International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-1, February 2022
https://doi.org/10.55524/ijirem.2022.9.1.21
Article ID IJIR-IRP22919, Pages 120-123
www.ijirem.org

A Review on Flexible AC Transmission System Controllers

Laxmi Goswami [1], and Deepak Singh [2]

[1, 2] Assistant Professor, Department of Electrical Engineering, Sanskriti University, Mathura, Uttar Pradesh

Correspondence should be addressed to Laxmi Goswami; laxmigoswami.ee@sanskriti.edu.in

ABSTRACT: Voltage stability has been a major concern for operators in recent years, particularly for power system that is highly loaded & have a reactive power deficit. The voltage instability is a significant danger to the protection, safety, and dependability of power systems. Due to limited resources, power production and transmission development has been insufficient in the past 10 years, even though power consumption has risen considerably. As a result, under high loads, existing transmission lines are utilized near their thermal stability limitations, and system stability becomes a power transfer limiting issue. Environmental, political, social, and regulatory limitations prevent significant development of generating and transmission systems to meet increasing demand. Flexible Alternating Current Transmission System (FACTS) controllers open the way to improved power systems control, at least for the transmissions line, in this context. FACTS technologies aids in the exploration of novel flow control options and enhances the operating capabilities of current and future transmission lines. This article provide a thorough examination of the main FACTS controllers and their applications.

KEYWORDS: Electricity markets, FACTS controllers, Flexible ac transmission system, Power flow control, Modern power systems, Power electronic, Power transmission.

I. INTRODUCTION

Power systems are becoming increasingly sophisticated and complicated as a result of various generating source, and transmissions of power source without altering & adding more transmissions capabilities requires the system to operate under highly strained conditions in certain cases. Furthermore, meeting the need for reactive power and keeping the bus voltage below acceptable levels has become challenging. The power systems operator are being pushed shift away from traditional or conventional paradigm of the centralized generations, transmissions, and distributions and toward decentralized and less than controlled operation in order to increase overall efficiency. In an open market context, this is a global trends of a deregulation attempts to increase the efficiency and competitiveness of the energy system. This research will focus on the transmissions component of power systems, but also the issues it faces [1-3].

Owed to limited transmissions line expansion or escalating producing challenges like as excessively burdened line, unscheduled power flow as well as power system stability are becoming more severe. New sensors have been introduced to address these issues by swiftly and effectively managing or regulating power flow inside the power systems while also addressing steady state voltage concerns. These devices, which are based on electrical machines, provide a variety of benefits.

1. Phase viewpoint control.
2. Transmissions line voltages control.
3. Impedances Control

Problems are to be faced by the powers sector using FACTS technologies, which is favored in certain research. In contrast to traditional devices that lack the speed and controllability of several parameters at the same time.

II. POWER SYSTEM CONTROL

A. Generations, Transmissions, & Distributions

The power system, which includes electrical energy production, transmission, distribution, or consumptions, may be divided into zones as indicated in Figure 1:

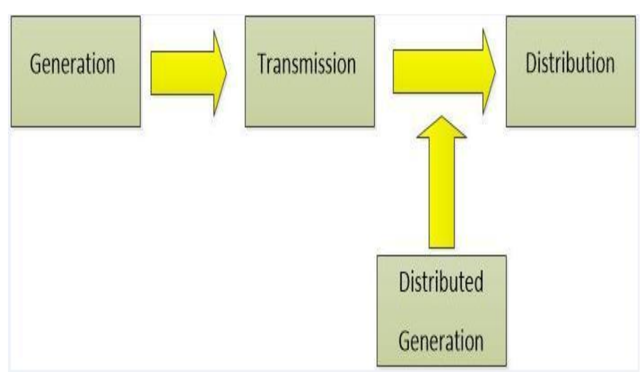

Figure 1: Illustrates the diagram of the Generations, Transmissions & Distribution.

B. Constraints of the Power System

Power system constraint are the many and they puts a limits overs powers transfers among area or the regions. Typically constraint are the shown in figure 2.

1.	Thermal
2.	Dynamic Voltage and voltage stability
3.	Power System Oscillation Damping
4.	Steady-State Power Transfer
5.	Short Circuit Current and Other limitations

Figure 2: Illustrates the block diagram of typical constraints for power transfer.

