

Guidelines for Modernizing Existing Electrical Switchgear in LV and MV Networks

by Georges Barbarin

Executive summary

Aging electrical switchgear infrastructure is a threat to the reliability of power networks. As the cost of downtime continues to rise, engineers and electrical distribution stakeholders need a strategy for either upgrading or replacing aging switchgear. This paper reviews the benefits of investing in an upgrade strategy. Costs and production downtime scenarios are analyzed and low and medium voltage switchgear upgrade methods are discussed.

Introduction

The reliable flow of electricity is what allows today’s ‘wired’ global business environment to thrive and grow. The cost of downtime is now calculated in the millions of dollars per hour (see **Figure 1**). Therefore, the proper maintenance of reliable switchgear and the switchboards that distribute electricity throughout the power system are more critical than ever.

However, investment limitations and operating budget constraints are leading electrical distribution operators to extend the life of their switchgear from 10- 30 years on average to 50-60 years. At the same time, electrical switchgear manufacturers are renewing their technology offerings 3 to 5 times during that same 30-year period.

Most power plants, for example, were designed for a 30-year life span. Energy generation companies are launching initiatives to maintain operation for 40 years to 60 years.

Therefore, a conflict exists between the older technologies that are in place and industry standards that are evolving at a much faster rate. It is not uncommon for an industrial facility to have a mix of power distribution technologies that span over 2-3 generations and several different technology architectures (e.g., air, oil, SF₆, vacuum).

The central question is how to modernize and ensure reliability when operating from an antiquated technology base. There are several factors to consider. An overriding concern may be the need to improve safety. Another issue may be the cost of maintenance. A third factor may be the ability to monitor and efficiently manage the network.

Figure 1
Financial impact in Dollars of one hour of downtime per industry (Courtesy of Contingency Planning Research)



Why invest in modernization

Today’s utility stakeholders have a number of issues to consider when deciding how to modernize their power networks. They need to balance costs versus the urgency to provide the reliability their customers require. Listed below are some key issues that utility stakeholders should consider when evaluating their installed base of power distribution equipment:

- Spare parts availability
- Maintenance costs
- Degree of equipment wear
- Urgency of upgrade
- Criticality of the processes affected

Spare parts availability

When making equipment upgrade decisions, the spare parts question should be analyzed by considering the distinct categories of spare parts. Listed below are examples of these categories:

1. **Active spare parts** – These parts include electrical distribution equipment that is made available by the manufacturer as an extension of their commercialized offering. These spare parts can be accessed via online or printed equipment catalogs.
2. **Discontinued spare parts** - These parts are not used to source new projects, rather, they are associated with products at the end of their sales lifecycle. However, these parts are made available to support an existing installed base of products that are no longer being marketed. This spare parts offering typically remains available for a period of 10 years for low voltage and 12 years for medium voltage equipment. When the spare parts are no longer readily available, the continuity of service and support is at risk. If a device breaks down, no parts may be available to fix it. At this stage, launching a solution modernization initiative is advisable.
3. **Limited maintenance agreements** – Under certain circumstances (like a huge existing install base of an older product), specific maintenance agreements may be structured. These are usually costly as the spare parts are rare, if available at all, and the expertise for proper installation of the parts is difficult to secure.

Spare parts for both active and discontinued electrical equipment can be supplied via electrical manufacturers. **Figure 2** illustrates the stages of the spare parts life cycle.

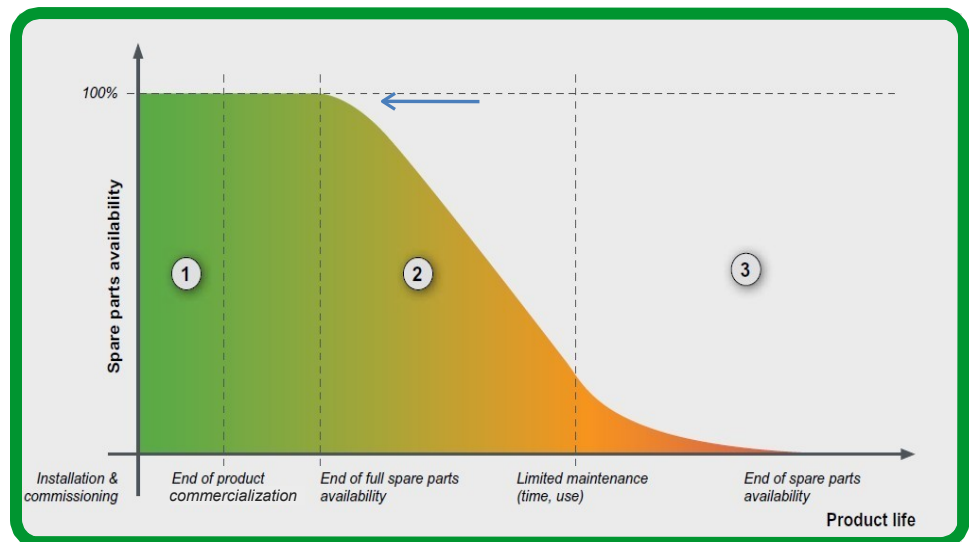


Figure 2

Spare parts availability is affected by the phase out scheduling of equipment manufacturers

