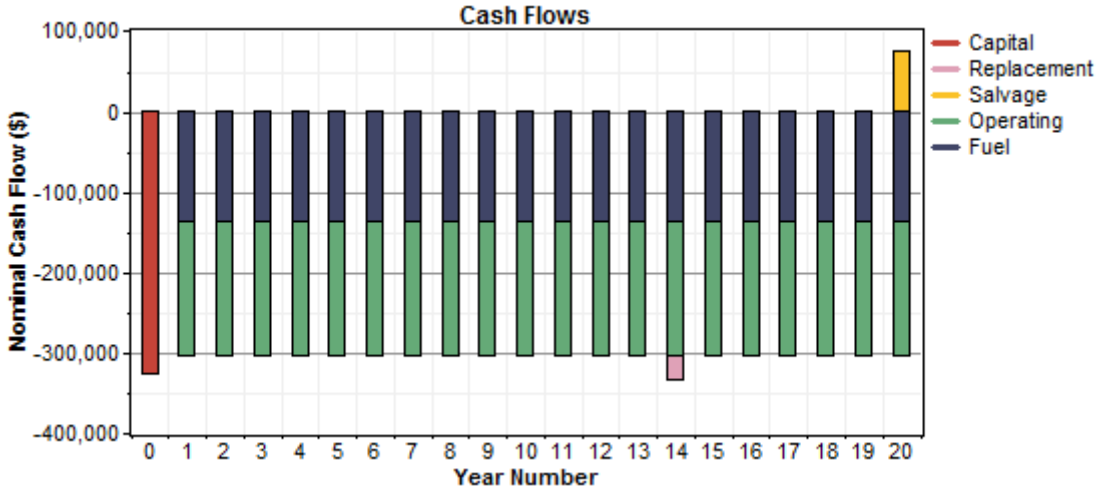
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	324,833	0	149,259	0	0	474,092
Generator 3	0	20,119	257,854	1,600,015	-9,637	1,868,351
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	62,346	372,134	-15,507	418,974
Boiler	0	0	0	89,148	0	89,148
Other	0	0	2,027,154	0	0	2,027,154
System	324,833	20,119	2,496,613	2,061,298	-41,741	4,861,121

Annualized Costs

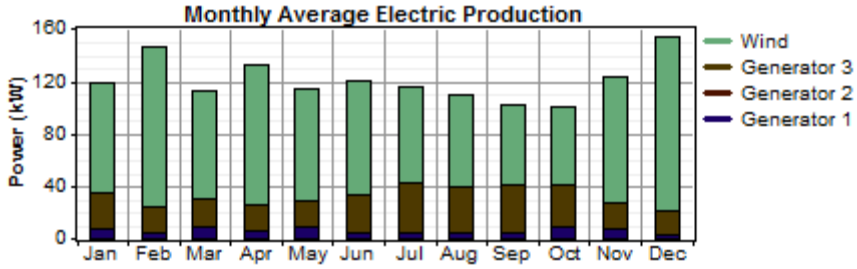
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	21,633	0	9,940	0	0	31,573
Generator 3	0	1,340	17,172	106,554	-642	124,424
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,152	24,783	-1,033	27,902
Boiler	0	0	0	5,937	0	5,937
Other	0	0	135,000	0	0	135,000
System	21,633	1,340	166,264	137,274	-2,780	323,730



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	771,961	73%
Generator 3	232,434	22%
Generator 2	0	0%
Generator 1	53,889	5%
Total	1,058,284	100%



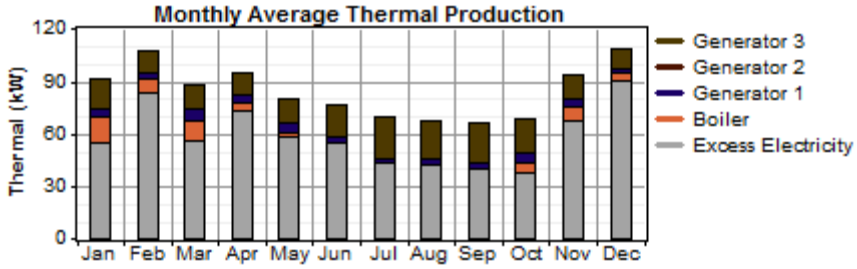
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	510,789	kWh/yr
Unmet load	0.000702	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.601	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	147,713	20%
Generator 1	35,957	5%
Boiler	42,807	6%
Excess electricity	510,789	69%
Total	737,266	100%



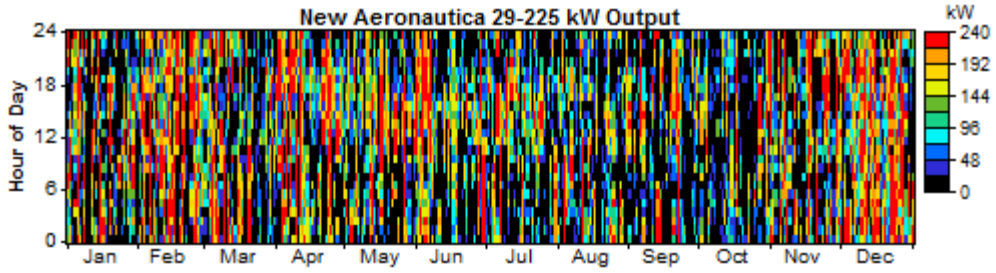
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	354,017	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	88.1	kW
Capacity factor	39.2	%
Total production	771,961	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	141	%
Hours of operation	7,109	hr/yr
Levelized cost	0.0409	$/kWh

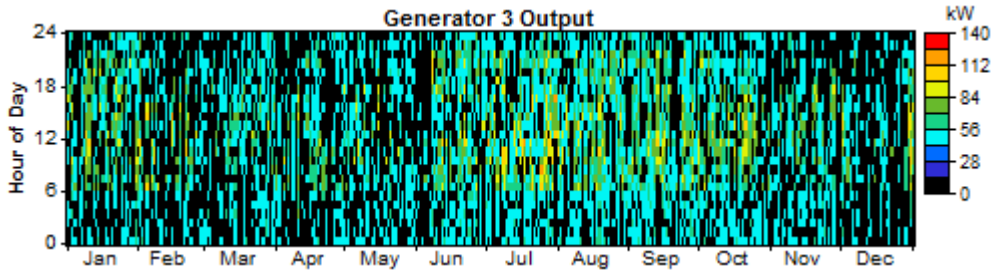


Generator 3

Quantity	Value	Units
Hours of operation	4,293	hr/yr
Number of starts	1,280	starts/yr
Operational life	14.0	yr
Capacity factor	18.3	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	232,434	kWh/yr
Mean electrical output	54.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	147,713	kWh/yr
Mean thermal output	34.4	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	91,857	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	903,875	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.1	%



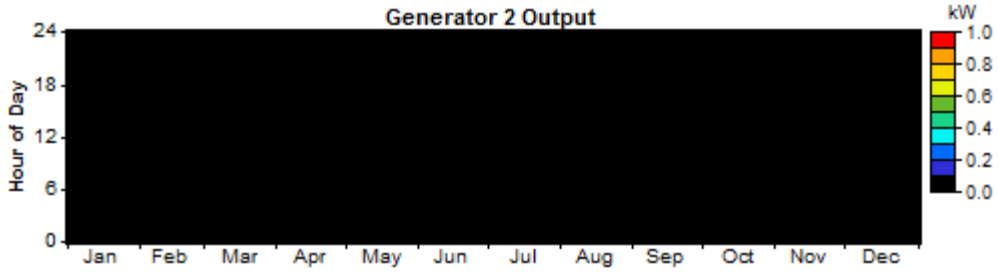
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



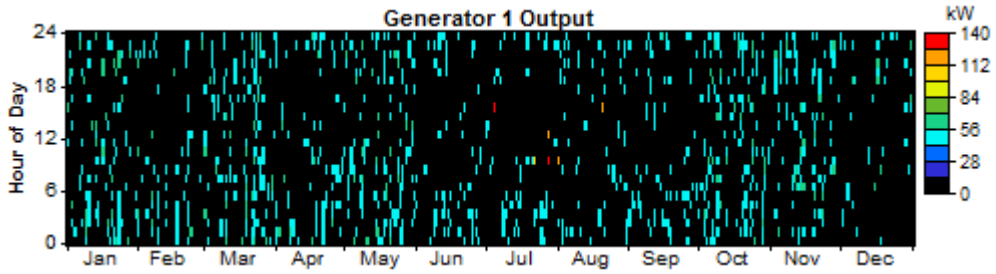
Generator 1

Quantity	Value	Units
Hours of operation	1,038	hr/yr
Number of starts	708	starts/yr
Operational life	57.8	yr
Capacity factor	3.84	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	53,889	kWh/yr
Mean electrical output	51.9	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	35,957	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	21,364	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	210,225	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	311,691
Carbon monoxide	736
Unburned hydocarbons	81.5
Particulate matter	55.5
Sulfur dioxide	626
Nitrogen oxides	6,567

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Site 1
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

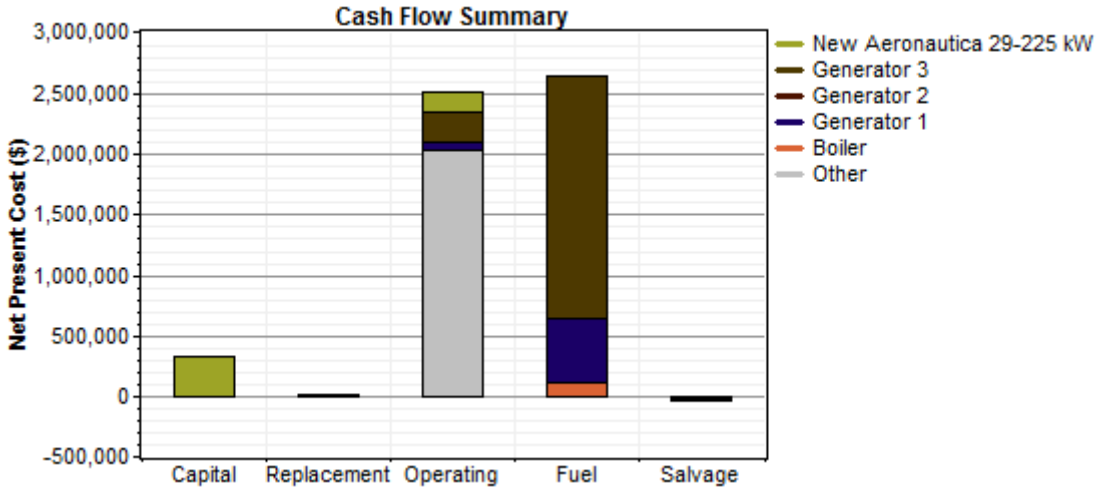
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	8.05 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,429,426
Levelized cost of energy	$ 0.537/kWh
Operating cost	$ 339,944/yr



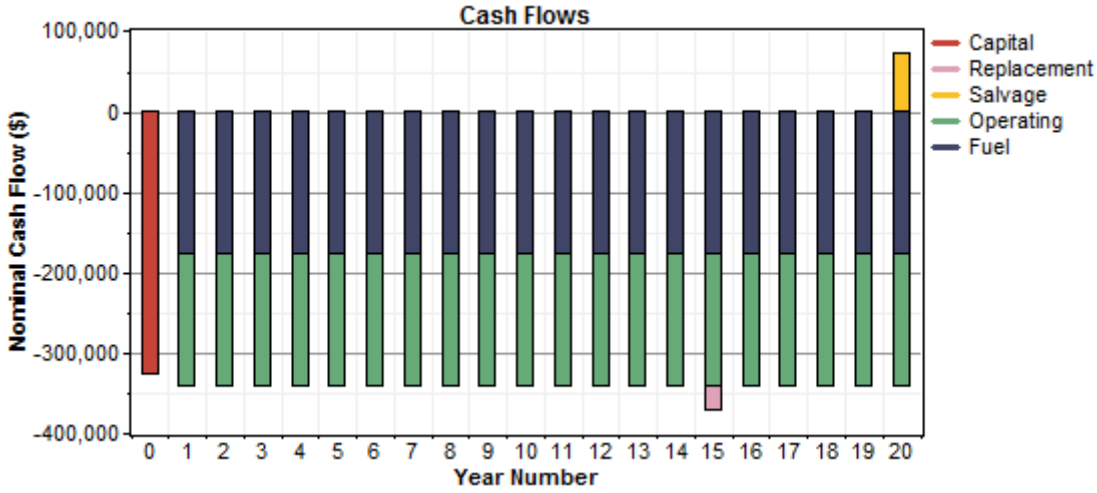
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	324,833	0	149,259	0	0	474,092
Generator 3	0	19,914	251,427	1,990,370	-10,241	2,251,471
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	68,773	526,058	-14,661	580,170
Boiler	0	0	0	113,135	0	113,135
Other	0	0	2,027,154	0	0	2,027,154
System	324,833	19,914	2,496,613	2,629,563	-41,499	5,429,424

Annualized Costs

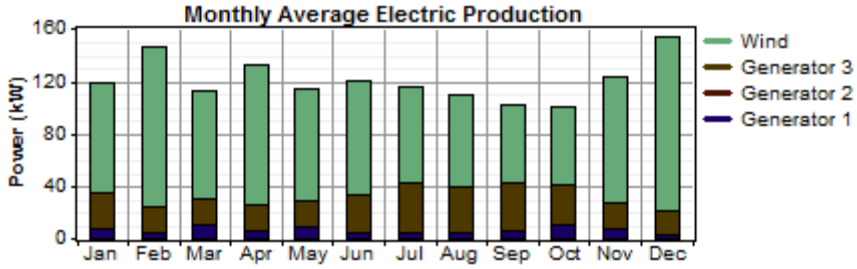
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	21,633	0	9,940	0	0	31,573
Generator 3	0	1,326	16,744	132,550	-682	149,939
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,580	35,033	-976	38,637
Boiler	0	0	0	7,534	0	7,534
Other	0	0	135,000	0	0	135,000
System	21,633	1,326	166,264	175,118	-2,764	361,577



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	771,961	73%
Generator 3	226,614	21%
Generator 2	0	0%
Generator 1	59,800	6%
Total	1,058,376	100%



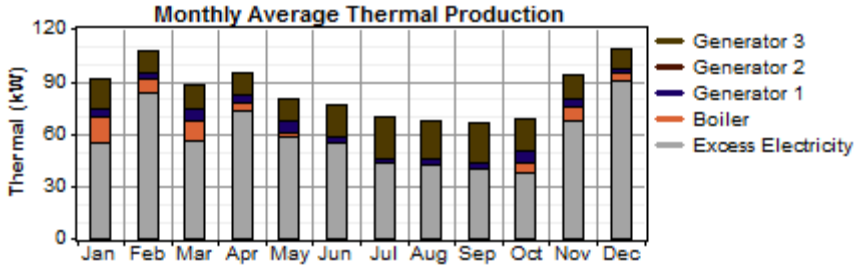
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	510,880	kWh/yr
Unmet load	0.000710	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.601	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	144,023	20%
Generator 1	39,818	5%
Boiler	42,579	6%
Excess electricity	510,880	69%
Total	737,301	100%



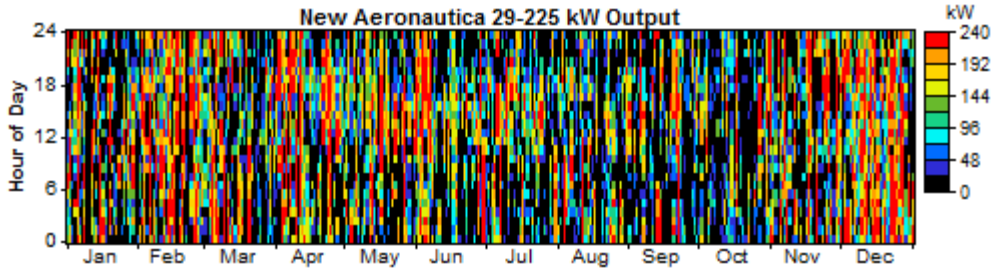
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	354,051	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	88.1	kW
Capacity factor	39.2	%
Total production	771,961	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	141	%
Hours of operation	7,109	hr/yr
Levelized cost	0.0409	$/kWh

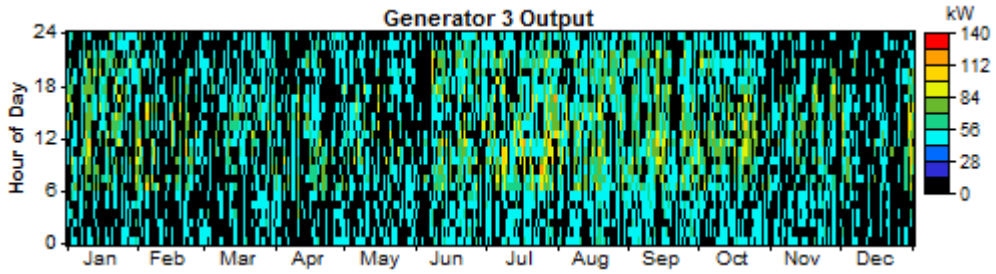


Generator 3

Quantity	Value	Units
Hours of operation	4,186	hr/yr
Number of starts	1,318	starts/yr
Operational life	14.3	yr
Capacity factor	17.8	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	226,614	kWh/yr
Mean electrical output	54.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	144,023	kWh/yr
Mean thermal output	34.4	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	89,561	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	881,281	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.1	%



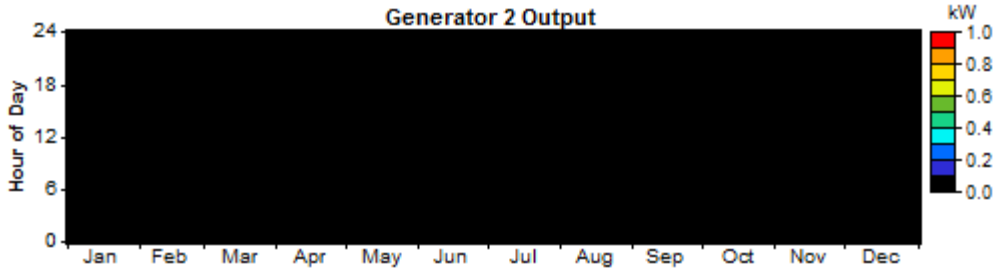
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



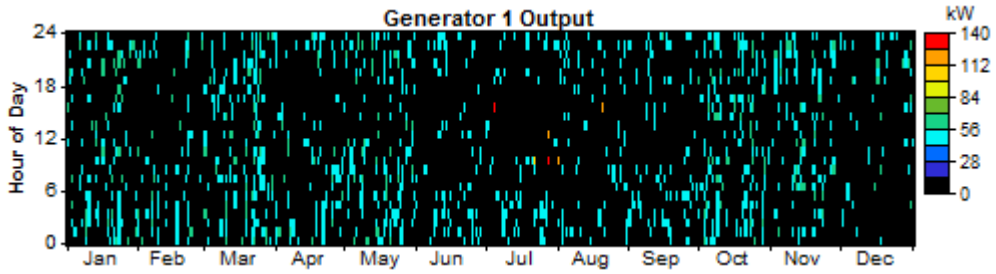
Generator 1

Quantity	Value	Units
Hours of operation	1,145	hr/yr
Number of starts	757	starts/yr
Operational life	52.4	yr
Capacity factor	4.27	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	59,800	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	39,818	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	23,671	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	232,924	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	311,647
Carbon monoxide	736
Unburned hydocarbons	81.5
Particulate matter	55.5
Sulfur dioxide	626
Nitrogen oxides	6,567

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Site 1
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

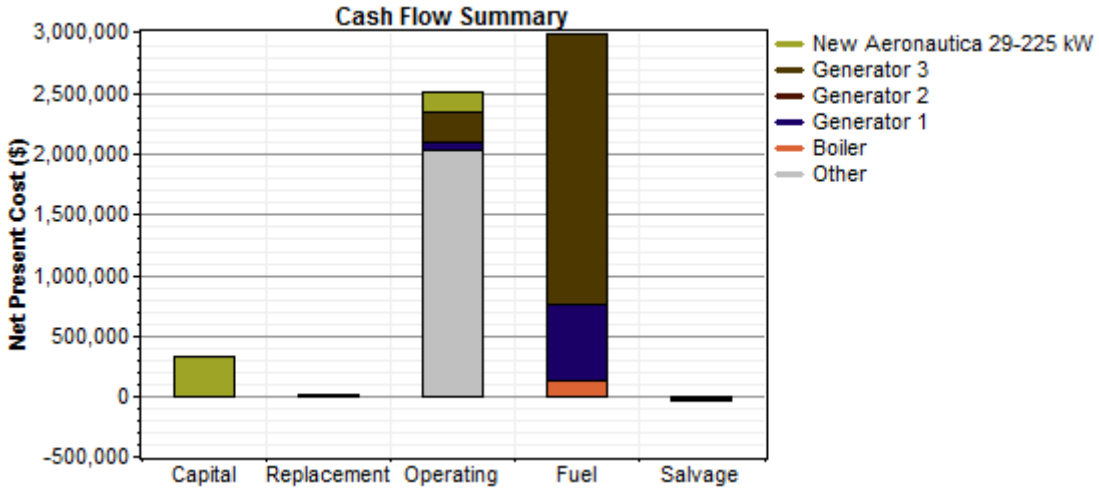
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	8.05 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,784,610
Levelized cost of energy	$ 0.563/kWh
Operating cost	$ 363,598/yr



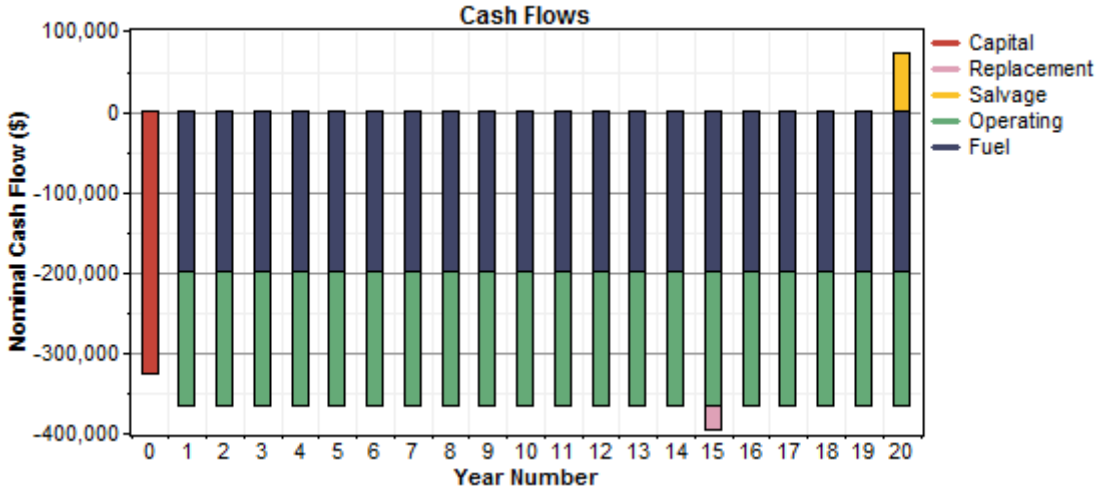
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	324,833	0	149,259	0	0	474,092
Generator 3	0	19,804	248,064	2,228,667	-10,557	2,485,977
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	72,137	628,044	-14,218	685,962
Boiler	0	0	0	128,019	0	128,019
Other	0	0	2,027,154	0	0	2,027,154
System	324,833	19,804	2,496,613	2,984,730	-41,373	5,784,607

Annualized Costs

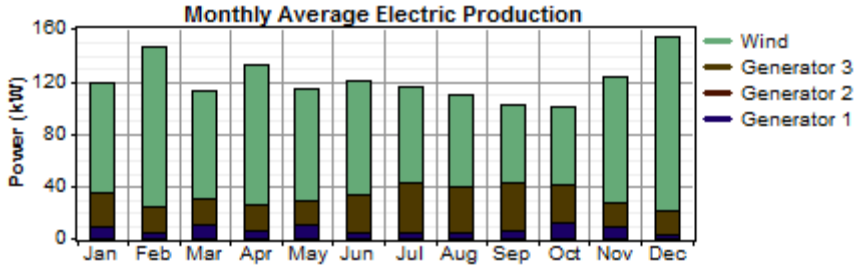
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	21,633	0	9,940	0	0	31,573
Generator 3	0	1,319	16,520	148,420	-703	165,556
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,804	41,825	-947	45,682
Boiler	0	0	0	8,526	0	8,526
Other	0	0	135,000	0	0	135,000
System	21,633	1,319	166,264	198,770	-2,755	385,231



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	771,961	73%
Generator 3	223,512	21%
Generator 2	0	0%
Generator 1	62,954	6%
Total	1,058,427	100%



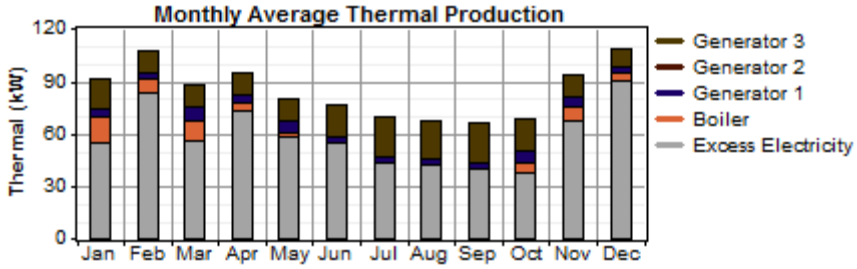
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	510,931	kWh/yr
Unmet load	0.000698	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.601	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	142,074	19%
Generator 1	41,865	6%
Boiler	42,445	6%
Excess electricity	510,931	69%
Total	737,315	100%



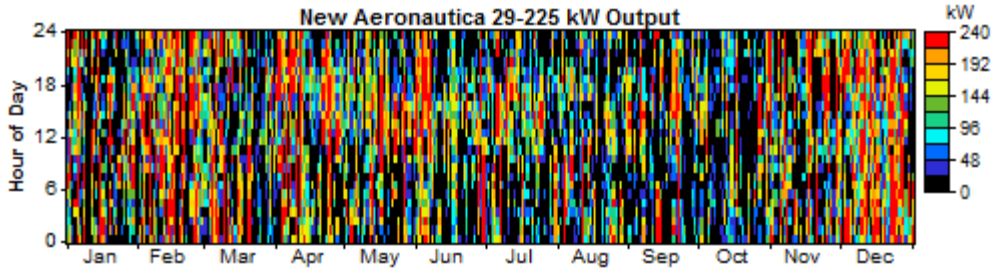
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	354,065	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	88.1	kW
Capacity factor	39.2	%
Total production	771,961	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	141	%
Hours of operation	7,109	hr/yr
Levelized cost	0.0409	$/kWh

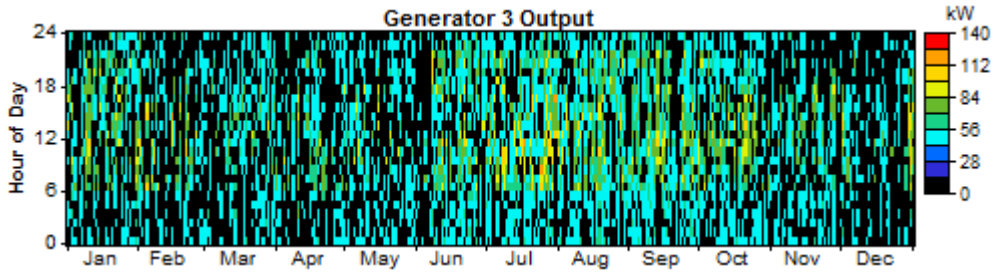


Generator 3

Quantity	Value	Units
Hours of operation	4,130	hr/yr
Number of starts	1,334	starts/yr
Operational life	14.5	yr
Capacity factor	17.6	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	223,512	kWh/yr
Mean electrical output	54.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	142,074	kWh/yr
Mean thermal output	34.4	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	88,345	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	869,317	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.1	%



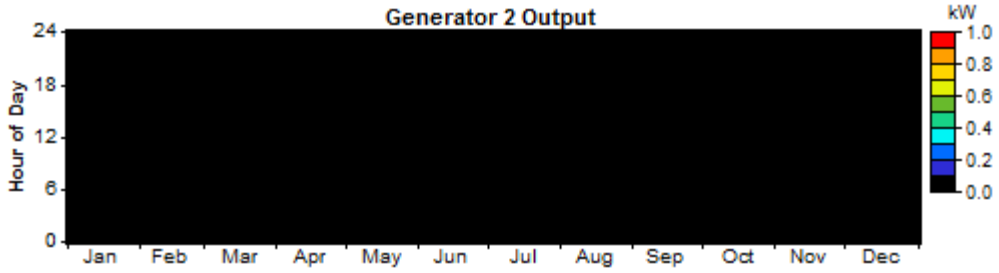
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



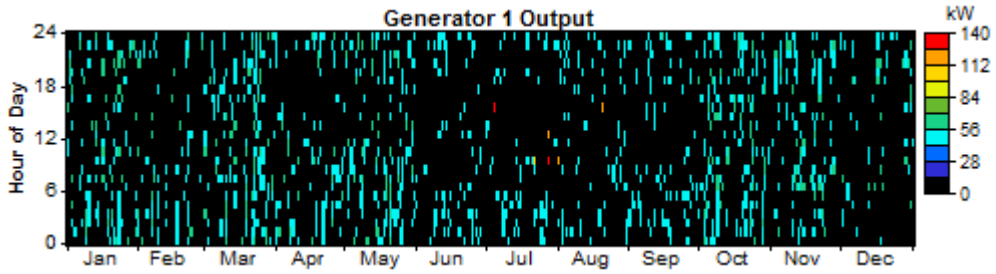
Generator 1

Quantity	Value	Units
Hours of operation	1,201	hr/yr
Number of starts	785	starts/yr
Operational life	50.0	yr
Capacity factor	4.49	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	62,954	kWh/yr
Mean electrical output	52.4	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	41,865	kWh/yr
Mean thermal output	34.9	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	24,896	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	244,976	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	311,628
Carbon monoxide	736
Unburned hydocarbons	81.5
Particulate matter	55.5
Sulfur dioxide	626
Nitrogen oxides	6,568

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Site 2
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_Vestas_Aeronautica.hmr

Sensitivity case

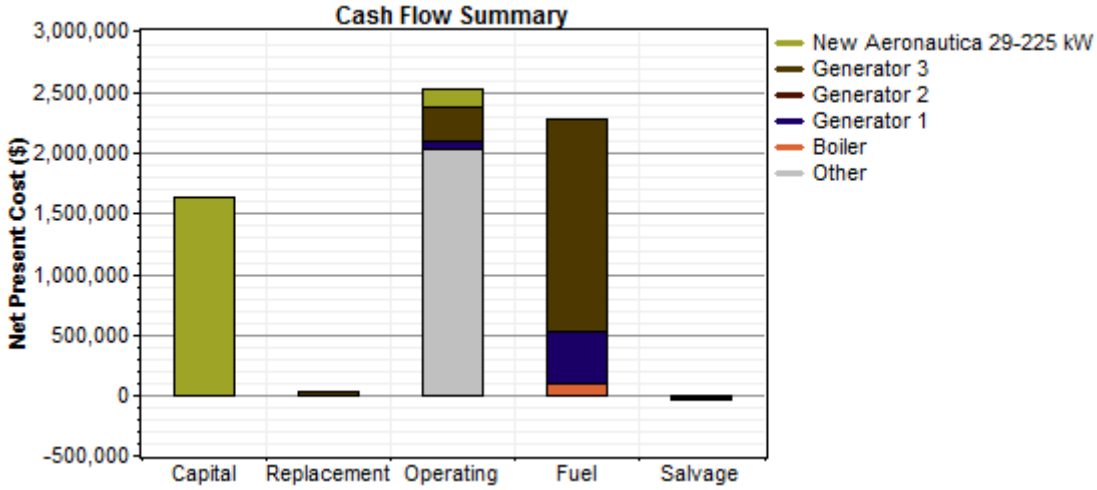
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.27 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,408,718
Levelized cost of energy	$ 0.682/kWh
Operating cost	$ 318,631/yr



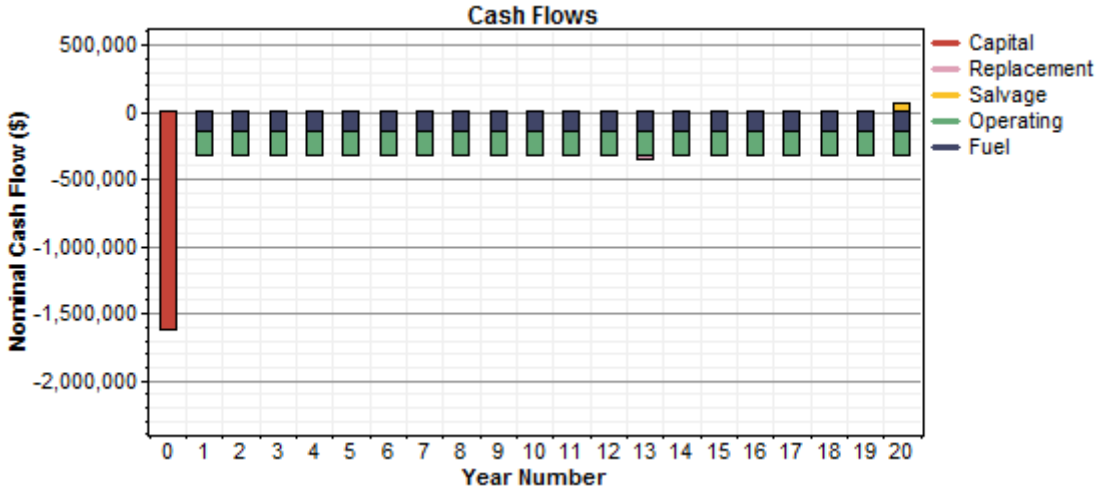
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,624,164	0	149,259	0	0	1,773,423
Generator 3	0	20,790	280,919	1,754,673	-7,469	2,048,912
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	70,335	420,293	-14,456	476,172
Boiler	0	0	0	99,653	0	99,653
Other	0	0	2,027,154	0	0	2,027,154
System	1,624,164	20,790	2,527,666	2,274,618	-38,522	6,408,716

Annualized Costs

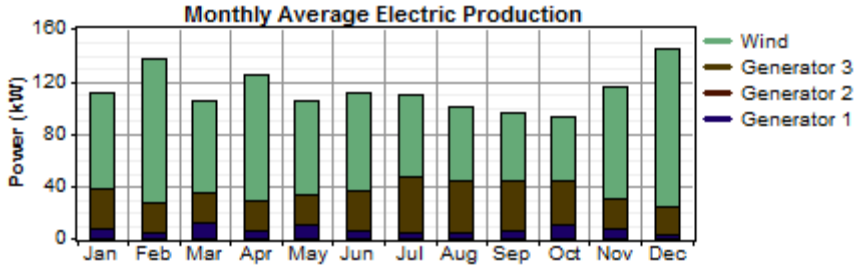
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	108,163	0	9,940	0	0	118,103
Generator 3	0	1,385	18,708	116,854	-497	136,449
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,684	27,990	-963	31,711
Boiler	0	0	0	6,636	0	6,636
Other	0	0	135,000	0	0	135,000
System	108,163	1,385	168,332	151,480	-2,565	426,794



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	670,705	68%
Generator 3	255,873	26%
Generator 2	0	0%
Generator 1	60,887	6%
Total	987,464	100%



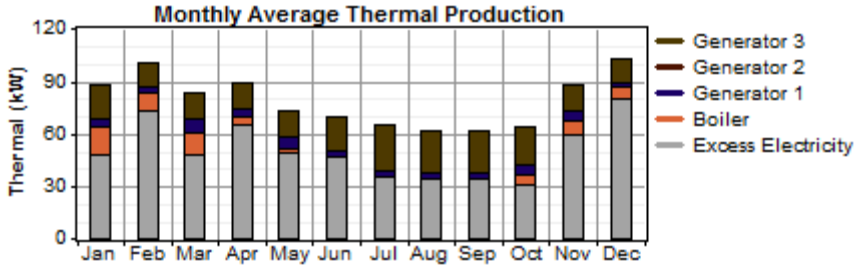
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	439,966	kWh/yr
Unmet load	0.000488	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.542	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	161,778	23%
Generator 1	40,605	6%
Boiler	47,851	7%
Excess electricity	439,966	64%
Total	690,200	100%



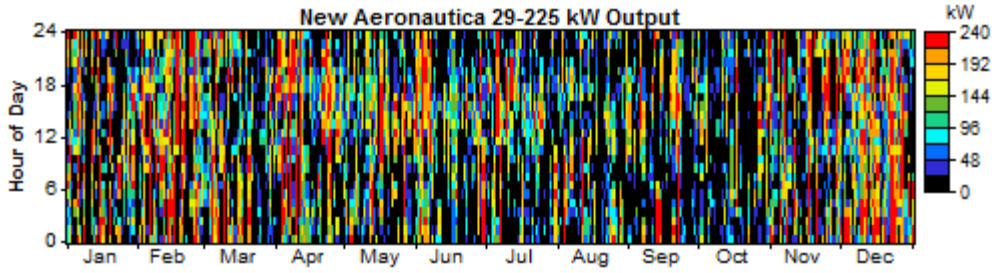
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	306,950	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	76.6	kW
Capacity factor	34.0	%
Total production	670,705	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	123	%
Hours of operation	6,868	hr/yr
Levelized cost	0.176	$/kWh