Increased transmission needs, a lack of long terms planning, or the necessity to allow producers and consumers free access have all led to a reduction in supply security and quality. Because it is critical for overcoming some, but not all, of these challenges in order to boost grid dependability, FACTS technology has become a popular teaching topic.

C. Power systems controllability

Three essential factors must be regulated in order to optimize the performance of a power systems. The voltage, angle, and resistance are really the three primary variables.
Network communication controllers or FACTS controllers are indeed the two kinds of ACl networks controllers used to increase the efficiency of a power systems. Figure 3 depicts an overview of various controllers.

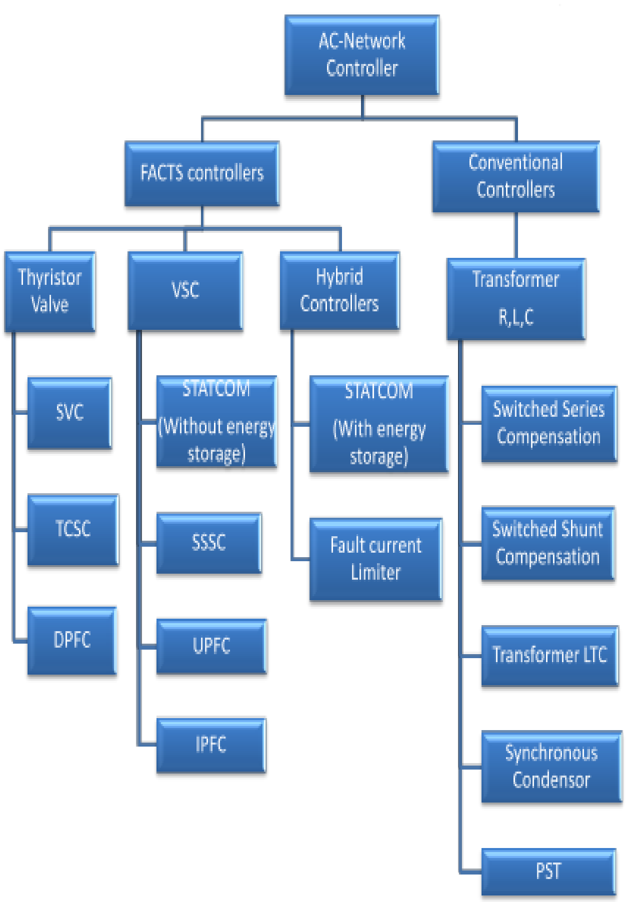

Figure 3: Illustrates the overview of a conventional networks controllers and the FACTS Controller.

To manage these characteristics in the past, equipment such as switched shunt capacitors, series capacitors, phase shifting transformers, and so on were utilized. The majority of traditional devices can only regulate one of the parameter at time. The FACTS controller allow you regulate parameters the same time. There are some FACTS controller, like the SSSCs, UPFCs, & IPFCs, can regulate all three parameters at the same time. Traditional switching shunt capacitors, low tap changing transformers, and synchronous condensers were utilized to regulate voltage. Series capacitors and phase shifting transformers were employed for impedance and angle control, respectively [4].

III. CLASSIFICATIONs & DESCRIPTIONs OF the FACTS

Devices are categorized as first, second, or third generation in the literature depending on their functionality and technological features. Another way to categorize FACTS devices is by how they connect to the network. FACTS devices are divided into four types based on the second classification: Shunt controllers, series to series controllers, but also series to shunt controllers are all types of controllers. These two groups are separate since many devices through one group of the very first categorization might belong towards the other category of the second classification. Researchers examine at gadgets based on their first classification in this study [5-7].

A. The first generation

With devices like SCR, the first generation devices utilize a thyristor valve. Devices are categorized as first, second, or third generation in the literature depending on their functionality and technological features. Another way to categorize FACTS devices is by how they connect to the network.

a. Statics VAR Compensators

This device provides reactive powers to the HV transmissions line quickly, resulting in improved line performance. The lack of any moving elements, like as circuit breaker, is referred to as "static." This SVC device was designed to match impedance in order to bring the power factor of the power system closer to unity. The SVC will employ VARs largely through thyristor controlled reactor if the power system's reactive load is leading; but, if the loads is trailing, the capacitor bank are instantly switched in, enabling improved system voltage management.

b. Thyristors Controlled Sequence Capacitors

The Transformer Reactor (TCR) is used in shunt with the power system in the TCSC. TCR and capacitors shunt arrangement allows capacitive reactance to be regulated over a wide range. Alternatively, putting the TCSC in series and in parallel enables comparison between perceived to be adjusted. The TCSC is a first-generation Passive component that, in a cost effective but also efficient way, tackles the transient stability problem as well as problems with dynamical, steady-state voltage regulation in power transmission.

