Contents

Table of Figures

Table of Tables

1. Abstract

This report discusses the analyses of ten different real-world load profiles through a MATLAB application and the design of two generating stations as part of a Complex Engineering Problem-based project for EE-411 Power Generation at NEDUET.

The report first provides an introduction to generating stations and their indispensable role in all modern power grids. It then briefly defines economic and technical metrics which can be used to analyse load profiles before discussing in detail 10 such real-world load profiles and how they could be improved. A MATLAB application is presented to assist in the technical, economic, and comparative analyses of these load profiles, the two least satisfactory of which are identified for further improvement. In this regard, the report proposes a design for two generating stations in the form of 3D models for powering the aforementioned load profiles, and relates specific design decisions to improvements in the load profile's technical and economic metrics.

2. Generating Stations

Electricity has become an indivisible part of our life today. It is required for many domestic, commercial as well as industrial purposes, and the requirement is still increasing day by day. This bulk demand for electric power is supplied by huge electric power-generating stations or power plants. Some fuel source, such as coal, oil, natural gas, or nuclear fuel produces heat, which is then used to boil water to create steam. The steam under high pressure is used to spin turbine coupled with the shaft(s) of one or more alternators or generating units. Generators then provide electric power to the grid through a transmission and distribution system. Indeed, generating stations are the source of all power

The type of power plant is defined by the type of main energy source. Today, most electric energy is generated from 4 major types of power plants - thermal, nuclear, hydroelectric, and nuclear. Since each has its own merits and demerits, there is no 'one-size-fits-all' solution to the problem of designing an economic, efficient, and ecological generating station for a given *load profile*.

3. Load Profile Metrics

Prior to proposing new or modified designs for a generating station, it is imperative to analyse the *load profile* of consumer(s) the station will serve - the variation of the network's receiving end demand over a specific period of time e.g. 24 hours. These metrics can be broadly classified into two categories: technical and economic.

3.1 Technical Metrics

1. Base Load: The minimum load that must always be supplied by a generating station.
2. Peak Load: The maximum load which a generating station has to supply. Also known as the maximum demand.
3. Average Load: The mean of all loads supplied by a generating station in a given period of time. Expressed as the ratio of area under a load profile to the load profile duration T.

$$Average\ Load = \frac{Area\ under\ Load\ Profile\ in\ T}{T} = \frac{\sum_{t=1}^{T} kW_t \times t}{T}$$

4. Load Factor: Perhaps the single, most important technical metric in the analysis of a load profile. It is the ratio if the average load to the maximum demand, and represents the proportion of time that a given load makes full use of installed plant capacity.

$$Load\ Factor = \frac{Average\ Load}{Max\ Demand} = \frac{Units\ Generated\ in\ T}{Max\ Demand \times T}$$

$$0 \leq Load\ Factor \leq 1$$

   The ideal load factor is 1 - such a load is always drawing the maximum possible power from a generating station, and thus proved the most revenue to recover (and exceed) the cost of operating the generating station. The lower the load factor, the lesser the revenue, and thus the higher the cost of generating a single unit of energy.

5. Units of Energy: a single 'unit' of energy represents a single kilowatt-hour: the energy generated by a power source of 1 kW operating for 1 hour.
6. Demand Factor: The ratio of a power station's maximum demand to its connected load.
7. Diversity Factor: The ratio of the sum of individual maximum demands to coincident maximum demand.

Metrics 6 and 7, along with Plant Use Factor and Plant Capacity Factor, are more relevant to generating stations rather than individual feeders or consumers.

3.2 Economic Metrics

1. Fixed Cost: Capital costs such as cost of purchasing equipment, rent, land, and salaries of senior management. Fixed costs do not change with either the installed capacity or amount of energy produced by a generating station.
2. Semi-Fixed Cost: These costs will vary with the installed capacity of a generating station, but are independent of the amount of energy produced.
3. Variable Cost: Costs that depend entirely on the amount of energy produced by a generating station - fuel, maintenance, transportation, storage, daily wages.
4. Per kW Cost: The cost incurred per each kW of installed plant capacity.
5. Per kWh Cost: The cost incurred per each unit of electrical energy produced.
6. Levelized Cost of Energy (LCOE)/Overall per Unit Cost: The minimum price at which kWhs of energy must be consistently sold over a generating station's lifetime in order to break even and completely recover all expenses made. It can be thought of as the average of all costs of building, maintaining, and operating a generating station over the energy it produces.

Fixed, semi-fixed, and variable costs of generation (over the same timespan) can be combined to compute an overall cost per kWh cost with a three-part expression as follows:

$$\frac{Overall\ Cost}{Unit\ Generated} = \frac{Fixed\ Cost + Semi - Fixed\ Cost + Variable\ Cost}{kWh\ Generated}$$

$$\frac{Overall\ Cost}{Unit\ Generated} = \frac{Fixed\ Cost + b \times Max\ Demand + c \times Units}{kWh\ Generated}$$

Alternatively, the same metric can be computed in terms of the cost per kW and kWhs

$$\frac{Overall\ Cost}{Units\ Generated} = \frac{Cost\ per\ kW + Cost\ per\ kWh}{kWh\ Generated}$$

$$= \frac{A \times Max\ Demand + B \times Units}{kWh\ Generated}$$

b, c , A, and B are constants that depend on various economic and logistic factors such as cost of fuel storage and transportation, machine longevity, etc.