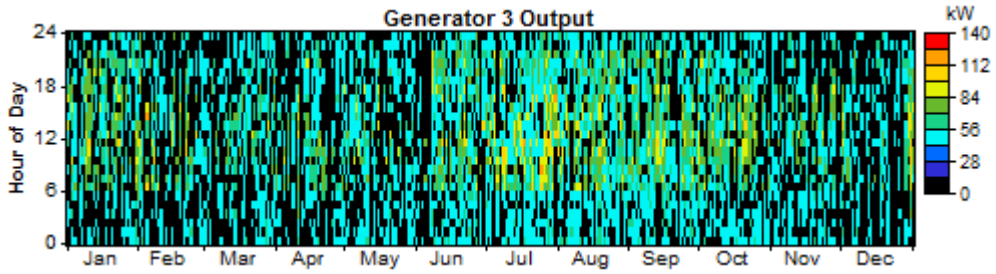


Generator 3

Quantity	Value	Units
Hours of operation	4,677	hr/yr
Number of starts	1,300	starts/yr
Operational life	12.8	yr
Capacity factor	20.1	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	255,873	kWh/yr
Mean electrical output	54.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	161,778	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	100,736	L/yr
Specific fuel consumption	0.394	L/kWh
Fuel energy input	991,244	kWh/yr
Mean electrical efficiency	25.8	%
Mean total efficiency	42.1	%



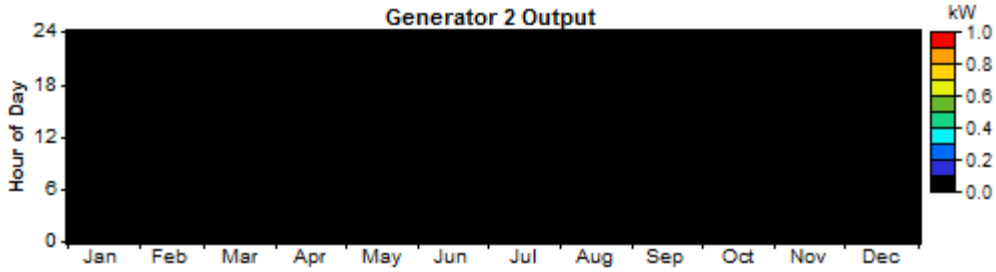
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



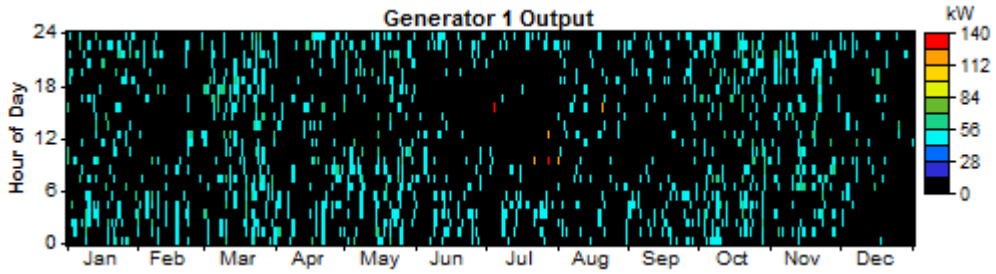
Generator 1

Quantity	Value	Units
Hours of operation	1,171	hr/yr
Number of starts	798	starts/yr
Operational life	51.2	yr
Capacity factor	4.34	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	60,887	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	40,605	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	24,129	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	237,430	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	343,948
Carbon monoxide	812
Unburned hydocarbons	89.9
Particulate matter	61.2
Sulfur dioxide	691
Nitrogen oxides	7,242

Knight Piésold CONSULTING

Site 2
Diesel @ $5.60/gallon-$1.48/liter

System Report - CLG_Vestas_Aeronautica.hmr

Sensitivity case

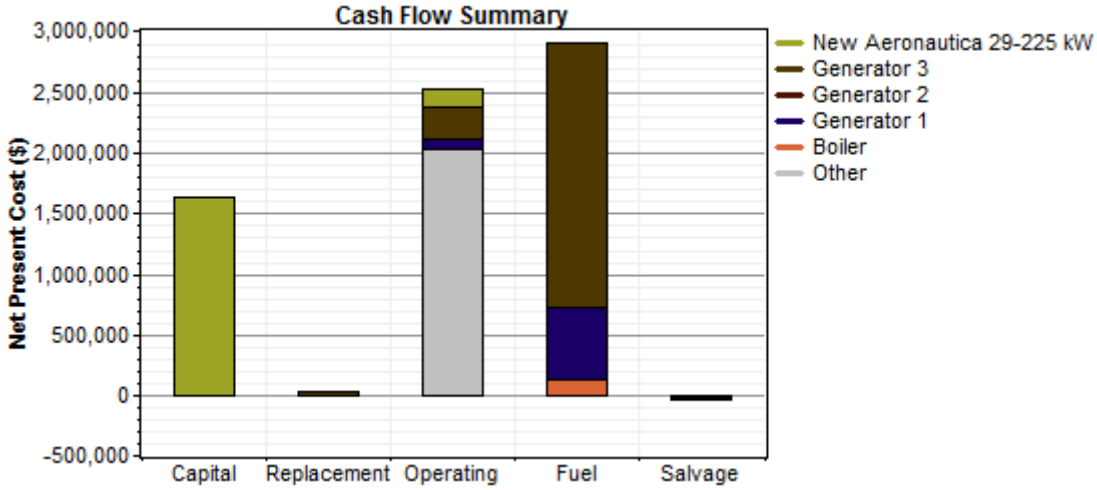
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.27 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,035,862
Levelized cost of energy	$ 0.732/kWh
Operating cost	$ 360,396/yr



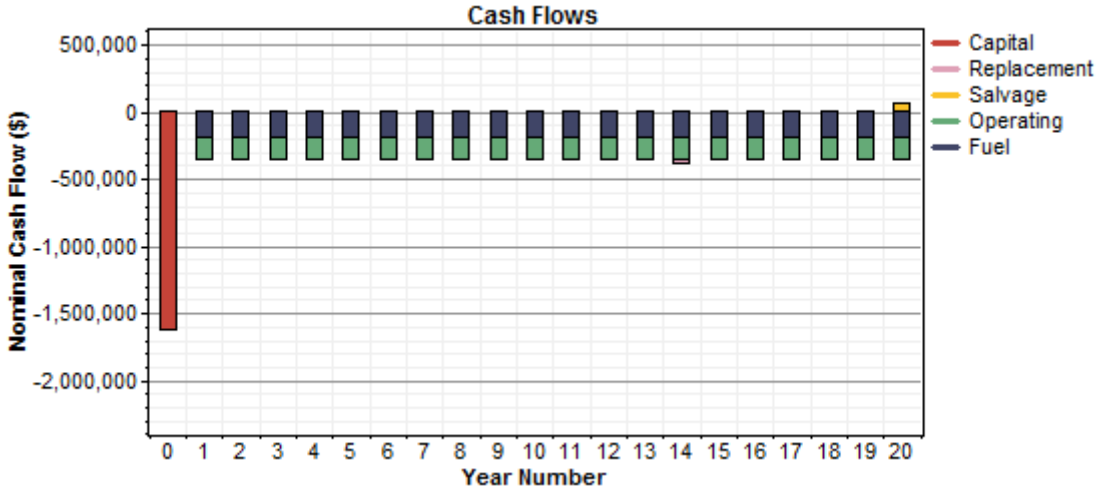
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,624,164	0	149,259	0	0	1,773,423
Generator 3	0	20,593	273,831	2,181,913	-8,135	2,468,203
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	77,422	593,228	-13,523	657,128
Boiler	0	0	0	126,550	0	126,550
Other	0	0	2,027,154	0	0	2,027,154
System	1,624,164	20,593	2,527,666	2,901,691	-38,255	7,035,860

Annualized Costs

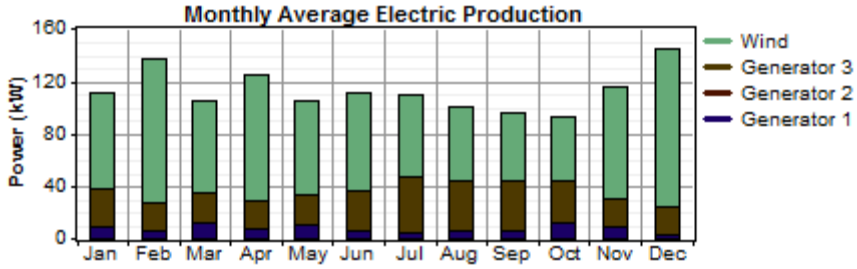
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	108,163	0	9,940	0	0	118,103
Generator 3	0	1,371	18,236	145,306	-542	164,372
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,156	39,507	-901	43,762
Boiler	0	0	0	8,428	0	8,428
Other	0	0	135,000	0	0	135,000
System	108,163	1,371	168,332	193,240	-2,548	468,559



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	670,705	68%
Generator 3	249,359	25%
Generator 2	0	0%
Generator 1	67,476	7%
Total	987,539	100%



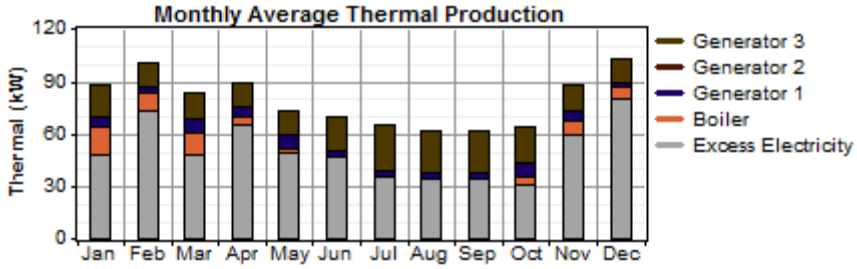
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	440,041	kWh/yr
Unmet load	0.000484	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.542	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	157,677	23%
Generator 1	44,893	7%
Boiler	47,628	7%
Excess electricity	440,041	64%
Total	690,239	100%



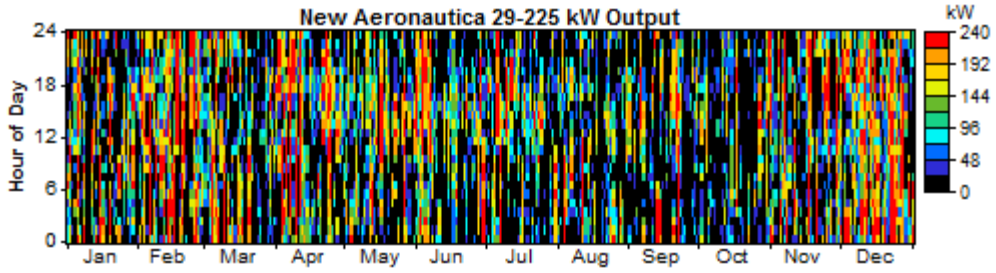
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	306,990	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	76.6	kW
Capacity factor	34.0	%
Total production	670,705	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	123	%
Hours of operation	6,868	hr/yr
Levelized cost	0.176	$/kWh

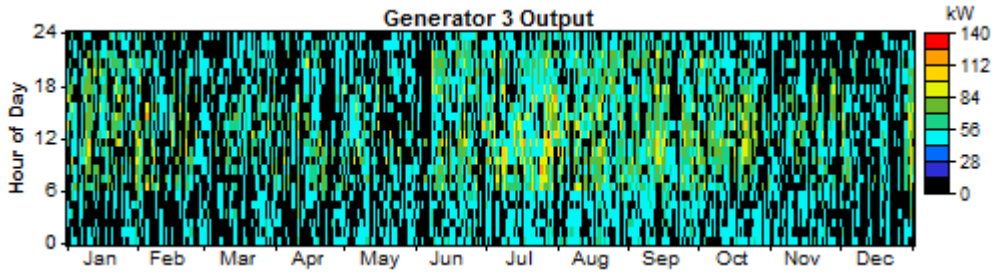


Generator 3

Quantity	Value	Units
Hours of operation	4,559	hr/yr
Number of starts	1,346	starts/yr
Operational life	13.2	yr
Capacity factor	19.6	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	249,359	kWh/yr
Mean electrical output	54.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	157,677	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	98,180	L/yr
Specific fuel consumption	0.394	L/kWh
Fuel energy input	966,091	kWh/yr
Mean electrical efficiency	25.8	%
Mean total efficiency	42.1	%



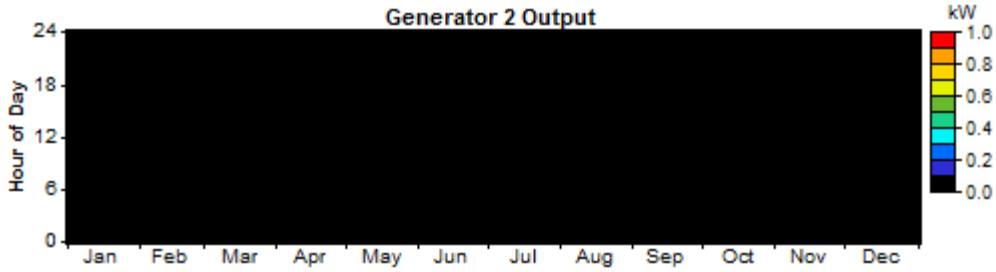
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



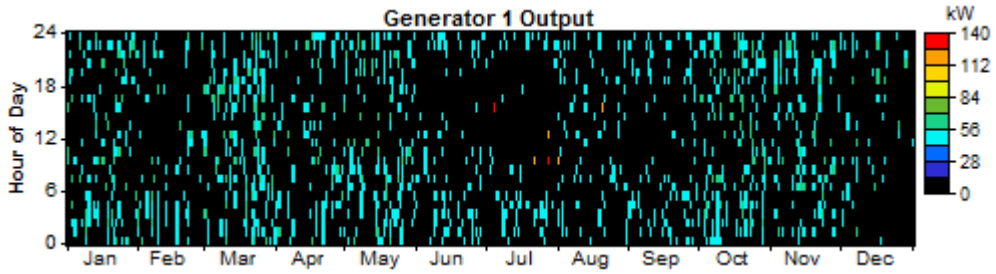
Generator 1

Quantity	Value	Units
Hours of operation	1,289	hr/yr
Number of starts	855	starts/yr
Operational life	46.5	yr
Capacity factor	4.81	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	67,476	kWh/yr
Mean electrical output	52.3	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	44,893	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	26,694	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	262,665	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	343,900
Carbon monoxide	812
Unburned hydocarbons	89.9
Particulate matter	61.2
Sulfur dioxide	691
Nitrogen oxides	7,243

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Site 2
Diesel @ $6.36/gallon-$1.68/liter

System Report - CLG_Vestas_Aeronautica.hmr

Sensitivity case

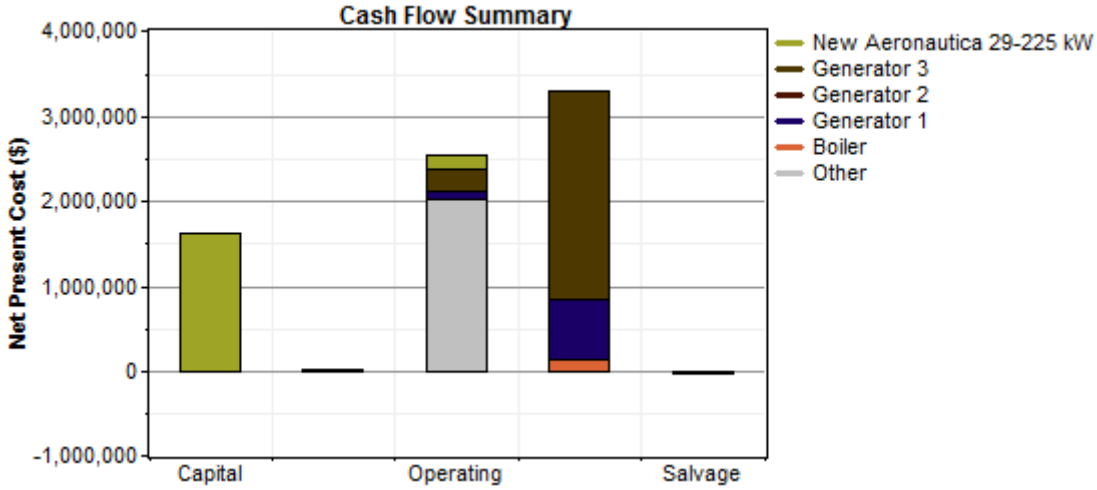
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.27 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,427,833
Levelized cost of energy	$ 0.763/kWh
Operating cost	$ 386,500/yr



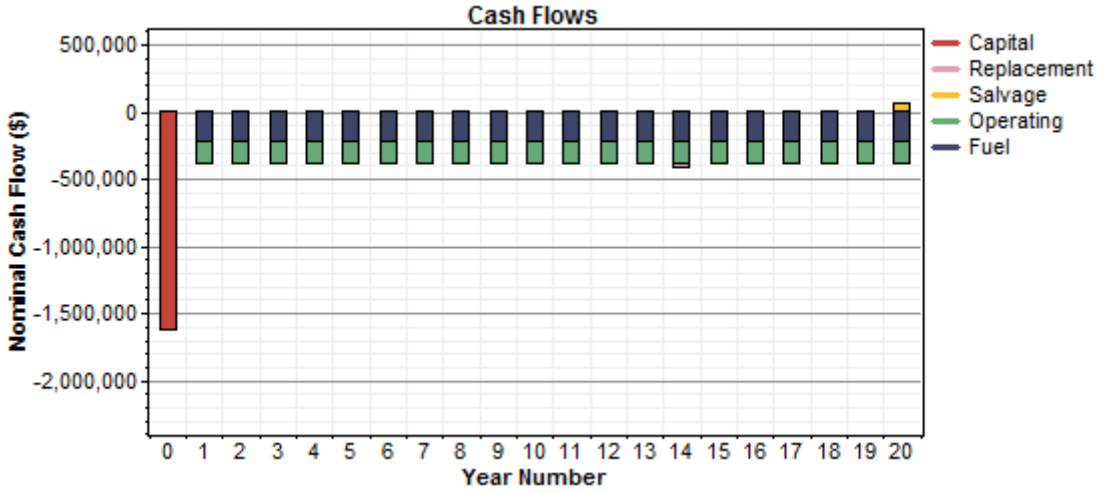
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,624,164	0	149,259	0	0	1,773,423
Generator 3	0	20,497	270,467	2,446,535	-8,451	2,729,048
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	80,786	703,836	-13,080	771,541
Boiler	0	0	0	143,261	0	143,261
Other	0	0	2,027,154	0	0	2,027,154
System	1,624,164	20,497	2,527,666	3,293,631	-38,129	7,427,830

Annualized Costs

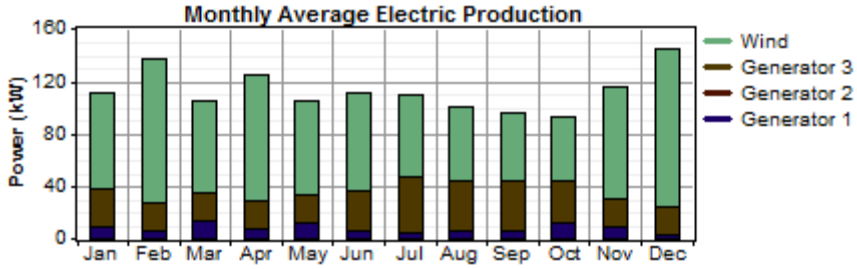
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	108,163	0	9,940	0	0	118,103
Generator 3	0	1,365	18,012	162,929	-563	181,743
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,380	46,872	-871	51,381
Boiler	0	0	0	9,541	0	9,541
Other	0	0	135,000	0	0	135,000
System	108,163	1,365	168,332	219,342	-2,539	494,662



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	670,705	68%
Generator 3	246,326	25%
Generator 2	0	0%
Generator 1	70,568	7%
Total	987,599	100%



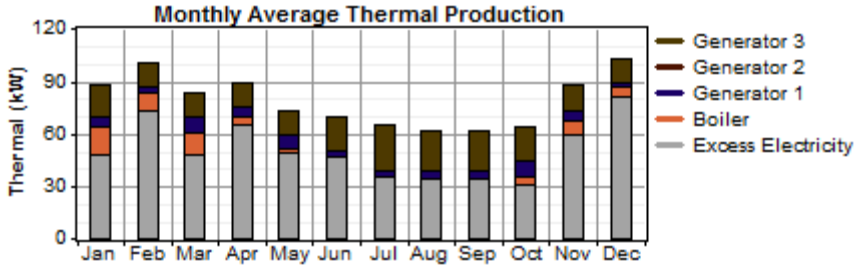
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	440,100	kWh/yr
Unmet load	0.000477	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.542	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	155,750	23%
Generator 1	46,913	7%
Boiler	47,499	7%
Excess electricity	440,100	64%
Total	690,262	100%



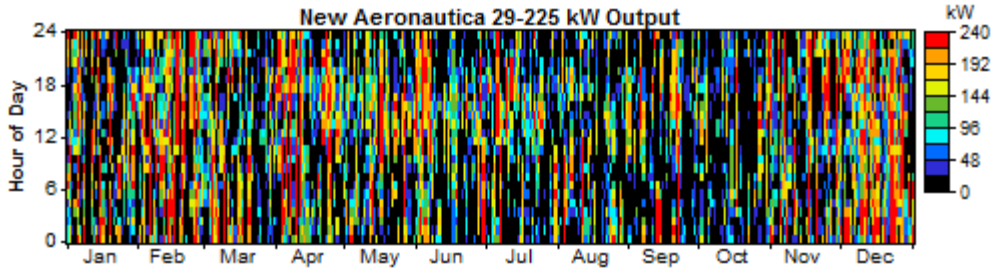
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	307,012	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	76.6	kW
Capacity factor	34.0	%
Total production	670,705	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	123	%
Hours of operation	6,868	hr/yr
Levelized cost	0.176	$/kWh

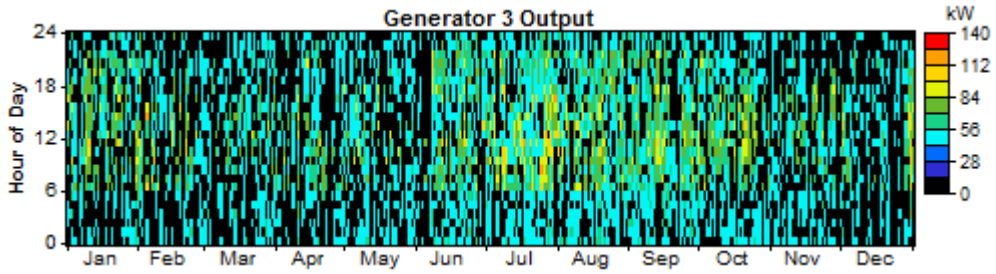


Generator 3

Quantity	Value	Units
Hours of operation	4,503	hr/yr
Number of starts	1,358	starts/yr
Operational life	13.3	yr
Capacity factor	19.4	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	246,326	kWh/yr
Mean electrical output	54.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	155,750	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	96,982	L/yr
Specific fuel consumption	0.394	L/kWh
Fuel energy input	954,299	kWh/yr
Mean electrical efficiency	25.8	%
Mean total efficiency	42.1	%



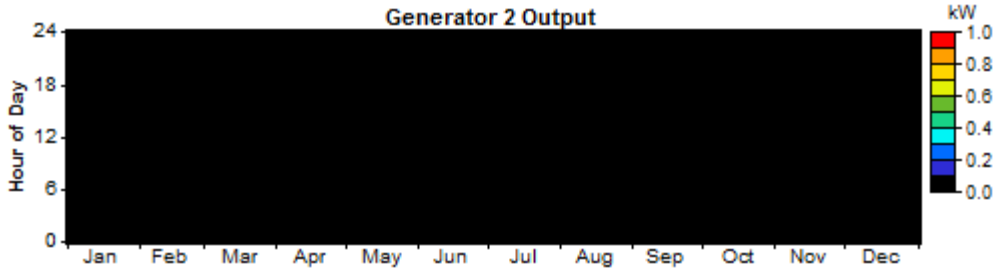
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



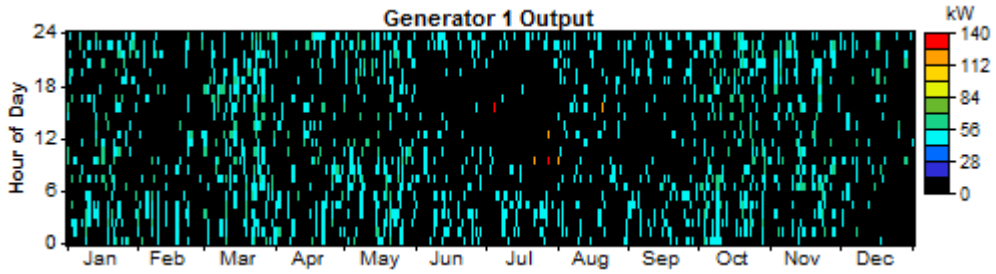
Generator 1

Quantity	Value	Units
Hours of operation	1,345	hr/yr
Number of starts	874	starts/yr
Operational life	44.6	yr
Capacity factor	5.03	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	70,568	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	46,913	kWh/yr
Mean thermal output	34.9	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	27,900	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	274,539	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	343,881
Carbon monoxide	812
Unburned hydocarbons	89.9
Particulate matter	61.2
Sulfur dioxide	691
Nitrogen oxides	7,243

Knight Piésold CONSULTING

Site 2
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

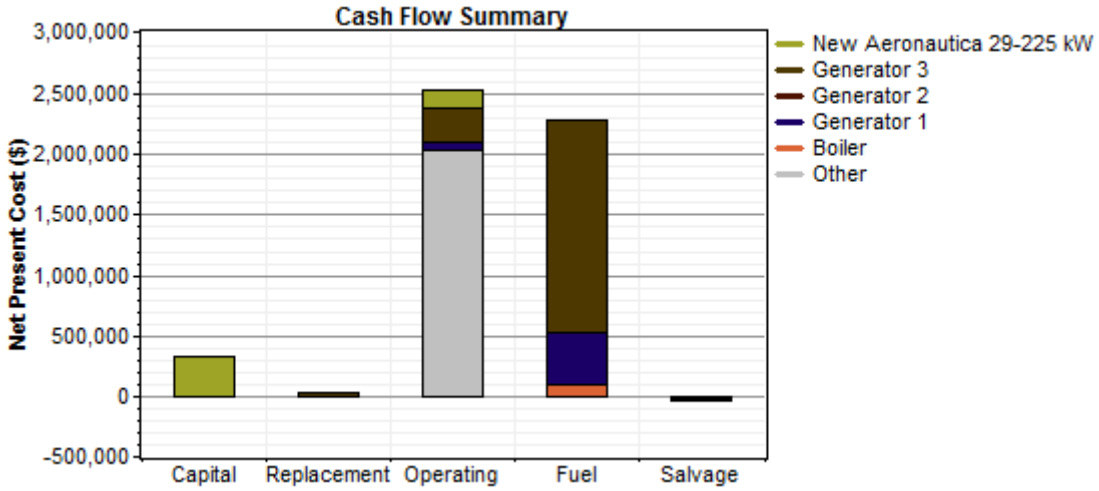
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.27 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,109,387
Levelized cost of energy	$ 0.524/kWh
Operating cost	$ 318,631/yr



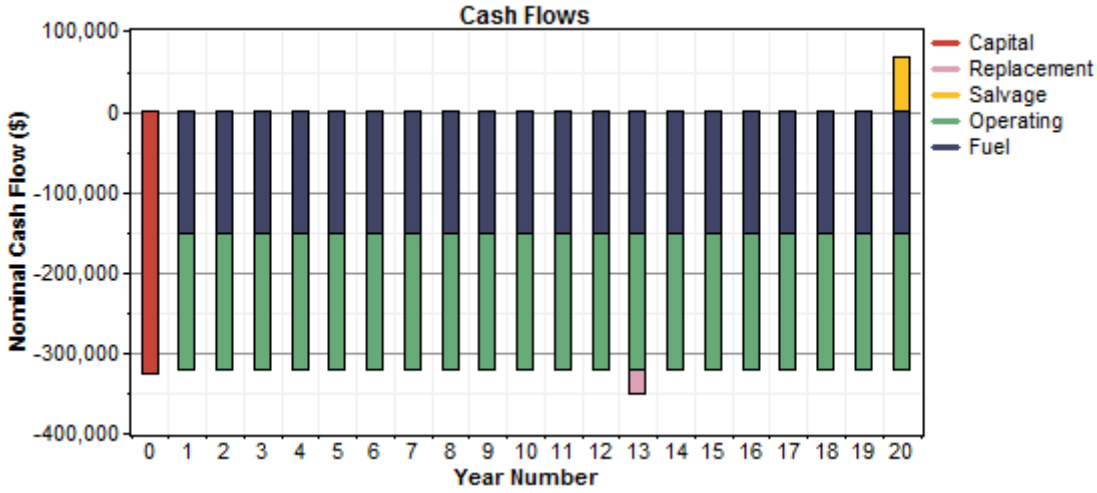
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	324,833	0	149,259	0	0	474,092
Generator 3	0	20,790	280,919	1,754,673	-7,469	2,048,912
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	70,335	420,293	-14,456	476,172
Boiler	0	0	0	99,653	0	99,653
Other	0	0	2,027,154	0	0	2,027,154
System	324,833	20,790	2,527,666	2,274,618	-38,522	5,109,385

Annualized Costs

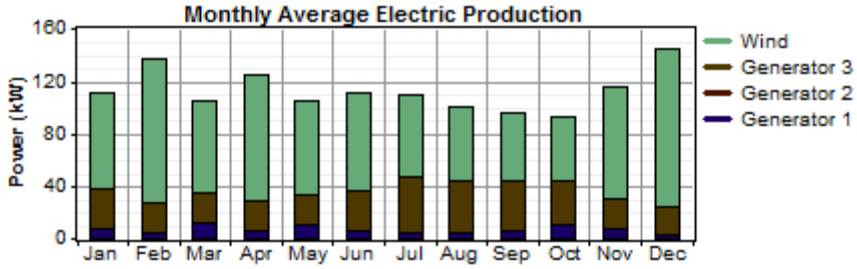
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	21,633	0	9,940	0	0	31,573
Generator 3	0	1,385	18,708	116,854	-497	136,449
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,684	27,990	-963	31,711
Boiler	0	0	0	6,636	0	6,636
Other	0	0	135,000	0	0	135,000
System	21,633	1,385	168,332	151,480	-2,565	340,264



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	670,705	68%
Generator 3	255,873	26%
Generator 2	0	0%
Generator 1	60,887	6%
Total	987,464	100%



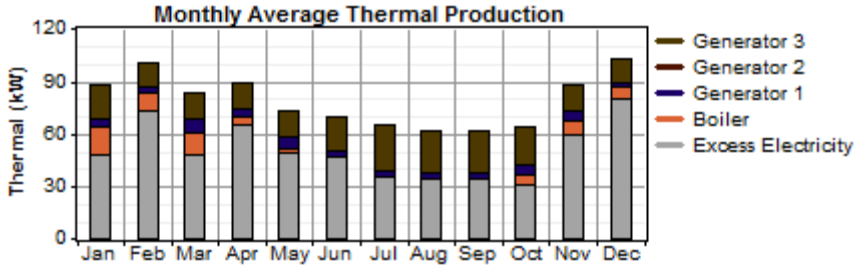
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	439,966	kWh/yr
Unmet load	0.000488	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.542	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	161,778	23%
Generator 1	40,605	6%
Boiler	47,851	7%
Excess electricity	439,966	64%
Total	690,200	100%



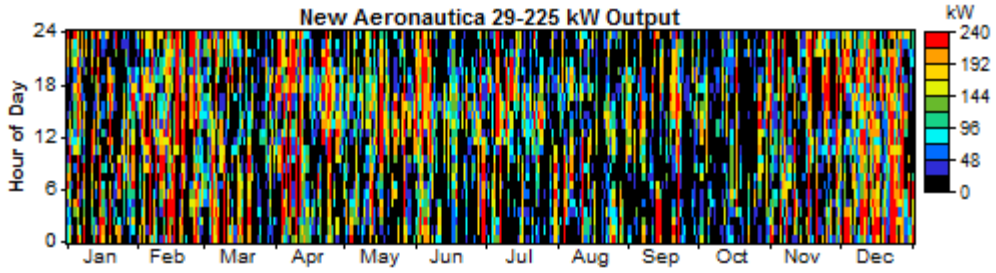
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	306,950	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	76.6	kW
Capacity factor	34.0	%
Total production	670,705	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	123	%
Hours of operation	6,868	hr/yr
Levelized cost	0.0471	$/kWh

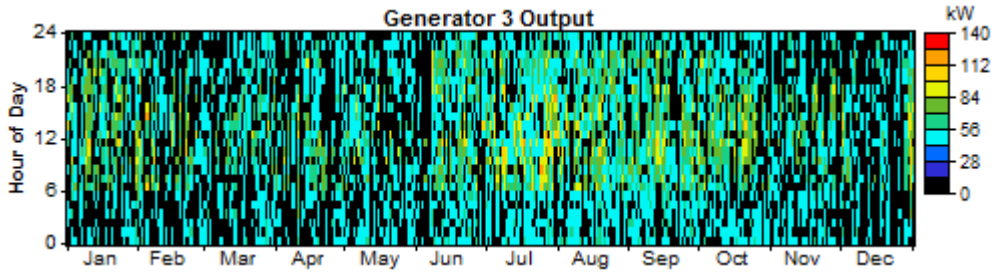


Generator 3

Quantity	Value	Units
Hours of operation	4,677	hr/yr
Number of starts	1,300	starts/yr
Operational life	12.8	yr
Capacity factor	20.1	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	255,873	kWh/yr
Mean electrical output	54.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	161,778	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	100,736	L/yr
Specific fuel consumption	0.394	L/kWh
Fuel energy input	991,244	kWh/yr
Mean electrical efficiency	25.8	%
Mean total efficiency	42.1	%



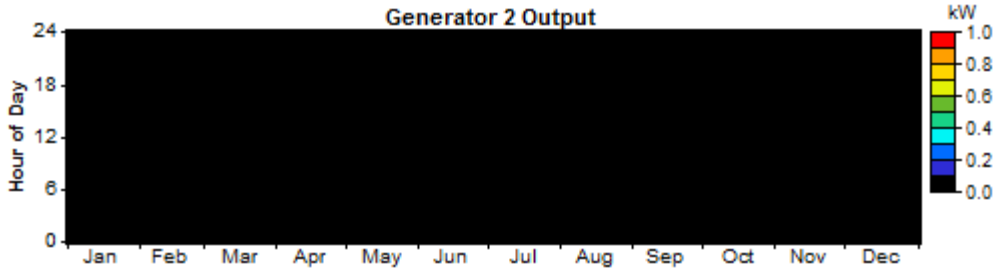
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



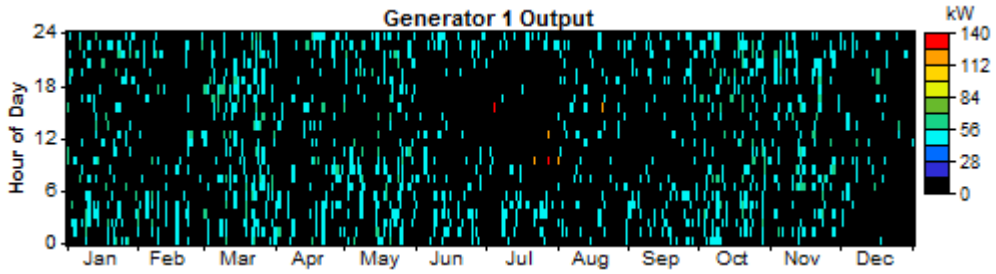
Generator 1

Quantity	Value	Units
Hours of operation	1,171	hr/yr
Number of starts	798	starts/yr
Operational life	51.2	yr
Capacity factor	4.34	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	60,887	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	40,605	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	24,129	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	237,430	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	343,948
Carbon monoxide	812
Unburned hydocarbons	89.9
Particulate matter	61.2
Sulfur dioxide	691
Nitrogen oxides	7,242