B. Second Generation

Second-generation devices are capable of exchanging active or reactive powers, or absorbing and manufacturing it on their own.

a. STATCOM (Static Compensator)

A static Compensator, also known as a STATCOM, Devices are categorized as first, second, or third generation in the literature depending on their functionality and technological features. Another way to categorize FACTS devices is by how they connect to the network and belongs to the FACTS family's second generation (VSC). Because it's connected in parallel, it's also known as a shunt connected controller. The output current of the STATCOM may be changed independently of the system voltages, regardless of whether it is inductive or capacitive. It's often utilised in power networks with a low power factors to assist with voltage regulation. When linked to a source, it may offer dynamic stability and active AC power, although it is most frequently employed to provide voltage stability in power systems [8].

b. Unified Powers Flow Controller

The UPFC controller is one of the most sophisticated or progressive FACTS controller available. It's one of the most adaptable and adaptable FACTS devices ever used to enhance power system performance. In 1991, Gyugi originally proposed the UPFC concept. Devices are categorized as first, second, or third generation in the literature depending on their functionality and technological features. Another way to categorize FACTS devices is by how they connect to the network. Second, it can perform individual or simultaneous voltage control, transient stability enhancement, and oscillation damping in an adaptive manner. Inverter 1 generates or absorbs real power based on the dc link, which would then be supplied to the transmission system through a series connection transformer but also converted to ac. The main purpose of the UPFC inverter 2 is to inject AC power with controlled phase angle and magnitude into a transmission line that is linked in parallel. Because of the shared dc link, there are two terminals. Inverter 2 produces reactive power at the AC terminal, while actual power is exchanged and converted to dc power at the DC terminal [9].

c. Interline Power Flow Controller (IPFC)

Gyugyi first developed devices are categorized as first, second, or third generation in the literature depending on their functionality and technological features. Another way to categorize FACTS devices is by how they connect to the network. This solution allows for the optimal operation of the whole distribution grid by transferring power from overcrowded to underloaded overhead wires through a common DC link. In a simple IPFC, so every inverter injects voltage signal to modify the transmission system, and a bi-directional link indicates the shared DC connections for real transition of power between these two input voltages. As a consequence, IPFC's capacity to regulate power flow is comparable to that of UPFC. The only difference among IPFC but also UPFC would be that inverter 1's power output is balanced by an additional capacity enhancement 2 that utilizes an upgrade option rather than a shunt inverter to compensate for inverter 1's power factor [10].

IV. DISCUSSION

This section of the study of the FACTS device concludes with an overview of the flexibles AC transmissions device application to the power systems issues.

A. To Ideal Power Flow

Researchers have developed novel methods or algorithms/processes for addressing the optimal power flow issue in recent years. FACTS controllers are one of the most important innovations made by scientists in recent years. To enhance control and boost power transmission capacity, several FACTS controllers are utilized. Researchers have developed novel methods or algorithms/processes for addressing the optimal power flow issue in recent years. FACTS controllers are one of the most important innovations made by scientists in recent years. To enhance control and boost power transmission capacity, several FACTS controllers are utilized The Interline Powers Flow Controllers is similar to Upstream Power Flow Controller (UPFC), however it is less costly. It's VSC based FACTS controller that regulates power flow effectively using a multi-line Transmission System.

B. Electricity Market Decentralization

Electricity consumption is significantly rising at the moment. It is essential to build new power transmission systems since there are no new significant projects for improving or strengthening power transmissions system or networks. Though, a variety of issues like as expense, the atmosphere, or the difficulty in acquiring rights of the way have all contributed to the construction's ongoing delays. As a consequence, existing transmission lines are being used at full capacity. As the energy industry decentralizes, a competitive environment emerges on the open market. By regulating the power flow, FACTS controllers may be used to alleviate as a consequence, existing transmission lines are being used at full capacity. As the energy industry decentralizes, a competitive environment emerges on the open market. With the growth of the energy supply industry, new locations of operations of power system connected to the decentralised market have emerged. Commercial pressures for better results from present power transmission imply that FACTS devices including super capacitors will play an important role in managing.

