

## Upgrading obsolete Static Var Compensators (SVCs) with Static Synchronous Compensator (STATCOM) in Electric Arc Furnace applications.

### Introduction

Electric Arc Furnaces (EAFs) have traditionally relied on Static Var Compensators (SVCs) as the primary technology for power quality and power factor improvement. However, with advancements in power electronics, STATCOMs (Static Synchronous Compensators) have emerged as the preferred solution for EAF applications.

There are many existing plants with electric arc furnaces that currently have an SVC and need to upgrade it, because they require more power, the equipment has ceased to operate properly, or availability of repair parts, among other reasons.

In this document, we will compare the two most viable upgrade options (SVC and STATCOM) and explain the **advantages of upgrading obsolete SVCs with STATCOMs**.

### Transitioning away from SVCs as the primary technology for EAF applications

In the past, Static Var Compensators (SVCs) have been the preferred technology for Electric Arc Furnace (EAF) applications, primarily because they were considered the most advanced technology available at the time. They have been widely used in this industry for many years and have gained a reputation as a mature and proven solution.

Given the critical nature of EAF operations, some steel customers hesitated to adopt newer technologies like STATCOMs for this application.

However, **STATCOMs have proven to be reliable solutions** which can significantly improve the performance of EAF's, providing tangible monetary benefits for the steel industry.

Their advanced capabilities have positioned them as a compelling alternative to SVCs for EAF applications.

### SVC basic operation in EAF loads

The basic operation principle of an SVC (Static Var Compensator) involves the control and regulation of reactive power in an electrical system.

It consists of a set of passive fixed filters and a variable reactor known as a Thyristor Controlled Reactor (TCR). The TCR adjusts the amount of reactive power consumed or injected into the system based on voltage fluctuations or reactive compensation needs.

By dynamically varying the impedance, the TCR either absorbs excess reactive power or supplies additional reactive power to compensate for the system's needs.

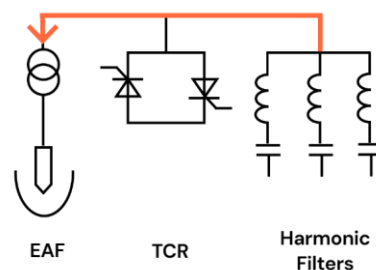


Figure 1. Reactive power supplied to the load

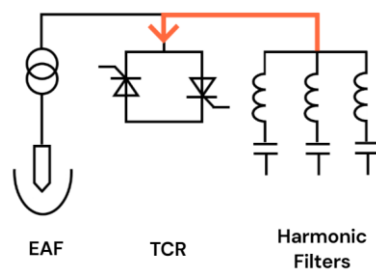


Figure 2. Reactive power absorbed by the TCR

The passive filters are designed to attenuate harmonic distortions caused by the non-linear loads, providing improved power quality. Together, these components enable the SVC to regulate voltage, improve power factor, and mitigate harmonic disturbances, ensuring stable and efficient operation of the electrical system.

## SVCs present some limitations in EAF applications

While SVCs have been widely used in EAF applications, they do possess certain limitations.

One key limitation of SVCs is their limited speed of response capabilities in addressing sudden changes in EAF load conditions. This can lead to suboptimal voltage regulation, which, in turn, **adversely affects the stability of the electric arc**.

Furthermore, SVCs are limited to providing only passive harmonic filtering, which may pose challenges in adequately mitigating certain harmonics prevalent in EAF applications. Notably, SVCs are unable to filter the second harmonic, and the operation of the TCR itself can contribute to the generation of these harmonics.

These limitations have led to the exploration of alternative technologies like STATCOMs (Static Synchronous Compensators), which offer active harmonic filtering, faster response times, improved voltage regulation, and better arc stability, addressing some of the limitations associated with SVCs in EAF applications.

## STATCOMs are the new trend to regulate EAF loads

STATCOMs are emerging as the new trend in regulating EAF loads. With their advanced power electronics and control capabilities, STATCOMs offer significant advantages over traditional SVCs.

The adoption of STATCOMs in the steel industry has witnessed a growing number of successful cases, establishing them as a reliable technology for various applications.

## STATCOM basic operation in EAF loads

The basic operational principle involves the use of advanced power electronics and control techniques to provide precise voltage regulation and reactive power compensation.

It consists of a voltage source converter (VSC) that generates a controllable output voltage, typically connected in parallel with the power system.

By injecting or absorbing reactive power through the VSC, the STATCOM regulates the system voltage, compensates for reactive power imbalances, and improves power factor.

In EAF applications, the typical configuration of a STATCOM often involves a hybrid solution, utilizing a combination of power electronics and passive harmonic filters to optimize costs and serve as a reactive power source.