Knight Piésold CONSULTING

Site 2
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

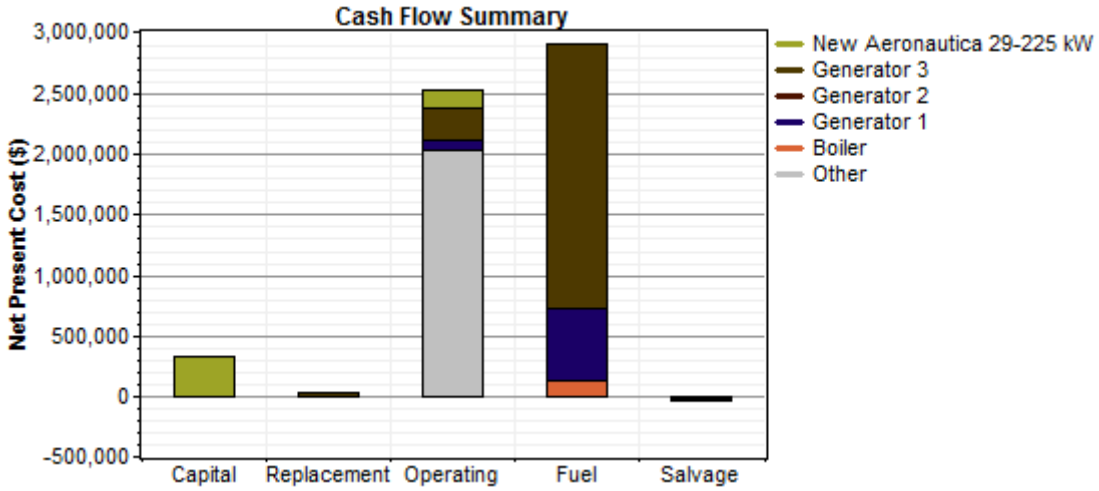
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.27 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,736,530
Levelized cost of energy	$ 0.574/kWh
Operating cost	$ 360,396/yr



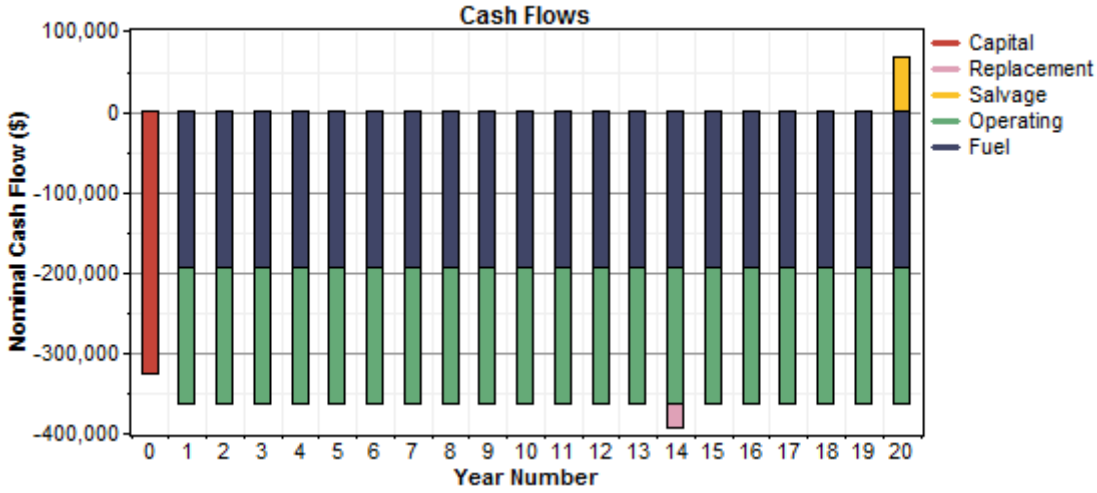
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	324,833	0	149,259	0	0	474,092
Generator 3	0	20,593	273,831	2,181,913	-8,135	2,468,203
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	77,422	593,228	-13,523	657,128
Boiler	0	0	0	126,550	0	126,550
Other	0	0	2,027,154	0	0	2,027,154
System	324,833	20,593	2,527,666	2,901,691	-38,255	5,736,528

Annualized Costs

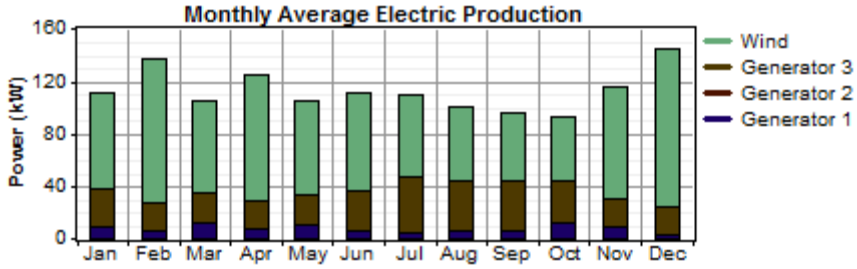
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	21,633	0	9,940	0	0	31,573
Generator 3	0	1,371	18,236	145,306	-542	164,372
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,156	39,507	-901	43,762
Boiler	0	0	0	8,428	0	8,428
Other	0	0	135,000	0	0	135,000
System	21,633	1,371	168,332	193,240	-2,548	382,029



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	670,705	68%
Generator 3	249,359	25%
Generator 2	0	0%
Generator 1	67,476	7%
Total	987,539	100%



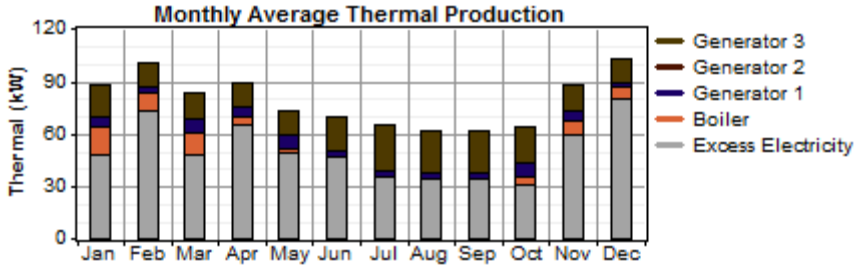
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	440,041	kWh/yr
Unmet load	0.000484	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.542	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	157,677	23%
Generator 1	44,893	7%
Boiler	47,628	7%
Excess electricity	440,041	64%
Total	690,239	100%



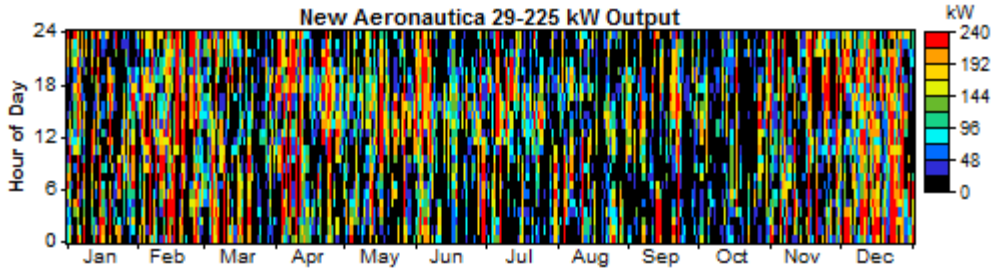
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	306,990	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	76.6	kW
Capacity factor	34.0	%
Total production	670,705	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	123	%
Hours of operation	6,868	hr/yr
Levelized cost	0.0471	$/kWh

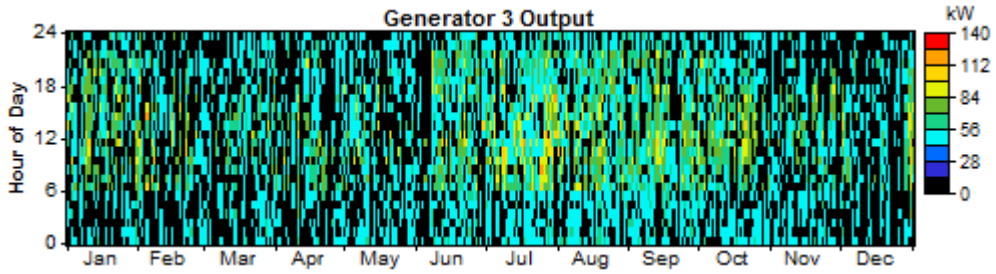


Generator 3

Quantity	Value	Units
Hours of operation	4,559	hr/yr
Number of starts	1,346	starts/yr
Operational life	13.2	yr
Capacity factor	19.6	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	249,359	kWh/yr
Mean electrical output	54.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	157,677	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	98,180	L/yr
Specific fuel consumption	0.394	L/kWh
Fuel energy input	966,091	kWh/yr
Mean electrical efficiency	25.8	%
Mean total efficiency	42.1	%



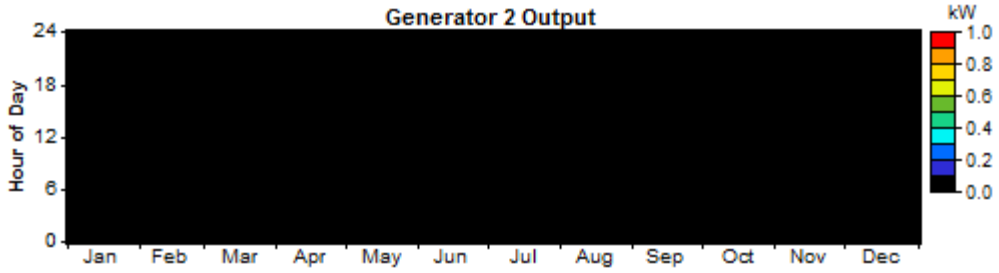
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



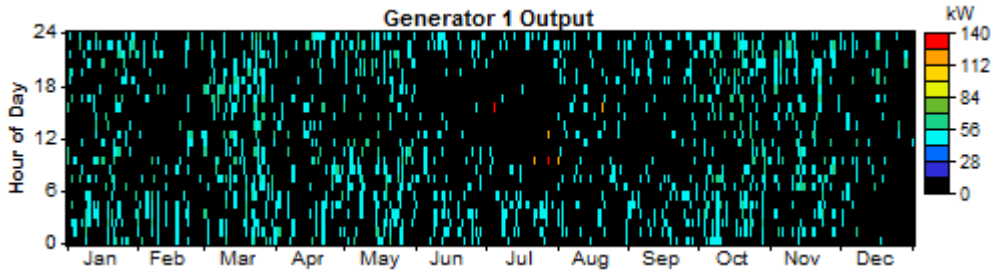
Generator 1

Quantity	Value	Units
Hours of operation	1,289	hr/yr
Number of starts	855	starts/yr
Operational life	46.5	yr
Capacity factor	4.81	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	67,476	kWh/yr
Mean electrical output	52.3	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	44,893	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	26,694	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	262,665	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	343,900
Carbon monoxide	812
Unburned hydocarbons	89.9
Particulate matter	61.2
Sulfur dioxide	691
Nitrogen oxides	7,243

Knight Piésold CONSULTING

Site 3
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

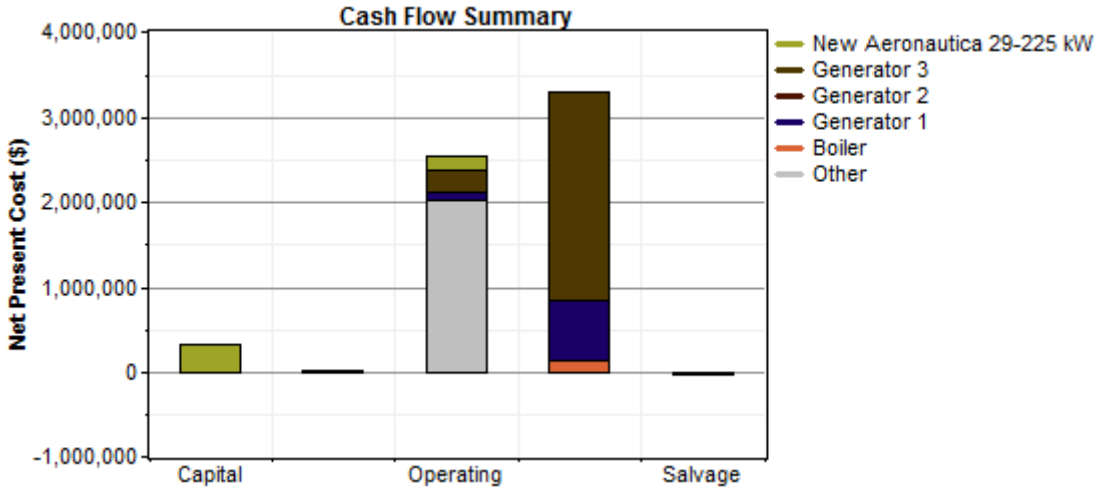
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.27 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,128,501
Levelized cost of energy	$ 0.605/kWh
Operating cost	$ 386,500/yr



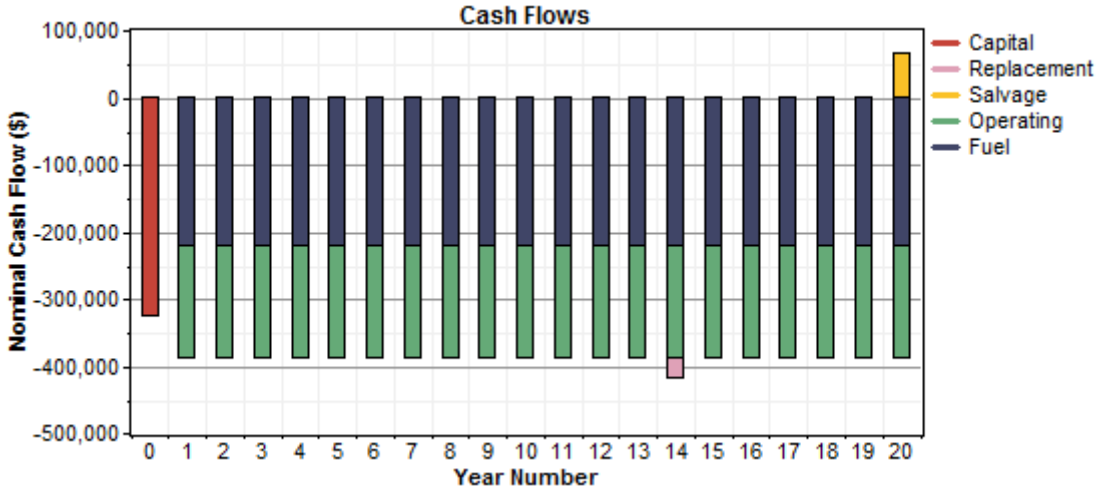
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	324,833	0	149,259	0	0	474,092
Generator 3	0	20,497	270,467	2,446,535	-8,451	2,729,048
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	80,786	703,836	-13,080	771,541
Boiler	0	0	0	143,261	0	143,261
Other	0	0	2,027,154	0	0	2,027,154
System	324,833	20,497	2,527,666	3,293,631	-38,129	6,128,499

Annualized Costs

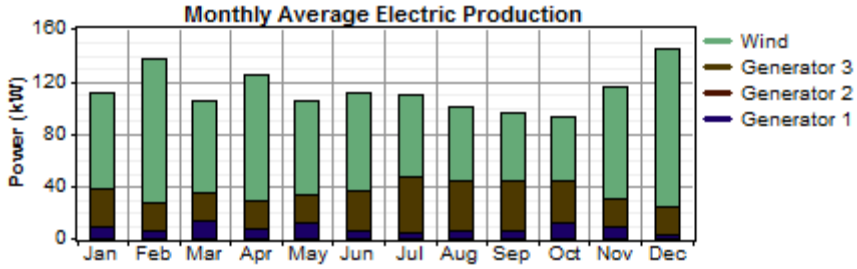
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	21,633	0	9,940	0	0	31,573
Generator 3	0	1,365	18,012	162,929	-563	181,743
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	5,380	46,872	-871	51,381
Boiler	0	0	0	9,541	0	9,541
Other	0	0	135,000	0	0	135,000
System	21,633	1,365	168,332	219,342	-2,539	408,132



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	670,705	68%
Generator 3	246,326	25%
Generator 2	0	0%
Generator 1	70,568	7%
Total	987,599	100%



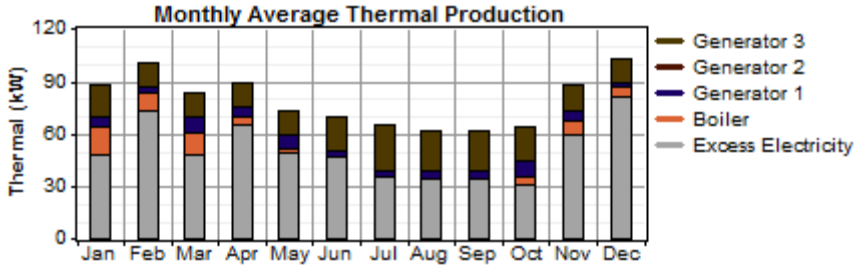
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	440,100	kWh/yr
Unmet load	0.000477	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.542	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	155,750	23%
Generator 1	46,913	7%
Boiler	47,499	7%
Excess electricity	440,100	64%
Total	690,262	100%



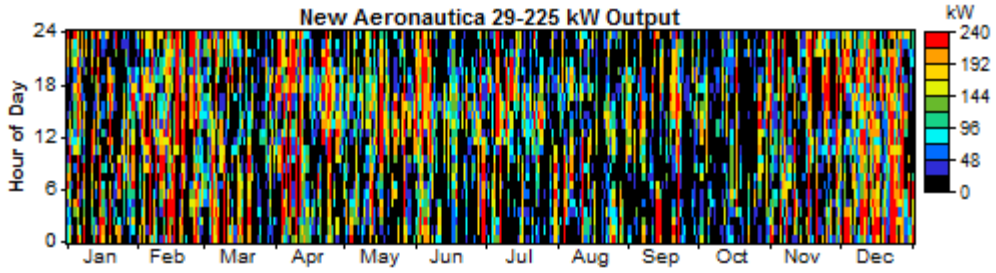
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	307,012	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	76.6	kW
Capacity factor	34.0	%
Total production	670,705	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	123	%
Hours of operation	6,868	hr/yr
Levelized cost	0.0471	$/kWh

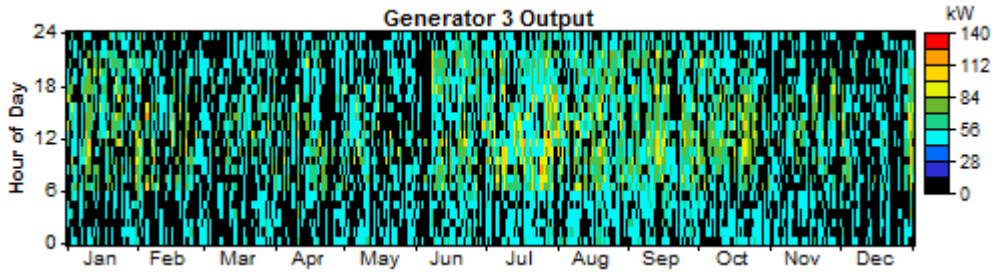


Generator 3

Quantity	Value	Units
Hours of operation	4,503	hr/yr
Number of starts	1,358	starts/yr
Operational life	13.3	yr
Capacity factor	19.4	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	246,326	kWh/yr
Mean electrical output	54.7	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	155,750	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	96,982	L/yr
Specific fuel consumption	0.394	L/kWh
Fuel energy input	954,299	kWh/yr
Mean electrical efficiency	25.8	%
Mean total efficiency	42.1	%



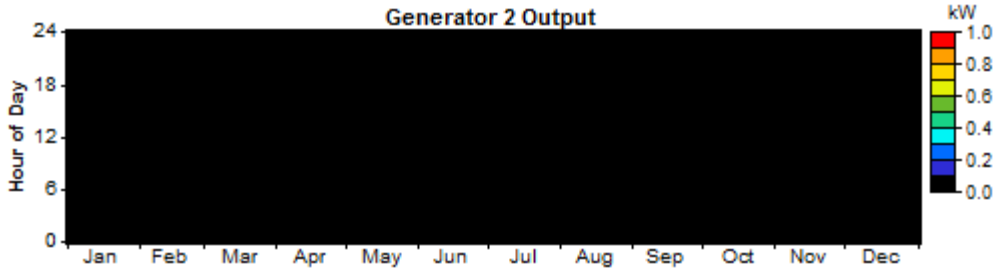
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



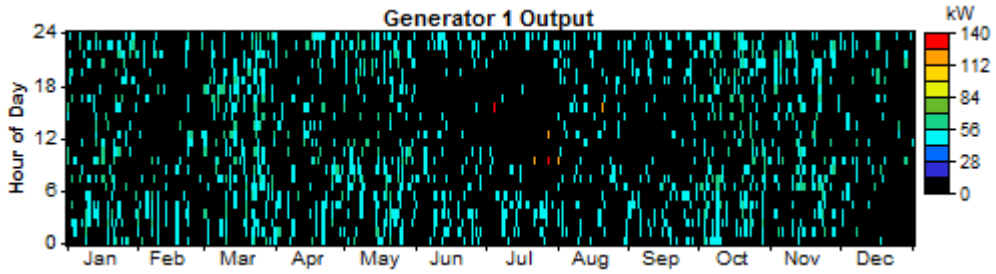
Generator 1

Quantity	Value	Units
Hours of operation	1,345	hr/yr
Number of starts	874	starts/yr
Operational life	44.6	yr
Capacity factor	5.03	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	70,568	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	46,913	kWh/yr
Mean thermal output	34.9	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	27,900	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	274,539	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	343,881
Carbon monoxide	812
Unburned hydocarbons	89.9
Particulate matter	61.2
Sulfur dioxide	691
Nitrogen oxides	7,243

Knight Piésold CONSULTING

Site 3
Diesel @ $4.40/gallon-$1.16/liter

System Report - CLG_Vestas_Aeronautica.hmr

Sensitivity case

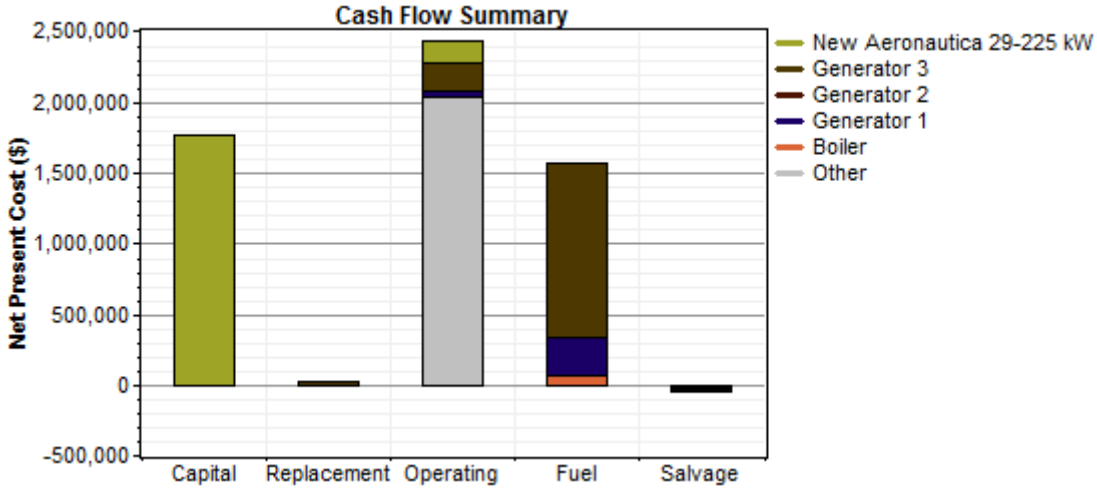
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	11.1 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1.09
New Aeronautica 29-225 kW Capital Cost Multiplier:	1.09

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,730,097
Levelized cost of energy	$ 0.600/kWh
Operating cost	$ 263,703/yr



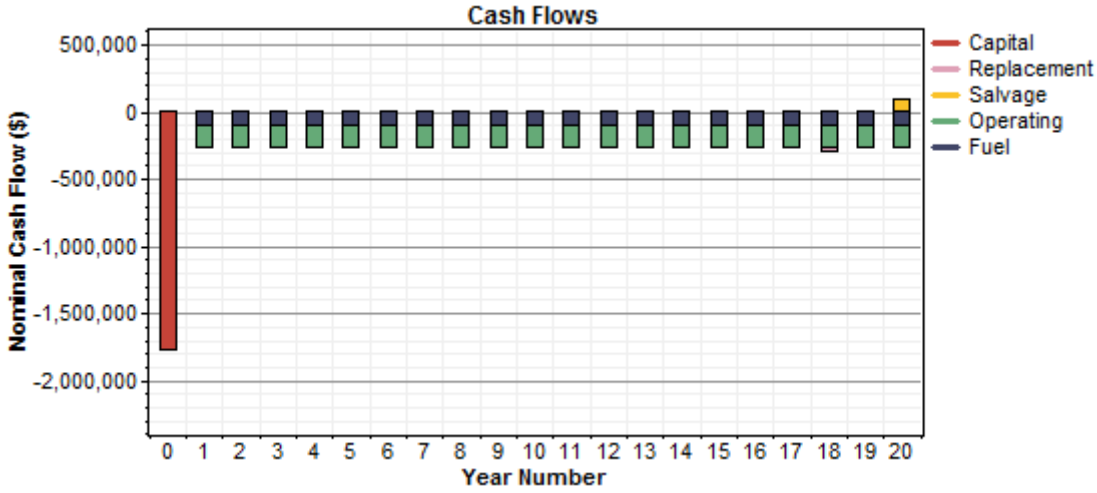
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,770,339	0	149,259	0	0	1,919,598
Generator 3	0	18,020	202,115	1,239,764	-14,876	1,445,022
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	43,967	262,264	-17,925	288,306
Boiler	0	0	0	66,613	0	66,613
Other	0	0	2,027,154	0	0	2,027,154
System	1,770,339	18,020	2,422,494	1,568,640	-49,398	5,730,095

Annualized Costs

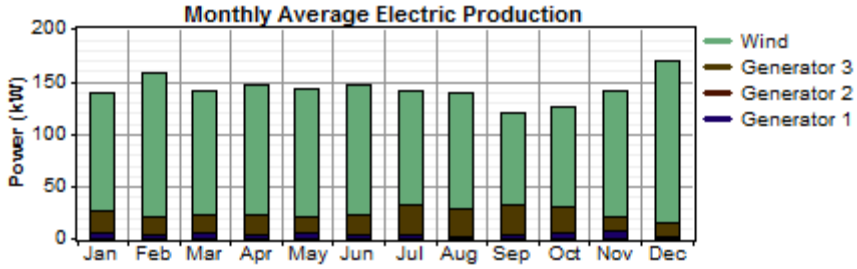
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	117,897	0	9,940	0	0	127,837
Generator 3	0	1,200	13,460	82,563	-991	96,232
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	2,928	17,466	-1,194	19,200
Boiler	0	0	0	4,436	0	4,436
Other	0	0	135,000	0	0	135,000
System	117,897	1,200	161,328	104,465	-3,290	381,600



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,029,962	83%
Generator 3	178,889	14%
Generator 2	0	0%
Generator 1	37,970	3%
Total	1,246,822	100%



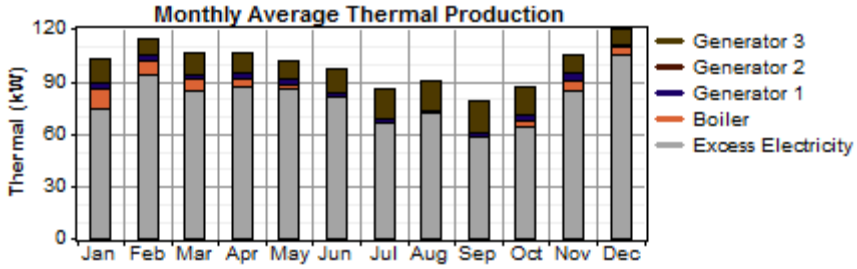
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	699,326	kWh/yr
Unmet load	0.000301	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.726	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	114,722	13%
Generator 1	25,343	3%
Boiler	31,986	4%
Excess electricity	699,326	80%
Total	871,377	100%



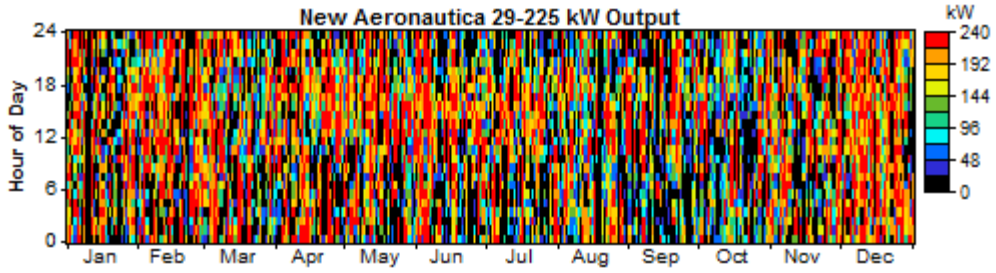
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	488,127	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	118	kW
Capacity factor	52.3	%
Total production	1,029,962	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	188	%
Hours of operation	7,517	hr/yr
Levelized cost	0.124	$/kWh

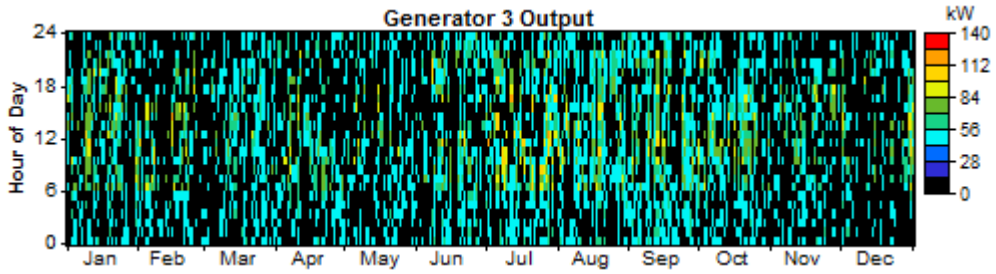


Generator 3

Quantity	Value	Units
Hours of operation	3,365	hr/yr
Number of starts	1,256	starts/yr
Operational life	17.8	yr
Capacity factor	14.1	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	178,889	kWh/yr
Mean electrical output	53.2	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	114,722	kWh/yr
Mean thermal output	34.1	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	71,175	L/yr
Specific fuel consumption	0.398	L/kWh
Fuel energy input	700,363	kWh/yr
Mean electrical efficiency	25.5	%
Mean total efficiency	41.9	%



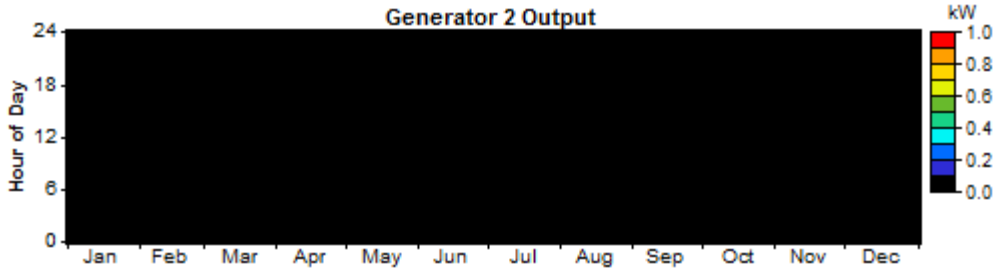
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



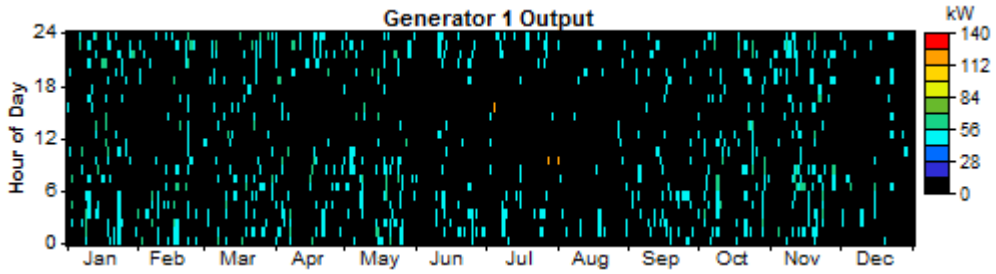
Generator 1

Quantity	Value	Units
Hours of operation	732	hr/yr
Number of starts	528	starts/yr
Operational life	82.0	yr
Capacity factor	2.71	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	37,970	kWh/yr
Mean electrical output	51.9	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	25,343	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	15,057	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	148,157	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	237,195
Carbon monoxide	561
Unburned hydocarbons	62.1
Particulate matter	42.3
Sulfur dioxide	477
Nitrogen oxides	5,001

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Site 3
Diesel @ $5.60/gallon-$1.48/liter

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Sensitivity case

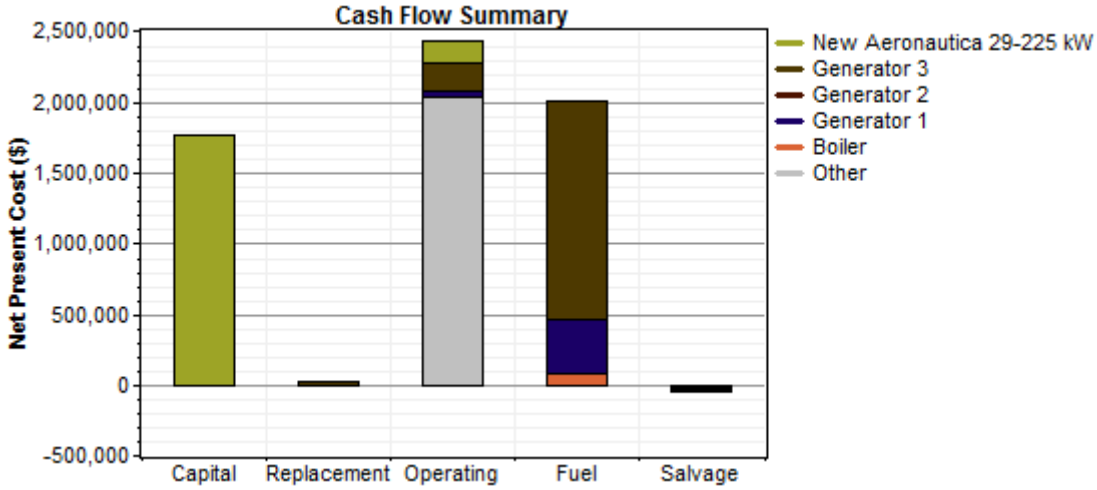
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	11.1 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1.09
New Aeronautica 29-225 kW Capital Cost Multiplier:	1.09

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,162,502
Levelized cost of energy	$ 0.626/kWh
Operating cost	$ 292,500/yr



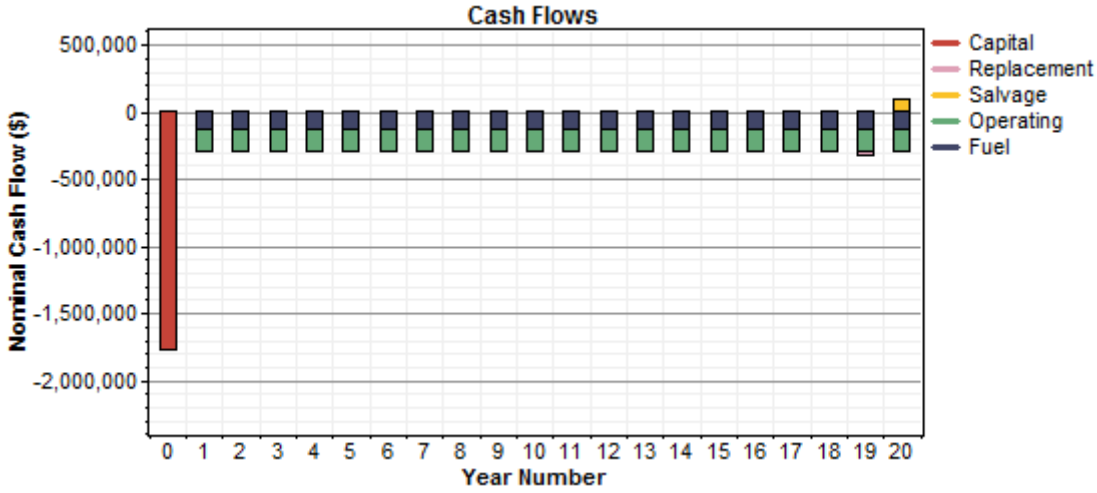
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,770,339	0	149,259	0	0	1,919,598
Generator 3	0	17,795	197,250	1,542,811	-15,333	1,742,523
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	48,832	373,699	-17,285	405,245
Boiler	0	0	0	84,578	0	84,578
Other	0	0	2,027,154	0	0	2,027,154
System	1,770,339	17,795	2,422,494	2,001,088	-49,215	6,162,501

Annualized Costs

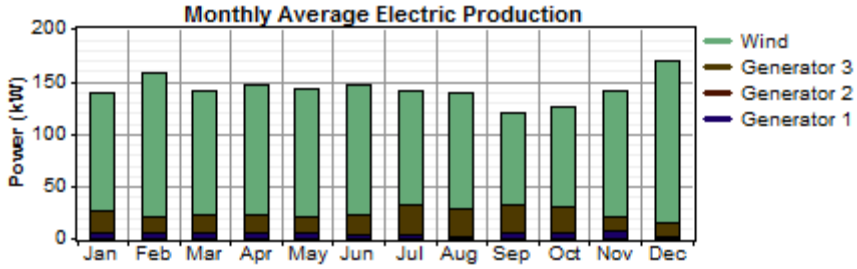
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	117,897	0	9,940	0	0	127,837
Generator 3	0	1,185	13,136	102,745	-1,021	116,045
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,252	24,887	-1,151	26,988
Boiler	0	0	0	5,633	0	5,633
Other	0	0	135,000	0	0	135,000
System	117,897	1,185	161,328	133,264	-3,278	410,397



