Grid outage in the data center and the DG sets are not kicking-off as expected...whom do you blame for the downtime?

There is no room for downtime in the data center, but there are times when this could happen. One of the most common reasons is a grid power outage. By design, the emergency backup power of Diesel Gensets should kickin in less than 40 sec to avoid interruptions in operations. However, at times those DG sets may just refuse to respond immediately, causing the worst nightmare for the data center operating team. Very few professionals though understand and appreciate that the “fuel management system” or lack of it may be the root cause and not the DG set itself.

Demand for data in India is soaring and hence the number of data centers are increasing manifolds. The new hyperscale facilities are much more power hungry and designed with tier IV levels of uptime assurance. However, the grid power scenario in the country has not been keeping pace both in terms of the capacity, reliable availability and the quality of power supplied. Hence more than 95% of data centers in India are dependent on DG backup power plants which are put into actual operation more frequently.

In spite of provision of redundancy, disruption of DG power is not uncommon and causes undesired downtime for data center. However, ‘fuel management system’ is often unfortunately a less focused aspect of the data center project right from the design phase, where much attention is given to the DG sets due to their higher capex.

This paper discusses the fuel management system to highlight it’s critical importance and help data center professionals understand it’s components, design, role and value in avoiding costly downtime.

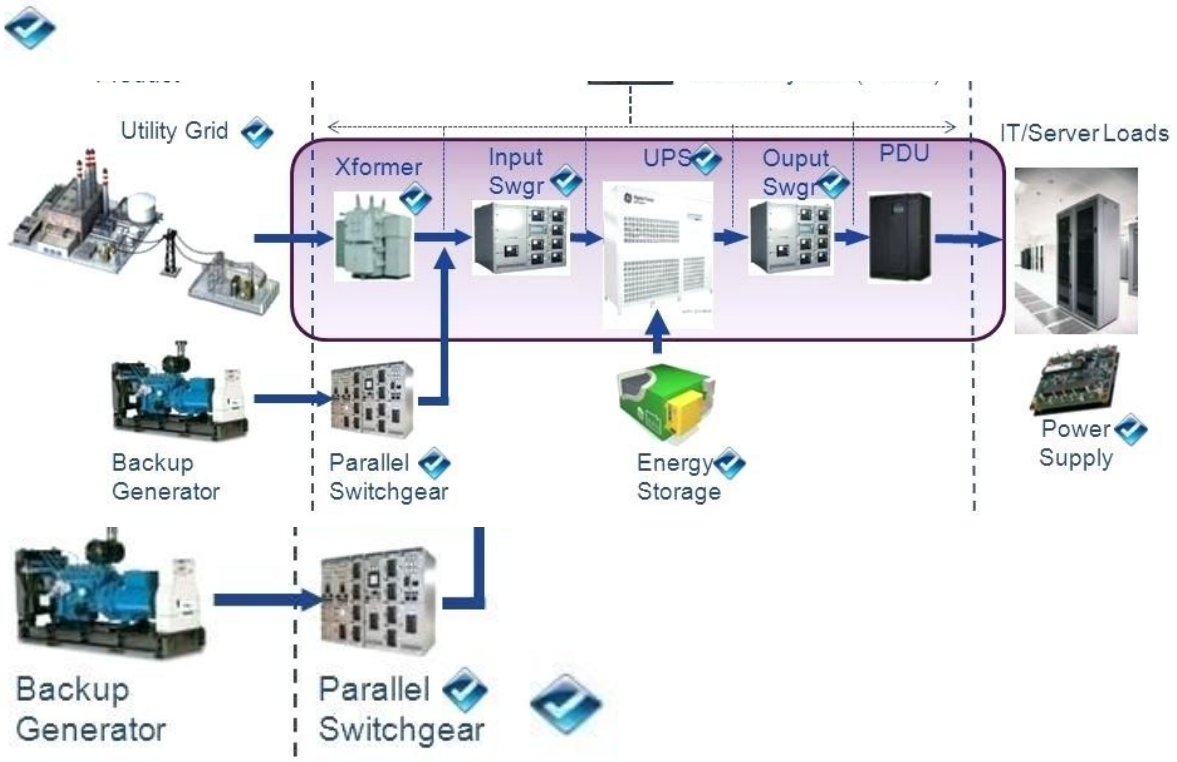
Power supply architecture & utilities for data centers

Figure 1 below shows a power supply system schematic for a typical data center.