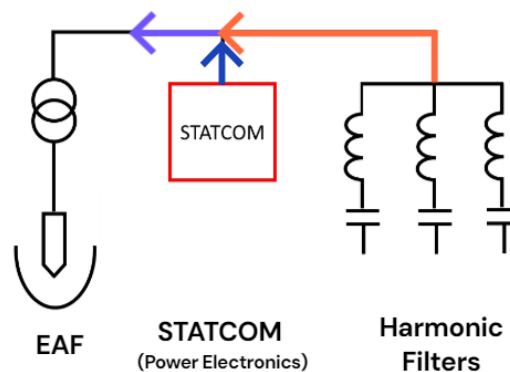


Figure 3. Typical STATCOM configuration in EAF applications

The advanced control algorithms of the STATCOM enable fast response times and dynamic control, allowing it to mitigate voltage fluctuations and harmonic distortions in the electrical system.

## STATCOM offers several benefits over SVC in EAF applications.

The STATCOM offers several key benefits over the SVC in EAF applications:

1. **Faster response time:** STATCOMs offer faster response times, resulting in improved voltage stability and reduced flicker levels.
2. **Superior harmonic mitigation:** STATCOMs excel in harmonic mitigation, including effective mitigation of the second-order harmonic and other harmonics.
3. **Modular design for easier power upgrades:** The modular design of STATCOMs facilitates easier power upgrades, allowing for seamless expansion or modification of the system.
4. **Reduced energy consumption:** In contrast to SVCs, which consume reactive power continuously for voltage regulation and power factor improvement, STATCOMs do not consume reactive power, leading to reduced energy consumption.

## Opting for a STATCOM as a replacement for an outdated SVC is a smart decision.

Opting for a STATCOM to replace an outdated SVC is a smart decision, not only due to the numerous technical benefits it offers but also because it has the potential to require less capital expenditure (CAPEX), less operational expenditure (OPEX) and occupy a smaller footprint.

As described previously, SVCs regulate the input of reactive power by delivering reactive power through the harmonic filters and absorbing any excess reactive power using the TCR.

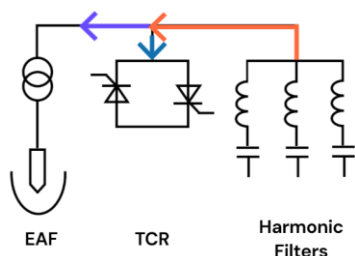


Figure 4: Regulation of Reactive Power through Excess Absorption

Based on the above, the SVC requires the TCR size to be at least the same as the total power of the harmonic filters. Practically, it is designed larger to have the capacity to properly stabilize the voltage and reduce flicker values.

## An SVC can potentially be replaced by a significantly smaller STATCOM.

Since the STATCOM has the capability to provide and absorb reactive power, the existing harmonic filters from the SVC being replaced can be utilized as part of the STATCOM system. This results in a significant reduction in the required power electronics for the STATCOM.

Figure 5 provides an example illustrating how an 80 Mvar SVC can potentially be replaced with a 40 Mvar STATCOM, leveraging its reactive power delivery and absorption capabilities.

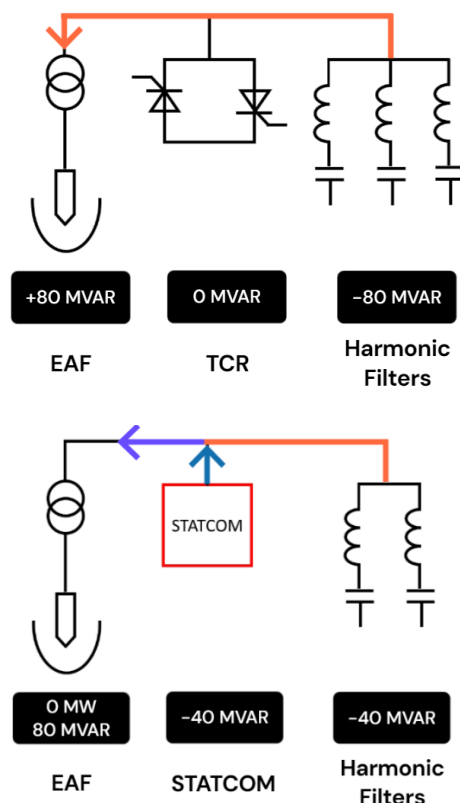


Figure 5. Upgrading 80 Mvar SVC with 40 Mvar STATCOM

## Conclusions:

When opting for a STATCOM solution to replace an outdated SVC, you can gain the following benefits:

1. **Energy reduction to help achieve green steel goals:** SVCs can consume a large amount of energy, especially during Power Off time. However, this is not the case with the STATCOM.
2. **Advanced technology:** STATCOM represents the newest and most trending solution for EAF loads.
3. **Better performance:** As explained previously, the performance of STATCOM is significantly superior to that of SVC.
4. **Less CAPEX expenditure required:** The capability of STATCOM to deliver or consume reactive power provides the flexibility to utilize the SVC's existing harmonic filters as part of the solution, reducing the required investment.
5. **Less OPEX expenditure required:** With lower losses overall, fewer maintenance requirements, and a smaller footprint, the associated OPEX is lower with STATCOMs compared to SVCs.
6. **Reduced footprint required:** STATCOM units typically occupy only 30-40% of the space compared to SVCs.
7. **Backup system option:** The compact footprint of STATCOM usually allows for the retention of the SVC's TCR as a backup system in the event that the STATCOM needs to be taken out of service.