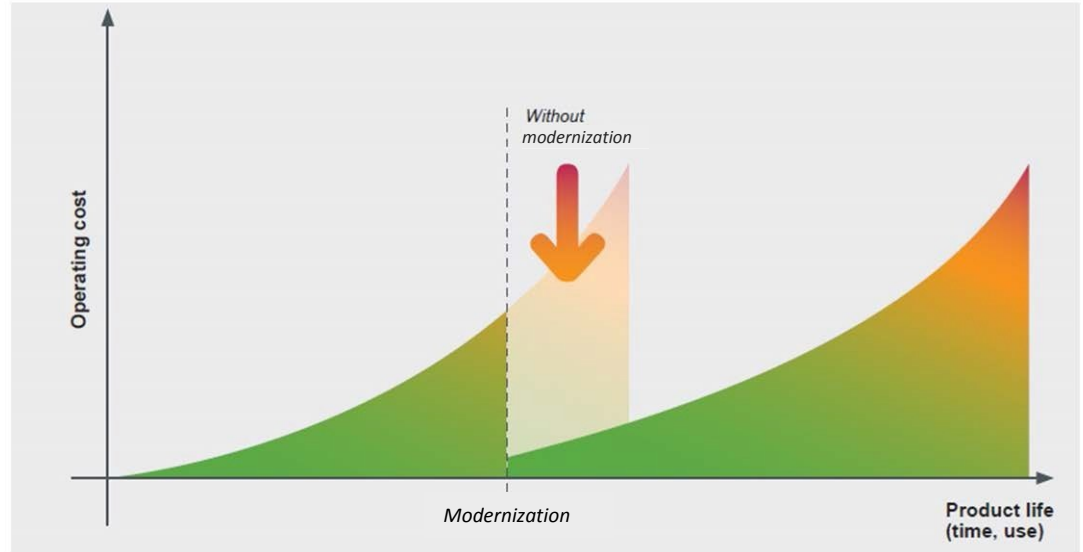
Maintenance costs

In addition to the life cycle of the products, the decision to upgrade and modernize is also linked with the risk of product failure and the increased cost of maintenance over the years.

Figure 3 illustrates the curve for how maintenance costs can be reduced as a result of a timely upgrade.

Figure 3

Maintenance costs increase as products are allowed to get older. A timely upgrade can reset the bar on maintenance costs