The primary source of power at the data center is typically the local power grid managed & operated by a power distribution utility. Often a dedicated EHT (Extra High Voltage) line and a distribution transformer is assigned for high consumption subscribers like data centers. In case of a grid power interruption (which is a common phenomenon in India), a provision of backup power source is mandatory. This is fulfilled through a DG backup power plant set-up within the data center premises. This also includes infrastructure for on-site storage and handling of fuel (diesel) with underground tanks and network of pipelines connected to the DG room. As per the industry standard practice, storage capacity provision should be enough to keep the DG sets running continuously for 24~48 hours.

In the event of grid outage, an automatic switching mechanism is provided to seamlessly switch the connectivity from grid power to DG power in case of grid outage. An intermediate emergency power backup provision is also made for a brief period of a few minutes to give time for the load to switch and stabilize from primary power to backup power. This need is

mostly fulfilled using a battery backup and UPS system. This system also protects the delicate electronic components & equipment against spikes in voltage, harmonic distortion, and other issues related to the power quality. Typically a UPS system is designed to provide power for at least 5 minutes at the maximum load, and in this time period the backup power solution makes attempts to start and ramp-up so as to take over the load.



Why DG set fails to start or take load?

The DG backup power is kicked into the operation only when the primary grid power fails to deliver. However, in practice, even these DG sets may fail to start and take-up full load required to run the data center. Apart from reasons like design of backup power system, choice of DG sets and not following the prescribed preventive maintenance & trial runs of DG sets, there is one more factor that's largely responsible for their failure. It's related to the poor quality of fuel used to run the DG sets owing to inadequately designed fuel management system.

Need for fuel management system

Diesel is the most common fuel used for backup power. By nature, diesel deteriorates over time, and the longer it is kept idle either in storage tank or inside the diesel generator, the rate of degradation is faster. If such diesel is fed into the DG set, it will lead to sludge formation, clogging of filters and several problems.

Recent amendments to the environmental laws mandate use of ‘cleaner’ fuel and accordingly the composition of diesel that we get today has been changed from the yesteryears. It now has less sulfur content, sometimes blended with biodiesel and other additives to ensure clean burning and less harmful emissions. While it’s a good move in general, it is also a cause of trouble for data centers in a different way. Due to extended idle status of the DG set, this new grade of clean diesel stored for a longer period in the tanks leads to faster decomposition and sedimentation thus deteriorating the fuel quality.

In a study conducted on the life expectancy of stored diesel, revealed that there could be as much as 26% more degradation in the quality of diesel under normal conditions when stored for one month in a closed tank.

One of the solutions to overcome this challenge is the use of a fuel cleaning & polishing unit which is a key component of Fuel Management System. Benefits of Fuel Polishing are as follows;
• Less likelihood of failure of Fuel injectors
• Reduction in maintenance expenses
• Retards the buildup of sludge (sediment, rust, water, etc...)
• Significantly less noise and smoke during DG set operations

Other factors that drive the need for the fuel management system are critical controls involved at various stages of fuel handling, right from the intake at the tanker unloading bay to intermediate movement between the storage tanks, supply through a network of pipelines, day tank and final supply into the DG set. Leaving this handling operations to manual judgement can be prone to errors. Further, automated measurement, view and control of process parameters like level, flow, pressure, temperature and oil quality help in efficient and safe management of fuel.