C. Advantages of Facts

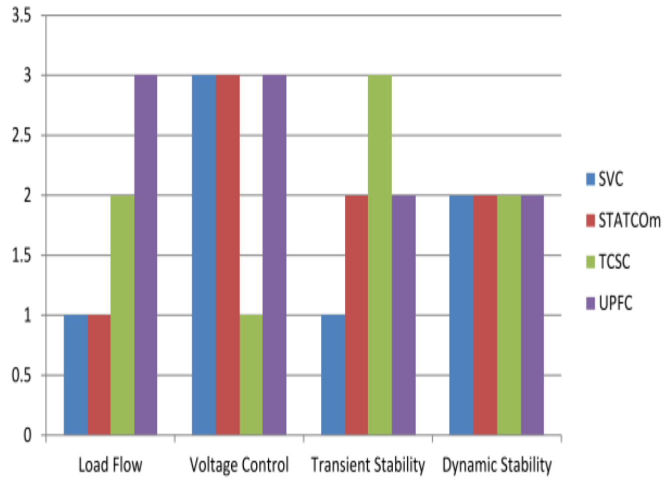

Figure 4: Illustrates the graphical representation of Practical Advantage of main FACT system.

In Figure 4, the practical assistance and flexibility of the FACTS in addressing problem such as transient or dynamic stability, loads flow current, or voltage management are described. Traditional solutions to these issues are less costly than FACTS devices, but they lack the versatility of FACTS.

V. CONCULSION

This article compares, contrasts, and discusses several FACTS devices or controllers. Increased transmission needs, a lack of the long terms planning, or the requirement to allow producers and consumers free access have all led to a reduction in supply security and quality. Because it is critical for overcoming some, although not all, of these challenges in order to boost grid dependability, FACTS technology is becoming a common teaching topic. FACTS devices have been successfully installed on transmission system in recent years to increase voltage profile or power flow. Its high initial cost of Facts devices, on the other hand, continues to be a major impediment to their widespread adoption. FACTS device are predicted to become increasingly integrated into transmissions technologies in the context, allowing for far more efficient power flow control via power lines.

REFERENCES

[1] Baby A, Thomas J, Tibin J. Analysis of voltage collapse in the Kerala power grids using SVC, UPFC & SSSC. In: Proceedings - 2013 IEEE International Multi Conference on Automation, Computing, Control, Communication and Compressed Sensing, iMac4s 2013. 2013.

[2] Goyal V, Aslam K. A Review on Controllable Parameters of UPFC for Power Quality Methods ? Real Time Application. Int J Commun Netw Syst. 2013;

[3] Alam S, Siddiquee SMS, Islam K, Arafat IM, Reza MH. Implementation and Control of Low Voltage Transformation for Compensating Voltage Sag. In: 2nd Int'l Conf on Electrical Engineering and Information & Communication Technology (ICEEICT). 2015.

[4] Müller Z, Sýkora T, Švec J, Tlustý J. Dynamic loading control using FACTS in extraordinary states. In: Proceedings of the 12th International Scientific Conference Electric Power Engineering 2011, EPE 2011. 2011.

[5] Hoseynpoor M, Najafi M, Ebrahimi R, Davoodi M. Power system stability improvement using comprehensive FACTS devices. Int Rev Model Simulations. 2011;

[6] Čonka Z, Kolcun M, Kolcun Jr. M, Dudiak J, Mikita M, Vojtek M. Improvement of Power System Stability Using FACTS Device. Power Electr Eng. 2016;

[7] Constantin C, Eremia M, Bulac C. Power system transient stability improvement using series facts devices. UPB Sci Bull Ser C Electr Eng Comput Sci. 2015;

[8] Devi S, Geethanjali M. Optimal location and sizing of Distribution Static Synchronous Series Compensator using Particle Swarm Optimization. Int J Electr Power Energy Syst. 2014;

[9] Zhu X, Jin M, Kong X, Zhao J, Liu J, Zhou Q. Subsynchronous resonance and its mitigation for power system with unified power flow controller. J Mod Power Syst Clean Energy. 2018;

[10] Mishra A, Gundavarapu VNK. Contingency management of power system with Interline Power Flow Controller using Real Power Performance Index and Line Stability Index. Ain Shams Eng J. 2016;