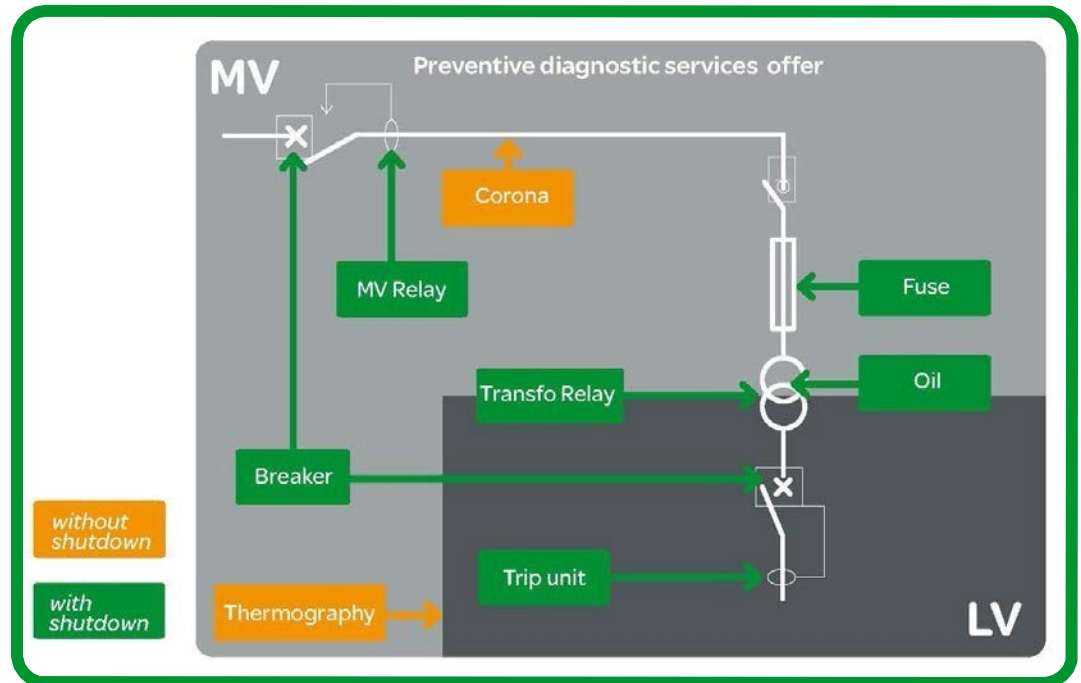
Degree of equipment wear

Aging materials reduce equipment reliability. Both dielectric breakdown of insulating components and degradation of aging mechanical parts can disrupt equipment uptime.

Diagnostic tools can verify the wear and tear of electrical equipment and compare current performance to how the equipment performed when new (see **Figure 4**).

Figure 4

Types of equipment upon which diagnostics can be performed



Urgency of upgrade

Upgrade urgency is influenced by both internal and external factors:

Internal factors:

- Modification / evolution of the power requirement within an industrial facility
- An improvement in the supervision and monitoring abilities of existing installations. In these cases, improvements in connectivity open the door to considerable operational cost savings

External factors:

- Compliance with new regulations requesting the ban of hazardous substances (e.g., asbestos, tin, chemicals).
- The need to comply with new standards that influence both mechanical and human safety

Criticality of the processes affected

When the decision is made to modernize, the next step is to decide which parts of the install base will be prioritized for modernization. Such a prioritization will take into account available budget and also the tools and expertise available to perform such an assessment. When manufacturers perform these assessments, four key aspects are considered: a maintenance plan, a modernization plan, a monitoring plan, and a management plan.

Two categories of components make up a typical low and medium voltage electrical switchgear system: passive and active. The passive components include steel frames, cover plates, barriers, and horizontal and vertical bus structures. The active components are more critical and include power circuit breakers or fused devices. These components are responsible for protection from overcurrent.

The following two active components and one passive component have the most impact on maintenance and obsolescence issues. **Figure 5** illustrates these components.

- The steel / copper / or resin housing (passive, illustrated in blue in **Figure 5**)
- The circuit breakers, either removable or fixed (active, illustrated in orange in **Figure 5**)
- The protection relays (active, illustrated in red in **Figure 5**)

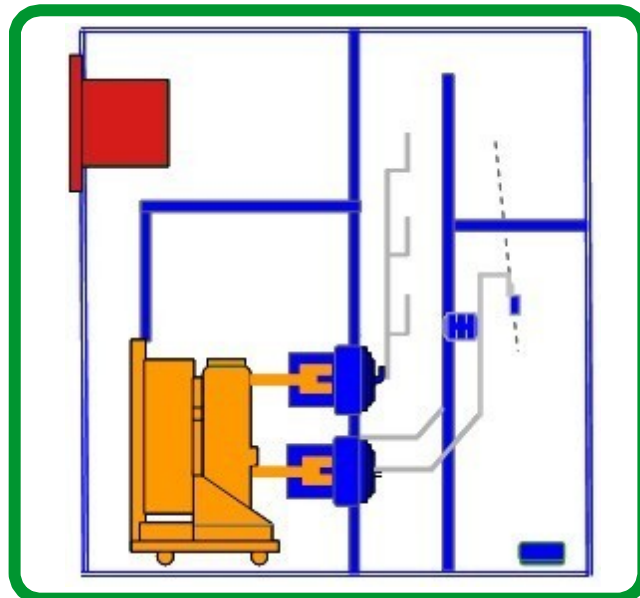
**Figure 5**

Illustration of components likely to experience maintenance issues

Low and Medium Voltage Modernization

These components experience different levels of stress depending on their operation and sensitivity to their particular environments (e.g., heat, humidity, chemicals, and dust, for example). They also often have different obsolescence dates, which are generated as a result of the life cycle specifications outlined by the original manufacturer.

The steel / copper / or resin housings typically do not show much wear over time. Risks are usually related to moving parts impairment as a result of dust/chemical deposit when basic maintenance operations are not performed.

In the case of protection relays, these can be easily replaced with a minimum switchgear front door and wiring modification. Circuit breakers and contactors, which are the core active element of switchgear, require more care as they are critical in ensuring equipment reliability and safety.

