A Case for Centralization of Utilities in an Industry

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Abstract

There are many forms of systems that industries adopt to ensure that their plants run optimally, with minimal cost and ensuring availability of equipment and machines. Industries choose either to centralize or decentralize their utility system for certain varied reasons since each has benefits and limitations.

This paper outlines the benefits that have been achieved through centralization of two utility systems namely; compressed air system and emergency diesel generators. From a total of nine generators, the centralization and synchronization process required only five, with the other four being available for sale thus recovering some initial capital. Centralization of the air compressors enabled the company to save on energy consumption. In both cases, this translated to lowered maintenance costs and better utilization of machines. Factors to consider when deciding which system to adopt are discussed and the benefits reaped are demonstrated by the case study.

Keywords: Availability; Utilization; Synchronization; Maintenance

1 Introduction

Kapa Oil Refineries Limited is located along Mombasa Road near Syokimau Railway Station. It manufactures a range of products and has five different production departments namely Refinery, Soap, Baking and Noodles, Detergent, Tissue, Boiler and Effluent Treatment Plants, which run throughout but this may change depending on changes in product demand. As a result, power availability has to be prompt and adequate at all times and from this is borne the need for emergency generators in the absence of utility supply. Nine stationary generator sets were distributed around the company, ranging in size from 500 to 1,675 KVA.

The gensets are of diesel-fueled engine prime movers and in each location, there was sufficient quantity of fuel stored both on day tanks and underground tanks. These were also conforming to the required regulations. The total tank capacity of these units is more than 64,000 liters.

Maintaining all the units is only one of the challenges of owning standby gensets. The noise produced when running the units disturbs not only the employees working but also the exhaust fumes from the gensets may be drawn into ventilation systems thus causing false alarms and complaints especially to the neighborhood. We can say that standby genset are a necessary evil.

2 Methodology.

In 2018, the company undertook a decision to centralize the emergency power. Unlike the common centralized compressed air system, the emergency-only gensets had a very limited amount of run time to result in any energy savings. The decision was driven the need for better utilization; as some gensets were running at less than 40%, safety, noise and maintenance costs.

Data on machine efficiency and reliability that had been collected over a three year period was analyzed. The analysis captured the size, location, age, and actual load of all the decentralized gensets. Actual load profile was also analyzed and projection of plant upgrades were included to determine the combination of the gensets that would give us the optimum capacity.

Site selection for the Centralized Generator Plant (CGP) was done taking into consideration the impacts of noise and exhaust. Location and sizing of both the day and underground tank were done to ensure smooth running of the gensets. Nearness to existing cable racks was also considered as the plant had to connect to the existing main substation.

2.1. Central generator plant

From the nine available gensets, the CGP required only five which had a capacity of 5,400 KVA (4,320 kW). The site location was made easier by the fact that we had a place where we had four gensets in one place which was also far from the main administration block.

Table 1. Table of gensets showing location & size and the ones selected for synchronization

No.	Location	Model & Make	Rating (KVA)	CGP (KVA)	CGP (kW)	Opt. Load (kW)
1	Refinery Plant 1	Cummins, KTA38-G5	1125			
2	Refinery Plant 2	Cummins, KTA50-G8	1675	1675	1340	938
3	Boiler House	Cummins, QST 30-G4	1100	1100	880	616
4	Toilet Soap	Cummins, KTA38-G5	1125	1125	900	630
5	Baking	Cummins, KTA38-G5	1125			
6	LB Soap Plant	Cummins, KTA38-G5	1000	1000	800	560
7	LB Soap Plant	Volvo / TAD1631GE	500	500	400	280
8	LB Soap Plant	Volvo / TAD1631GE	500			
9	LB Soap Plant	Volvo / TAD1641GE	550			
	TOTAL		**8700**	**5400**	**4320**	**3024**

2.2. Site Preparation

Preparation for location for the generator set mounting and auxiliary systems before installation always saves system down time. The items below were performed prior to installing the generator set:

- Concrete pad – Enough distance was left between generators to ensure it met the required distancing. According to Cummins (2016), the recommended spacing for open DG set in open room are; free space on both sides – minimum of 2 metres, free space at the front when outlet is placed at the front – minimum of 1.5 meters, free space at the rear – minimum of 2 meters and the distance between two sets is 1.5 meters. We took the option of insulating the exhaust pipes so that we could have the gensets as close as possible.
- Intake air – Since engine intake air is provided from air in the room, walling was kept to a bare minimum while utilizing mesh. To ensure positive air supply when engine(s) are in operation. The recommended fresh air inlet area should be a minimum of 1.5 times the radiator area while the hot air discharge opening area should be at least 2.5 times the radiator area (Cummins, 2016).
- Fuel supply – To improve on maintenance and also identify and repair leakages in a timely manner, the fuel supply piping was located on/above floor level.
- Exhaust – The exhaust system was insulated to ensure that the heat generated would not remain in the room.