4. Load Profiles

The table below provides names and descriptions of 10 different load profiles selected for analysis as part of this project. In addition to profile's unit consumed and load factors, the table also provides analyses of the consumption patterns along with recommendations to improve load factor.

Table 1: Summary of Load Profiles

<table>
<tr><th colspan="2">Household Electricity Survey [1]</th><th colspan="2">Commercial Building - Indonesia [2]</th></tr>
<tr><td colspan="2">This load profile shows the electricity demand for domestic use and water heating. For our CEP we have considered the demand during the winter season while The actual load profile compares demand during summer and winter, where the demand for heating during winters is quite high due to lower ambient external temperatures.</td><td colspan="2">Electrical load profile of commercial building (shopping center) in Indonesia. The original load profile in the case study includes shopping centers, hotels, private and government offices and hospitals. Load (kwh) is on Y axis and time is on x axis. Since Shopping centers have the highest electrical load due to major utilities including Air conditioners and lighting system we have chosen its load profile for our experiment.</td></tr>
<tr><td>Load Factor = 0.63</td><td>Units Consumed = 278332</td><td>Load Factor = 0.60</td><td>Units Consumed = 220666</td></tr>
<tr><td>Analysis</td><td>Recommendations</td><td>Analysis</td><td>Recommendations</td></tr>
<tr><td>This load profile shows the electricity demand for domestic use and water heating. For our CEP we have considered the demand during the winter season while The actual load profile compares demand during summer and winter, where the demand for heating during winters is quite high due to lower ambient external temperatures.</td><td>To manage this highly volatile load profile the generators at the power station should be turned on and off repeatedly. The base load can be powered by a nuclear power plant while a diesel generator is suitable for this to manage the peaks during high demand hours, as they take less time to start up.</td><td>In this case a shopping center opens at around 9 AM and then continues to consume an almost constant amount of electricity (7000 KW) until closing time around 11 PM. Afterwards, there is low constant power demand of 1000 KW which can be attributed to the night lights, security systems and air condition of security rooms etc.</td><td>This type of non-varying load for specific period of time can be supplied with a steam power plant, as generating station can be setup before the peak load on the system is expected.</td></tr>
</table>

<table>
<tr><th colspan="2">Commercial Buildings - Hangzhou [3]</th><th colspan="2">Hybrid Grid System [4]</th></tr>
<tr><td colspan="2">Load profile analysis for commercial buildings micro grids under demand response in Hangzhou region, china. The load profile originally simulated the load variations of commercial users in micro grids before and after the demand response. We have chosen the load profile before the demand response to access the region’s raw data.</td><td colspan="2">This is a load profile of an undisclosed commercial installation from an energy audit conducted by Huxham Energy, an Australian energy consulting firm.</td></tr>
<tr><td>Load Factor = 0.51</td><td>Units Consumed = 305542</td><td>Load Factor = 0.41</td><td>Units Consumed = 22215.5</td></tr>
<tr><th>Analysis</th><th>Recommendations</th><th>Analysis</th><th>Recommendations</th></tr>
<tr><td>Commercial buildings usually don’t operate during the night time hence the demand is quite low at night. During the day the demand is moderate while at around 9 and 10 PM the peak demand occurs due to lighting and air conditioning load.</td><td>As before this load is manageable with a steam based power plant or a hydro power plant as the commercial load is periodic. During the off time (after midnight) the power station can be shut down as the demand is very low, for energy savings.</td><td>The load profile shows a lot of variation. The base load is only ~22 kW, but rises to a ~1100 kW around midday. Between 1 PM and 5 PM, there is constant variation of ~100 to 200 kW around 900 kW. Demand decreases eventually at night.</td><td>With a load factor of 0.41, this load profile is a strong candidate for improvement. This load should either employ belly filling during the initial hours of the day, or use a generating solution that is inexpensive to switch on and off.</td></tr>
<tr><th colspan="2">Indonesian Industrial Load [5]</th><th colspan="2">Zambia Residential Sector [6]</th></tr>
<tr><td colspan="2">Daily load profile for an industry where the electricity consumption could be attributed to the operations of mechanical machineries and equipment, electricity-driven thermal equipment (i.e. induction furnace and electric heater), heating, ventilation and cooling (HVAC) facilities, lighting, as well as control and instrumentation systems.</td><td colspan="2">This graph shows the average daily load profile for the electricity consumption pattern of Zambia’s residential sector in 2008. This study was done alongside the annual electricity consumption survey to suggest policy options for suitable development of Zambia’s electricity sector.</td></tr>
<tr><td>Load Factor = 0.75</td><td>Units Consumed = 101823</td><td>Load Factor = 0.59</td><td>Units Consumed = 331093</td></tr>
<tr><th>Analysis</th><th>Recommendations</th><th>Analysis</th><th>Recommendations</th></tr>
<tr><td>The load profile suggests that the main operation occurs after the midnight as the power demand during those hours is high, this could be due to the fact that</td><td>Averagely the demand is between 1500 and 2500 KW with occasional peaks during day time. To supply such a load a diesel station can be used as they can</td><td>Demand during the day (7AM to 2PM) is almost constant i.e. at 1150 MW while after midnight hours it is very low. The demand becomes high during peak load</td><td>Hydro plant will be ideal as demand is high most of the time. The peak at night increases demand to almost twice the base load, hence a diesel station will be</td></tr>
</table>