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,029,962	83%
Generator 3	174,425	14%
Generator 2	0	0%
Generator 1	42,488	3%
Total	1,246,875	100%



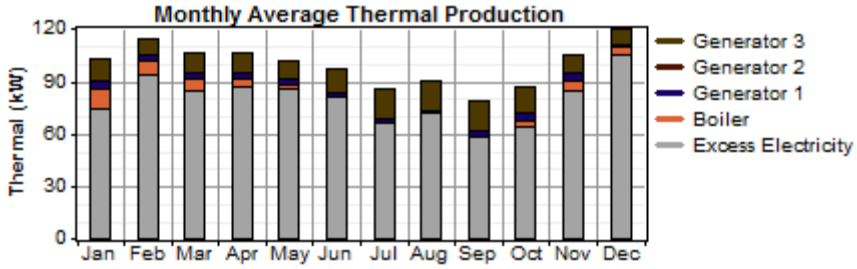
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	699,379	kWh/yr
Unmet load	0.000309	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.726	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	111,909	13%
Generator 1	28,284	3%
Boiler	31,832	4%
Excess electricity	699,379	80%
Total	871,404	100%



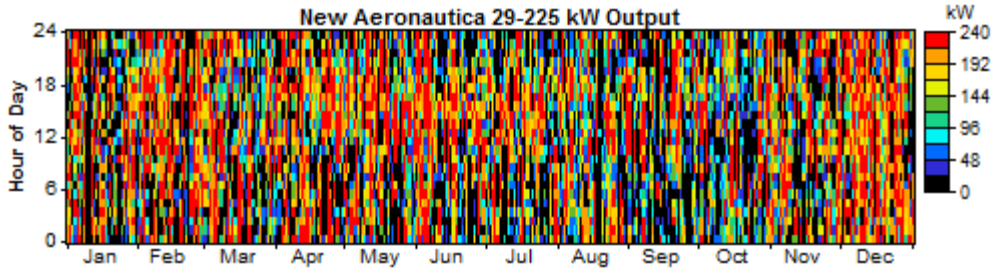
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	488,154	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	118	kW
Capacity factor	52.3	%
Total production	1,029,962	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	188	%
Hours of operation	7,517	hr/yr
Levelized cost	0.124	$/kWh

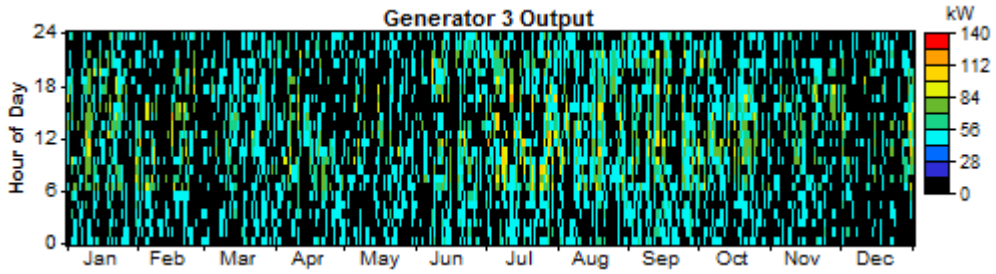


Generator 3

Quantity	Value	Units
Hours of operation	3,284	hr/yr
Number of starts	1,283	starts/yr
Operational life	18.3	yr
Capacity factor	13.7	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	174,425	kWh/yr
Mean electrical output	53.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	111,909	kWh/yr
Mean thermal output	34.1	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	69,422	L/yr
Specific fuel consumption	0.398	L/kWh
Fuel energy input	683,114	kWh/yr
Mean electrical efficiency	25.5	%
Mean total efficiency	41.9	%



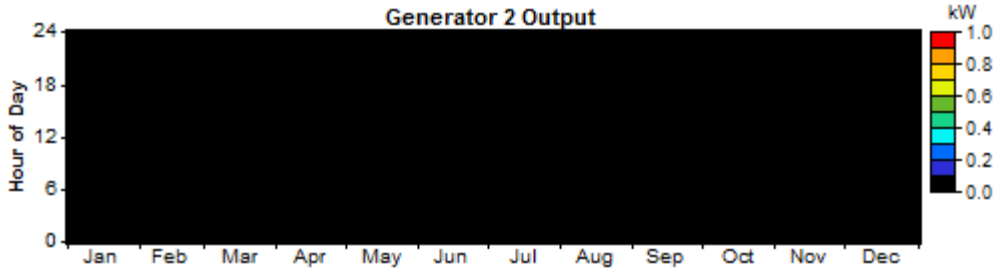
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



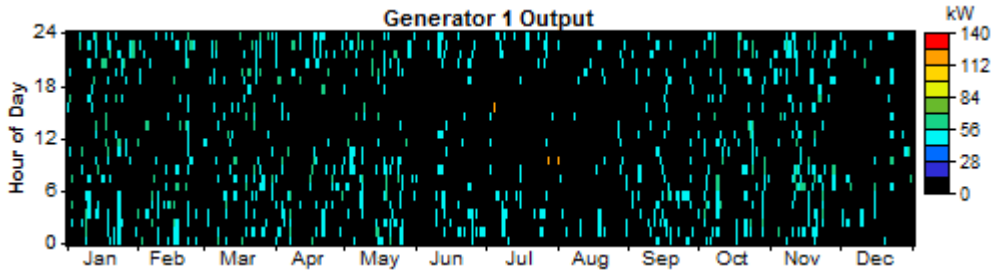
Generator 1

Quantity	Value	Units
Hours of operation	813	hr/yr
Number of starts	584	starts/yr
Operational life	73.8	yr
Capacity factor	3.03	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	42,488	kWh/yr
Mean electrical output	52.3	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	28,284	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	16,815	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	165,463	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	237,161
Carbon monoxide	561
Unburned hydocarbons	62.1
Particulate matter	42.3
Sulfur dioxide	477
Nitrogen oxides	5,002

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Site 3
Diesel @ $6.36/gallon-$1.68/liter

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Sensitivity case

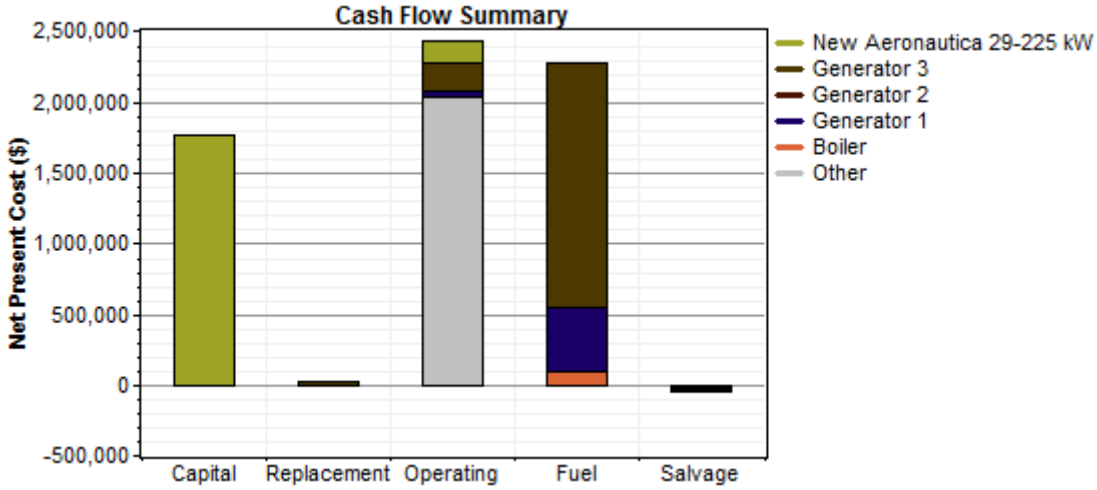
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	11.1 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Vestas V-27 (A-27) Capital Cost Multiplier:	1.09
New Aeronautica 29-225 kW Capital Cost Multiplier:	1.09

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,432,767
Levelized cost of energy	$ 0.642/kWh
Operating cost	$ 310,498/yr



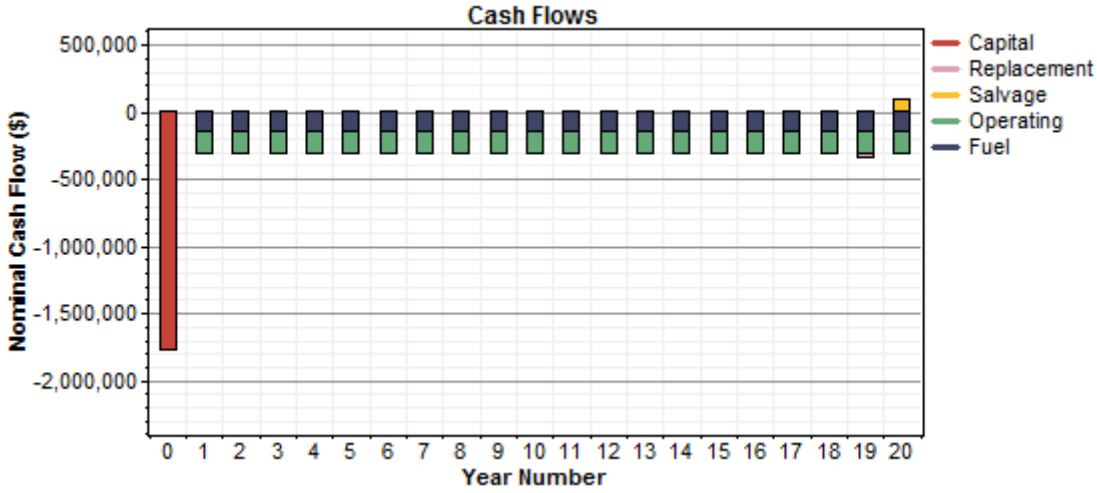
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	1,770,339	0	149,259	0	0	1,919,598
Generator 3	0	17,680	194,847	1,728,945	-15,559	1,925,913
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	51,234	446,618	-16,969	480,884
Boiler	0	0	0	95,815	0	95,815
Other	0	0	2,027,154	0	0	2,027,154
System	1,770,339	17,680	2,422,494	2,271,377	-49,125	6,432,765

Annualized Costs

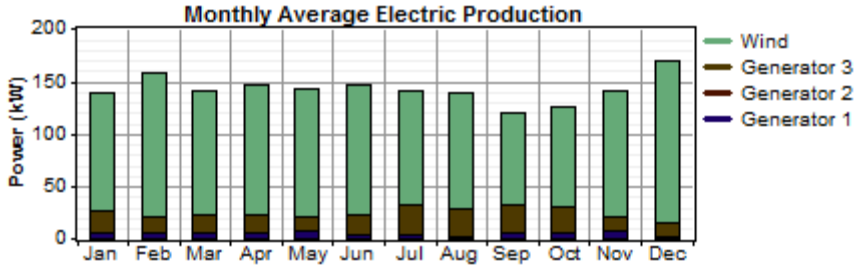
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	117,897	0	9,940	0	0	127,837
Generator 3	0	1,177	12,976	115,140	-1,036	128,258
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,412	29,743	-1,130	32,025
Boiler	0	0	0	6,381	0	6,381
Other	0	0	135,000	0	0	135,000
System	117,897	1,177	161,328	151,264	-3,272	428,395



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,029,962	83%
Generator 3	172,138	14%
Generator 2	0	0%
Generator 1	44,787	4%
Total	1,246,888	100%



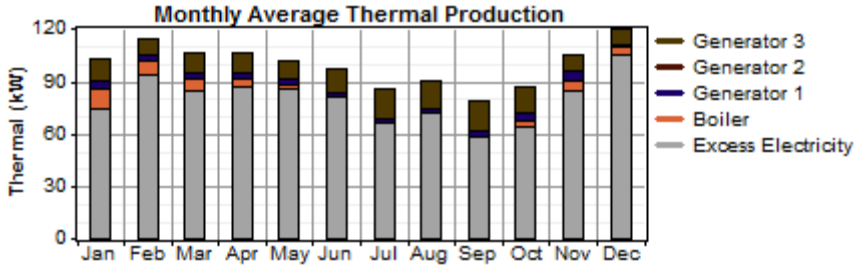
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	699,392	kWh/yr
Unmet load	0.000309	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.726	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	110,494	13%
Generator 1	29,767	3%
Boiler	31,768	4%
Excess electricity	699,392	80%
Total	871,420	100%



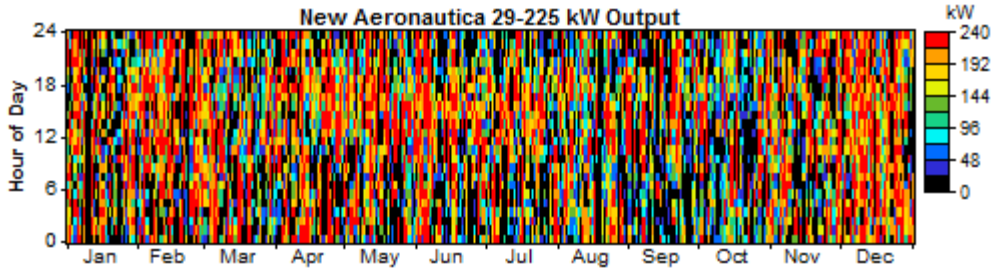
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	488,171	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	118	kW
Capacity factor	52.3	%
Total production	1,029,962	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	188	%
Hours of operation	7,517	hr/yr
Levelized cost	0.124	$/kWh

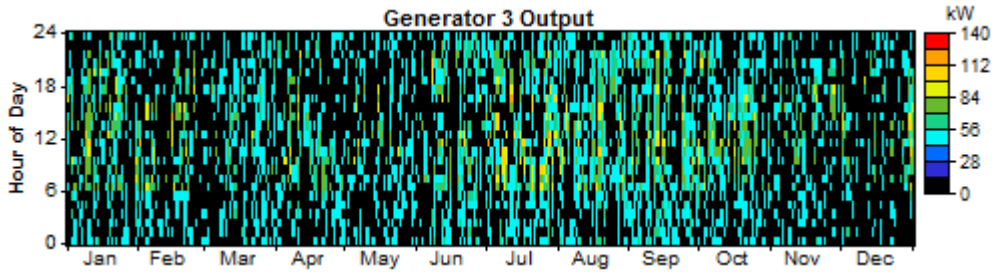


Generator 3

Quantity	Value	Units
Hours of operation	3,244	hr/yr
Number of starts	1,291	starts/yr
Operational life	18.5	yr
Capacity factor	13.6	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	172,138	kWh/yr
Mean electrical output	53.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	110,494	kWh/yr
Mean thermal output	34.1	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	68,536	L/yr
Specific fuel consumption	0.398	L/kWh
Fuel energy input	674,395	kWh/yr
Mean electrical efficiency	25.5	%
Mean total efficiency	41.9	%



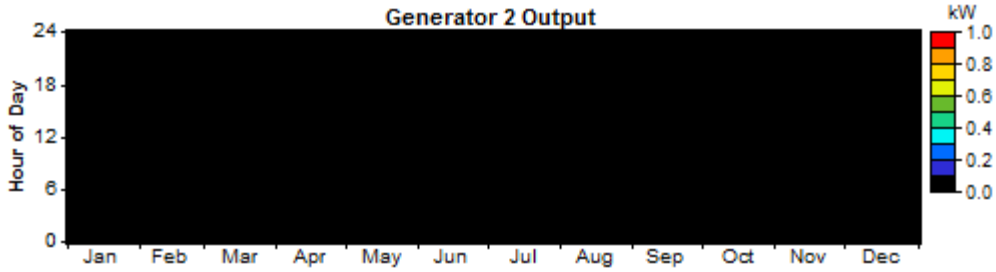
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



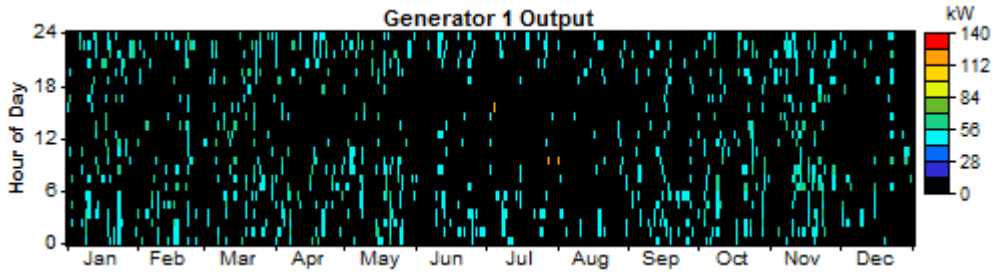
Generator 1

Quantity	Value	Units
Hours of operation	853	hr/yr
Number of starts	605	starts/yr
Operational life	70.3	yr
Capacity factor	3.20	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	44,787	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	29,767	kWh/yr
Mean thermal output	34.9	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	17,704	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	174,208	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	237,148
Carbon monoxide	561
Unburned hydocarbons	62.1
Particulate matter	42.3
Sulfur dioxide	477
Nitrogen oxides	5,002

Knight Piésold CONSULTING

Site 3
Diesel @ $4.40/gallon-$1.16/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

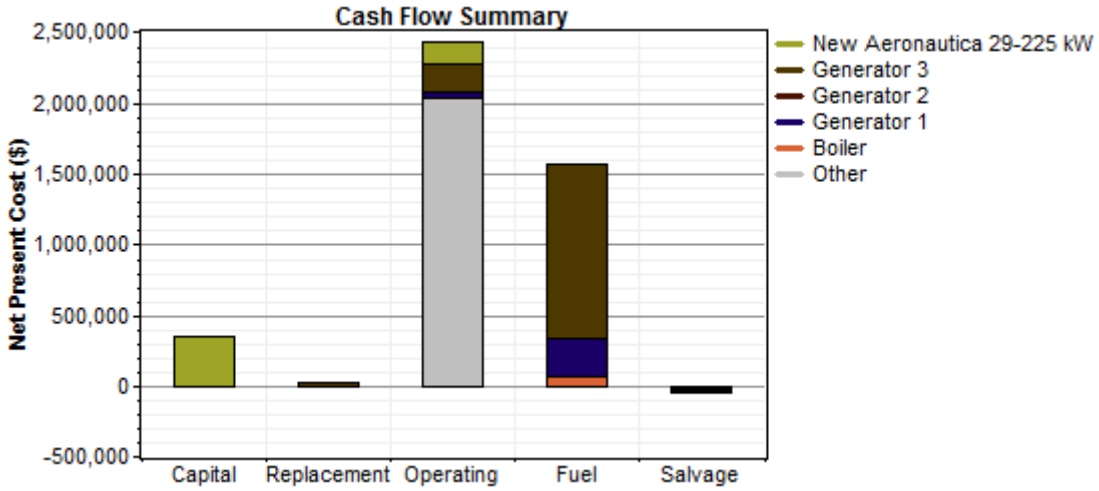
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	11.1 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1.09

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 4,313,826
Levelized cost of energy	$ 0.428/kWh
Operating cost	$ 263,703/yr



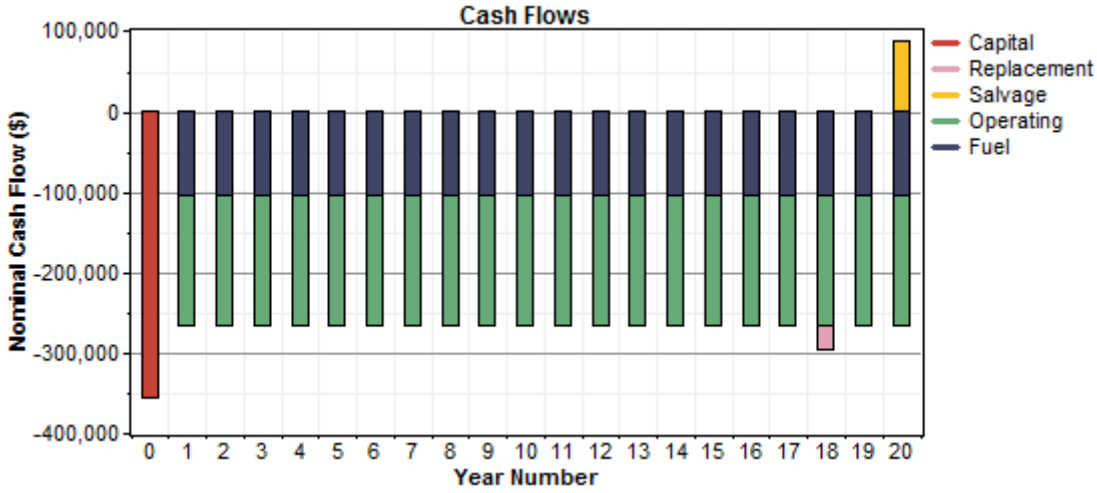
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	354,068	0	149,259	0	0	503,327
Generator 3	0	18,020	202,115	1,239,764	-14,876	1,445,022
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	43,967	262,264	-17,925	288,306
Boiler	0	0	0	66,613	0	66,613
Other	0	0	2,027,154	0	0	2,027,154
System	354,068	18,020	2,422,494	1,568,640	-49,398	4,313,825

Annualized Costs

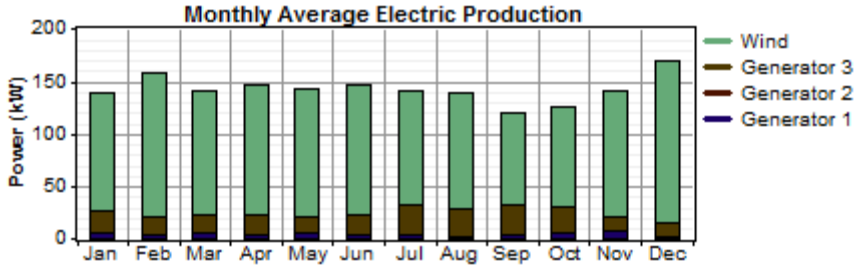
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	23,579	0	9,940	0	0	33,519
Generator 3	0	1,200	13,460	82,563	-991	96,232
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	2,928	17,466	-1,194	19,200
Boiler	0	0	0	4,436	0	4,436
Other	0	0	135,000	0	0	135,000
System	23,579	1,200	161,328	104,465	-3,290	287,283



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,029,962	83%
Generator 3	178,889	14%
Generator 2	0	0%
Generator 1	37,970	3%
Total	1,246,822	100%



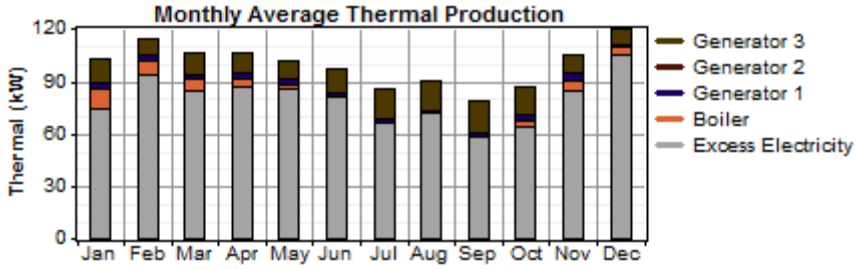
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	699,326	kWh/yr
Unmet load	0.000301	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.726	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	114,722	13%
Generator 1	25,343	3%
Boiler	31,986	4%
Excess electricity	699,326	80%
Total	871,377	100%



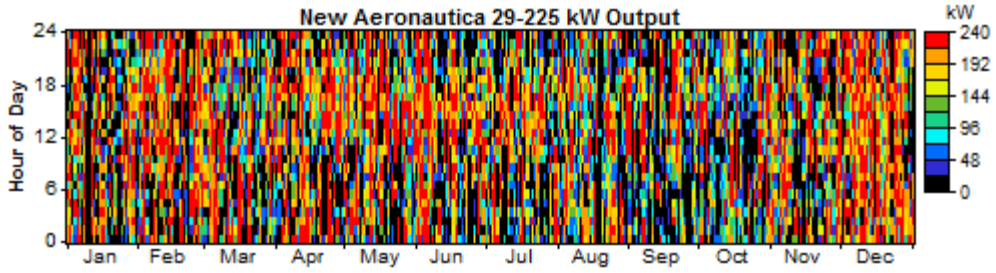
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	488,127	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	118	kW
Capacity factor	52.3	%
Total production	1,029,962	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	188	%
Hours of operation	7,517	hr/yr
Levelized cost	0.0325	$/kWh

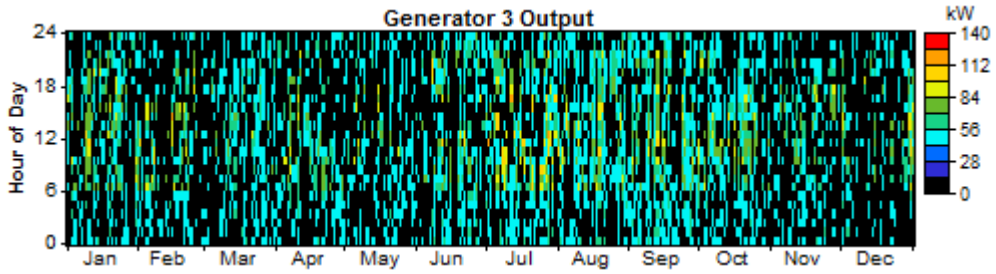


Generator 3

Quantity	Value	Units
Hours of operation	3,365	hr/yr
Number of starts	1,256	starts/yr
Operational life	17.8	yr
Capacity factor	14.1	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	178,889	kWh/yr
Mean electrical output	53.2	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	114,722	kWh/yr
Mean thermal output	34.1	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	71,175	L/yr
Specific fuel consumption	0.398	L/kWh
Fuel energy input	700,363	kWh/yr
Mean electrical efficiency	25.5	%
Mean total efficiency	41.9	%



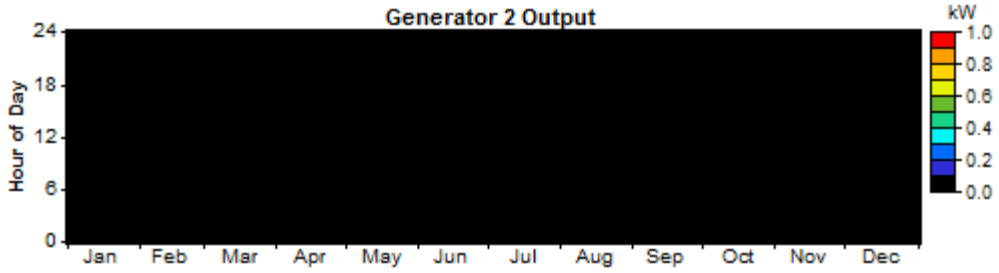
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



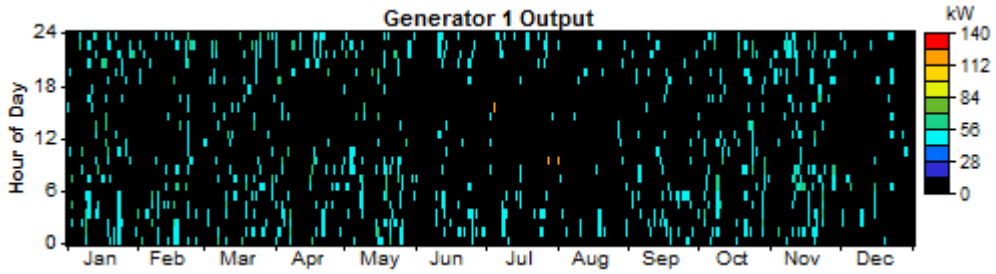
Generator 1

Quantity	Value	Units
Hours of operation	732	hr/yr
Number of starts	528	starts/yr
Operational life	82.0	yr
Capacity factor	2.71	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	37,970	kWh/yr
Mean electrical output	51.9	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	25,343	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	15,057	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	148,157	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	237,195
Carbon monoxide	561
Unburned hydocarbons	62.1
Particulate matter	42.3
Sulfur dioxide	477
Nitrogen oxides	5,001

Knight Piésold CONSULTING

Site 3
Diesel @ $5.60/gallon-$1.48/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

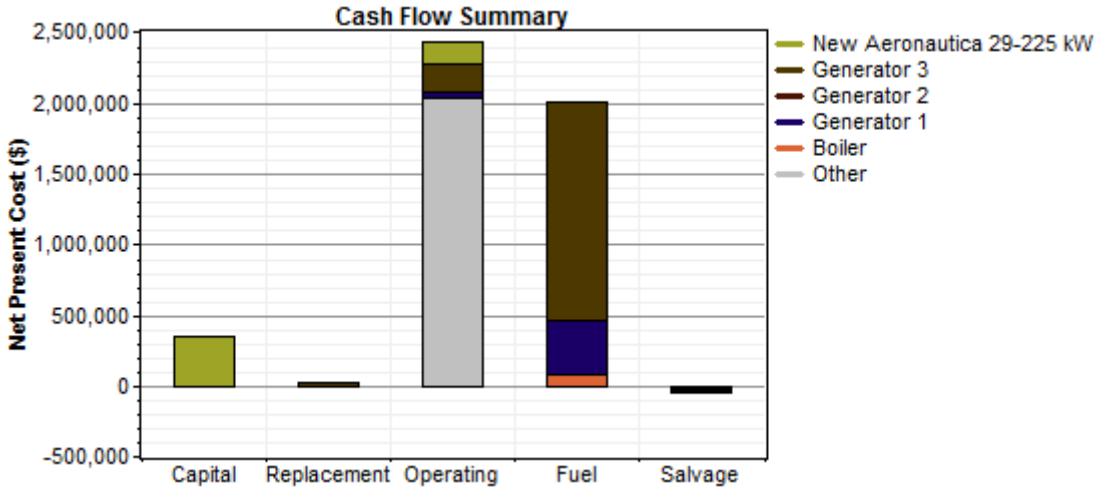
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	11.1 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1.09

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 4,746,231
Levelized cost of energy	$ 0.453/kWh
Operating cost	$ 292,500/yr



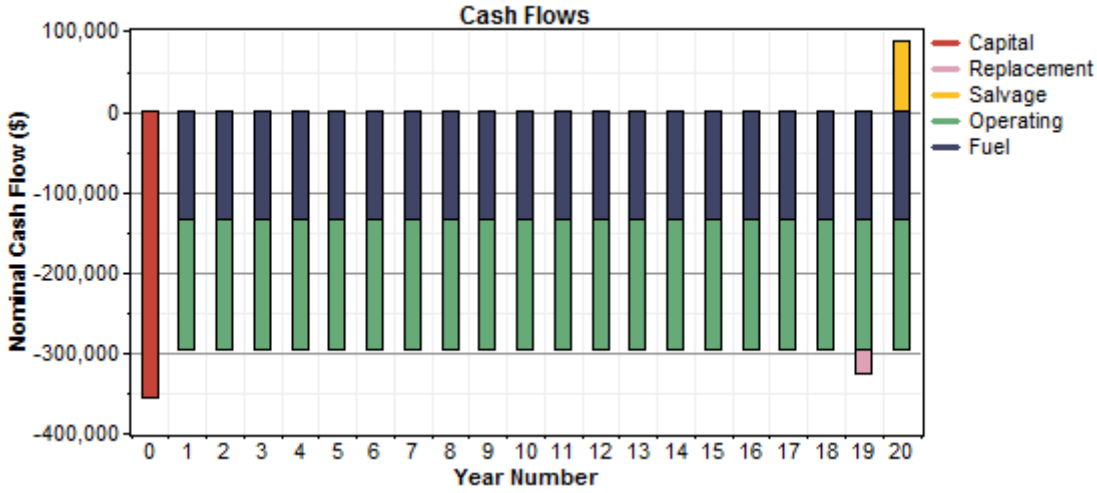
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	354,068	0	149,259	0	0	503,327
Generator 3	0	17,795	197,250	1,542,811	-15,333	1,742,523
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	48,832	373,699	-17,285	405,245
Boiler	0	0	0	84,578	0	84,578
Other	0	0	2,027,154	0	0	2,027,154
System	354,068	17,795	2,422,494	2,001,088	-49,215	4,746,230

Annualized Costs

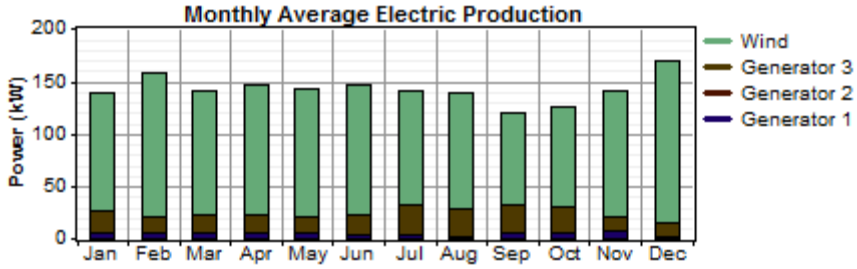
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	23,579	0	9,940	0	0	33,519
Generator 3	0	1,185	13,136	102,745	-1,021	116,045
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,252	24,887	-1,151	26,988
Boiler	0	0	0	5,633	0	5,633
Other	0	0	135,000	0	0	135,000
System	23,579	1,185	161,328	133,264	-3,278	316,079



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,029,962	83%
Generator 3	174,425	14%
Generator 2	0	0%
Generator 1	42,488	3%
Total	1,246,875	100%



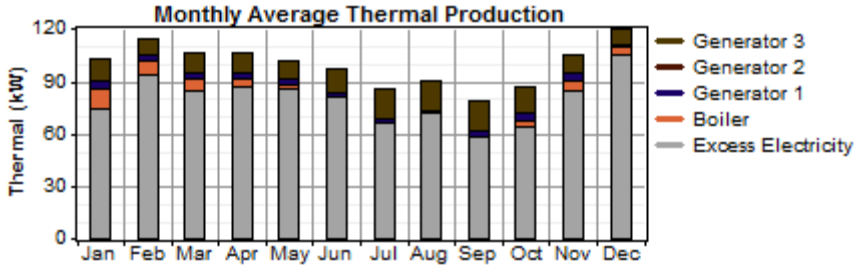
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	699,379	kWh/yr
Unmet load	0.000309	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.726	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	111,909	13%
Generator 1	28,284	3%
Boiler	31,832	4%
Excess electricity	699,379	80%
Total	871,404	100%



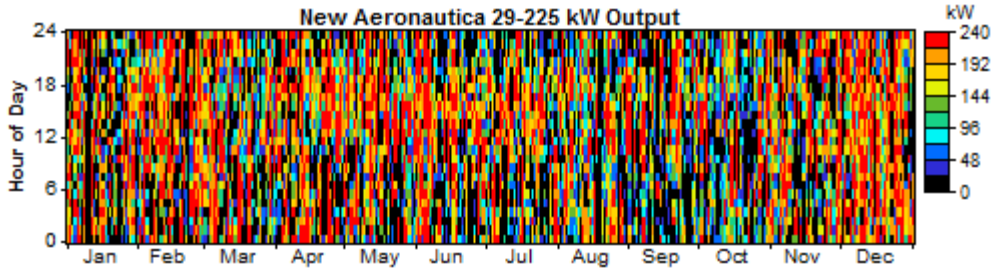
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	488,154	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	118	kW
Capacity factor	52.3	%
Total production	1,029,962	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	188	%
Hours of operation	7,517	hr/yr
Levelized cost	0.0325	$/kWh

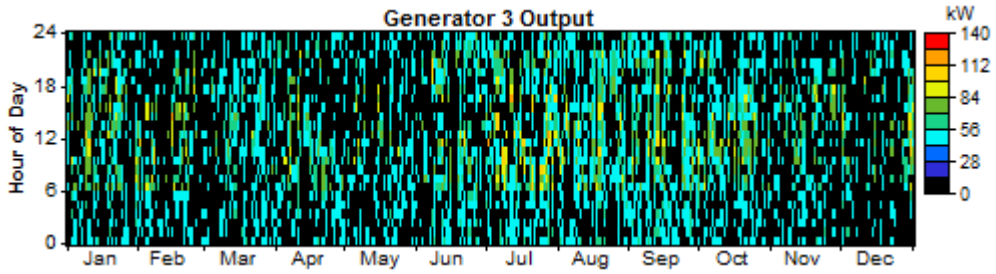


Generator 3

Quantity	Value	Units
Hours of operation	3,284	hr/yr
Number of starts	1,283	starts/yr
Operational life	18.3	yr
Capacity factor	13.7	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	174,425	kWh/yr
Mean electrical output	53.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	111,909	kWh/yr
Mean thermal output	34.1	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	69,422	L/yr
Specific fuel consumption	0.398	L/kWh
Fuel energy input	683,114	kWh/yr
Mean electrical efficiency	25.5	%
Mean total efficiency	41.9	%