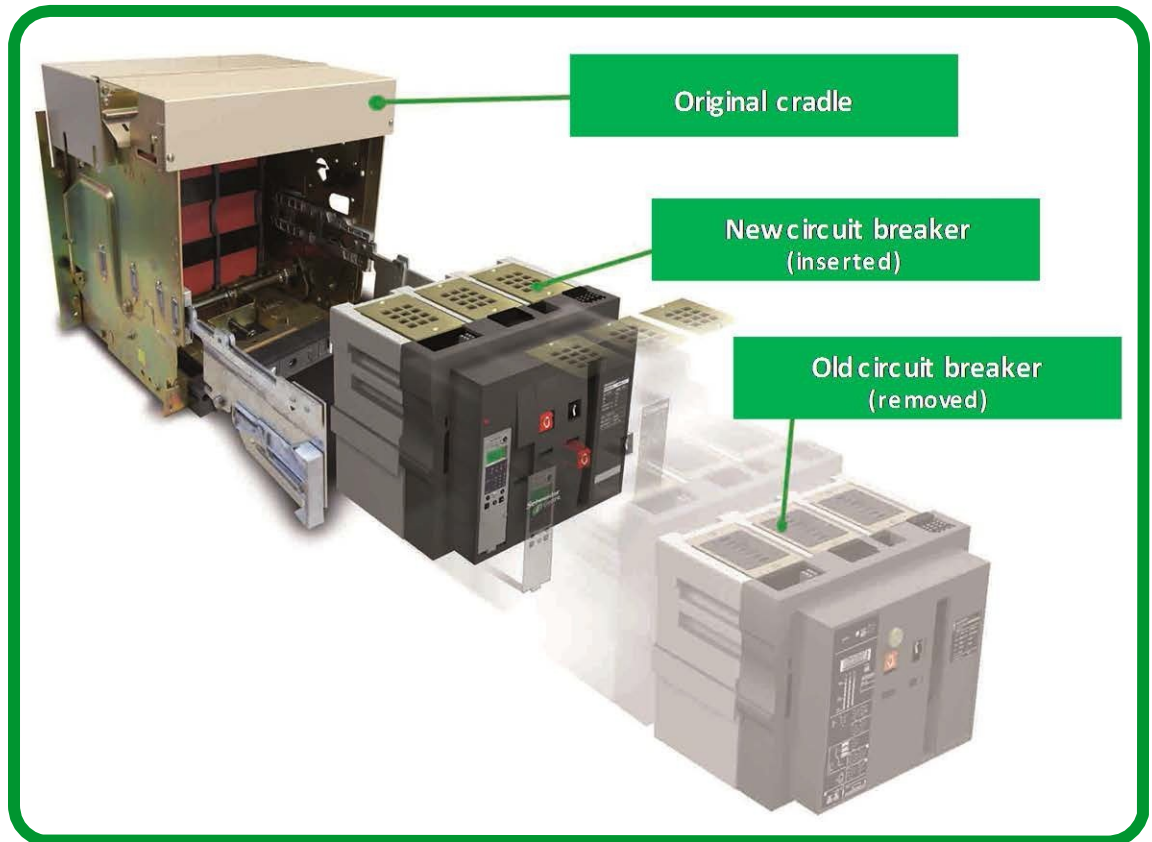


Figure 6
Aging or obsolete circuit breaker) is replaced with modern circuit breaker while maintaining original cradle

Modern power circuit breakers are designed utilizing space-age materials packaged in compact fashion, with digital trip units. They can withstand higher fault currents than the older equipment. The modern circuit breakers also reduce the risk to electrical workers from electrical faults. In addition, they have fewer maintenance requirements than the older, open air circuit breaker designs. When units are modernized, because of their modular, swappable design, the switchgear structure, conduits, cabling and footprint are left intact, which saves time and money (see **Figure 6**).