electricity tariff is low during low demand which could be beneficial for the industry.	handle occasional load peaks and have less standby losses.	hours i.e. between 8 PM and 11 PM because of the lighting load at night	very costly. A coal based power plant can also be fit for this demand curve.
Residential Simulation [7]		**Industrial Park [8]**	
Load curve of a single day of 1000 households with around 12 appliances each, composing thus an amount of approximately 12000 simulation elements. This type of simulation can provide the relevance of a determined power consumer in the household consumption. The 1000 household sample is composed of a distribution of the different social groups according to real statistical data, in order to obtain a sample of households that is as close as possible to reality. Rent social groups according to real statistical data, in order to obtain a sample of households that is as close as possible to reality.		The given load profile depicts the variations of electricity load of an industrial park with an electric-heat system which provide electricity and heating facility to all its users.	
Load Factor = 0.46	Units Consumed = 18944.3	Load Factor = 0.65	Units Consumed = 188540
Analysis	**Recommendations**	**Analysis**	**Recommendations**
The demand increases during the night time (8 PM to 11 PM) because of lighting load. The demand stays capped at around 400 KW during the day time (6 AM to 6 PM), with only occasional peaks occurring due to coincidental operation of heavy appliances. During the sleeping hours (after 12 AM to 5 AM) the demand is the lowest at 200 KW.	The gradual increase in demand during the day is a periodic trend for a residential consumer. Hence a hydroelectric or a diesel fuel based power plant can used to provide such load. The starting time for these power plants is very less hence can be used to manage peaks in the load curve.	Industrial parks have a constant power demand as the production in industries continues 24/7. During the day average demand is 50 MW. The load profile has 2 very peaks, the latter (8PM to 11PM) occurring during night because of additional lighting and heating load. The other peak occurs in the early morning when the shift starts at industries, likely due to the startup of machines.	Coal and/or hydroelectric power plants are capable of providing reliable and variable bulk power to the electric load. Diesel plants will be uneconomical, especially since variation is relatively gradual. Belly filling during off-peak hours may be a viable solution, especially between peaks.

San Francisco Suburb [9]		San Francisco Downtown [10]	
A simplified, custom load profile for a hypothetical suburban area on the outskirts of San Francisco. Comprises load profile data for 60 residential consumers, primary and secondary schools, hospitals, OPDs, midrise apartments, restaurants, and supermarkets aggregated by hour over the same 24 hour period. These load profiles are from the US Department of Energy's Open Data Catalog, which provides a year of kWh consumption data for 16 standardised commercial building types as well as residential consumers for all TMY3 locations in the US.		A simplified, custom load profile for a hypothetical commercial and industrial installation in Downtown San Francisco. Created by aggregating loads for several warehouses, quick and full service restaurants, large and small offices, large and small hotels, hospitals, OPDs, strip malls, and a few midrise apartments. These load profiles are from the US Department of Energy's Open Data Catalog, which provides a year of kW consumption data for 16 standardised commercial building types as well as residential consumers for all TMY3 locations in the US.	
Load Factor = 0.71	Units Consumed = 167785	Load Factor = 0.72	Units Consumed = 273426.15
Analysis	**Recommendations**	**Analysis**	**Recommendations**
Much like the city's downtown counterpart, demand starts to increase at 6 AM but declines by 9 PM instead of 7 PM. Peak demand is lower since there are fewer heavy induction load (motors, compressors, etc.) in this district owing to fewer commercial or industrial buildings.	While the load factor is high, it can be improved through demand side management. Since peak hours coincide with those of downtown, tariffs should be imposed to as a disincentive for consumers to distribute consumption over 24 hours.	Shows a much higher demand than residential counterpart, because load such as hotels, offices, warehouses, and restaurants consume more power. Demand begins to increase sharply after 6 AM and then stays high until 7 PM before gradually decreasing by midnight.	In addition to demand side management recommended for the suburb, the large power consumption may justify expenditure on belly filling equipment.

Graphs of these load profiles are provided as part of the MATLAB application (discussed in the following section) and in Appendix A.

5. Load Profile Analysis Application

As part of this CEP, a Load Profile Analysis application was built with MATLAB App Designer to allow users to perform technical, economic, and comparative analyses of the 10 load profiles discussed in Section (X.Y). For a chosen load, the app displays the load profile's graph and relevant metrics along with a description, recommendations to improve the profile's load factor, and an online reference to the load profile's data.