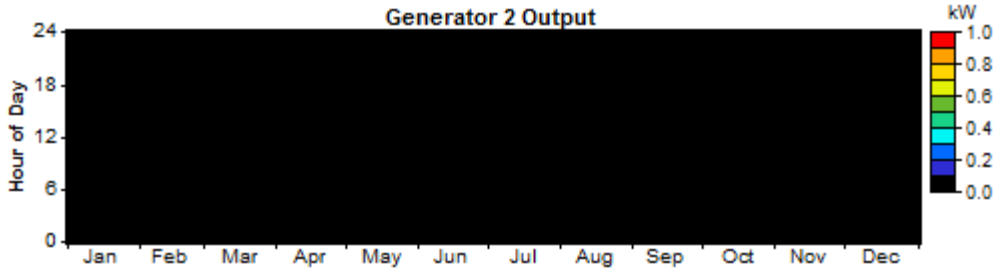
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



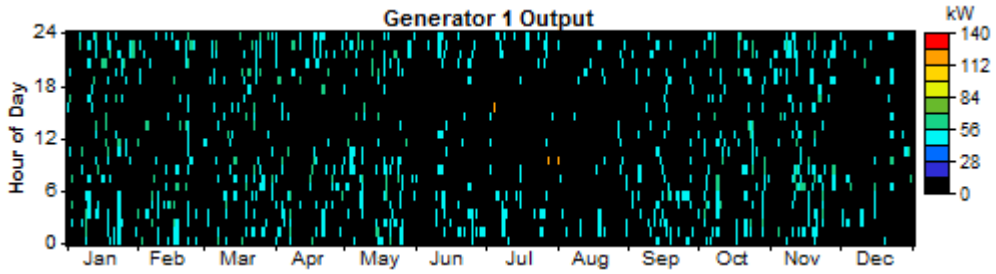
Generator 1

Quantity	Value	Units
Hours of operation	813	hr/yr
Number of starts	584	starts/yr
Operational life	73.8	yr
Capacity factor	3.03	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	42,488	kWh/yr
Mean electrical output	52.3	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	28,284	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	16,815	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	165,463	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	237,161
Carbon monoxide	561
Unburned hydocarbons	62.1
Particulate matter	42.3
Sulfur dioxide	477
Nitrogen oxides	5,002

Knight Piésold CONSULTING

Site 3
Diesel @ $6.36/gallon-$1.68/liter
and 80-Percent Funded Project

System Report - CLG_Vestas_Aeronautica_80%funded.hmr

Sensitivity case

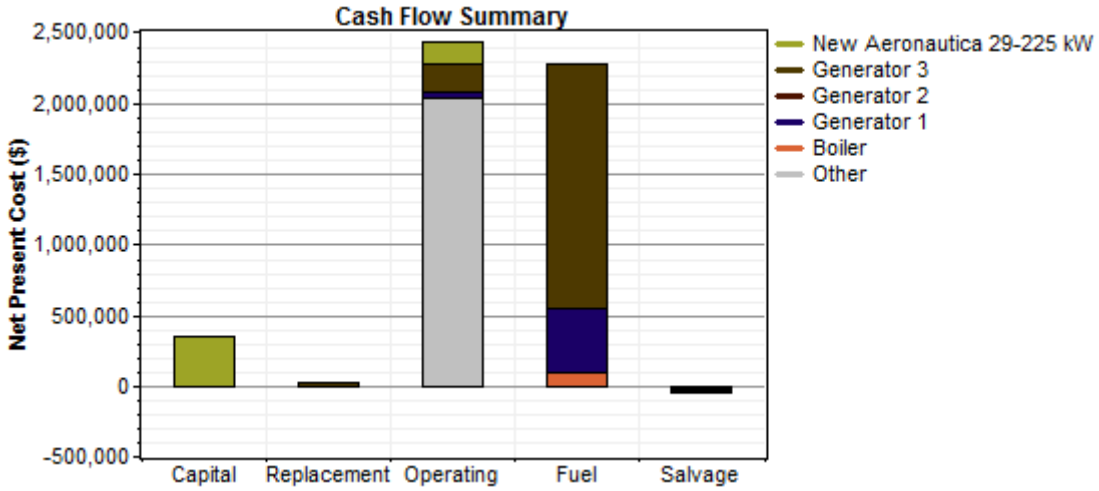
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	11.1 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
New Aeronautica 29-225 kW Capital Cost Multiplier:	1.09

System architecture

Wind turbine 1 New Aeronautica 29-225 kW
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,016,497
Levelized cost of energy	$ 0.470/kWh
Operating cost	$ 310,498/yr



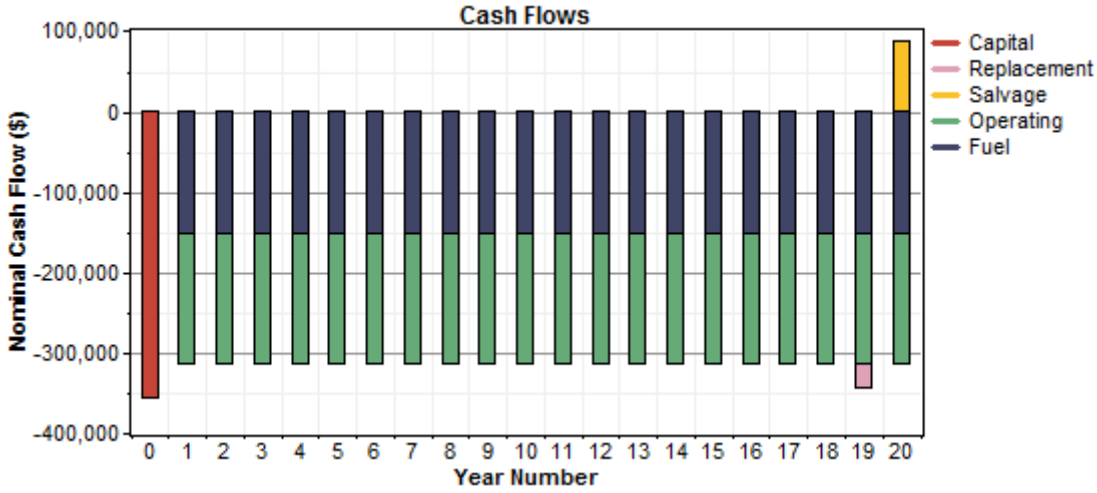
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
New Aeronautica 29-225 kW	354,068	0	149,259	0	0	503,327
Generator 3	0	17,680	194,847	1,728,945	-15,559	1,925,913
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	51,234	446,618	-16,969	480,884
Boiler	0	0	0	95,815	0	95,815
Other	0	0	2,027,154	0	0	2,027,154
System	354,068	17,680	2,422,494	2,271,377	-49,125	5,016,495

Annualized Costs

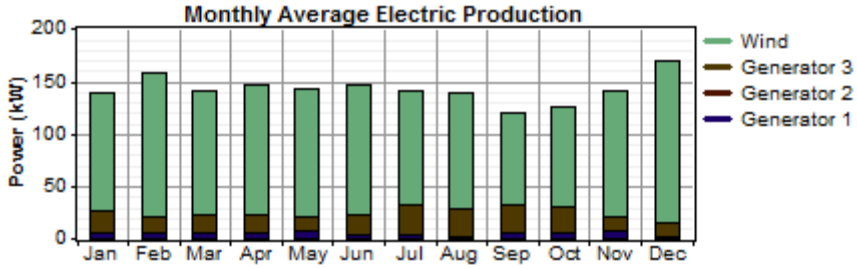
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
New Aeronautica 29-225 kW	23,579	0	9,940	0	0	33,519
Generator 3	0	1,177	12,976	115,140	-1,036	128,258
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,412	29,743	-1,130	32,025
Boiler	0	0	0	6,381	0	6,381
Other	0	0	135,000	0	0	135,000
System	23,579	1,177	161,328	151,264	-3,272	334,078



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbine	1,029,962	83%
Generator 3	172,138	14%
Generator 2	0	0%
Generator 1	44,787	4%
Total	1,246,888	100%



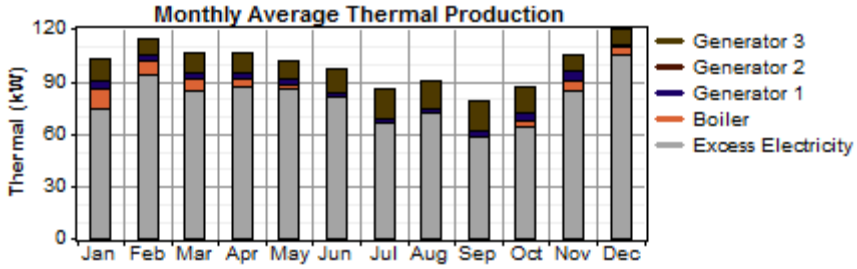
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	699,392	kWh/yr
Unmet load	0.000309	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.726	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	110,494	13%
Generator 1	29,767	3%
Boiler	31,768	4%
Excess electricity	699,392	80%
Total	871,420	100%



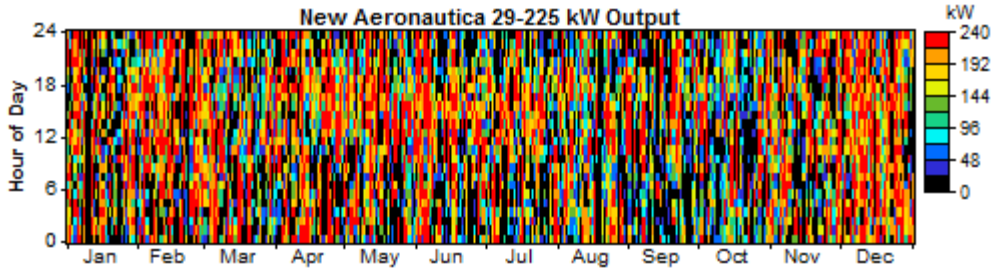
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	488,171	kWh/yr

AC Wind Turbine: New Aeronautica 29-225 kW

Variable	Value	Units
Total rated capacity	225	kW
Mean output	118	kW
Capacity factor	52.3	%
Total production	1,029,962	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	228	kW
Wind penetration	188	%
Hours of operation	7,517	hr/yr
Levelized cost	0.0325	$/kWh

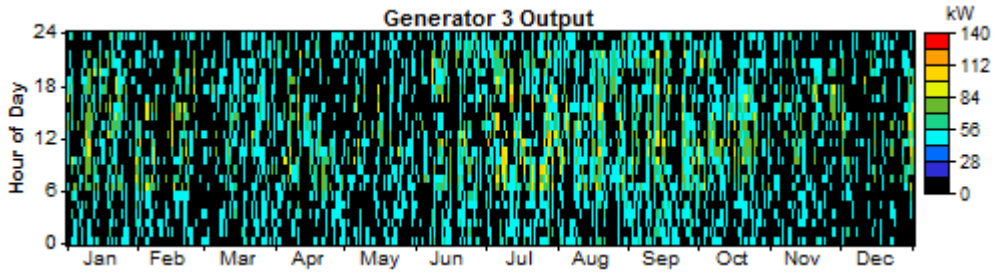


Generator 3

Quantity	Value	Units
Hours of operation	3,244	hr/yr
Number of starts	1,291	starts/yr
Operational life	18.5	yr
Capacity factor	13.6	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	172,138	kWh/yr
Mean electrical output	53.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	110,494	kWh/yr
Mean thermal output	34.1	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	68,536	L/yr
Specific fuel consumption	0.398	L/kWh
Fuel energy input	674,395	kWh/yr
Mean electrical efficiency	25.5	%
Mean total efficiency	41.9	%



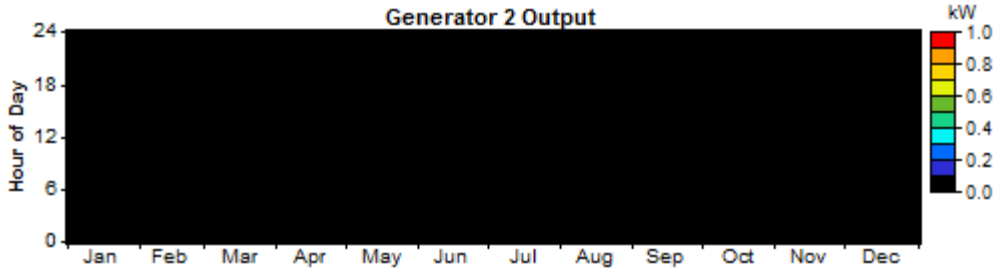
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



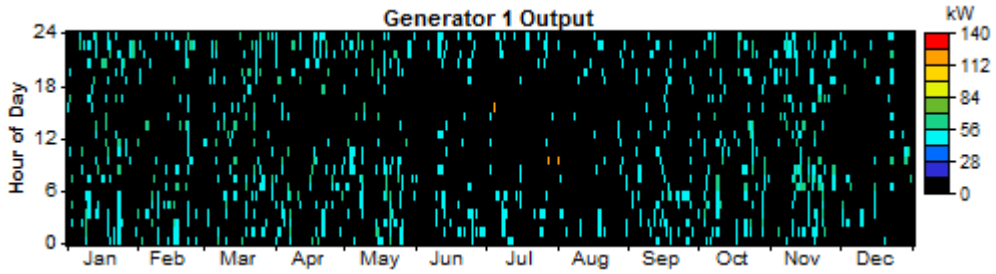
Generator 1

Quantity	Value	Units
Hours of operation	853	hr/yr
Number of starts	605	starts/yr
Operational life	70.3	yr
Capacity factor	3.20	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	44,787	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	48.0	kW
Max. electrical output	125	kW
Thermal production	29,767	kWh/yr
Mean thermal output	34.9	kW
Min. thermal output	32.9	kW

Max. thermal output	66.2	kW

Quantity	Value	Units
Fuel consumption	17,704	L/yr
Specific fuel consumption	0.395	L/kWh
Fuel energy input	174,208	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	237,148
Carbon monoxide	561
Unburned hydocarbons	62.1
Particulate matter	42.3
Sulfur dioxide	477
Nitrogen oxides	5,002

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Appendix H

Multiple Northwind 100B/21 Economics

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Diesel @ $4.40/gallon-$1.16/liter
2 NW100 Turbines

System Report - CLG_NW_Enercon.hmr

Sensitivity case

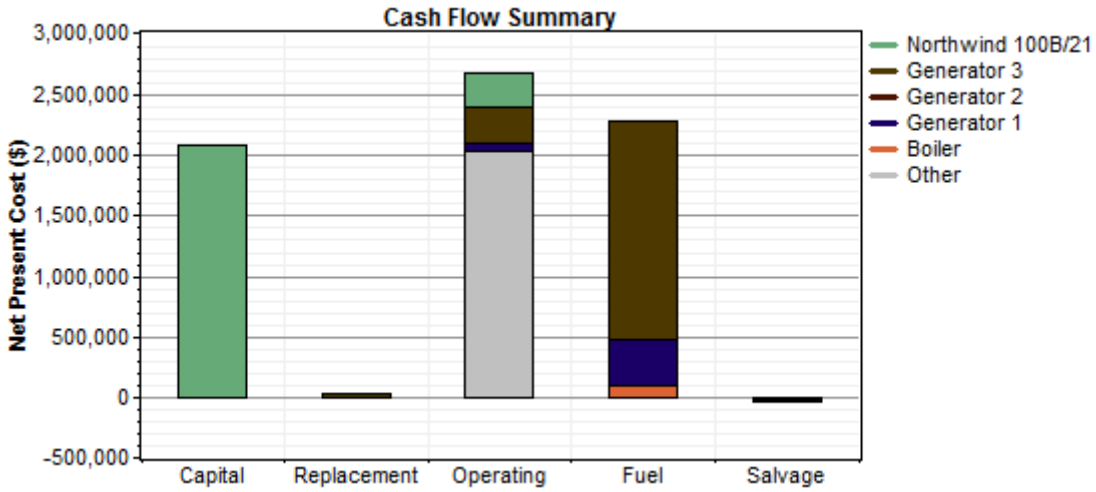
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 2 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,007,803
Levelized cost of energy	$ 0.755/kWh
Operating cost	$ 327,997/yr



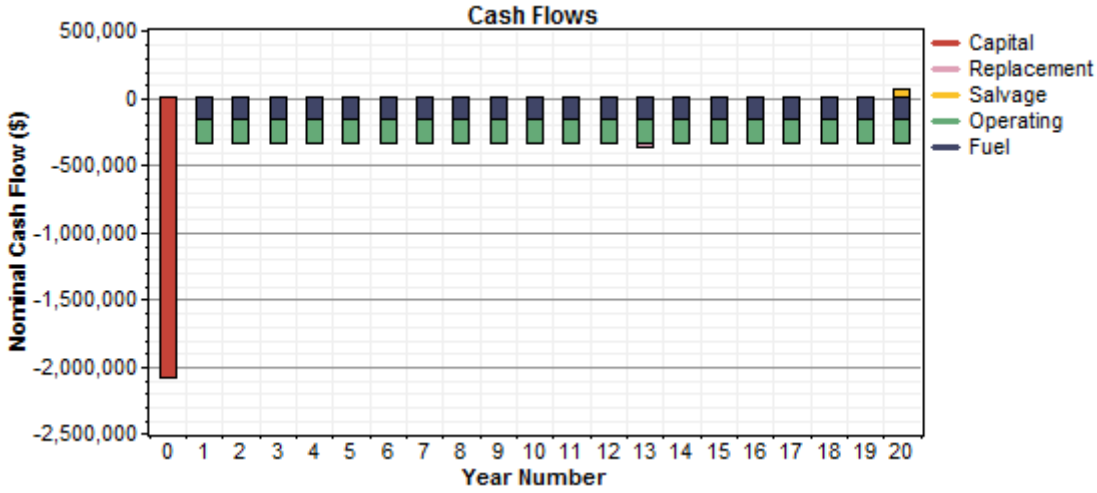
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	2,082,606	0	274,492	0	0	2,357,098
Generator 3	0	21,240	298,337	1,809,181	-5,832	2,122,926
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	62,767	374,163	-15,451	421,479
Boiler	0	0	0	95,742	0	95,742
Other	0	0	2,027,154	0	0	2,027,154
System	2,082,606	21,240	2,662,750	2,279,087	-37,880	7,007,801

Annualized Costs

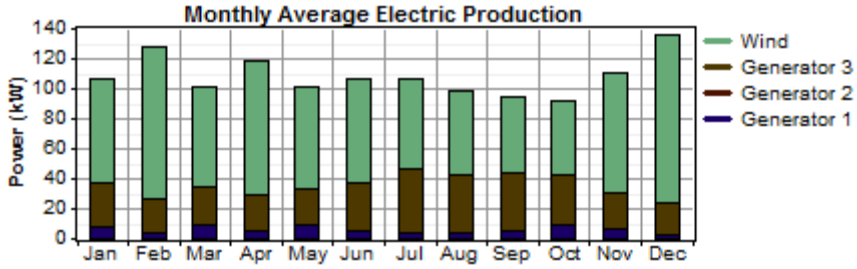
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	138,693	0	18,280	0	0	156,973
Generator 3	0	1,414	19,868	120,484	-388	141,378
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,180	24,918	-1,029	28,069
Boiler	0	0	0	6,376	0	6,376
Other	0	0	135,000	0	0	135,000
System	138,693	1,414	177,328	151,778	-2,523	466,690



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	634,348	67%
Generator 3	259,280	27%
Generator 2	0	0%
Generator 1	54,158	6%
Total	947,786	100%



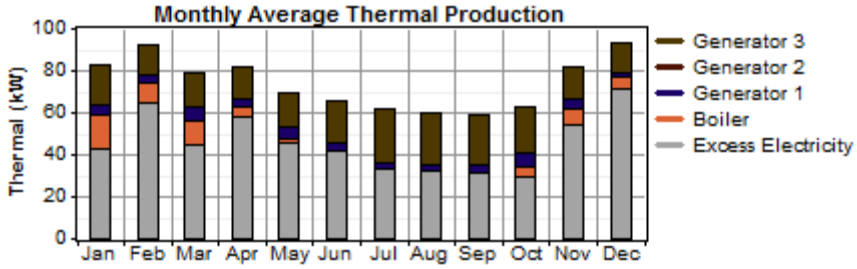
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	400,286	kWh/yr
Unmet load	0.000652	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.530	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	167,802	26%
Generator 1	36,159	6%
Boiler	45,973	7%
Excess electricity	400,286	62%
Total	650,220	100%



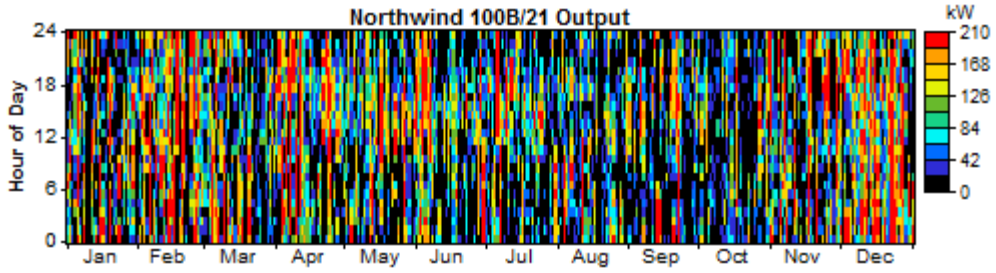
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	266,970	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	200	kW
Mean output	72.4	kW
Capacity factor	36.2	%
Total production	634,348	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	202	kW
Wind penetration	116	%
Hours of operation	7,238	hr/yr
Levelized cost	0.247	$/kWh

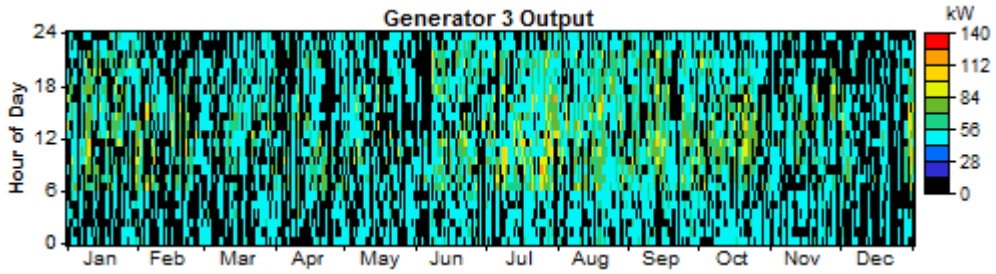


Generator 3

Quantity	Value	Units
Hours of operation	4,967	hr/yr
Number of starts	1,262	starts/yr
Operational life	12.1	yr
Capacity factor	20.4	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	259,280	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	167,802	kWh/yr
Mean thermal output	33.8	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	103,865	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	1,022,036	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



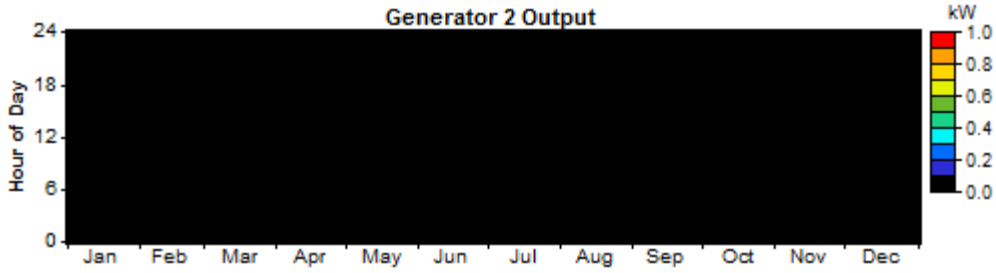
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



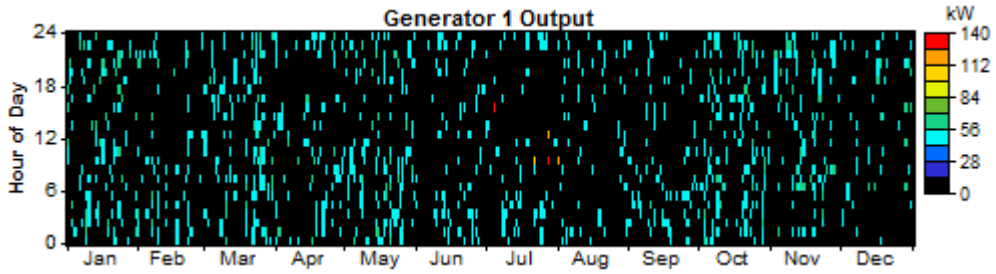
Generator 1

Quantity	Value	Units
Hours of operation	1,045	hr/yr
Number of starts	739	starts/yr
Operational life	57.4	yr
Capacity factor	3.86	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	54,158	kWh/yr
Mean electrical output	51.8	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	36,159	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	21,481	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	211,371	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	344,621
Carbon monoxide	815
Unburned hydocarbons	90.2
Particulate matter	61.4
Sulfur dioxide	693
Nitrogen oxides	7,270

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Diesel @ $5.60/gallon-$1.48/liter
2 NW100 Turbines

System Report - CLG_NW_Enercon.hmr

Sensitivity case

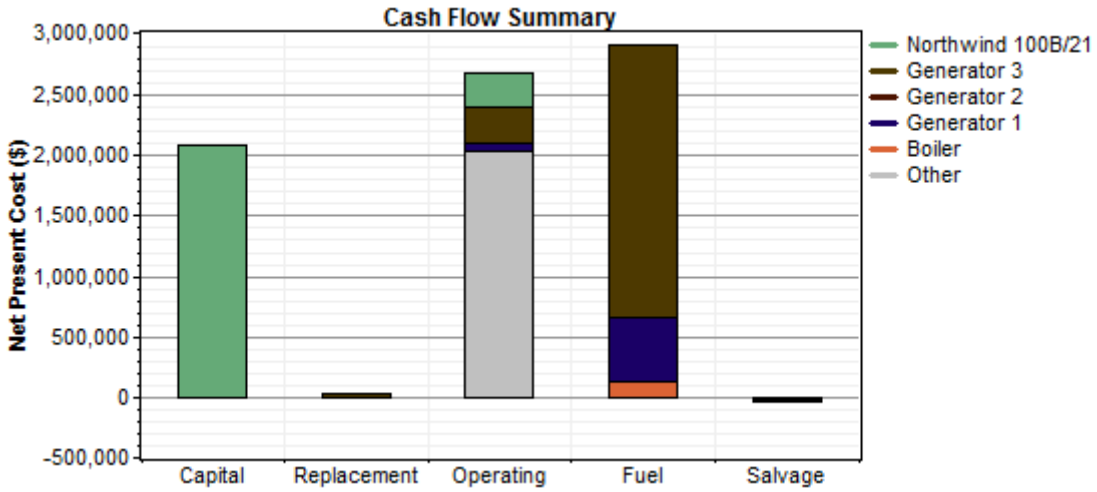
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 2 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,636,212
Levelized cost of energy	$ 0.805/kWh
Operating cost	$ 369,847/yr



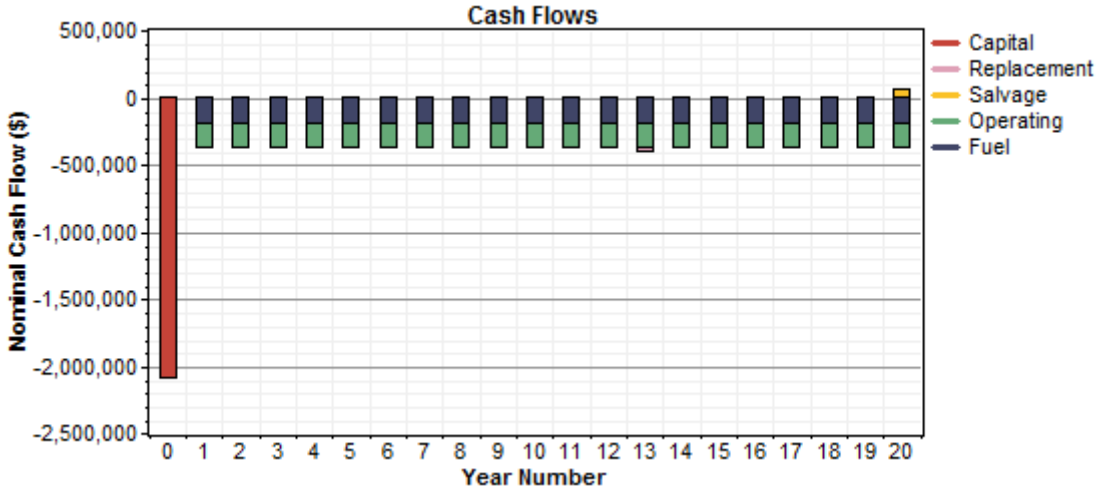
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	2,082,606	0	274,492	0	0	2,357,098
Generator 3	0	21,070	291,550	2,254,398	-6,470	2,560,547
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	69,554	531,502	-14,558	586,498
Boiler	0	0	0	121,511	0	121,511
Other	0	0	2,027,154	0	0	2,027,154
System	2,082,606	21,070	2,662,750	2,907,411	-37,625	7,636,210

Annualized Costs

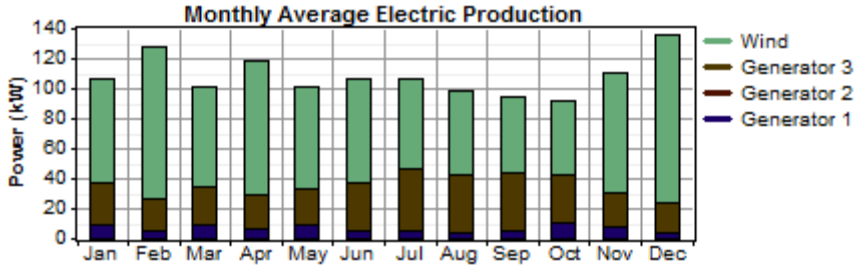
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	138,693	0	18,280	0	0	156,973
Generator 3	0	1,403	19,416	150,133	-431	170,522
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,632	35,396	-970	39,058
Boiler	0	0	0	8,092	0	8,092
Other	0	0	135,000	0	0	135,000
System	138,693	1,403	177,328	193,621	-2,506	508,540



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	634,348	67%
Generator 3	253,138	27%
Generator 2	0	0%
Generator 1	60,398	6%
Total	947,884	100%



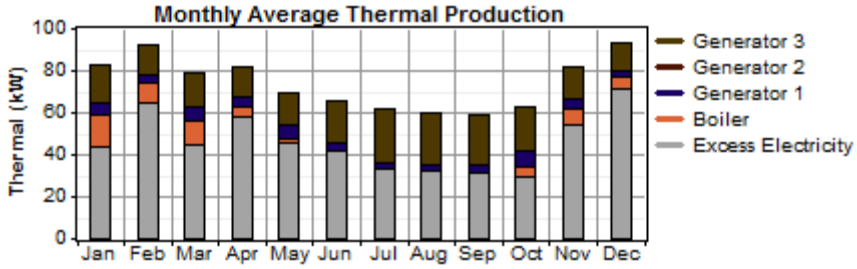
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	400,384	kWh/yr
Unmet load	0.000626	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.530	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	163,906	25%
Generator 1	40,235	6%
Boiler	45,732	7%
Excess electricity	400,384	62%
Total	650,256	100%



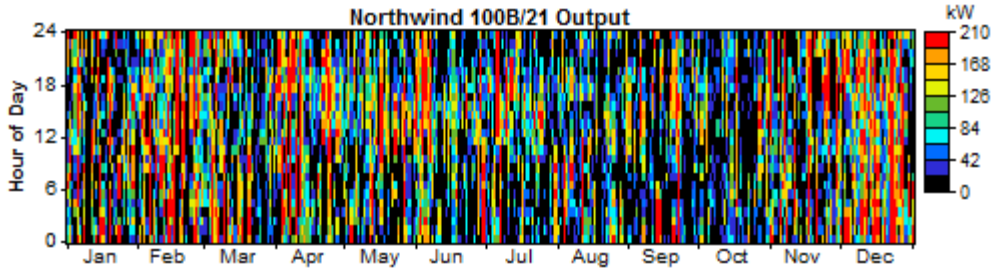
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	267,006	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	200	kW
Mean output	72.4	kW
Capacity factor	36.2	%
Total production	634,348	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	202	kW
Wind penetration	116	%
Hours of operation	7,238	hr/yr
Levelized cost	0.247	$/kWh

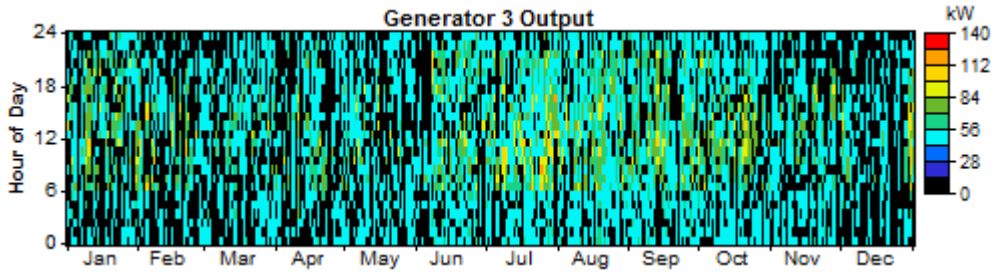


Generator 3

Quantity	Value	Units
Hours of operation	4,854	hr/yr
Number of starts	1,307	starts/yr
Operational life	12.4	yr
Capacity factor	19.9	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	253,138	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	163,906	kWh/yr
Mean thermal output	33.8	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	101,442	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	998,185	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



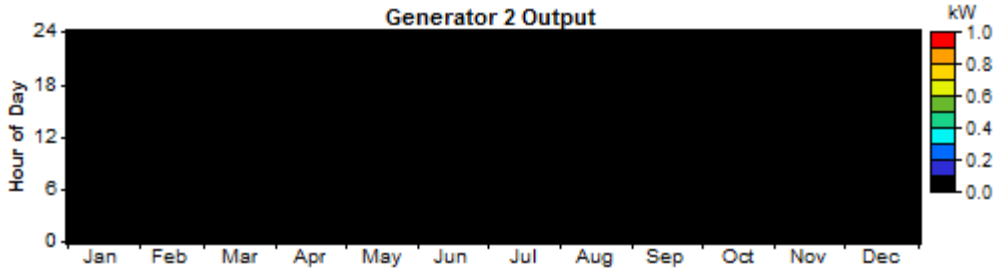
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



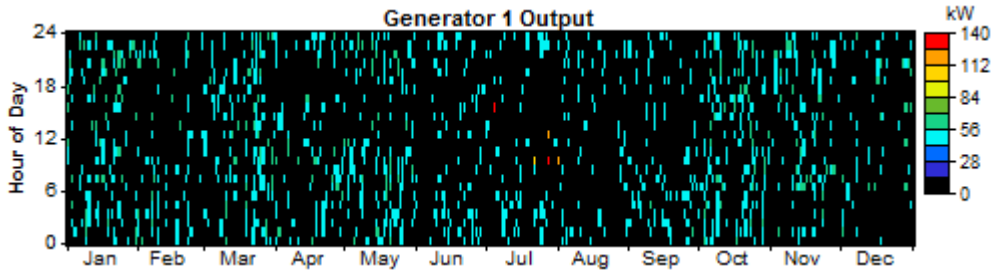
Generator 1

Quantity	Value	Units
Hours of operation	1,158	hr/yr
Number of starts	794	starts/yr
Operational life	51.8	yr
Capacity factor	4.31	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	60,398	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	40,235	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	23,916	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	235,334	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	344,575
Carbon monoxide	815
Unburned hydocarbons	90.3
Particulate matter	61.4
Sulfur dioxide	693
Nitrogen oxides	7,271

Knight Piésold CONSULTING

Diesel @ $6.36/gallon-$1.68/liter
2 NW100 Turbines

System Report - CLG_NW_Enercon.hmr

Sensitivity case

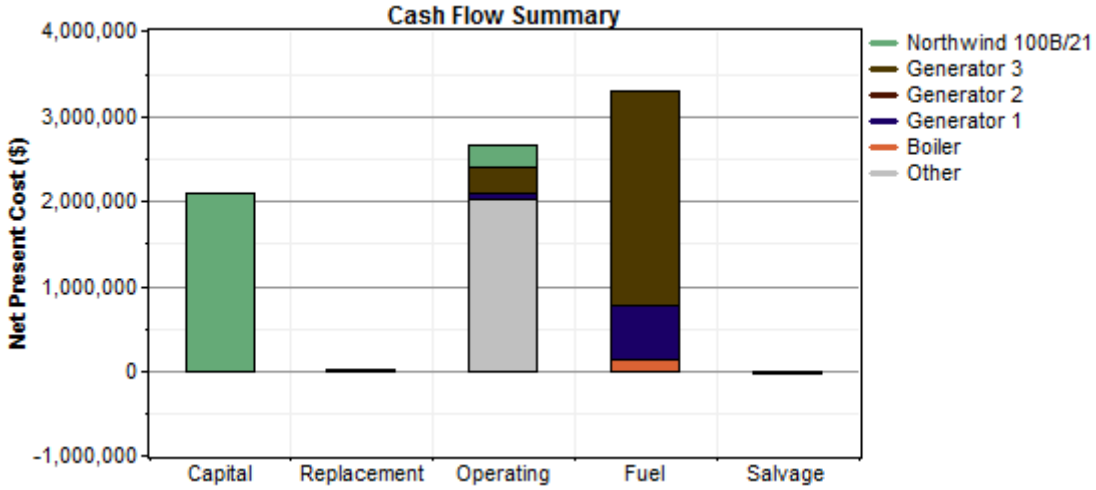
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 2 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 8,029,003
Levelized cost of energy	$ 0.836/kWh
Operating cost	$ 396,005/yr



