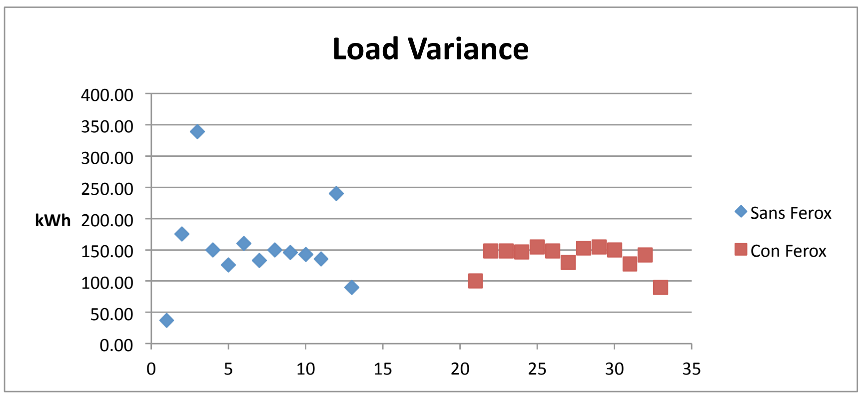
Customer A, Rawalpindi
Cummins Diesel Generator KTTA 19G 400Kva

Test Date: March 27, 2013

	Without FEROX								With FEROX								Saving %		
	Time	kWh	kWh (Net)	Load (kW)	Fuel IN	Return	Cons	Eff.	Time	kWh	kWh (Net)	Load (kW)	Fuel IN	Return	Cons	Eff.	Increased efficiency (Do more work with less fuel)	Decrease in Fuel consumption	Increase in kWh output
Runing Time	16:02	0.00			0.00	Return Collected and measured in Beaker	(Diesel intake - Return)		16:00	0.00			0.00	Return Collected and measured in Beaker	(Diesel intake - Return)				
	16:10	4.95	4.95	37.09	3.46				16:08	13.40	13.40	100.50	3.50						
	16:14	16.62	11.68	175.13	3.50				16:13	25.75	12.35	148.20	3.50						
	16:17	33.57	16.95	339.00	3.48				16:18	38.13	12.38	148.56	3.51						
	16:21	43.56	9.99	149.85	3.50				16:23	50.37	12.24	146.88	3.52						
	16:25	51.96	8.40	126.00	3.45				16:28	63.24	12.87	154.44	3.50						
	16:31	67.92	15.96	159.60	3.50				16:33	75.59	12.35	148.20	3.55						
	16:37	81.20	13.28	132.80	3.45				16:39	88.57	12.98	129.80	3.48						
	16:41	91.16	9.96	149.40	3.48				16:44	101.30	12.73	152.76	3.58						
	16:46	103.30	12.14	145.68	3.47				16:49	114.20	12.90	154.80	3.51						
	16:53	119.90	16.60	142.29	3.49				16:54	126.70	12.50	150.00	3.52						
	16:57	128.90	9.00	135.00	3.51				17:00	139.40	12.70	127.00	3.52						
	17:00	140.90	12.00	240.00	3.48				17:05	151.20	11.80	141.60	3.56						
	17:04	146.90	6.00	90.00	3.48	Liters	Liters	kWh/L	17:06	152.70	1.50	90.00	3.50		Liters	kWh/L			
Total	1:02	146.90			215.72	124	91.72	1.60	1:06	152.70			232.25	151	81.25	1.88	17.34%	-11.42%	3.95%
	62			142.16	3.48				66			138.82	3.52						
	Minuts			Avg load (kW)	Avg L/min				Minuts			Avg Load (kW)	Avg L/min						



Notes

1 This data was so close to being perfect. The only thing it needs is to have the return line measured at the same intervals as the Fuel In so we get net consumption for each chunk of data

2

The amount of fuel sent back through the return line is not constant, but varies with load. However, the relationship between load and fuel returned is neither direct nor linear (it is inverse and non-linear), so there is no way to guess how much fuel was returned during a time interval given the average load during that time and total fuel returned overall. In this case, we are only able to get average efficiency numbers because we only have average total fuel consumption. However, we were able to see Load Variance, which can be very useful.

3 Notice the large changes in load during the baseline on the Load Variance scatter plot above. Measuring in small intervals allows us to see how constant or variable the load is. Averaging over a day erases these pieces of insight. The more the load changes between baseline and Ferox runs, the less we can rely on averaged numbers to accurately represent the results.

4 I corrected the Total Fuel In. Because the time intervals are not all the same length, you can't just average the L/min measured for each chunk. Instead, you have to take the weighted average and multiply it by the total number of minutes run. I don't know if this is more correct because I suspect that the flow meter was set to instantaneous readout and an assumption was made that the value remained constant between measurments. We could get more accurate numbers by reading the total fuel flow between intervals rather than the flow rate at each measurement time.

5

Notice how the Fuel In rate remained almost constant the entire time during the baseline and Ferox treatment. In fact, during the Ferox treatment, the average Fuel In value was slightly higher than the baseline. However, the total fuel consumed was less during Ferox treatment despite running for an extra 4 minutes. This is most likely because the fuel pump just maintains a constant pressure on the fuel system and the actual fuel consumed is determined by the fuel injectors. To determine how much fuel the injectors used, it is necessary to measure the amount of fuel that went through the return line during each time interval. This can be done either by a second flow meter on the return line, or by just feeding the return into a beaker and measureing the weight or volume at each interval. If you only have one flow meter, you might establish what the average flow rate is on the Fuel In line, then if it seems safe to assume that the flow rate on Fuel In is constant (it was in this case), use the flow meter to measure only the return line during testing.

6

Notice how the average load during the Ferox test was slightly less than the baseline. Usually, gensets have an efficiency curve that peaks at a certain load and anything beyond it is considered overload because your efficiency starts to drop. Below the peak, the efficiency will drop as you approach lower loads. We don't know where that peak is in this case, so a skeptic might try to say the increase in efficiency could be attributed to the baseline being established in an overload state, and the Ferox demonstration run at closer to peak efficiency. However, there are two indicators that suggest this is not the case: (1) The average load between the two is only about 2.5% different. It's unlikely such a dramatic change in efficiency could be explained by a 2.5% change in load. (2) The scatter plot shows that except for three outliers, the loads between the baseline and Ferox runs were nearly identical.

7 Decrease in fuel consumption is only part of the story. We must also look at how much work was done. When you account for the additional power produced, the benefit goes from around 11% to over 17%.

8 Notice that the change in efficiency is not equal to the sum of the change in fuel consumption and the change in power production.

9 Notice that the biggest change in fuel consumption showed up in how much fuel was returned, rather than how much fuel was pumped into the Fuel In line.