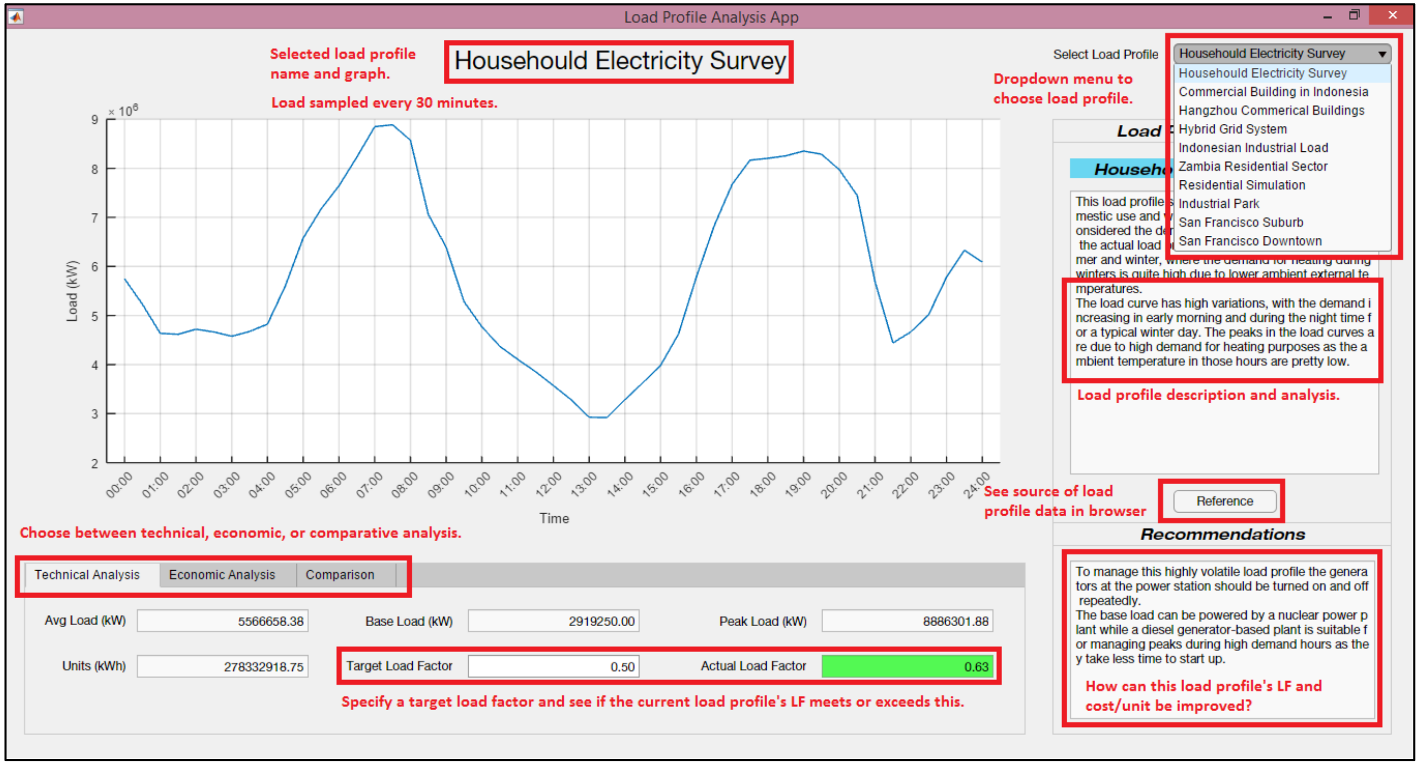

Figure 1: Salient features of Load Profile Analysis App - Metric Panels

Data Organization: Load profile data is stored as an Excel spreadsheet. Descriptions, recommendations, and references for each profile are stored as TXT files with profile's name in separate folders, and are loaded into the app as and when required.

Functionality: The user selects one of the available load profiles from the dropdown menu, after which the load profile graph is displayed along with its description and recommendation. The user can then explore the load profile in more detail in the context of three separate tabs:

1. *Technical*: Allows the user to gain a technical understanding of the load profile by giving the user tools to:
   a. View minimum, maximum, and average load (in KWs) for each load profile.
   b. View number of units consumed (kWhs) by the load in the 24-hour period.
   c. Specify an ideal or target load factor which the load profile should meet as a benchmark for operational efficiency.
   d. View the actual load factor along with a colour-coded indication of whether this factor meets the ideal value specified in 1(c).
2. *Economic*: Provides the user with all necessary information required for the costing or financial analysis of a load profile. The user can:
   a. Specify rates or tariffs for either a two-part or three-part tariff cost of generation per kWh, and compute the cost accordingly.
   b. View the total kWhs consumed in the 24-hour period.
   c. Specify an ideal overall cost per kWh generated as a target to be met by the load profile.
   d. View the actual overall cost per kWh generated along with a colour-coded indication of whether it meets the benchmark in 2(c).
3. *Comparison*: Get a comparative, bird's eye view of all load profiles relative to each other. Specifically, the user can:
   a. Compare and contrast the per-unit cost of generation and load factors of all load profiles in a single visualization.
   b. Specify tariffs for computing a two-part overall cost per unit generated for all load profiles, and update the visualization accordingly.
   c. Identify the load profile with the best (highest) load factor and best (lowest) overall cost per unit generated.