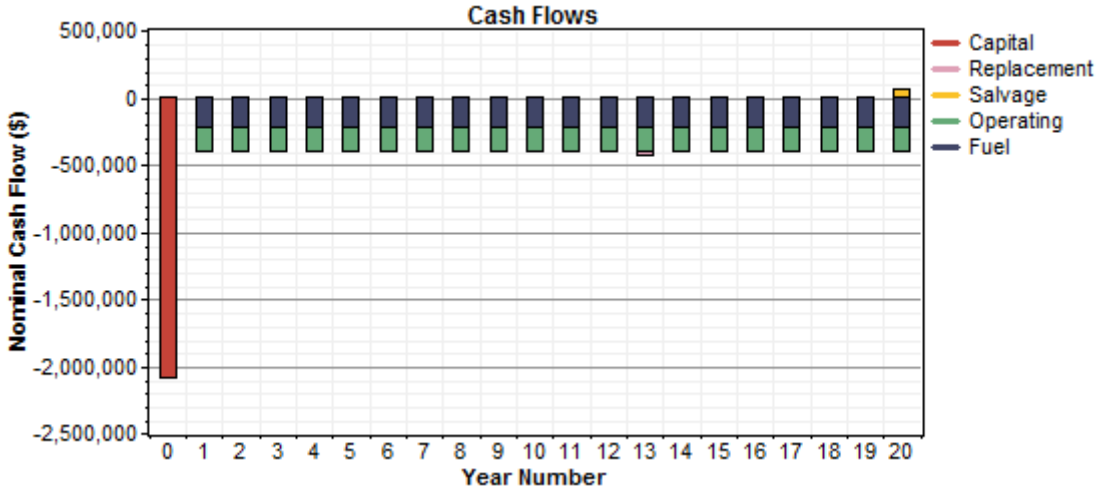
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	2,082,606	0	274,492	0	0	2,357,098
Generator 3	0	21,006	289,087	2,536,563	-6,701	2,839,955
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	72,017	625,924	-14,234	683,706
Boiler	0	0	0	137,685	0	137,685
Other	0	0	2,027,154	0	0	2,027,154
System	2,082,606	21,006	2,662,750	3,300,172	-37,533	8,029,000

Annualized Costs

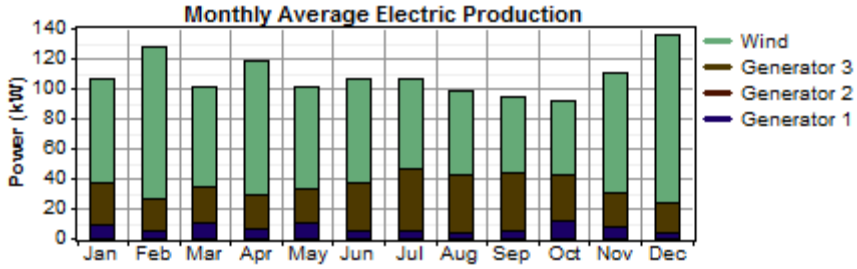
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	138,693	0	18,280	0	0	156,973
Generator 3	0	1,399	19,252	168,924	-446	189,129
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,796	41,684	-948	45,532
Boiler	0	0	0	9,169	0	9,169
Other	0	0	135,000	0	0	135,000
System	138,693	1,399	177,328	219,778	-2,500	534,698



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	634,348	67%
Generator 3	250,862	26%
Generator 2	0	0%
Generator 1	62,704	7%
Total	947,914	100%



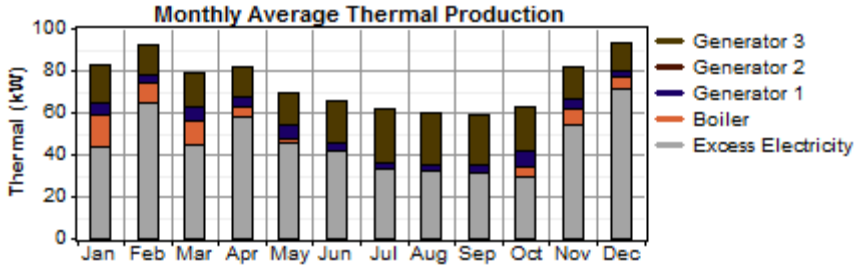
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	400,413	kWh/yr
Unmet load	0.000633	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.530	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	162,477	25%
Generator 1	41,732	6%
Boiler	45,650	7%
Excess electricity	400,413	62%
Total	650,273	100%



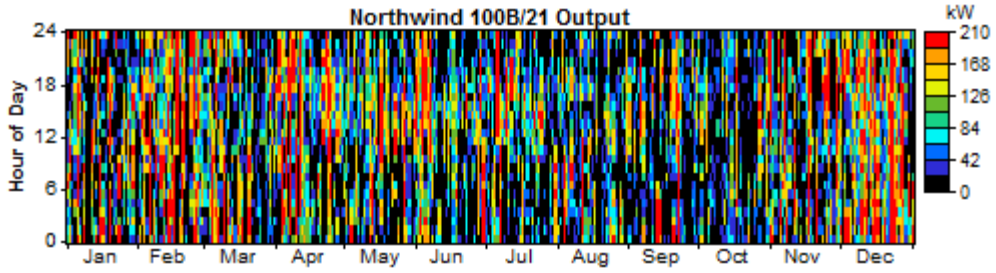
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	267,023	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	200	kW
Mean output	72.4	kW
Capacity factor	36.2	%
Total production	634,348	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	202	kW
Wind penetration	116	%
Hours of operation	7,238	hr/yr
Levelized cost	0.247	$/kWh

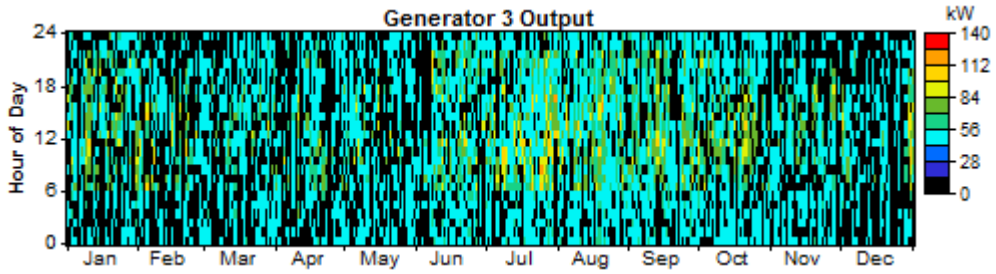


Generator 3

Quantity	Value	Units
Hours of operation	4,813	hr/yr
Number of starts	1,319	starts/yr
Operational life	12.5	yr
Capacity factor	19.7	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	250,862	kWh/yr
Mean electrical output	52.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	162,477	kWh/yr
Mean thermal output	33.8	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	100,550	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	989,415	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



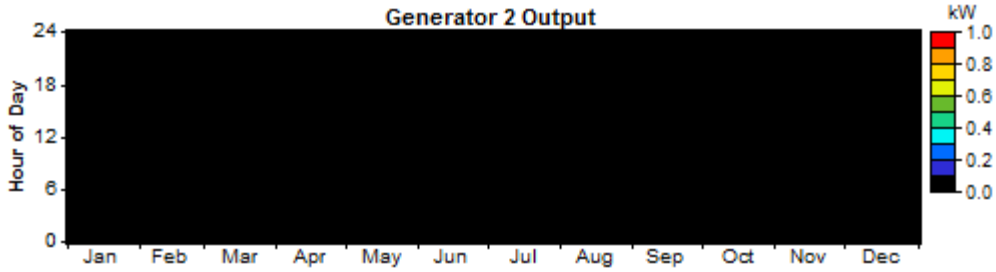
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



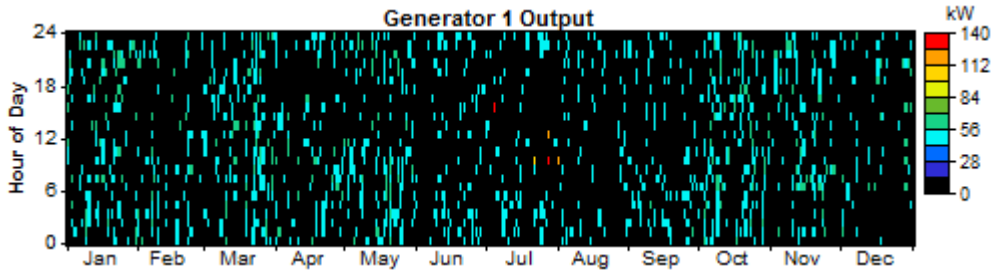
Generator 1

Quantity	Value	Units
Hours of operation	1,199	hr/yr
Number of starts	808	starts/yr
Operational life	50.0	yr
Capacity factor	4.47	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	62,704	kWh/yr
Mean electrical output	52.3	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	41,732	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	24,812	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	244,149	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	344,561
Carbon monoxide	815
Unburned hydocarbons	90.3
Particulate matter	61.4
Sulfur dioxide	692
Nitrogen oxides	7,271

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Diesel @ $4.40/gallon-$1.16/liter
2 NW100 Turbines
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

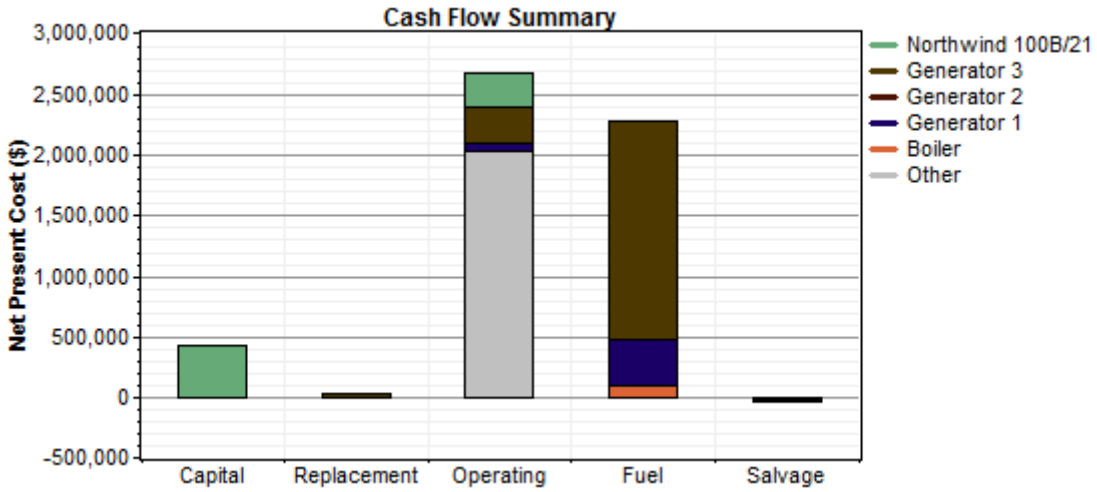
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 2 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,341,718
Levelized cost of energy	$ 0.553/kWh
Operating cost	$ 327,997/yr



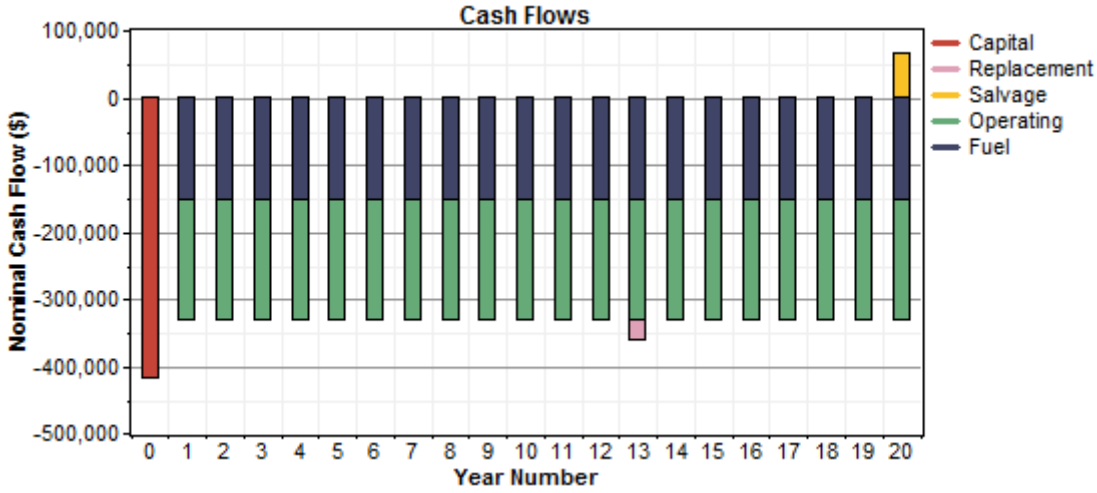
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	416,521	0	274,492	0	0	691,013
Generator 3	0	21,240	298,337	1,809,181	-5,832	2,122,926
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	62,767	374,163	-15,451	421,479
Boiler	0	0	0	95,742	0	95,742
Other	0	0	2,027,154	0	0	2,027,154
System	416,521	21,240	2,662,750	2,279,087	-37,880	5,341,717

Annualized Costs

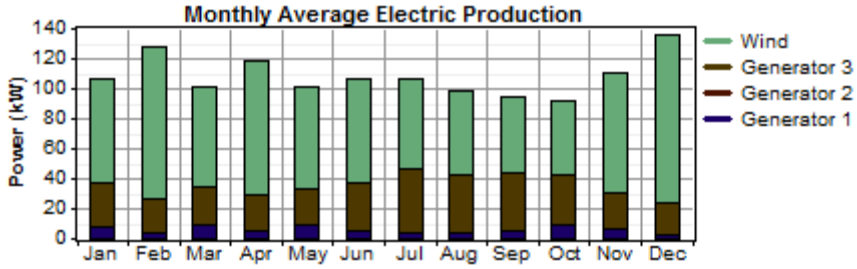
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	27,739	0	18,280	0	0	46,019
Generator 3	0	1,414	19,868	120,484	-388	141,378
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,180	24,918	-1,029	28,069
Boiler	0	0	0	6,376	0	6,376
Other	0	0	135,000	0	0	135,000
System	27,739	1,414	177,328	151,778	-2,523	355,736



Electrical

Component	Production (kWh/yr)	Fraction
Wind turbines	634,348	67%
Generator 3	259,280	27%
Generator 2	0	0%
Generator 1	54,158	6%
Total	947,786	100%



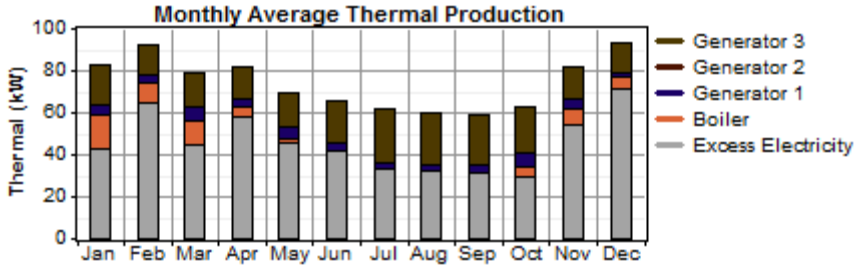
Load	Consumption (kWh/yr)	Fraction
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	400,286	kWh/yr
Unmet load	0.000652	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.530	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	167,802	26%
Generator 1	36,159	6%
Boiler	45,973	7%
Excess electricity	400,286	62%
Total	650,220	100%



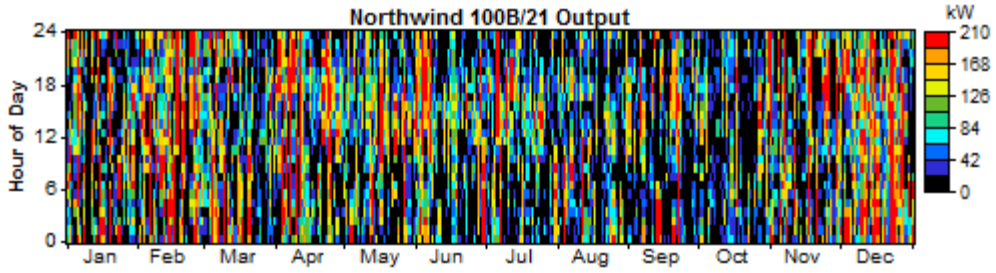
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	266,970	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	200	kW
Mean output	72.4	kW
Capacity factor	36.2	%
Total production	634,348	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	202	kW
Wind penetration	116	%
Hours of operation	7,238	hr/yr
Levelized cost	0.0725	$/kWh

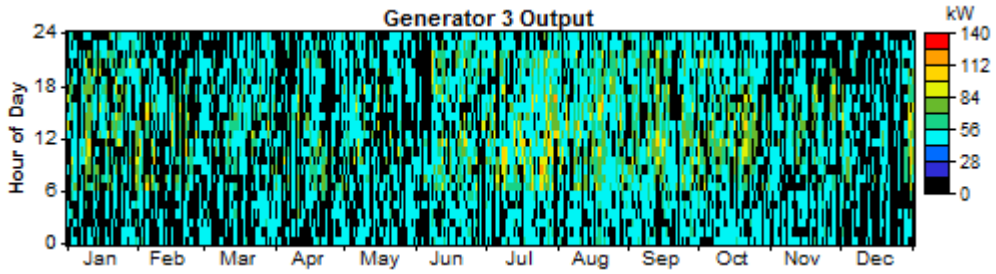


Generator 3

Quantity	Value	Units
Hours of operation	4,967	hr/yr
Number of starts	1,262	starts/yr
Operational life	12.1	yr
Capacity factor	20.4	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	259,280	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	167,802	kWh/yr
Mean thermal output	33.8	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	103,865	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	1,022,036	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



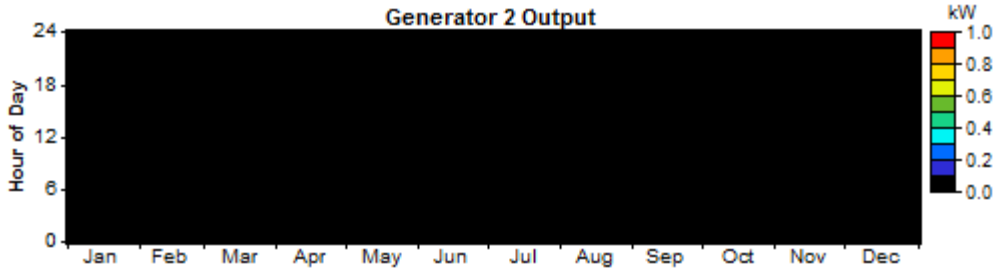
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



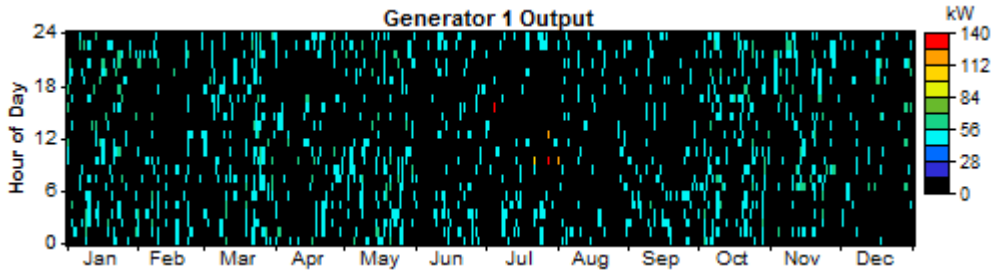
Generator 1

Quantity	Value	Units
Hours of operation	1,045	hr/yr
Number of starts	739	starts/yr
Operational life	57.4	yr
Capacity factor	3.86	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	54,158	kWh/yr
Mean electrical output	51.8	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	36,159	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	21,481	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	211,371	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	344,621
Carbon monoxide	815
Unburned hydocarbons	90.2
Particulate matter	61.4
Sulfur dioxide	693
Nitrogen oxides	7,270

Knight Piésold
CONSULTING

Diesel @ $5.60/gallon-$1.48/liter
2 NW100 Turbines
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

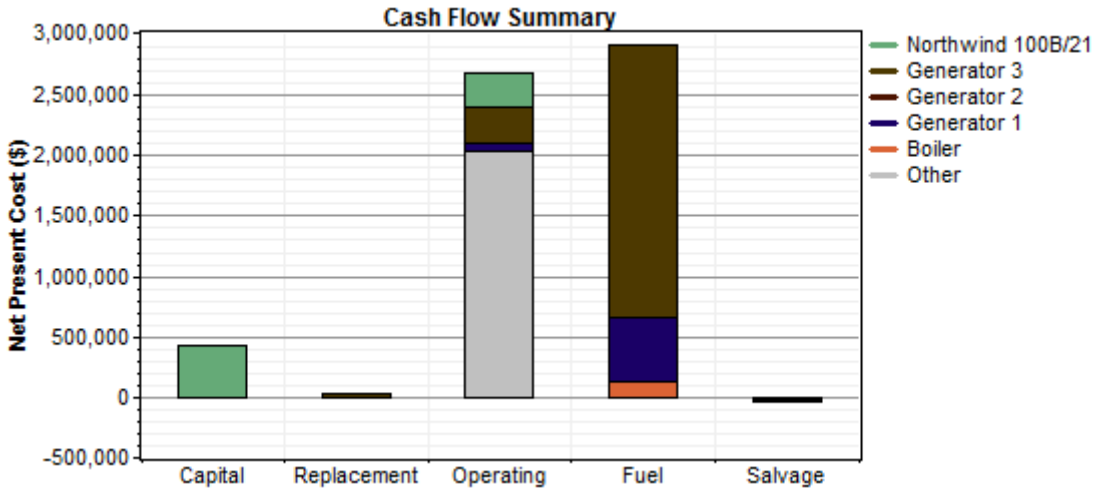
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 2 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,970,128
Levelized cost of energy	$ 0.602/kWh
Operating cost	$ 369,847/yr



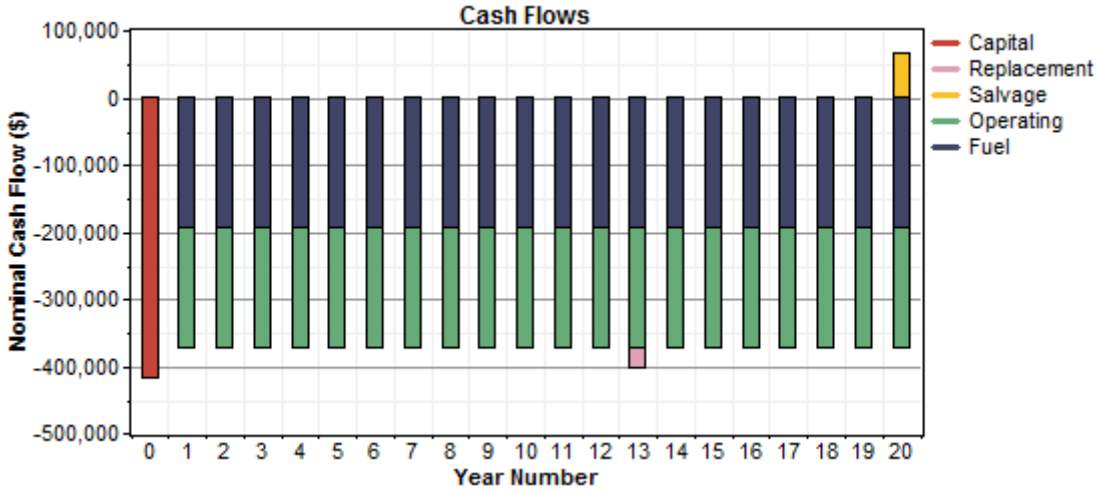
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	416,521	0	274,492	0	0	691,013
Generator 3	0	21,070	291,550	2,254,398	-6,470	2,560,547
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	69,554	531,502	-14,558	586,498
Boiler	0	0	0	121,511	0	121,511
Other	0	0	2,027,154	0	0	2,027,154
System	416,521	21,070	2,662,750	2,907,411	-37,625	5,970,125

Annualized Costs

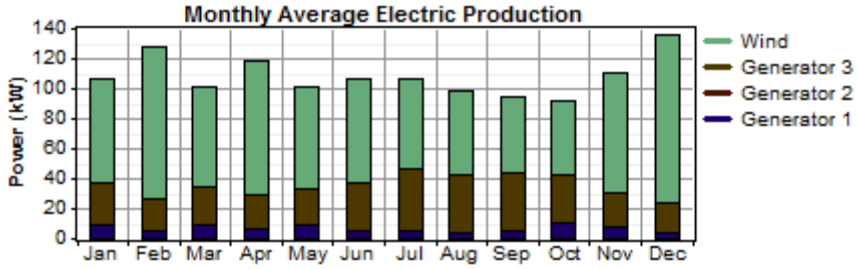
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	27,739	0	18,280	0	0	46,019
Generator 3	0	1,403	19,416	150,133	-431	170,522
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,632	35,396	-970	39,058
Boiler	0	0	0	8,092	0	8,092
Other	0	0	135,000	0	0	135,000
System	27,739	1,403	177,328	193,621	-2,506	397,585



Electrical

Component	Production (kWh/yr)	Fraction
Wind turbines	634,348	67%
Generator 3	253,138	27%
Generator 2	0	0%
Generator 1	60,398	6%
Total	947,884	100%



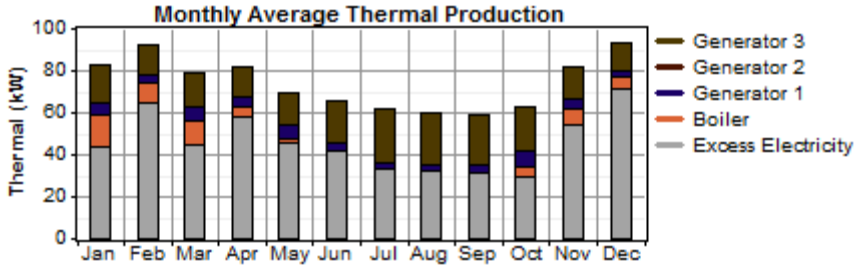
Load	Consumption (kWh/yr)	Fraction
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	400,384	kWh/yr
Unmet load	0.000626	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.530	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	163,906	25%
Generator 1	40,235	6%
Boiler	45,732	7%
Excess electricity	400,384	62%
Total	650,256	100%



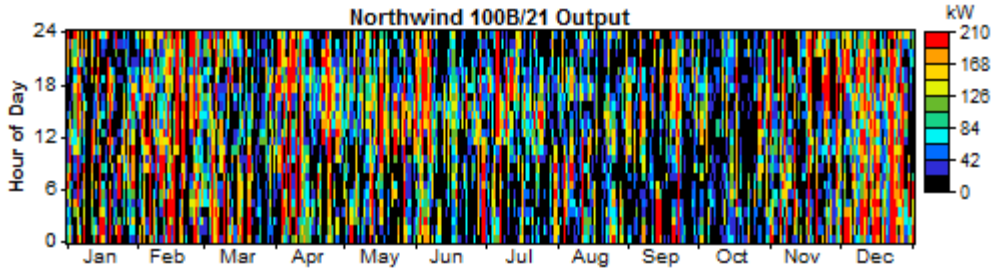
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	267,006	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	200	kW
Mean output	72.4	kW
Capacity factor	36.2	%
Total production	634,348	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	202	kW
Wind penetration	116	%
Hours of operation	7,238	hr/yr
Levelized cost	0.0725	$/kWh

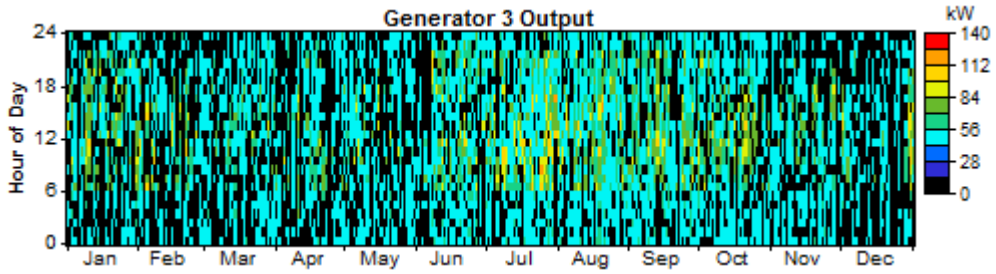


Generator 3

Quantity	Value	Units
Hours of operation	4,854	hr/yr
Number of starts	1,307	starts/yr
Operational life	12.4	yr
Capacity factor	19.9	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	253,138	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	163,906	kWh/yr
Mean thermal output	33.8	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	101,442	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	998,185	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



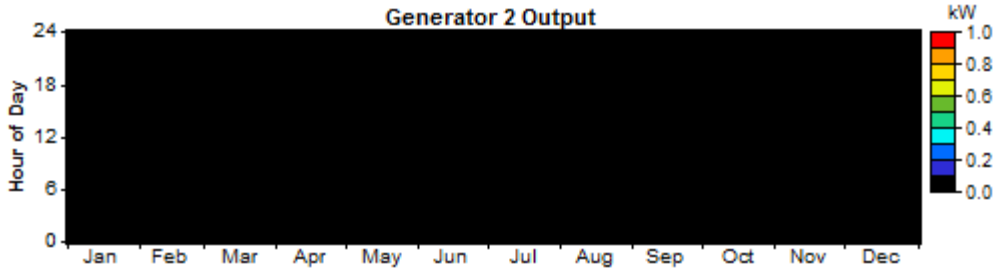
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



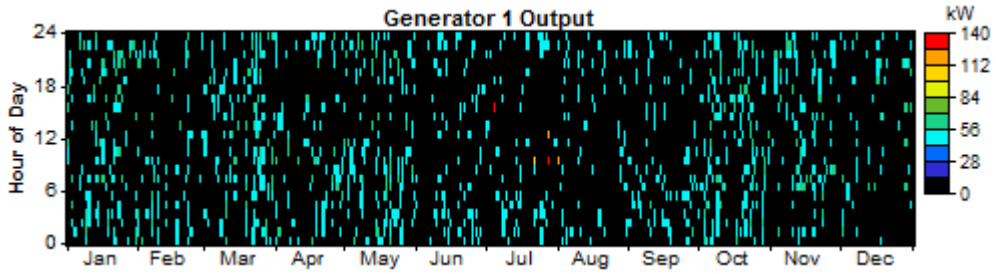
Generator 1

Quantity	Value	Units
Hours of operation	1,158	hr/yr
Number of starts	794	starts/yr
Operational life	51.8	yr
Capacity factor	4.31	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	60,398	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	40,235	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	23,916	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	235,334	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	344,575
Carbon monoxide	815
Unburned hydocarbons	90.3
Particulate matter	61.4
Sulfur dioxide	693
Nitrogen oxides	7,271

Knight Piésold CONSULTING

Diesel @ $6.36/gallon-$1.68/liter
2 NW100 Turbines
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

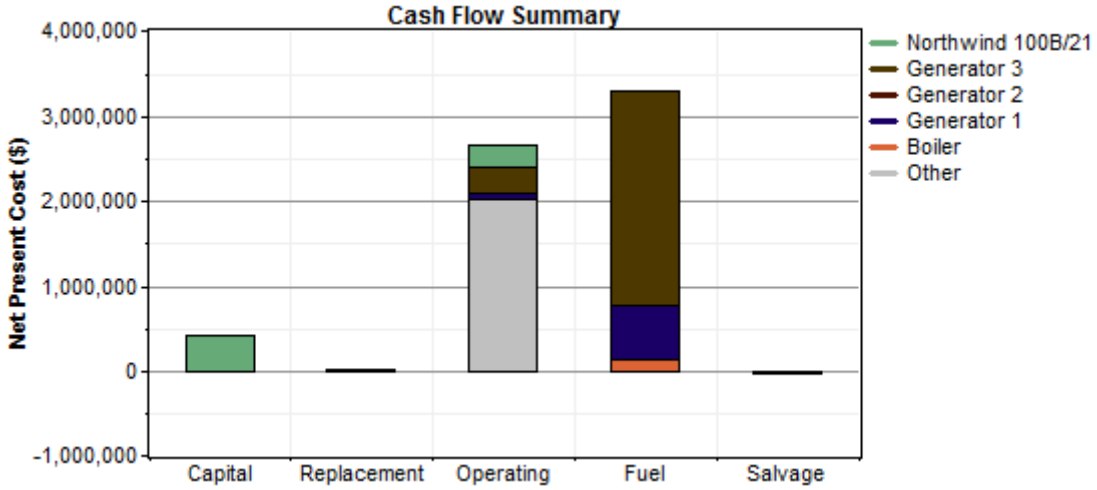
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 2 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,362,918
Levelized cost of energy	$ 0.633/kWh
Operating cost	$ 396,005/yr



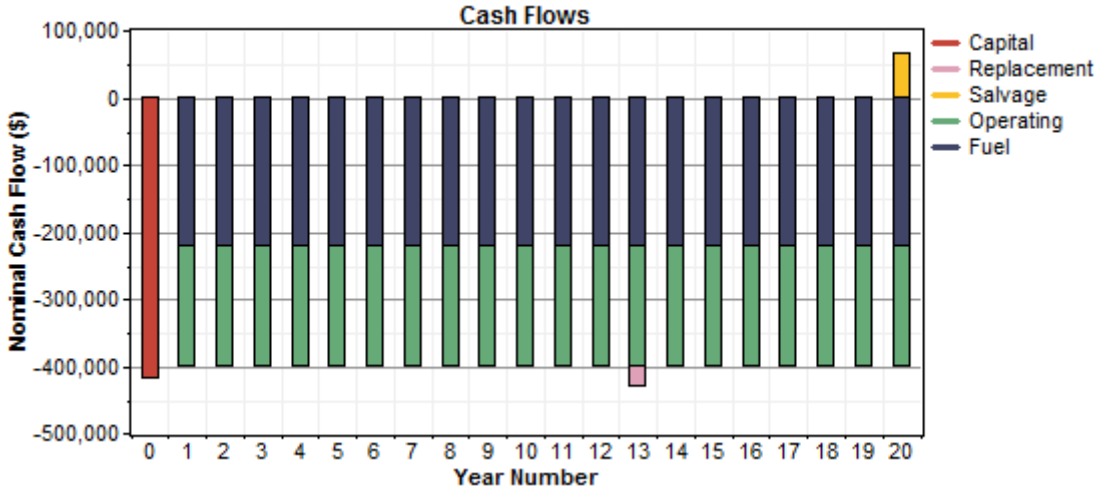
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	416,521	0	274,492	0	0	691,013
Generator 3	0	21,006	289,087	2,536,563	-6,701	2,839,955
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	72,017	625,924	-14,234	683,706
Boiler	0	0	0	137,685	0	137,685
Other	0	0	2,027,154	0	0	2,027,154
System	416,521	21,006	2,662,750	3,300,172	-37,533	6,362,915

Annualized Costs

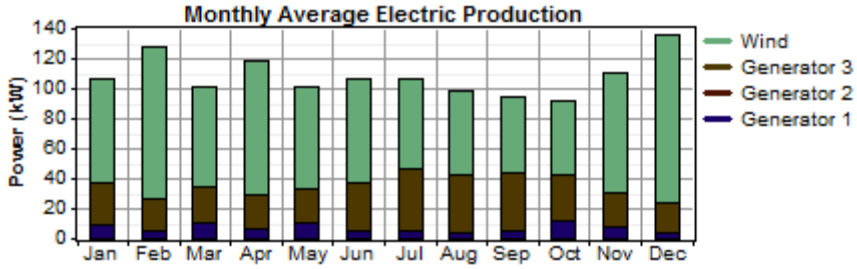
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	27,739	0	18,280	0	0	46,019
Generator 3	0	1,399	19,252	168,924	-446	189,129
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,796	41,684	-948	45,532
Boiler	0	0	0	9,169	0	9,169
Other	0	0	135,000	0	0	135,000
System	27,739	1,399	177,328	219,778	-2,500	423,743



Electrical

Component	Production (kWh/yr)	Fraction
Wind turbines	634,348	67%
Generator 3	250,862	26%
Generator 2	0	0%
Generator 1	62,704	7%
Total	947,914	100%



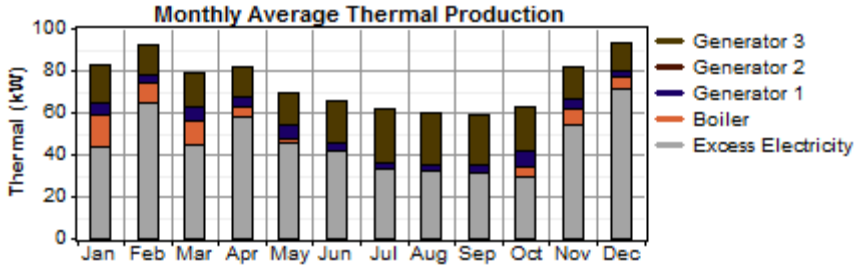
Load	Consumption (kWh/yr)	Fraction
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	400,413	kWh/yr
Unmet load	0.000633	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.530	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	162,477	25%
Generator 1	41,732	6%
Boiler	45,650	7%
Excess electricity	400,413	62%
Total	650,273	100%



