

# Increasing Distribution Demands: 5 Benefits of Modular Substations

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Substations play a critical role in the power industry. They support the transmission grid in moving power from generation sources to customer load, while electrical utilities use them for system protection, switching capabilities, and more importantly, voltage transformations.

Today, most power companies around the world are looking to increase capacity of substations or replace them altogether due to growing demand and aging equipment. However, modernizing the transmission

infrastructure is a costly process, resulting in utilities seeking more cost-effective solutions to overhaul their systems [Figure 1]. This is where modular designs - the next generation of distribution substations - come into play.

A modular substation [Figure 2], also called a compact substation, is a grouping of electrical equipment assembled on a platform or a trailer. It is integrated and tested in a factory environment to enable energizing upon delivery to the site. It comes



Figure 1: Typical Distribution Customer Station

as a pre-assembled, modular unit and offers many advantages over a conventional substation, such as: reducing space requirements, decreasing the construction duration, improving overall safety, reducing the environmental impact, and increasing design flexibility. This paper outlines the benefits of using a modular-type substation design as a replacement for a smaller, more conventional distribution substation. First, it's important to discuss the challenges associated with growing demand.

## 4 Challenges of Growing Demand

The main reasons for a growing power demand include: new miniaturizing and retail facilities, existing facilities replacing man power with equipment, the increase of household equipment for convenience, and an expanding population. Nevertheless, there are several ways to address the issues of a growing

capacity demand and aging substations. The most common ways to increase capacity or replace aging equipment include voltage conversion, regular maintenance, or a complete replacement. However, building conventional substations pose several additional challenges, including:

### 01 LAND

Land prices have increased significantly over the past decade, especially in urban areas. Therefore, finding an adequate footprint for new substations and expanding existing substations can be costly or unfeasible due to the lack of available land. When replacing the equipment, adequate access roads and space is needed for replacement and construction equipment. Additionally, with new safety codes being enforced, additional land area is typically required for future expansion and maintenance.

### 02 COST

Regular maintenance on older equipment can become costly due to the limited availability of replacement parts and intensive labor requirements. Over time, equipment failure rates will rise, while



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additional stock of parts will fall. As the industry moves forward with new technologies and new security requirements, the costs to retrofit or maintain older equipment increases.

Furthermore, voltage conversion to increase the capacity is a lengthy and expensive process. Aging and failing equipment must be upgraded to work at both existing and new voltage levels. After the conversion is completed at the substation, there are additional costs associated with line reconductoring.

### 03 SAFETY

The additional safety requirements of conventional substations include: a perimeter fence to protect the public from getting an electric shock from live

and unprotected equipment, an oil containment deep enough to contain oil and rainwater, and safety clearances from live components [Figures 3 + 4]. Many existing substations have ground systems with poor connectivity due to the corrosion of ground conductors. Replacement of an old transformer requires improvements to the grounding system to comply with the latest safety requirements. Also, regular substations carry many unprotected live parts such as open overhead conductors, exposed ground conductors, and live connections, etc. These present added safety hazards to the surrounding area.

During a fire, open oil-contained equipment can be extremely dangerous. Heat due to fire can be deadly and reach well beyond protective fencing to nearby residential areas.



Figure 2: Modular Substation Solutions



Figure 3: Open Live Parts at a DC Substation



Figure 4: Oil Contained Equipment Closer to Public Building



Figure 5: Typical Modular Integrated Transportable Substation to Support Reliable and Cost-effective Power

## 04 ENVIRONMENTAL REGULATIONS

New environmental laws have become more stringent over the past 30 years and have demanded more to reduce the impact on the surrounding area of a substation. Some of the new laws include necessary measures for proper drainage, oil containment, lighting requirements, and sound pollution. Continuing to use old equipment creates a challenge in complying with new regulations. Installing or retrofitting replacement equipment may be impossible due to limitations that these new laws impose.

# 5 Benefits of a Modular Substation

**A modular substation is a turnkey solution that can fit into any configuration per customer needs.** With advanced planning, they can provide the following benefits:

## 01 A SMALLER FOOTPRINT

These units are engineered to use very little space and have the mobility to fit in different configurations to meet project and client needs. Their positioning on a platform allows for easy transportation and relocation as needed [Figure 5]. Covered equipment eliminates the need for additional property for electrical clearances as well.

## 02 MINIMIZED COSTS

Unlike a traditional substation, these units come pre-assembled. Thus, reducing cost for transportation of multiple parts as well as cost of assembly, field wiring, and testing at the site.

These units are engineered to minimize field connections to expedite the installation process. This will reduce construction time and labor at the site. Additionally, cutting down the lengthy process

# ABOUT THE AUTHOR



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of testing at the site is an advantage in terms of cost savings and time, especially on wait time for any replacement parts. Time is money, and less time spent on construction will result in significant cost savings.

### 03 POSITIVE ENVIRONMENTAL IMPACTS

Modular units are contained within a tamperproof metal container. This eliminates environmental hazards such as fencing and exposed grounding conductors. Also, self-contained oil retention will prevent oil spills that result in ground contamination. Conventional substation builds require excavation of the ground which impacts the natural drainage, whereas modular substations require minimum land preparations and disruption.

### 04 FLEXIBILITY AND CONVENIENCE

Modular stations are engineered to fit different

layouts and can easily expand to make more complex substations. Future capacity expansions will be easier due to the contained equipment requiring a smaller footprint. Likewise, the pre-fabricated designs result in shorter line outages compared to a conventional substation. Additionally, one of the most significant advantages of a modular station is the convenience of relocating equipment. Compact build and mobility is a significant benefit over the demolition and reconstruction of a traditional station.

### 05 SAFETY

Safety features like contained equipment, covered ground conductors, built-in oil containment, and fewer live parts exposed to the public are some of the advantages modular units have compared to conventional substations. In most cases, modular substations do not require perimeter fencing. This presents a hazard-free environment for the public and surrounding wildlife.



## Pre-fabricated turnkey modular stations provide many benefits over conventional substations.

Modular substations provide a much smaller footprint, lower construction costs, reduced construction duration, enhanced safety, and greater flexibility.

## Summary

A large number of existing substations are approaching the end of their operating life, as well as reaching their full potential in capacity limits. To alleviate these concerns, utility companies have three routes to choose from: costly maintenance to sustain the old equipment, lengthy and expensive voltage conversion, or a full replacement of old equipment. Although viable, all three of these options pose a different set of challenges such as the high costs of acquiring additional land space, the ability to source replacement parts, and finding highly-skilled labor. Plus, each of these solutions require additional funding which, when looking at the bottom line, is not a wise investment decision.

Proposing a new solution like the pre-fabricated turnkey modular stations provides many benefits over conventional substations. Modular substations provide a much smaller footprint, lower construction costs, reduced construction duration, enhanced safety, and greater flexibility. With these benefits in mind, electrical utilities looking to modernize their infrastructure should strongly consider the use of modular substations.

To learn more about the advantages of modular substations or how they can be a solution for you, contact the author at [ajayasuriya@primeraeng.com](mailto:ajayasuriya@primeraeng.com).

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