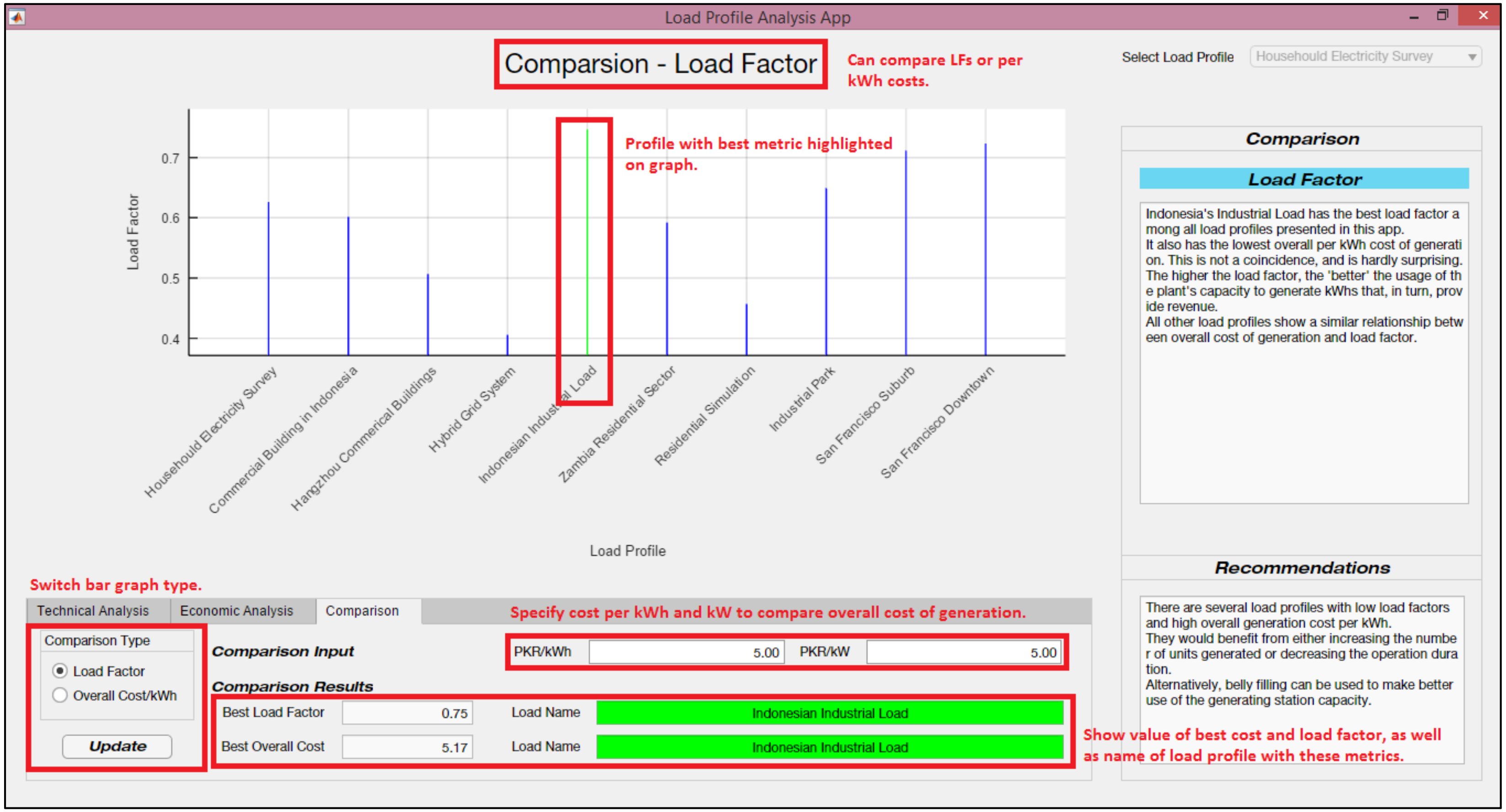

Figure 2: Salient features of Load Profile Analysis App - Comparison Panel

6. Choosing Load Profiles for GX Station Design

The two load profiles with the lowest load factors and, unsurprisingly, the highest overall cost per unit generated are:

1. Hybrid Grid System [4] - a load profile of an undisclosed commercial installation conducted by Huxham Energy Consulting form.
2. Zambia's Residential Sector [6] - estimated daily load profile of all residential consumers in Zambia.

One way of load factor improvement is demand side management: offering consumers incentives not to use energy during peak hours. This will reduce maximum demand and distribute consumption more evenly over the day, thus improving load factor.

Alternatively, generating stations can be designed or modified to make energy generation more economical for the same load factor. To this end, designs for diesel-based thermal and nuclear power stations are proposed for [4] and [6] respectively.

Diesel Power Plant for [4]

[4]'s load profile shows the most variation over 24 hours, with demand repeatedly fluctuating several hundred kWs in a span of only a few hours, and sometimes even within an hour. Meeting such a volatile demand requires constant switching of generator units, which can be expensive and inefficient - gas or coal-fired generators have a limited number of switching cycles, and usually take time to operate and synchronise. This is precisely why a diesel engine-based plant is a good choice for the load profile: the slightly higher fuel cost is offset by the benefits achieved by being able to rapidly operate and shut down diesel generating units to closely follow a demand profile. Furthermore, the peak load is only a few hundred kWs, which is low compared to that of other load profiles, which means fuel costs will be low. This, coupled with the benefits of being able to switch generator units on and off quickly, means the diesel plant is an economic and efficient solution for this load profile.