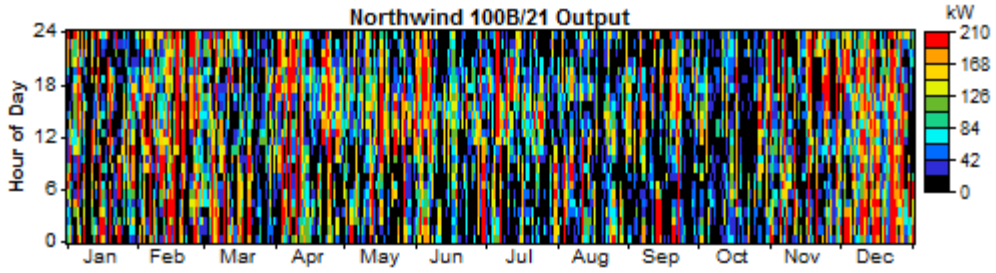
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	267,023	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	200	kW
Mean output	72.4	kW
Capacity factor	36.2	%
Total production	634,348	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	202	kW
Wind penetration	116	%
Hours of operation	7,238	hr/yr
Levelized cost	0.0725	$/kWh

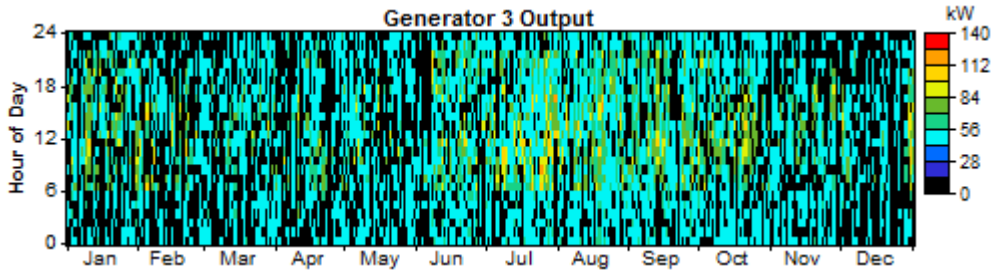


Generator 3

Quantity	Value	Units
Hours of operation	4,813	hr/yr
Number of starts	1,319	starts/yr
Operational life	12.5	yr
Capacity factor	19.7	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	250,862	kWh/yr
Mean electrical output	52.1	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	162,477	kWh/yr
Mean thermal output	33.8	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	100,550	L/yr
Specific fuel consumption	0.401	L/kWh
Fuel energy input	989,415	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



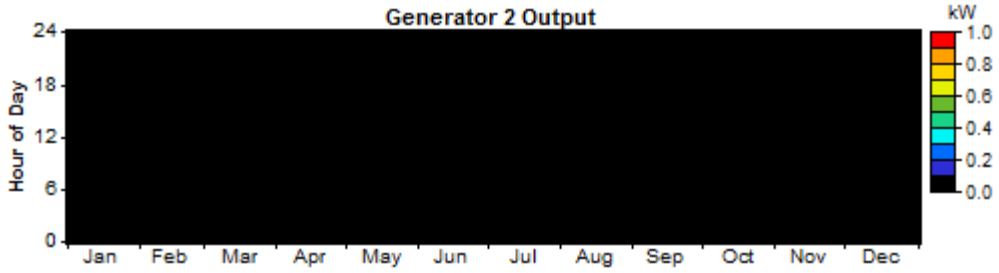
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



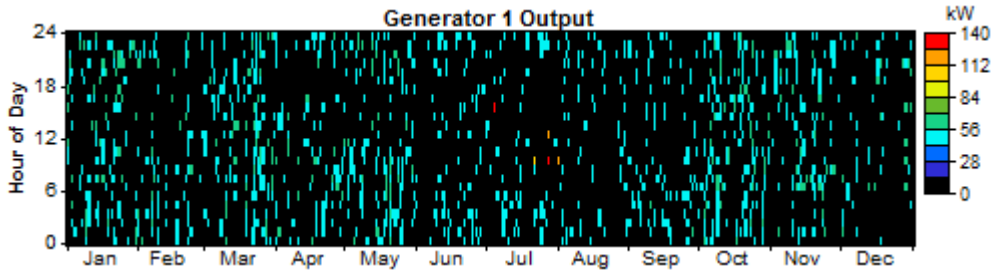
Generator 1

Quantity	Value	Units
Hours of operation	1,199	hr/yr
Number of starts	808	starts/yr
Operational life	50.0	yr
Capacity factor	4.47	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	62,704	kWh/yr
Mean electrical output	52.3	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	41,732	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	24,812	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	244,149	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	344,561
Carbon monoxide	815
Unburned hydocarbons	90.3
Particulate matter	61.4
Sulfur dioxide	692
Nitrogen oxides	7,271

Knight Piésold
CONSULTING

Diesel @ $4.40/gallon-$1.16/liter
3 NW100 Turbines

System Report - CLG_NW_Enercon.hmr

Sensitivity case

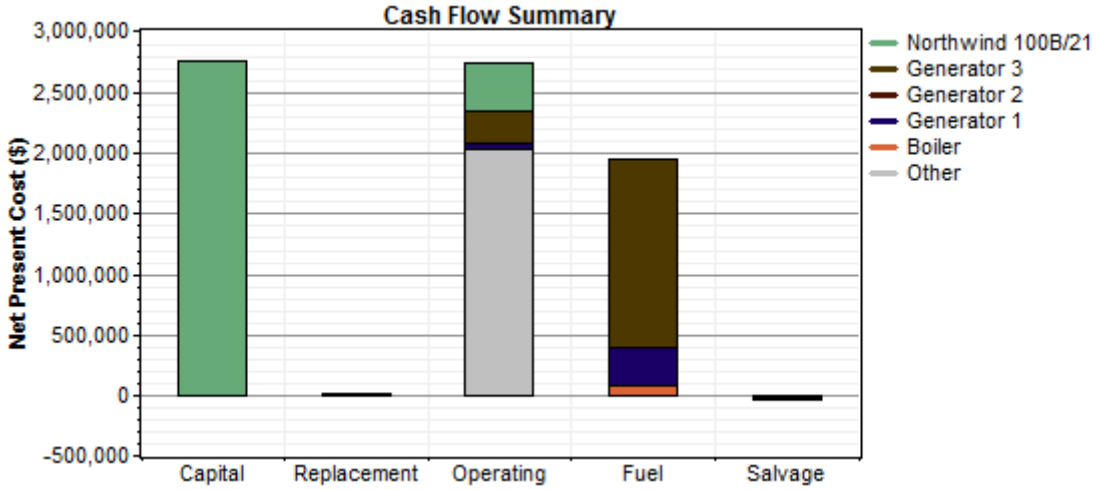
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 3 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,417,632
Levelized cost of energy	$ 0.805/kWh
Operating cost	$ 310,197/yr



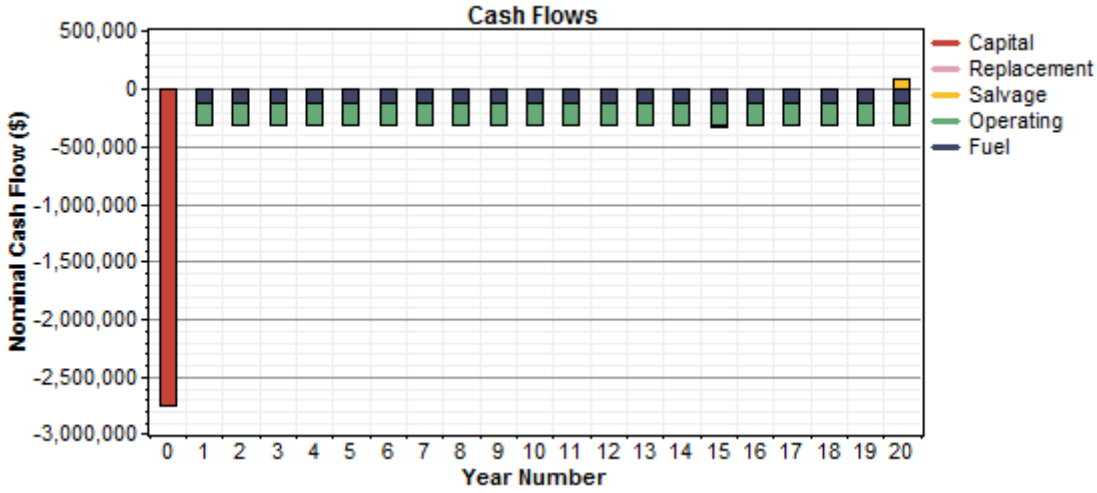
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	2,759,718	0	399,725	0	0	3,159,443
Generator 3	0	20,011	254,430	1,549,407	-9,958	1,813,889
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	53,277	317,144	-16,700	353,721
Boiler	0	0	0	80,020	0	80,020
Other	0	0	2,027,154	0	0	2,027,154
System	2,759,718	20,011	2,734,586	1,946,570	-43,256	7,417,629

Annualized Costs

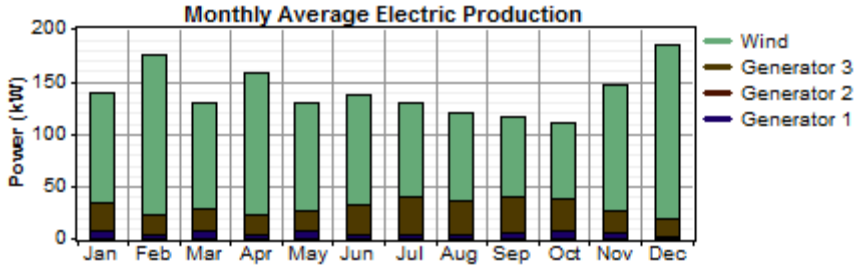
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	183,786	0	26,620	0	0	210,406
Generator 3	0	1,333	16,944	103,184	-663	120,797
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,548	21,120	-1,112	23,556
Boiler	0	0	0	5,329	0	5,329
Other	0	0	135,000	0	0	135,000
System	183,786	1,333	182,112	129,633	-2,881	493,983



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	951,523	78%
Generator 3	222,610	18%
Generator 2	0	0%
Generator 1	45,882	4%
Total	1,220,015	100%



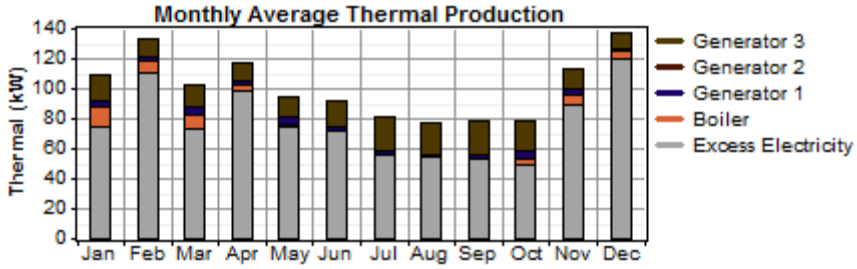
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	672,514	kWh/yr
Unmet load	0.000465	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.664	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	143,585	16%
Generator 1	30,654	3%
Boiler	38,424	4%
Excess electricity	672,514	76%
Total	885,176	100%



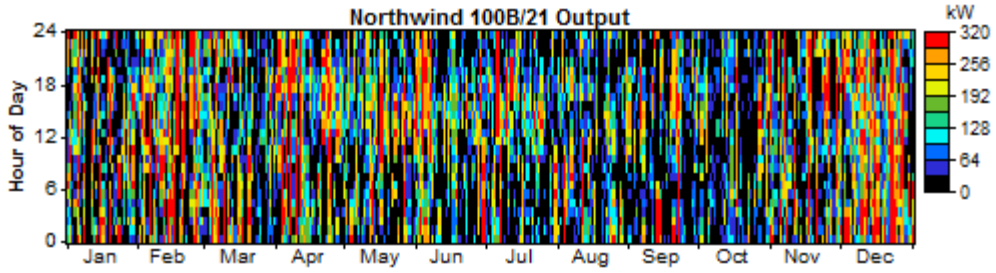
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	501,926	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	300	kW
Mean output	109	kW
Capacity factor	36.2	%
Total production	951,523	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	302	kW
Wind penetration	174	%
Hours of operation	7,238	hr/yr
Levelized cost	0.221	$/kWh

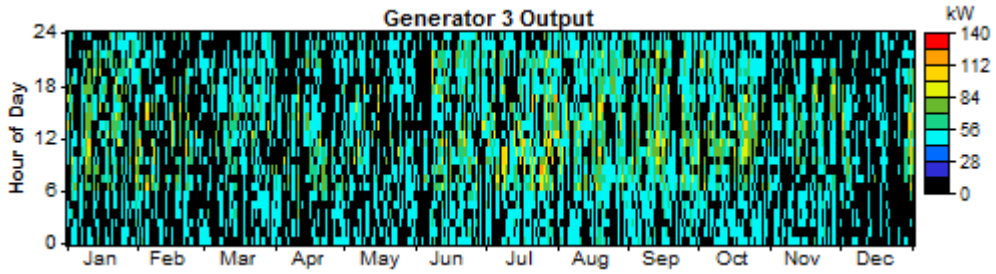


Generator 3

Quantity	Value	Units
Hours of operation	4,236	hr/yr
Number of starts	1,252	starts/yr
Operational life	14.2	yr
Capacity factor	17.5	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	222,610	kWh/yr
Mean electrical output	52.6	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	143,585	kWh/yr
Mean thermal output	33.9	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	88,952	L/yr
Specific fuel consumption	0.400	L/kWh
Fuel energy input	875,285	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



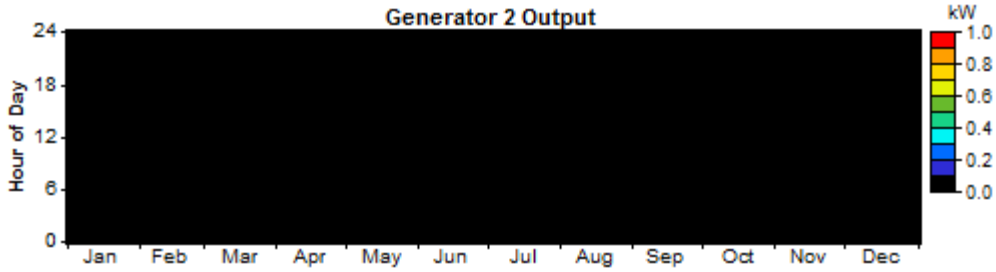
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



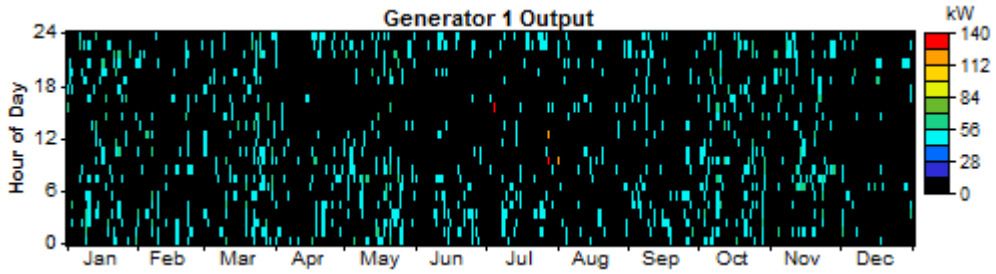
Generator 1

Quantity	Value	Units
Hours of operation	887	hr/yr
Number of starts	644	starts/yr
Operational life	67.6	yr
Capacity factor	3.27	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	45,882	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	30,654	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	18,207	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	179,160	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	294,340
Carbon monoxide	697
Unburned hydocarbons	77.2
Particulate matter	52.5
Sulfur dioxide	592
Nitrogen oxides	6,215

Knight Piésold CONSULTING

Diesel @ $5.60/gallon-$1.48/liter
3 NW100 Turbines

System Report - CLG_NW_Enercon.hmr

Sensitivity case

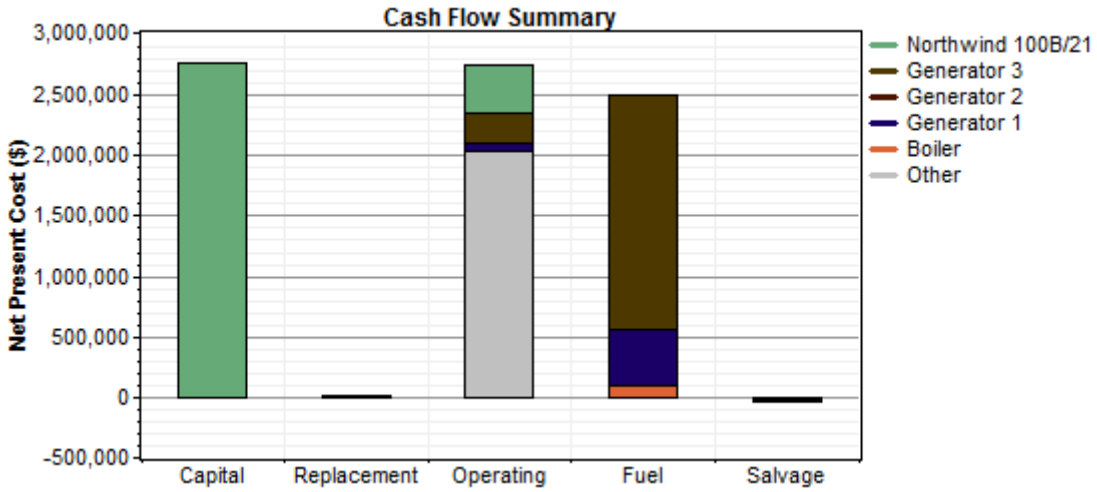
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 3 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 7,954,328
Levelized cost of energy	$ 0.844/kWh
Operating cost	$ 345,939/yr



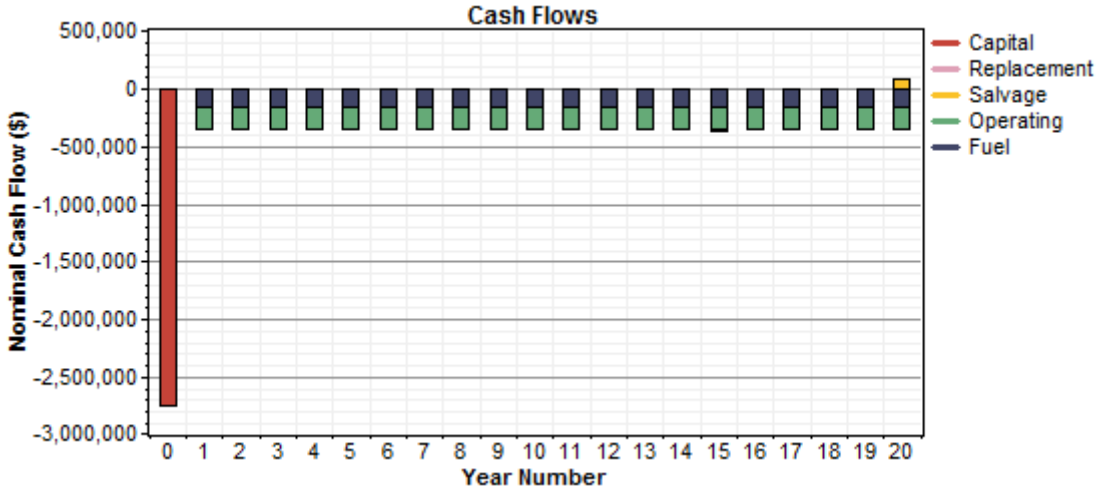
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	2,759,718	0	399,725	0	0	3,159,443
Generator 3	0	19,832	248,904	1,933,209	-10,478	2,191,467
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	58,802	448,488	-15,973	491,317
Boiler	0	0	0	101,542	0	101,542
Other	0	0	2,027,154	0	0	2,027,154
System	2,759,718	19,832	2,734,586	2,483,239	-43,048	7,954,327

Annualized Costs

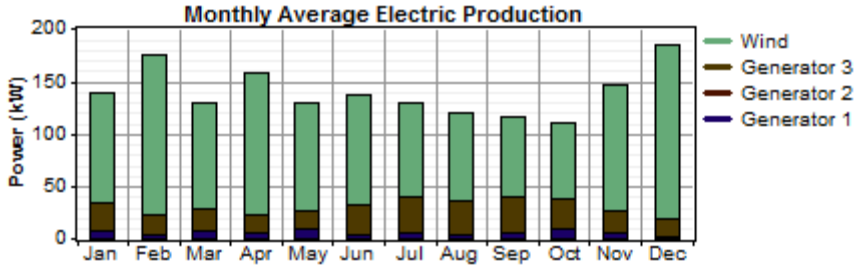
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	183,786	0	26,620	0	0	210,406
Generator 3	0	1,321	16,576	128,744	-698	145,942
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,916	29,867	-1,064	32,720
Boiler	0	0	0	6,762	0	6,762
Other	0	0	135,000	0	0	135,000
System	183,786	1,321	182,112	165,373	-2,867	529,725



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	951,523	78%
Generator 3	217,652	18%
Generator 2	0	0%
Generator 1	50,931	4%
Total	1,220,105	100%



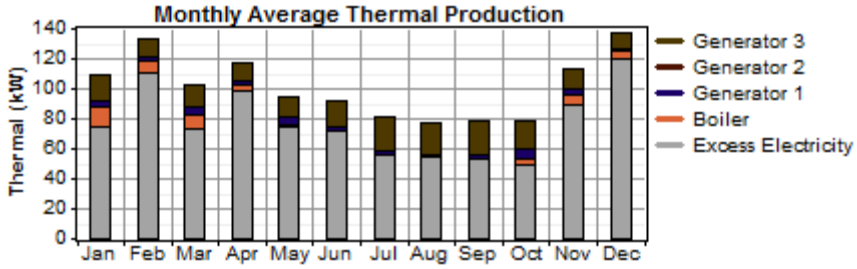
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	672,604	kWh/yr
Unmet load	0.000469	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.664	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	140,427	16%
Generator 1	33,959	4%
Boiler	38,216	4%
Excess electricity	672,604	76%
Total	885,205	100%



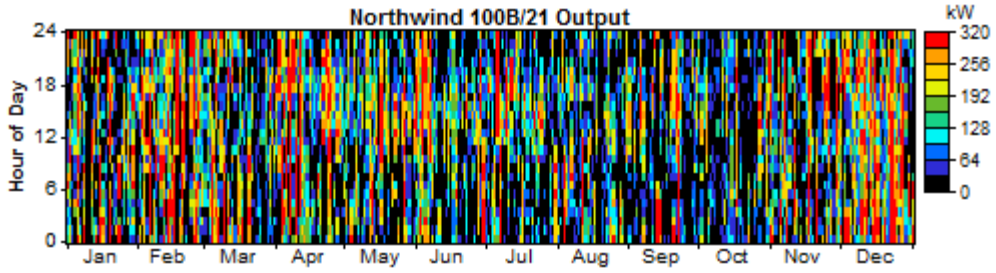
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	501,956	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	300	kW
Mean output	109	kW
Capacity factor	36.2	%
Total production	951,523	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	302	kW
Wind penetration	174	%
Hours of operation	7,238	hr/yr
Levelized cost	0.221	$/kWh

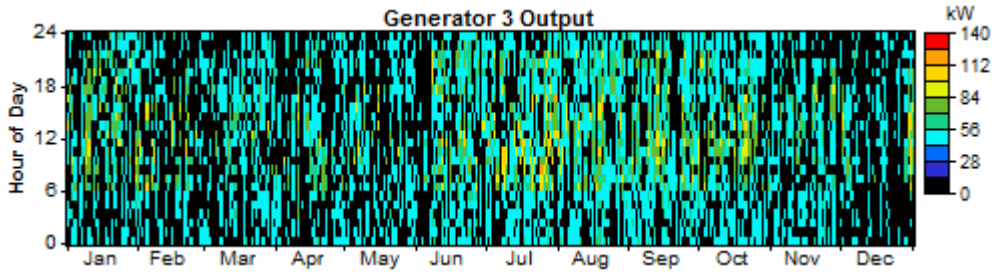


Generator 3

Quantity	Value	Units
Hours of operation	4,144	hr/yr
Number of starts	1,287	starts/yr
Operational life	14.5	yr
Capacity factor	17.1	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	217,652	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	140,427	kWh/yr
Mean thermal output	33.9	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	86,989	L/yr
Specific fuel consumption	0.400	L/kWh
Fuel energy input	855,971	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



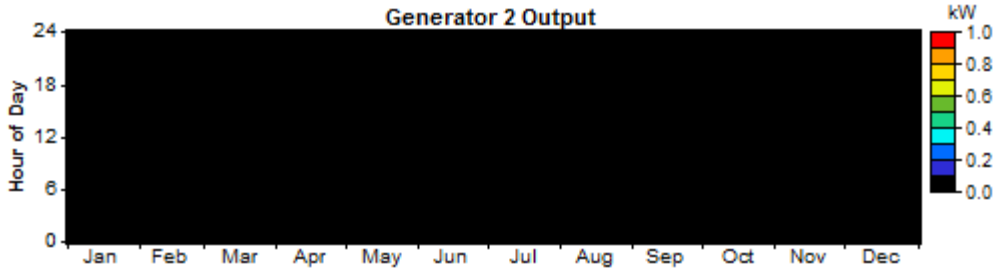
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



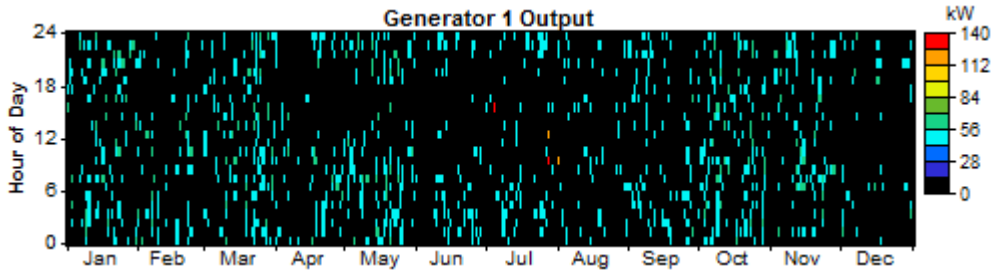
Generator 1

Quantity	Value	Units
Hours of operation	979	hr/yr
Number of starts	690	starts/yr
Operational life	61.3	yr
Capacity factor	3.63	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	50,931	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	33,959	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	20,181	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	198,578	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	294,302
Carbon monoxide	697
Unburned hydocarbons	77.2
Particulate matter	52.5
Sulfur dioxide	591
Nitrogen oxides	6,216

Knight Piésold CONSULTING

Diesel @ $6.36/gallon-$1.68/liter
3 NW100 Turbines

System Report - CLG_NW_Enercon.hmr

Sensitivity case

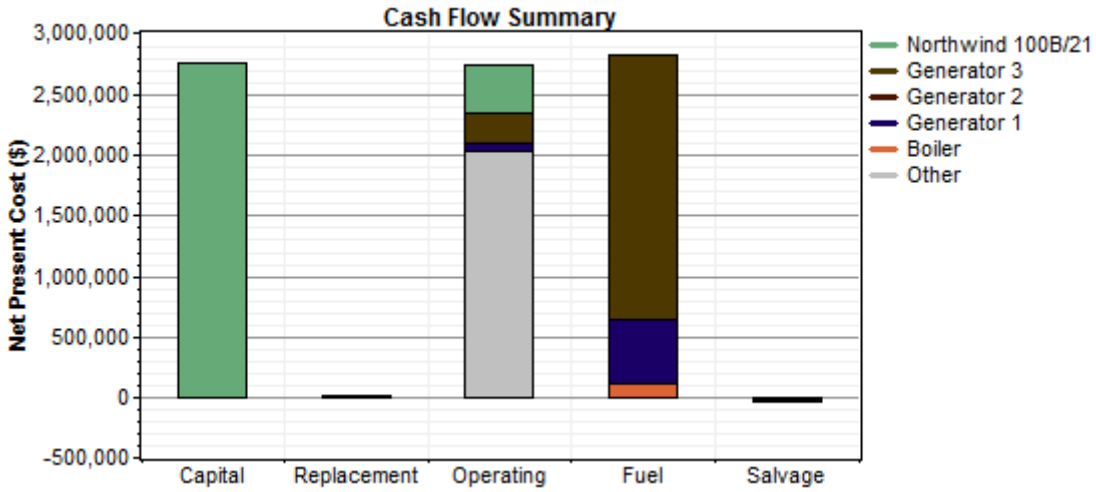
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 3 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 8,289,780
Levelized cost of energy	$ 0.868/kWh
Operating cost	$ 368,279/yr



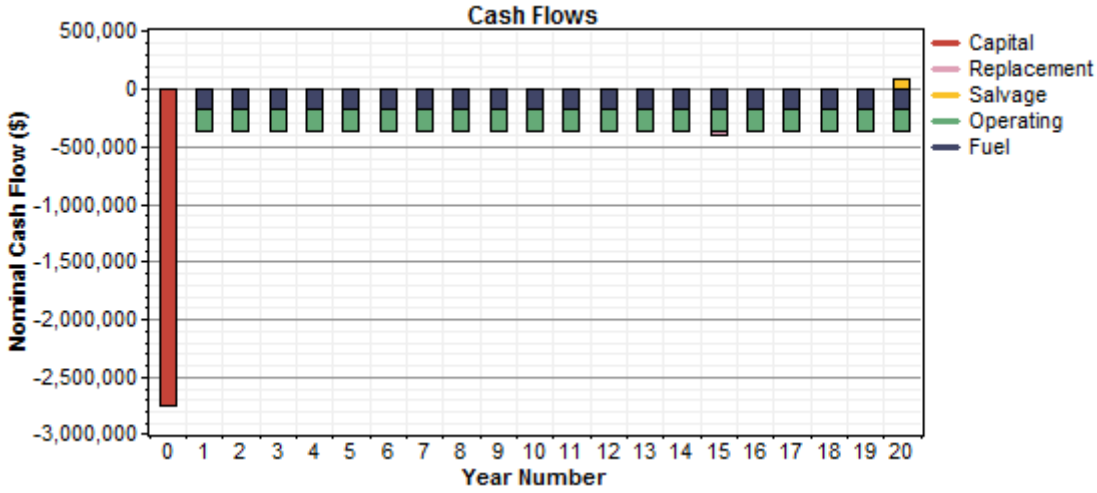
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	2,759,718	0	399,725	0	0	3,159,443
Generator 3	0	19,750	246,442	2,171,957	-10,709	2,427,439
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	61,265	531,721	-15,649	577,338
Boiler	0	0	0	115,001	0	115,001
Other	0	0	2,027,154	0	0	2,027,154
System	2,759,718	19,750	2,734,586	2,818,679	-42,956	8,289,778

Annualized Costs

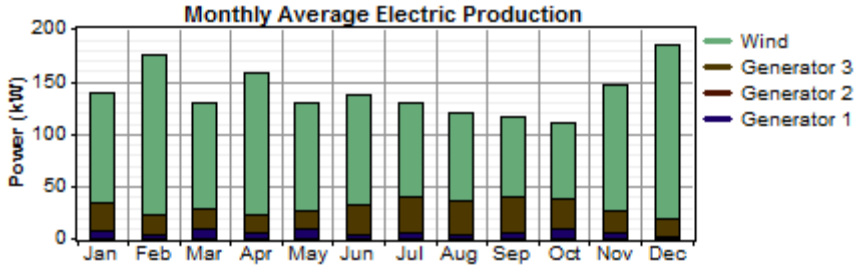
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	183,786	0	26,620	0	0	210,406
Generator 3	0	1,315	16,412	144,643	-713	161,657
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,080	35,410	-1,042	38,448
Boiler	0	0	0	7,659	0	7,659
Other	0	0	135,000	0	0	135,000
System	183,786	1,315	182,112	187,712	-2,861	552,064



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	951,523	78%
Generator 3	215,374	18%
Generator 2	0	0%
Generator 1	53,240	4%
Total	1,220,137	100%



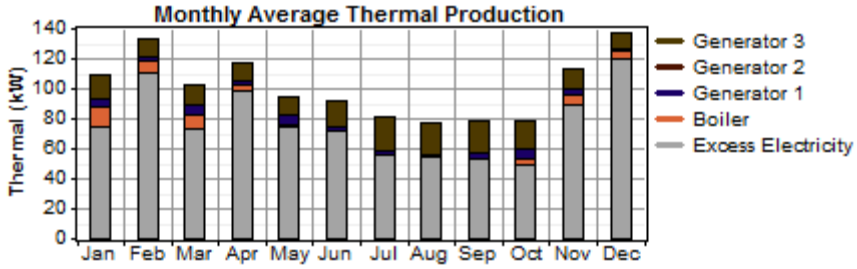
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	672,636	kWh/yr
Unmet load	0.000469	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.664	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	138,997	16%
Generator 1	35,458	4%
Boiler	38,129	4%
Excess electricity	672,636	76%
Total	885,219	100%



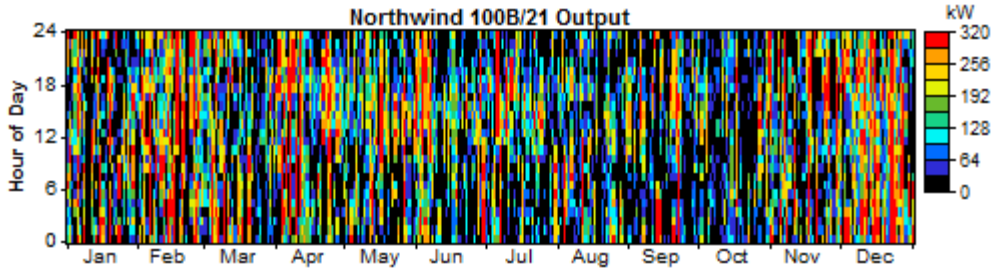
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	501,970	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	300	kW
Mean output	109	kW
Capacity factor	36.2	%
Total production	951,523	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	302	kW
Wind penetration	174	%
Hours of operation	7,238	hr/yr
Levelized cost	0.221	$/kWh

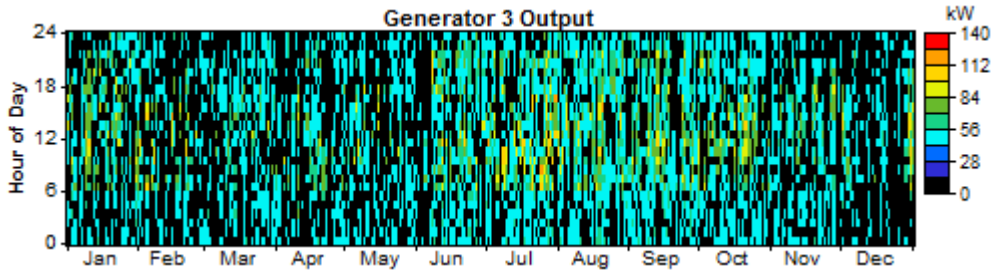


Generator 3

Quantity	Value	Units
Hours of operation	4,103	hr/yr
Number of starts	1,300	starts/yr
Operational life	14.6	yr
Capacity factor	17.0	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	215,374	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	138,997	kWh/yr
Mean thermal output	33.9	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	86,097	L/yr
Specific fuel consumption	0.400	L/kWh
Fuel energy input	847,196	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



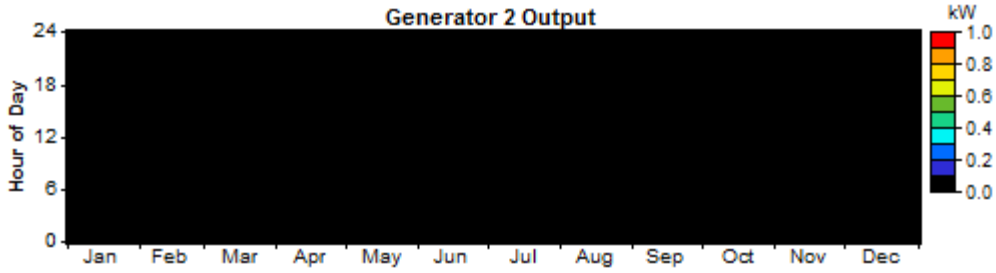
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



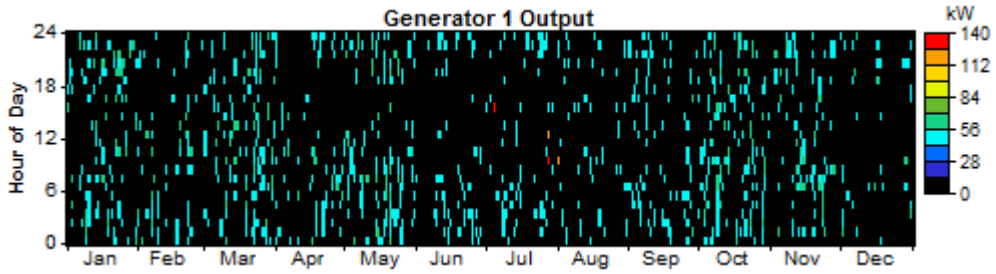
Generator 1

Quantity	Value	Units
Hours of operation	1,020	hr/yr
Number of starts	704	starts/yr
Operational life	58.8	yr
Capacity factor	3.80	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	53,240	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	35,458	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	21,078	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	207,404	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	294,288
Carbon monoxide	697
Unburned hydocarbons	77.2
Particulate matter	52.5
Sulfur dioxide	591
Nitrogen oxides	6,216