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A Contractor's office had to be relocated so as to accommodate the other gensets and the generator shed redesigned taking into account the air flow for cooling the gensets. The site was ideal since it had a high voltage cable rack near it (see Figure 1). Since the gensets are rated 415V, we had to include a step up transformer to enable tying the system together with the 11KV main supply. New lines were put from the existing day tank to accommodate the increased number of generators. The underground diesel fuel tank was of insufficient capacity (10,000L); a bigger capacity tank (30,000L) was installed to meet the requirements. Water lines were modified as well to accommodate the changes.

The key benefits of centralization include ability to allow us to choose a generator sets combinations that are most cost-effective.Redundancy and number of generators in a centralized generator gives flexibility in the design and helps to optimize the number of generators that have been installed thus ensuring high availability. With CGP, since sizing of the generators was informed by calculations of the worst-case scenario (maximum actual load experienced at peak production), it is possible to match the number of generators with the real load or even delay the relocation of some gensets as we wait for plant growth or expansion.

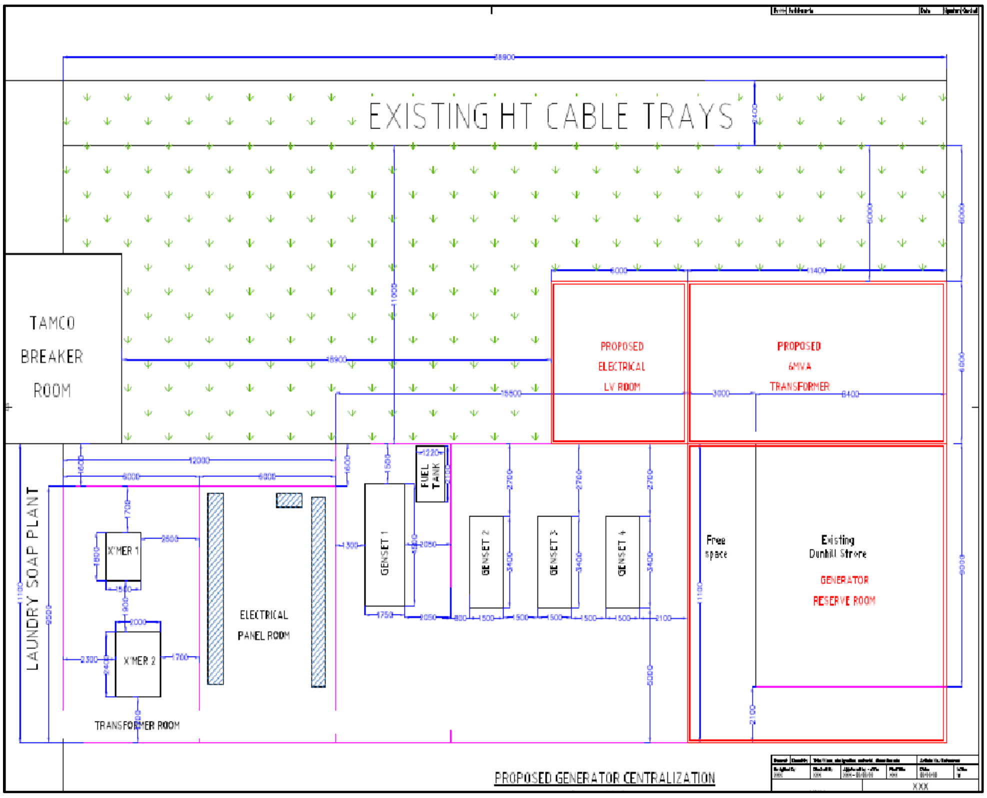

Figure 1: Layout of the four existing generator set and proposed location for centralized generator plant: Pre-intervention set up.

3 RESULTS

Figure 2 below shows the layout of the Centralized Generator Plant.

Table 2. Generator generation rate in 2018, 2019, 2020

Period	Diesel Consumed (L)	Generator Run Hours	Generated kWhrs	Generation Rate Watts/litre
2018	50,936	74.40	104,323	27.528
2019	42,697	60.13	96,206	37.473
2020	19,787	50.75	59,110	58.863

In 2018 the generator run hours was 74.40 in comparison to 2019 which was 60.13 and 2020 was 50.75. This was coupled with diesel fuel consumption of 50,936liters, 42,697liters and 19,787liters respectively. The energy generation (kWhrs) was 104,323 (2018), 96,206 (2019) and 59,110 (2020) while the power generated per liter of diesel fuel in 2018 was 27.528, in 2019 was 37.473 and in 2020 was 58.863.