Nuclear Plant for [6]

[6]'s load profile shows a demand of the order of hundreds of MWs, which makes it a good candidate for a nuclear, thermal, or hydroelectric power plant. While a thermal power plant based on coal or gas could also provide the same bulk power, a nuclear plant is more ecologically and economically sound: there are few, if any, greenhouse

gases produced by a nuclear power plant, and the high energy density of fissile material means operating and fuel costs are significantly lower - enough to offset the high capital cost of the plant over its useful life. The variation in demand is also far more gradual than in other load profiles, and can thus be met with control rod actuation in a nuclear power plant.

7. Modeling Power Stations

As per the requirement of the CEP which highlighted us to design models for 2 of the load profiles along with their technical and economic analysis, we have proposed a nuclear power plant for [6] and a diesel power plant for [4].

2D layouts of both power stations are provided in Appendix B.

8. Generating Station 1 - Diesel Station

8.1 Operating Schedule and Generating Sizing

Since this power station supplies bulk power to a commercial load, a power factor of 0.85 has been assumed. Based on the load profile, the required generators are 30 kVA, 235 kVA, 355 kVA, and 710 kVA with an additional 710 kVA generator for reserve capacity. These generators were selected from CAT's line of industrial diesel generators [11].

Table 2: Operating Schedule - Diesel Power Plant

Duration	Generators Operating (kVA)	Duration	Generators Operating (kVA)
00:00 - 04:00	30	16:30 - 17:00	710, 235
04:00 - 05:00	235	17:00 - 19:00	710
05:00 - 07:00	235, 355	19:00 - 19:30	235, 355
07:00 - 08:30	710	19:30 - 20:30	355
08:30 - 10:00	710, 235	20:30 - 00:00	30
10:00 - 16:30	710, 235, 355	-	-

8.2 Power Station Design and Recommendations

From the analysis of load profile [4] in the previous section we recommended proper generator size and running schedule for the required demand. We proposed 4 diesel generators with capacities mentioned in the previous section. The main salient features of our 3D model are as follows:

a. 4 diesel generators which acts as a prime mover are situated inside a generator house, as per the requirement of the load. The actual capacity and the dimensions of the diesel generators used for this model can be found at [11]. Sufficient space between the generators was left to avoid any mechanical obstruction during operation.

b. 4 Large fuel storage tanks were placed right outside the generator house with underground piping systems to supply fuel to the diesel engines.

c. 2 day fuel tanks are placed inside the generator house that are fed from the main fuel tanks outside the building. The day fuel tanks are directly connected the diesel engines via fuel pumps that takes fulfils the immediate fuel needs of the engines for roughly a day.

d. 2 exhaust pipes can be seen right beside the generator house. A network of pipes carry the exhaust gases from the diesel engines out in the air via a silencer and a purifier.

e. Oil tanks are also placed inside the same building as the generators to provide oil to the generators for lubrication via a pump.

f. Electric control panels are placed right beside each generator which are used to monitor generator output power parameters and other maintenance features.

g. Since a Diesel station requires very less amount of water hence can be placed away from a water body. The minimal amount of water required can be fulfilled via a small water tank on the site.

h. A second building is also situated on the plant site which houses LPG cylinders which can be used a form of auxiliary fuels in case of primary fuel shortage. The same building also contains auxiliary oil storage tanks.