Modernization solutions

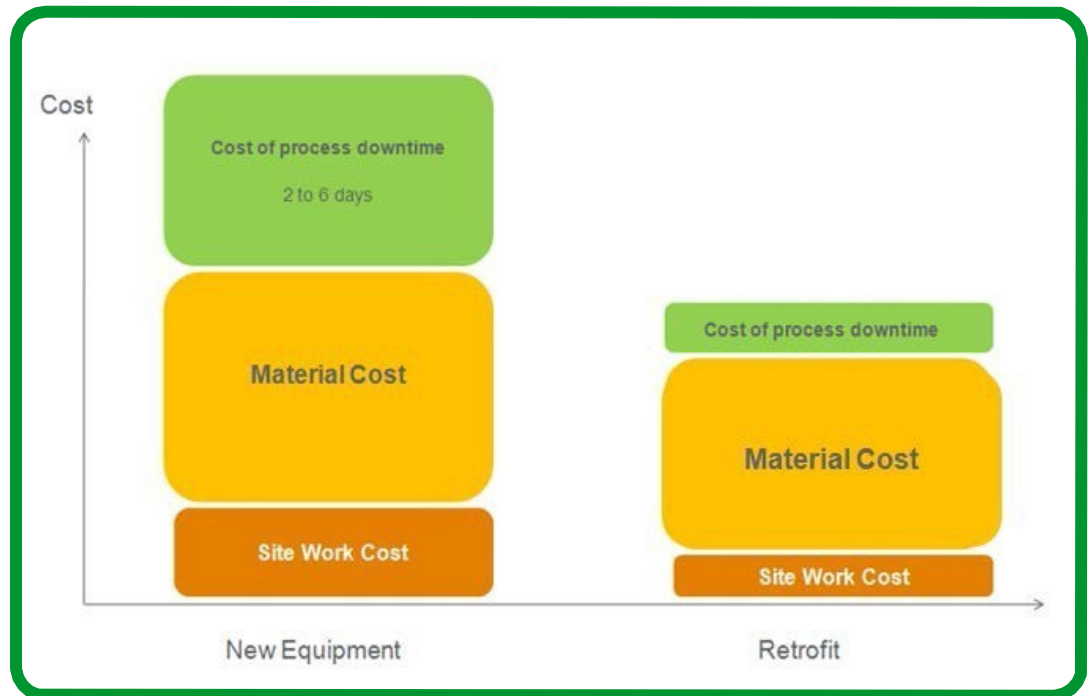
Owners of low and medium switchgear equipment have the option of either buying new (completely replacing the existing electrical installation with new equipment), or replacing only active components, while leaving switchgear structure intact (retrofit). The retrofit approach, in most cases, is the least disruptive and most cost effective approach.

The main advantages of implementing a retrofit solution include:

- **Optimization of assets** – Switchgear is upgraded to current technology, which extends the life of the existing equipment and increases the return on investment.
- **Reduced production stoppage** – When considering whether to maintain equipment or replace it, facility managers must take into account the initial capital cost, along with potential disruption to the facility’s processes and workflow during the course of changing out the equipment. Unless process loads can be rerouted temporarily during the demolition of old equipment and installation of the new switchgear, the cost of lost production can be substantial.
- **Improved cash flow** – A full retrofit of an industrial site could spread over several years. Oftentimes, when new equipment is purchased, the on-site physical plant also needs to be modified to accommodate the new equipment, which adds to the cost (see **Figure 7**).

Figure 7

A retrofit approach offers cost advantages in three important areas: materials, lost production time, and site preparation



- **Reduced risk** - Installing new switchgear involves more cabling (requires that existing cabling above and below the equipment be moved). In some cases, cabling may need to be replaced or spliced, which introduces a higher element of risk.
- **Peace of Mind** - Pre-tested solutions from established manufacturers provide a high degree confidence in a retrofit solution. Established players like Schneider Electric have managed thousands of switchgear retrofit projects and have an extensive library of lessons learned. Qualified personnel and up-to-date tools reduce the risk of accidents and delays. Accompanying safety improvements and updated warranties also contribute to overall power network peace of mind.
- **Digitization** - Retrofit solutions also open the door to enhanced equipment connectivity. This then allows access to more detailed levels of energy management data which enables better monitoring of energy consumption.
- **Less environmental impact** – Since a retrofit solution replaces only a portion of the existing electrical equipment, fewer waste materials need to be processed than if a complete replacement were to occur.

Conclusion

Cost savings is the most obvious benefit of upgrading existing electrical switchgear. That cost includes not only the physical equipment, but the time and labor involved in specification, procurement, installation, testing and commissioning. In addition, the upgrade can be performed without major downtime and possible loss of production

The modernization decision should be based on multiple considerations. It is important to understand the current status of the electrical installation and to have a clear vision of the site's future evolution. Then, a short and long term plan, including maintenance, modernization, monitoring and management can be implemented.



About the author

Georges Barbarin is a Senior Marketing Manager in the Schneider Electric Field Services electrical distribution business unit. He holds a Bachelor Degree in International Business Administration in Management and over the last 10 years has assumed numerous industrial and marketing positions within a variety of business units and operational international divisions. As expert in Operational Marketing and Business Development, he has recently helped to develop the modernization of electrical distribution switchboards business within Schneider Electric and is currently implementing standard and customized retrofit solutions across all geographies.