Table 3. Fuel and Maintenance costs for pre- and post CGP

	Pre-CGP	Post-CGP	Savings
Fuel Cost	4,301,323.00	1,622,929.00	2,678,394.00
Maintenance Cost	3,250,400.00	1,514,125.00	1,736,275.00

Table 3 presents results of the CGP intervention. Pre-CGP fuel cost was KES. 4,301,323.00 while post-CGP costs were KES. 1,622,929.00; the savings from the intervention were KES 2,678,394.00. The maintenance costs pre-CGP were KES 3,250,400.00 while post-CGP costs were KES 1,514,125.00; the savings from the intervention were KES 1,736,275.00.

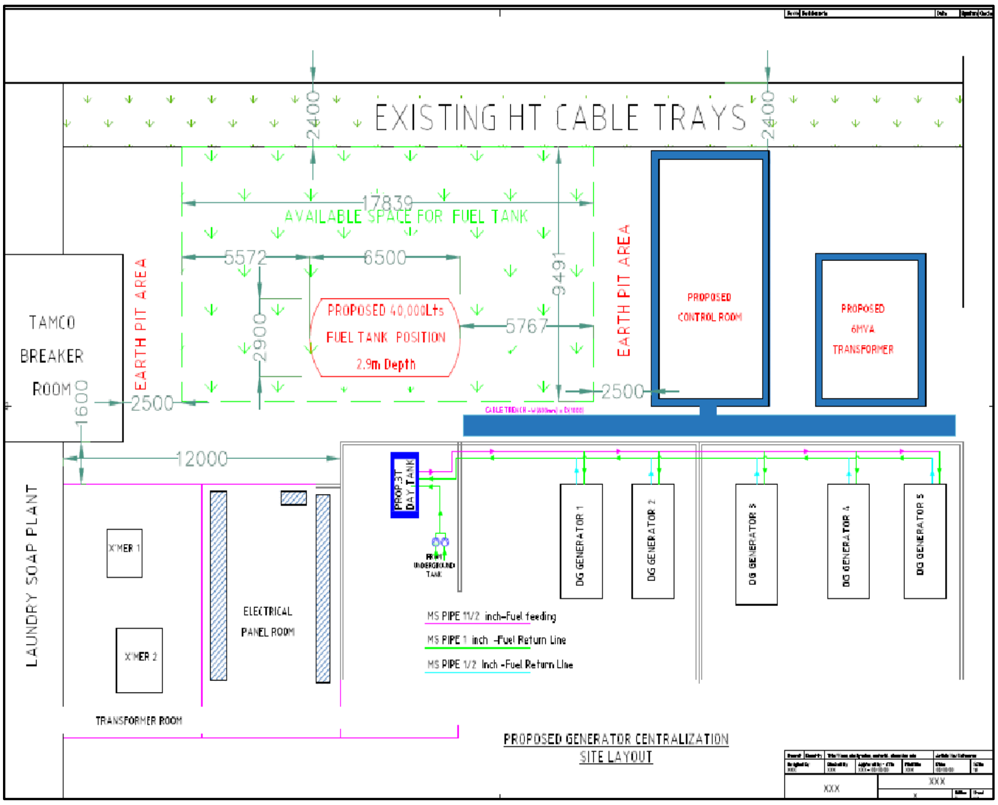

Figure 2: Layout of the five synchronized generator set including the underground tanks and switchroom

4 Discussion

Improved utilization of the gensets resulted in an increase in the wattage produced per litre; by increasing load the gensets efficiency translating to lowered cost of power produced. This translated in financial savings within the period of one year to the tune of over two million and about two million in fuel and maintenance cost respectively. A total savings of over four million was realized.

5 Conclusions

Executing a CGP at Kapa has been a success. The company management is satisfied with the location of all the diesel engines in one place in the plant. Costs associated with maintenance and fuel stocks holding reduced, with an average savings of approximately KES 1.7M per year with the generation rate increasing from about 35 to 59 watts per litre (60% improved production). As the location had existing gensets, there was no requirement to adjust to the environment. The reorganization of the gensets created a win-win situation for the company as growth of plant will require minimal expansion of the CGP.

Acknowledgement

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References

1. Cummins, P. G.: DG Set Installation Recommendation. 3243795 (2016).