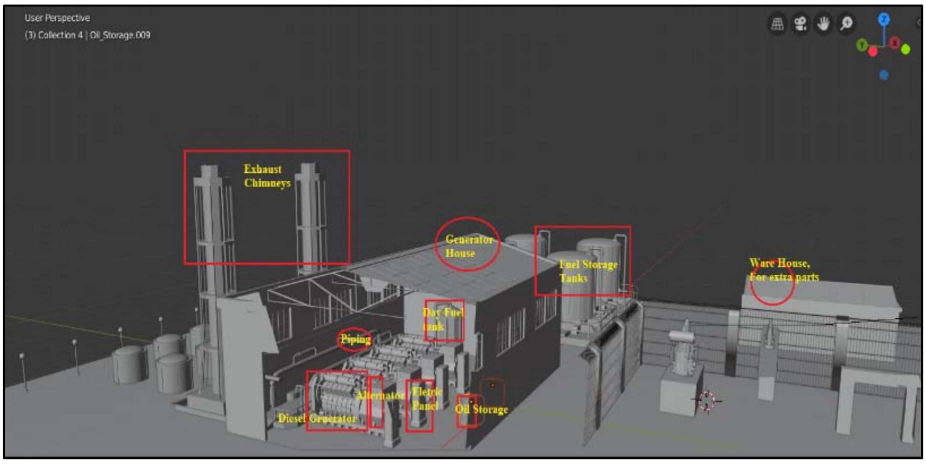

Figure 3: Diesel Power Station 3D Layout - View A

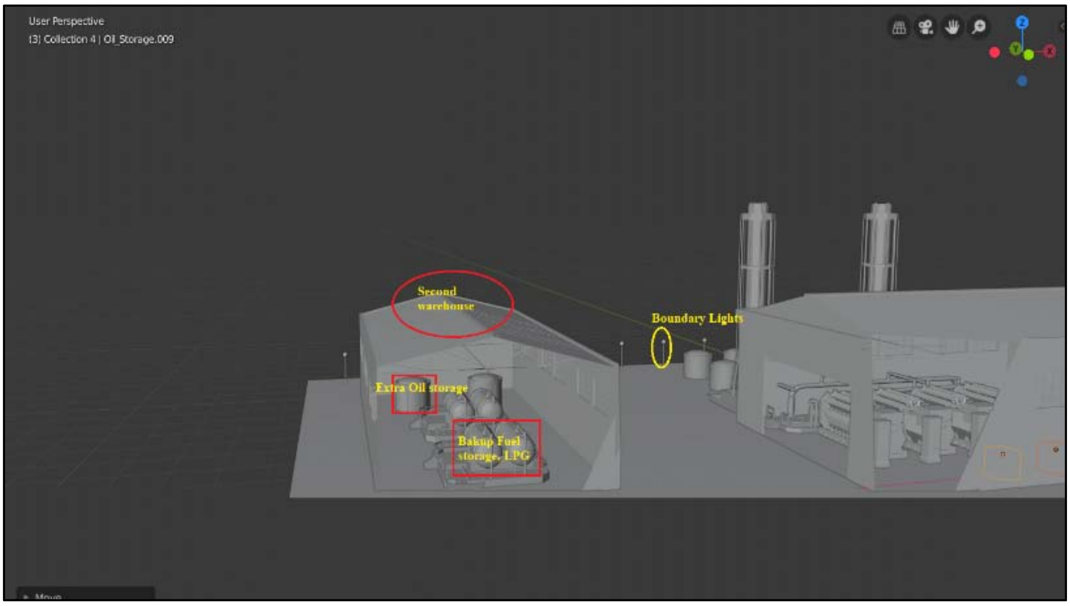

Figure 4: Diesel Power Station 3D Layout - View B

9. Generating Station 2 - Nuclear Station

9.1 Generator Sizing and Operating Schedule

The nuclear generating station powers a Zambia's residential sector. As such, a standard residential power factor of 0.9 is assumed.

This station therefore requires generators of capacities 225 MVA (200 MW), 340 MVA (300 MW), 680 MVA (600 MW), with another 680 MVA reserve generator. All generators for this plant were selected from Siemens SGen line [12].

Table 3: Operating Schedule - Nuclear Power Plant

Duration	Generators Operating (MVA)	Duration	Generators Operating (MVA)
00:00 - 04:00	340	14:00 - 17:30	680, 225
04:00 - 05:00	225, 340	17:30 - 21:30	680, 225, 340
05:00 - 06:00	680	21:30 - 23:00	680, 340
06:00 - 14:00	680, 340	23:00 - 00:00	225, 340

9.2 Design and Recommendations

For our Load profile [6] we have gone with a nuclear power plant that has been related to the load profile in the previous section. A nuclear power plant is an expensive investment for any country whose construction must be sorted out and planned way before its construction starts. Hence a practical 3D model is ideal for this. Similarly we have made a 3D model that can be served as a blueprint for a real power plant, its salient features are discussed below:

a. The main power house of a nuclear power plant is the nuclear reactor. In our model we have there is a single nuclear reactor placed inside a containment building, sited in the center of the power plant. The nuclear reactor contains nuclear fuel rods and control rods, which produces heat, which is used to heat water inside tubes.
b. These tubes carry the hot water to heat exchanger, which is placed inside the containment building right next to the nuclear reactor. Using a pump the steam is pressurized and sent to the generator rooms through tubes.
c. There are 2 generators in separate rooms whose shafts are attached to steam turbines. The steam from the heat exchanger is passed through the turbines to rotate the alternator and produce electricity. Each generator has an electrical panel for monitoring its output power parameters.
d. Since in a nuclear power plant the main medium for producing power is steam hence the plant must be situated near a natural water body. The plant also contains a purifier area and a large water tank to store the purified water.

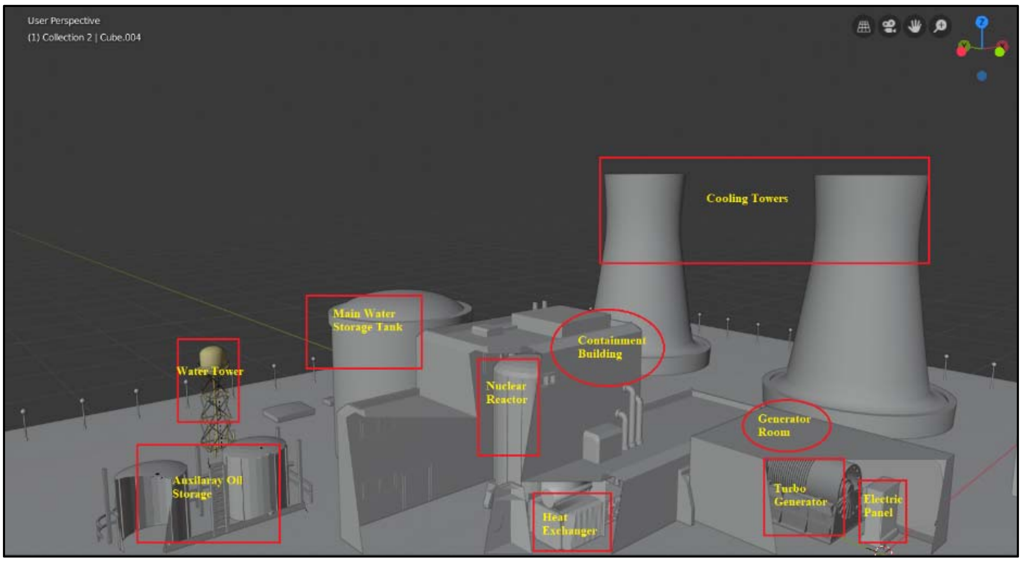

Figure 5: Nuclear Power Plant - 3D View

9.3 Transmission Yard

Both the power stations have a transmission yard with the following features:

a. A transmission yard that has power transformers placed on concrete platforms. Input comes directly from the generators through BUS bars and cables.