Knight Piésold CONSULTING

Diesel @ $4.40/gallon-$1.16/liter
3 NW100 Turbines
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

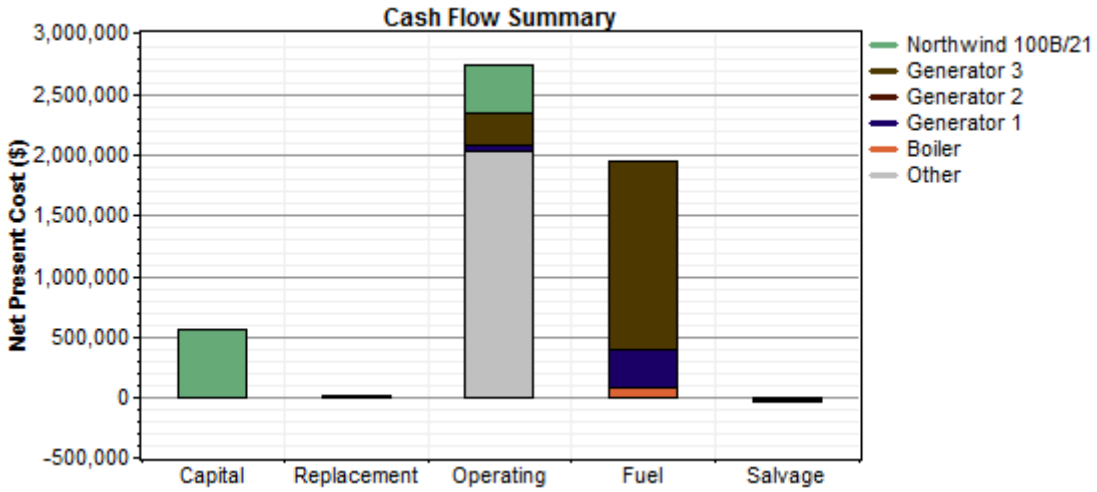
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.16 $/L
Heating Oil Price:	1.16 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 3 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,209,857
Levelized cost of energy	$ 0.537/kWh
Operating cost	$ 310,197/yr



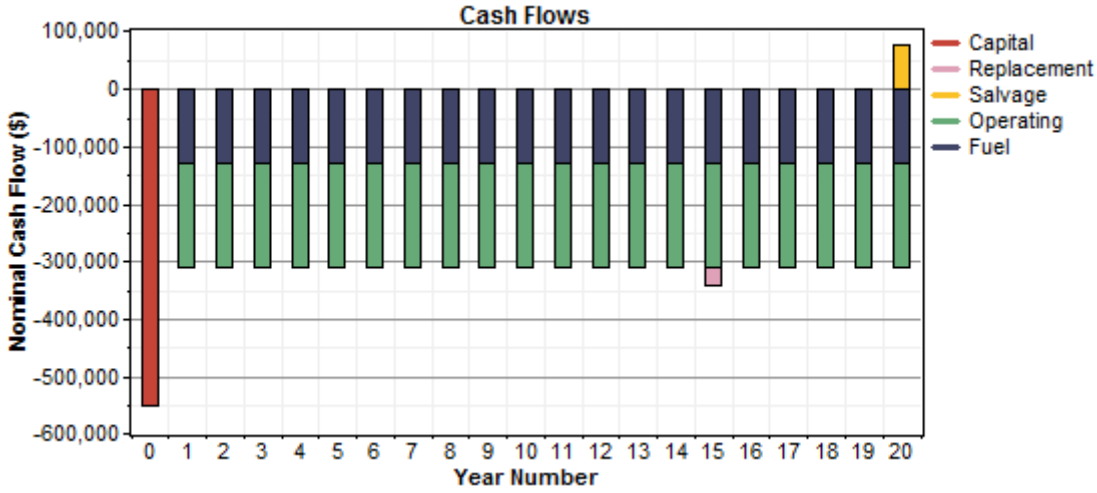
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	551,944	0	399,725	0	0	951,669
Generator 3	0	20,011	254,430	1,549,407	-9,958	1,813,889
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	53,277	317,144	-16,700	353,721
Boiler	0	0	0	80,020	0	80,020
Other	0	0	2,027,154	0	0	2,027,154
System	551,944	20,011	2,734,586	1,946,570	-43,256	5,209,856

Annualized Costs

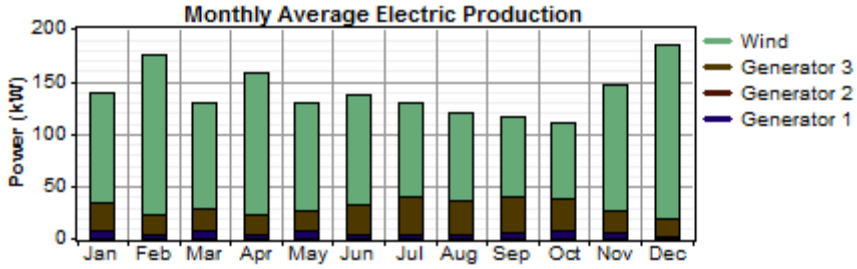
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	36,757	0	26,620	0	0	63,377
Generator 3	0	1,333	16,944	103,184	-663	120,797
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,548	21,120	-1,112	23,556
Boiler	0	0	0	5,329	0	5,329
Other	0	0	135,000	0	0	135,000
System	36,757	1,333	182,112	129,633	-2,881	346,955



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	951,523	78%
Generator 3	222,610	18%
Generator 2	0	0%
Generator 1	45,882	4%
Total	1,220,015	100%



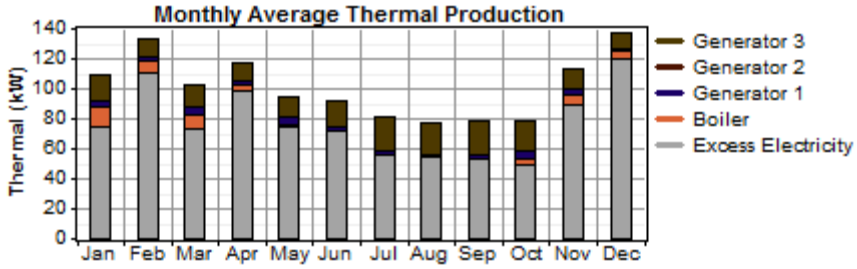
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	672,514	kWh/yr
Unmet load	0.000465	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.664	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	143,585	16%
Generator 1	30,654	3%
Boiler	38,424	4%
Excess electricity	672,514	76%
Total	885,176	100%



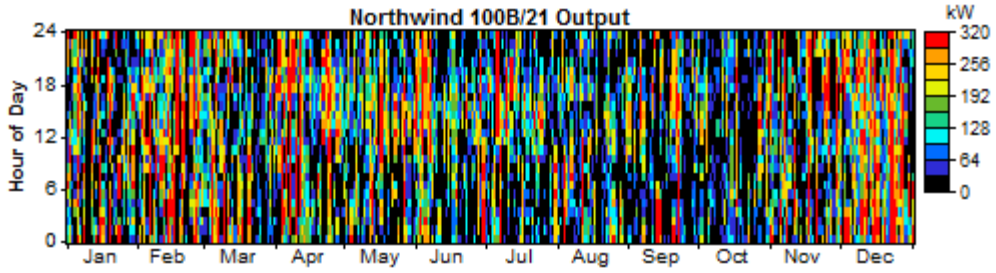
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	501,926	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	300	kW
Mean output	109	kW
Capacity factor	36.2	%
Total production	951,523	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	302	kW
Wind penetration	174	%
Hours of operation	7,238	hr/yr
Levelized cost	0.0666	$/kWh

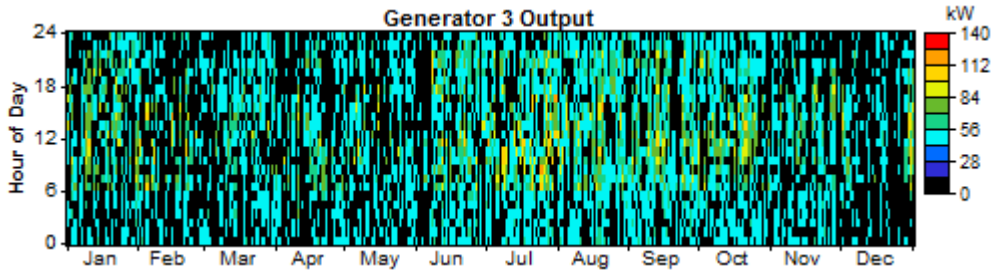


Generator 3

Quantity	Value	Units
Hours of operation	4,236	hr/yr
Number of starts	1,252	starts/yr
Operational life	14.2	yr
Capacity factor	17.5	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	222,610	kWh/yr
Mean electrical output	52.6	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	143,585	kWh/yr
Mean thermal output	33.9	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	88,952	L/yr
Specific fuel consumption	0.400	L/kWh
Fuel energy input	875,285	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



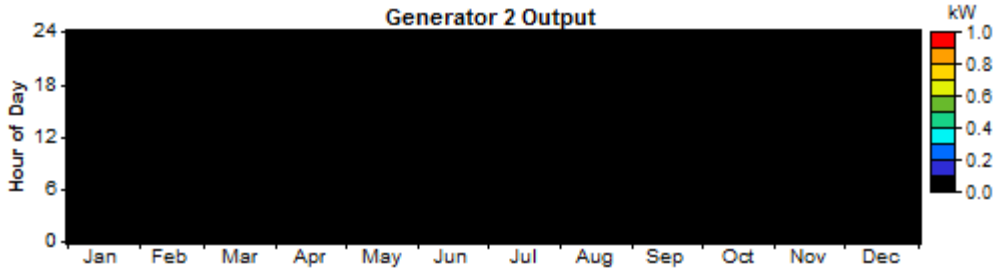
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	13.6	$/hr
Marginal generation cost	0.290	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



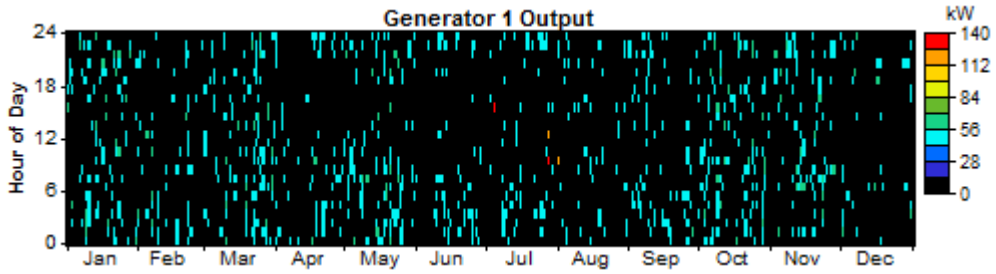
Generator 1

Quantity	Value	Units
Hours of operation	887	hr/yr
Number of starts	644	starts/yr
Operational life	67.6	yr
Capacity factor	3.27	%
Fixed generation cost	10.9	$/hr
Marginal generation cost	0.340	$/kWhyr

Quantity	Value	Units
Electrical production	45,882	kWh/yr
Mean electrical output	51.7	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	30,654	kWh/yr
Mean thermal output	34.6	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	18,207	L/yr
Specific fuel consumption	0.397	L/kWh
Fuel energy input	179,160	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	294,340
Carbon monoxide	697
Unburned hydocarbons	77.2
Particulate matter	52.5
Sulfur dioxide	592
Nitrogen oxides	6,215

Knight Piésold
CONSULTING

Diesel @ $5.60/gallon-$1.48/liter
3 NW100 Turbines
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

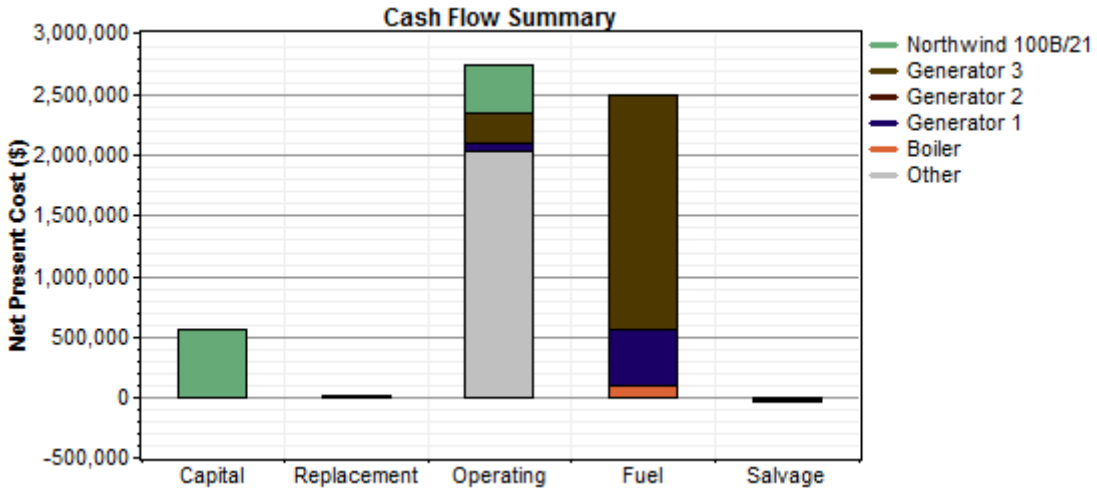
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.48 $/L
Heating Oil Price:	1.48 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 3 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 5,746,554
Levelized cost of energy	$ 0.575/kWh
Operating cost	$ 345,939/yr



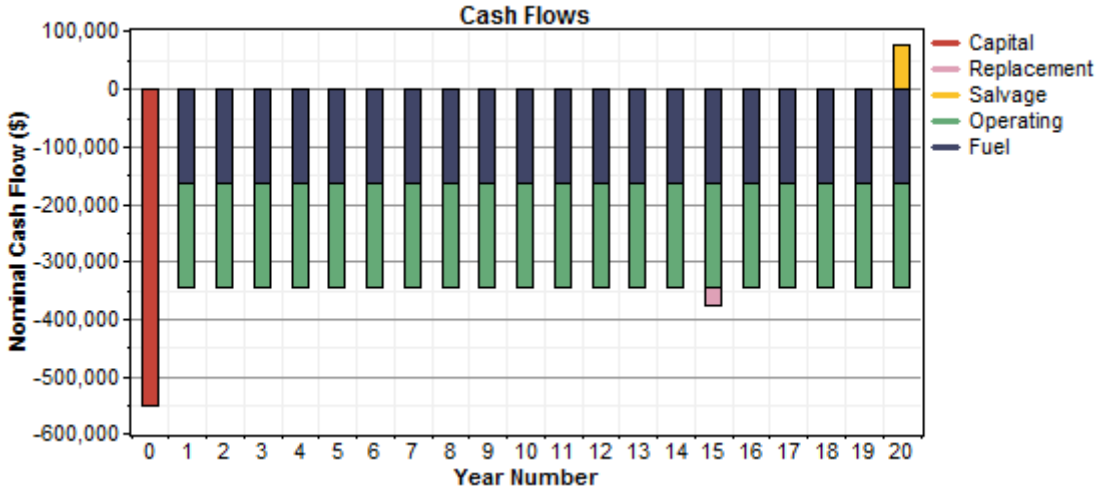
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	551,944	0	399,725	0	0	951,669
Generator 3	0	19,832	248,904	1,933,209	-10,478	2,191,467
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	58,802	448,488	-15,973	491,317
Boiler	0	0	0	101,542	0	101,542
Other	0	0	2,027,154	0	0	2,027,154
System	551,944	19,832	2,734,586	2,483,239	-43,048	5,746,552

Annualized Costs

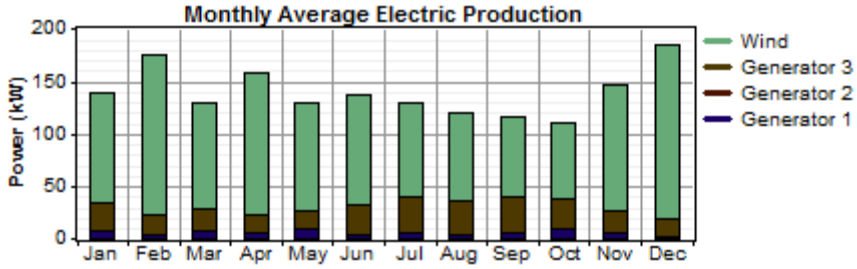
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	36,757	0	26,620	0	0	63,377
Generator 3	0	1,321	16,576	128,744	-698	145,942
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	3,916	29,867	-1,064	32,720
Boiler	0	0	0	6,762	0	6,762
Other	0	0	135,000	0	0	135,000
System	36,757	1,321	182,112	165,373	-2,867	382,696



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	951,523	78%
Generator 3	217,652	18%
Generator 2	0	0%
Generator 1	50,931	4%
Total	1,220,105	100%



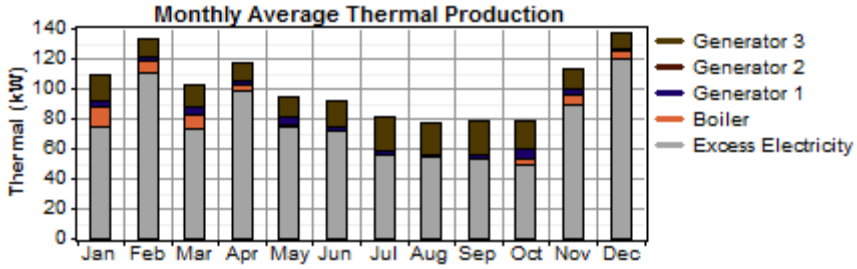
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	672,604	kWh/yr
Unmet load	0.000469	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.664	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	140,427	16%
Generator 1	33,959	4%
Boiler	38,216	4%
Excess electricity	672,604	76%
Total	885,205	100%



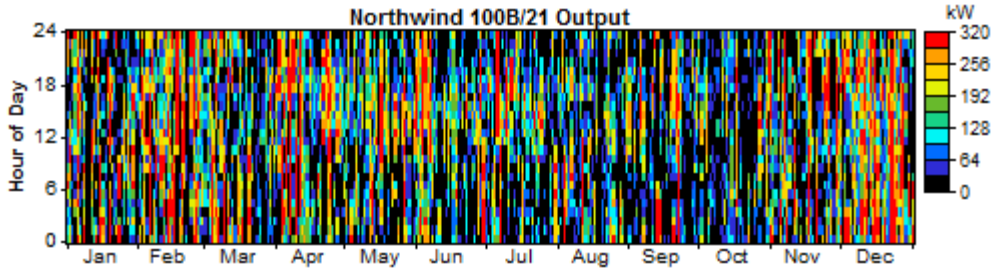
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	501,956	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	300	kW
Mean output	109	kW
Capacity factor	36.2	%
Total production	951,523	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	302	kW
Wind penetration	174	%
Hours of operation	7,238	hr/yr
Levelized cost	0.0666	$/kWh

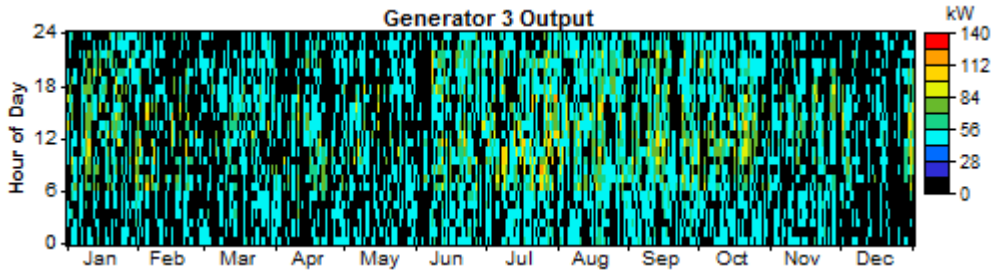


Generator 3

Quantity	Value	Units
Hours of operation	4,144	hr/yr
Number of starts	1,287	starts/yr
Operational life	14.5	yr
Capacity factor	17.1	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	217,652	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	140,427	kWh/yr
Mean thermal output	33.9	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	86,989	L/yr
Specific fuel consumption	0.400	L/kWh
Fuel energy input	855,971	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



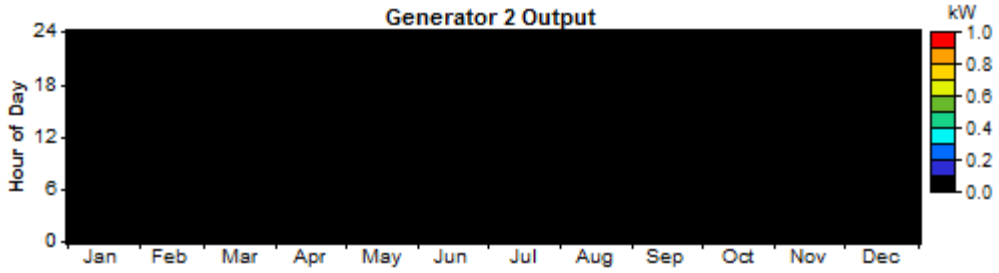
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	16.1	$/hr
Marginal generation cost	0.370	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



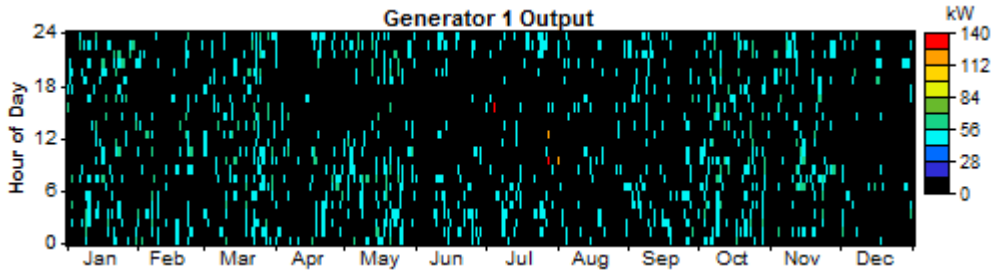
Generator 1

Quantity	Value	Units
Hours of operation	979	hr/yr
Number of starts	690	starts/yr
Operational life	61.3	yr
Capacity factor	3.63	%
Fixed generation cost	12.6	$/hr
Marginal generation cost	0.434	$/kWhyr

Quantity	Value	Units
Electrical production	50,931	kWh/yr
Mean electrical output	52.0	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	33,959	kWh/yr
Mean thermal output	34.7	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	20,181	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	198,578	kWh/yr
Mean electrical efficiency	25.6	%
Mean total efficiency	42.7	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	294,302
Carbon monoxide	697
Unburned hydocarbons	77.2
Particulate matter	52.5
Sulfur dioxide	591
Nitrogen oxides	6,216

Knight Piésold
CONSULTING

Diesel @ $6.36/gallon-$1.68/liter
3 NW100 Turbines
and 80-Percent Funded Project

System Report - CLG_NW_Enercon_80%funded.hmr

Sensitivity case

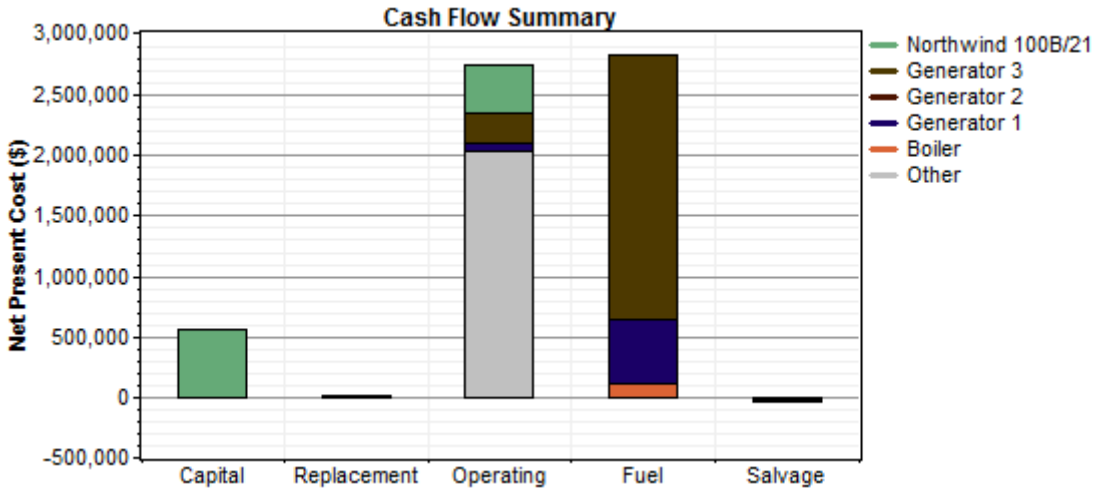
Thermal Load 1 Scaled Average:	1,050 kWh/d
Wind Data Scaled Average:	7.22 m/s
Diesel Price:	1.68 $/L
Heating Oil Price:	1.68 $/L
Northwind 100B/21 Capital Cost Multiplier:	1
Enercon E33 Capital Cost Multiplier:	1

System architecture

Wind turbine 3 Northwind 100B/21
Generator 3 145 kW
Generator 2 145 kW
Generator 1 160 kW

Cost summary

Total net present cost	$ 6,082,006
Levelized cost of energy	$ 0.599/kWh
Operating cost	$ 368,279/yr



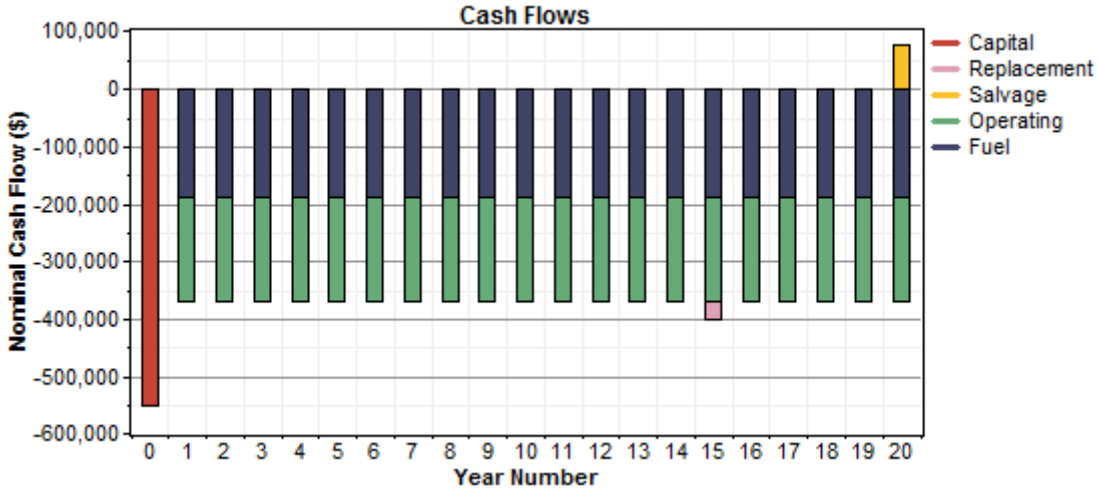
Net Present Costs

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	($)	($)	($)	($)	($)	($)
Northwind 100B/21	551,944	0	399,725	0	0	951,669
Generator 3	0	19,750	246,442	2,171,957	-10,709	2,427,439
Generator 2	0	0	0	0	-16,597	-16,597
Generator 1	0	0	61,265	531,721	-15,649	577,338
Boiler	0	0	0	115,001	0	115,001
Other	0	0	2,027,154	0	0	2,027,154
System	551,944	19,750	2,734,586	2,818,679	-42,956	6,082,004

Annualized Costs

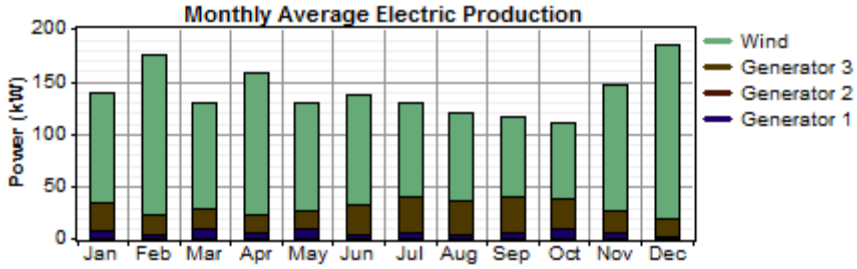
Component	Capital	Replacement	O&M	Fuel	Salvage	Total

	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
Northwind 100B/21	36,757	0	26,620	0	0	63,377
Generator 3	0	1,315	16,412	144,643	-713	161,657
Generator 2	0	0	0	0	-1,105	-1,105
Generator 1	0	0	4,080	35,410	-1,042	38,448
Boiler	0	0	0	7,659	0	7,659
Other	0	0	135,000	0	0	135,000
System	36,757	1,315	182,112	187,712	-2,861	405,036



Electrical

Component	Production	Fraction
	(kWh/yr)	
Wind turbines	951,523	78%
Generator 3	215,374	18%
Generator 2	0	0%
Generator 1	53,240	4%
Total	1,220,137	100%



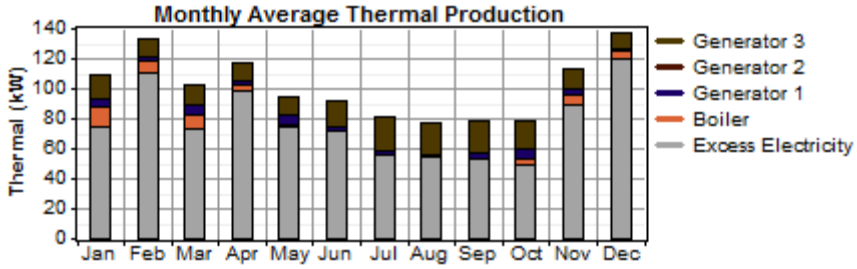
Load	Consumption	Fraction
	(kWh/yr)	
AC primary load	547,501	100%
Total	547,501	100%

Quantity	Value	Units
Excess electricity	672,636	kWh/yr
Unmet load	0.000469	kWh/yr

Capacity shortage	0.00	kWh/yr
Renewable fraction	0.664	

Thermal

Component	Production (kWh/yr)	Fraction
Generator 3	138,997	16%
Generator 1	35,458	4%
Boiler	38,129	4%
Excess electricity	672,636	76%
Total	885,219	100%



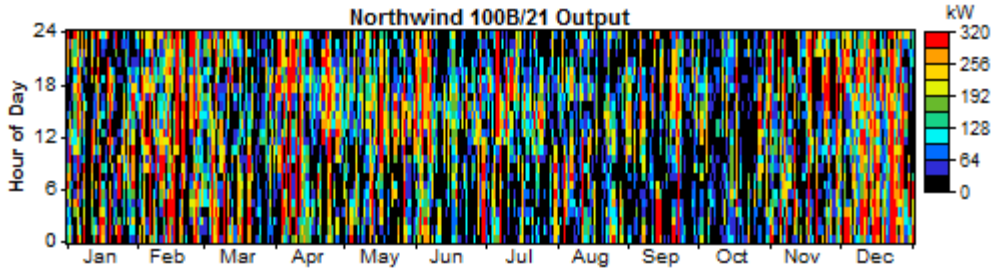
Load	Consumption (kWh/yr)	Fraction
Thermal load	383,250	100%
Total	383,250	100%

Quantity	Value	Units
Excess thermal energy	501,970	kWh/yr

AC Wind Turbine: Northwind 100B/21

Variable	Value	Units
Total rated capacity	300	kW
Mean output	109	kW
Capacity factor	36.2	%
Total production	951,523	kWh/yr

Variable	Value	Units
Minimum output	0.00	kW
Maximum output	302	kW
Wind penetration	174	%
Hours of operation	7,238	hr/yr
Levelized cost	0.0666	$/kWh

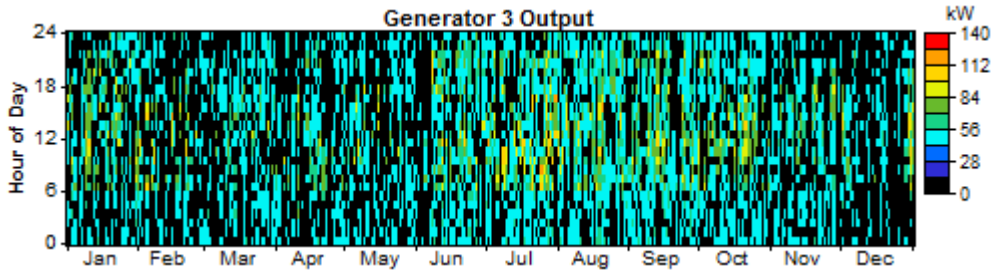


Generator 3

Quantity	Value	Units
Hours of operation	4,103	hr/yr
Number of starts	1,300	starts/yr
Operational life	14.6	yr
Capacity factor	17.0	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	215,374	kWh/yr
Mean electrical output	52.5	kW
Min. electrical output	43.5	kW
Max. electrical output	120	kW
Thermal production	138,997	kWh/yr
Mean thermal output	33.9	kW
Min. thermal output	31.0	kW
Max. thermal output	55.7	kW

Quantity	Value	Units
Fuel consumption	86,097	L/yr
Specific fuel consumption	0.400	L/kWh
Fuel energy input	847,196	kWh/yr
Mean electrical efficiency	25.4	%
Mean total efficiency	41.8	%



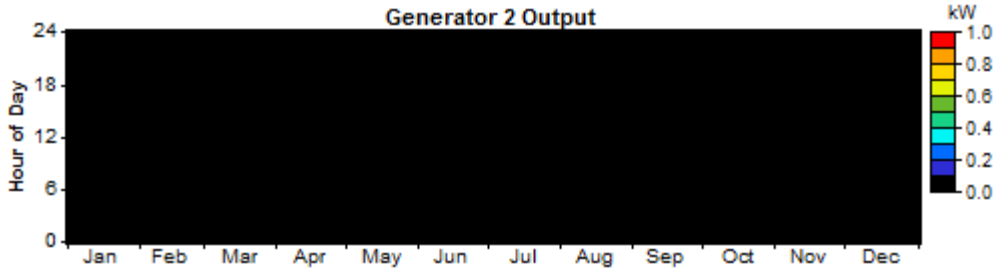
Generator 2

Quantity	Value	Units
Hours of operation	0	hr/yr
Number of starts	0	starts/yr
Operational life	1,000	yr

Capacity factor	0.00	%
Fixed generation cost	17.7	$/hr
Marginal generation cost	0.420	$/kWhyr

Quantity	Value	Units
Electrical production	0.00	kWh/yr
Mean electrical output	0.00	kW
Min. electrical output	0.00	kW
Max. electrical output	0.00	kW
Thermal production	0.00	kWh/yr
Mean thermal output	0.00	kW
Min. thermal output	0.00	kW
Max. thermal output	0.00	kW

Quantity	Value	Units
Fuel consumption	0	L/yr
Specific fuel consumption	0.000	L/kWh
Fuel energy input	0	kWh/yr
Mean electrical efficiency	0.0	%
Mean total efficiency	0.0	%



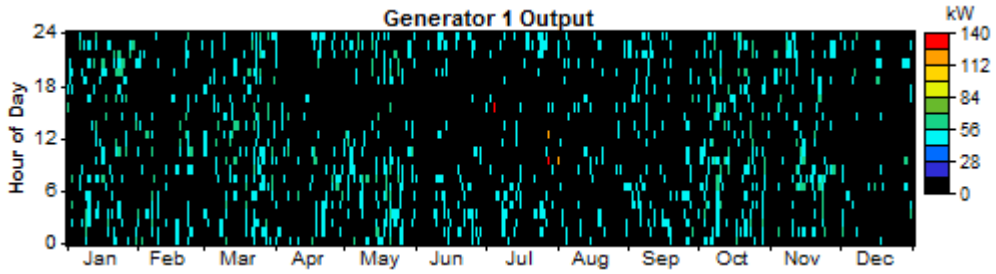
Generator 1

Quantity	Value	Units
Hours of operation	1,020	hr/yr
Number of starts	704	starts/yr
Operational life	58.8	yr
Capacity factor	3.80	%
Fixed generation cost	13.7	$/hr
Marginal generation cost	0.493	$/kWhyr

Quantity	Value	Units
Electrical production	53,240	kWh/yr
Mean electrical output	52.2	kW
Min. electrical output	48.0	kW
Max. electrical output	130	kW
Thermal production	35,458	kWh/yr
Mean thermal output	34.8	kW
Min. thermal output	32.9	kW

Max. thermal output	68.3	kW

Quantity	Value	Units
Fuel consumption	21,078	L/yr
Specific fuel consumption	0.396	L/kWh
Fuel energy input	207,404	kWh/yr
Mean electrical efficiency	25.7	%
Mean total efficiency	42.8	%



Emissions

Pollutant	Emissions (kg/yr)
Carbon dioxide	294,288
Carbon monoxide	697
Unburned hydocarbons	77.2
Particulate matter	52.5
Sulfur dioxide	591
Nitrogen oxides	6,216