For all new generation data centers with hyperscale capacities and tier IV reliability, the Fuel Management System is incorporated in the planning & design stage by default. However, even for the older data centers, it is a worthy upgrade to consider so as to stay competitive and avoid costly downtime in the future. Some of the reasons why older data center should go for IFMS are listed below;

1) For the data centers which were commissioned 3-5 years ago, pollutants and impurities would collect in the fuel tank and can cause faults in DG set operations.
2) Older fuel management systems that are not automated will not detect the fuel leaks leading to fuel wastage
3) Manual systems are prone to errors in terms of valve operations & safety lapses
4) Lack of IFMS can be a hindrance for capacity expansion and getting uptime certification etc.

Components of Intelligent Fuel Management System?

Fuel management at the data center site involves management of two parameters:

- **Quality:** In addition to its primary role of generating energy to run the DG set, diesel also serves as an effective lubricant for the pumps and lubrication/cooling for the injectors of engine generators. Maintaining the right quality is crucial across the life cycle of diesel from the moment it enters the storage tank till its consumed in the DG set. It has to be protected against the degradation that is helped by moisture, heat, oxygen, and biological growth.

- **Capacity:** Planning of optimum capacity is critical when it comes to designing the fuel management system. This largely depends upon factors like how long the DG backup power is required to run and the overall space available. There are also some regulatory guidelines (example CCoE, CPCB etc.) that govern the design. Other key factors include; automation for monitoring the fuel levels, detection of leak and theft, measurement of fuel consumption and providing real time insights of the same in a typical data center utilities set-up

System components & design considerations (see fig. 2)

FIGURE 2 : Fuel Management System Layout & Key Components

1) **Tank Yard**
    a) Underground tanks preferred due to better safety
    b) Tank capacity (std. 90kL - IS10978 std or usage requirement/ space constraint)
    c) Tank size 13-14 m length x 3.15-3.45 m height
    d) Tanks redundancy N+1
    e) Space considerations
        i) Provide for turning radius of the oil tanker
        ii) Provision of “dike wall” around each tank
    f) Fire protection & fighting system

2) **Fuel polishing unit**
        i) 1 running 1 standby : (n+n)
        ii) Pump + filter assembly

3) **Fuel transfer pump**
        i) n+n or n+1 redundancy
        ii) Canopy + Electrical panel
    b) Fuel input flow meter
    c) Instrumentation + earthing needed for each tank in the DG room
    d) Leak detection system - Hi resistance leak detection to give alarm

4) Related to the DG Room
    a) Spillage/settling tank fitted in DG room
    b) Fuel transfer pump - from storage tank to day tank
    c) Max limit for the day tank is 990 L as per the CCoE norms
    d) Automation - valves, instrumentation - connected to fuel automation system

e) Panels + PLC for control purpose

5) **Fuel Fire safety system**
    a) Piping design
    b) Tank isolation
    c) Minimise downtime

Conclusion:

Cost of a downtime is far more expensive in a data center than in any other industry. The DG backup power system is provided for to avoid the downtime by delivering reliable & uninterrupted power to keep the data center running in the event of primary grid power failure. It won't be an exaggeration to state that the most frequent cause of DG set failure can be traced to the fuel management (or lack of it)!

Sedimentation, impurities, decomposition as well as water ingrace are the main factors causing degradation of diesel that can cause serious problems leading to diesel generators failing to deliver in time and with reliability when needed in emergency situations. This was experienced in the USA. During the Hurricane's Sandy and Katrina, there were numerous instances of downtime reported by the data centers and other infrastructure due to failure of backup power to kick-off when needed.

A robust and well designed Intelligent Fuel Management System (IFMS) is the way to ensure that the DG backup power solution will be able to operate with very high reliability, responsiveness and efficiency whenever called for. From the fuel quality perspective, the domain knowledge authorities such as the Uptime Institute and The Society of Automotive Engineers (SAE) place a high degree of importance on fuel cleaning and polishing to ensure reliable operation of the DG set. From fuel capacity planning & automation perspective as well there are norms that guide designing of an efficient, reliable and intelligent Fuel Management System.

Data center establishments spend millions of dollars in erecting the sophisticated backup power infrastructure for ensuring power reliability and this investment can be justified by caring for the fuel that goes inside by incorporating intelligent fuel management system.