b. Lines from transformers are passed through isolators and bus bars which are illustrated in 3D model as thin solid structures0.
c. Power is finally transmitted through transmission towers using overhead lines.
d. The whole transmission yard is guarded with a fence as it is a high voltage area and can be fatal to workers without proper precaution.

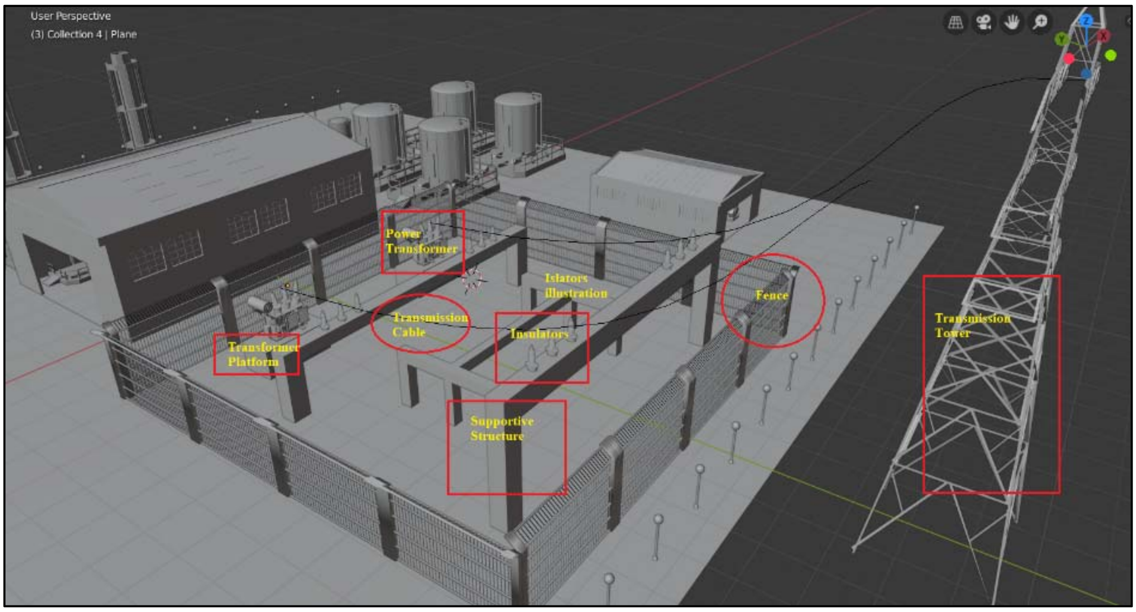

Figure 6: Transmission Yard in Diesel Station - 3D View

10. Generator Spacing

In the design of both power stations, a thorough literature review was conducted to identify generator dimensions as per [11] and [12] along with spacing requirements based on [13]. [14], [15], [16], and [17]. These findings, which guided the development of the 3D and 2D models, are summarized below.

- The National Fire Protection Association (NFPA), in its National Electric Code (NEC), requires at least 18 inches of space between a generator's back and a wall.
- NEC specifies minimum acceptable aisle space for live electrical components as 1 - 1.3 m and 1 m - 4m for units with operating voltages below and above 600 V.
- If equipment in the generator room has ampacity > 1,200 A, the room must have two exits on opposite sides of the room (in case of arcing-induced fires).
- Caterpillar's generator installation guide recommends that floor space between an engine and parallel wall or generator set should not be less than the engine's width.
- Cummins installation guide recommends a minimum distance of 1 m from any wall, tank, or panel within the generator room.

- According to [15], the height of a generator room must be at least twice the height of its largest generating unit, or at least 1.5m higher than the tallest generator.

11. Conclusions

Load profiles of 10 different residential, industrial, and commercial loads have been investigated and analysed in terms of both technical and economic metrics.

Analysis shows that load profiles with lowest load factors have the highest overall cost per unit generated, regardless of the fixed, semi-fixed, variable, per kW, or per kWh costs involved. This clearly demonstrates the importance of demand side management and grid-end conservation methods such belly-filling as ways of improving load factor and thus profitability.

Two load profiles, namely [4] and [6], have been identified as the basis of proposed designs for diesel and nuclear generating stations respectively. [4] has relatively high variable costs owing to high price of diesel fuel, but this is offset by savings in the form of the next best alternative - belly filling equipment expenditure. This design also has the capability to rapidly vary supply to meet varying demand, which would have been difficult to achieve with conventional thermal power stations.

For [6], a nuclear power station has been proposed because it is the residential load profile of an entire country, and thus the high capital on a nuclear power station can be justified.

12. References

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