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INTELLIGENT SOLUTIONS FOR SUSTAINBILITY OF POWER SYSTEMS

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Abstract: Intelligent solutions provide the necessary features to avoid technical problems in the power systems that increase transmission capacity and system stability very efficiently and they assist in prevention of cascading disturbances. They support the great access of renewable energy resources and reduce the transmission losses by optimization of power flows.

Keywords: sustainable development, flexible systems, power flow.

1. INTRODUCTION

Global demand for renewable energy is pushing renewable energy to the side of fossil fuel energy production. Fossil fuel has limited resources in the world and increasing production has increasing pollution problems. Central power stations are low efficient, high polluting stations which contribute to environmental issues. In order to overcome these problems structural changes are needed in power production to change non-renewable based production to renewable based energy production. Due to public interest, appears a pressure to develop technical solutions to increase amount of renewable energy in power production, and to use opportunities to utilize renewable energy resources and address the technical challenges [1].

Carbon dioxide concentrations are rising mostly because of the fossil fuels that people are burning for energy. Fossil fuels like coal and oil contain carbon that plants pulled out of the atmosphere through photosynthesis over the span of many millions of years; we are returning that carbon to the atmosphere in just a few hundred years.

Small-scale power production is replacing large-scale centralized power production. Intermitted energy as wind power and solar energy are causing negative effects to power quality, voltage, frequency and reliability [5]. An increasing amount of intermittent energy increases problems for the grid.

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2. HVDC AND FACTS CONVERTER TECHNOLOGY

HVDC and FACTS controllers based on line commutated converter technology have a long and successful technology (fig.1). Thyristor was the key components of this converter topology and have reached a high degree of maturity due to their robust technology and their high reliability. HVDC transmission technology offers new dimensions for long distance transmission. In general, for transmission distances above 700km, DC transmission is more economical than AC transmission at least 1GW.

HVDC and FACTS provide the necessary features to avoid technical problems in the power systems that increase transmission capacity and system stability very efficiently and they assist in prevention of cascading disturbances. They support the great access of renewable energy resources and reduce the transmission losses by optimization of power flows.

The power systems work with transmission alternative voltage lines 220kV, 400kV, 750kV and continuous voltage $\pm$ 200kV… $\pm$ 800kV.

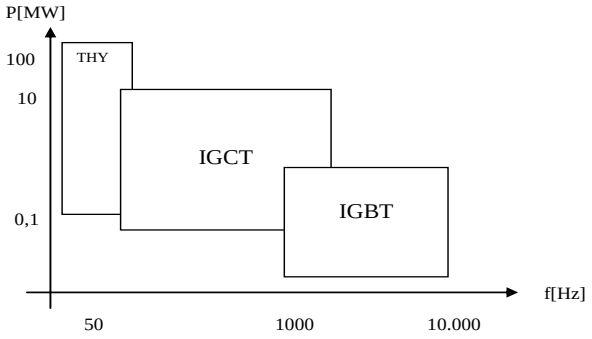


Fig. 1. Evolution of Si power electronics devices

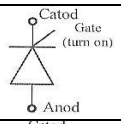
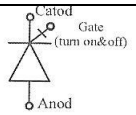
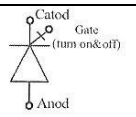
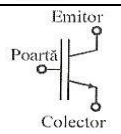
Advances in power electronic technologies together with sophisticated electronic control methods made possible the development of fast static compensators namely Flexible AC Transmission Systems (FACTS). The FACTS technology has become one of the most valuable compensation techniques, because it applies the latest advances in power electronics to achieve additional and more effective control of the parameters of the electrical systems [3]. This represents the most efficient combination of conventional primary equipment, high power semiconductor devices, microelectronics and telecommunications equipment, allowing a most flexible power electric system.

Till today, the thyristor having the highest voltages and currents are used in almost all FACTS technologies and in some HVDC lines having $\pm$ 800kV and power of 8GW. The thyristors are also using in static commutations from LCT (inductance controlled thyristor) and CCT (Capacity switched thyristor) in converters for static VAr compensator.

Especially in applications of wind plants off-shore the devices for HVDC must to have small dimensions so, more devices can be integrated in the same semiconductors structure.

The main definition of FACTS is the A.C. Transmission System which incorporate static commutates based on power electronics which improve the controllability and increase the transmission capacity. Flexible AC Transmission Systems (FACTS) technology helps utilities in reducing transmission congestion and in utilizing more efficiently the existing transmission system without compromising the reliability and security of the system. Their fast response offers high potential for power system stability enhancement apart from steady state flow control [2].

Table 1 ***The semiconductors characteristics for HVDC and FACTS***

Types of semiconductors	Symbol	Characteristics				
		Highest turn-off voltage [kV]	Highest direct current [kA]	The commutation frequency [Hz]	The nominal power	t_{off} [μs]
Thyristor		8	5,5	50/60	kW-GW	50
Gate Turn Off Thyristor		4,5	4	<500	MW	10
Integrated Gate Commutated Thyristor		6,5	1,5	<1000	MW	5
Isolated Gate Bipolar Transistor		6,5	2,4	<1000	MW	2

The benefits of employing FACTS are many: improvement of the dynamic and transient stability, voltage stability and security improvement, less active and reactive power loss, voltage and power profile improvement, power quality improvement, increasing power flow capability through the transmission line, voltage regulation and efficiency of power system operation improvement, steady state power flow improvement, voltage margin improvement, loss minimization, line capacity and load ability of the system improvement [4]. The abbreviation for used FACTS devices are: TSSC – Thyristor Switched Series Capacitor; SSSC – Static Synchronous Series Compensator; TCVR- Thyristor Controlled Voltage Compensator; CSC – Convertible Static Compensator; SVC – Static VAr Compensator; TCSC – Thyristor Controlled Series Capacitors; STATCOM – Static Synchronous Compensator.

In the last years, some mechanical switchers of parallel capacitors/inductances were being replaced by static switchers with thyristors. The modern devices of serial compensation are TSSC, TCSC and SSSC. The different FACTS devices contain as parallel components as well serial components connected together in the transmission system (as UPFC – Unified Power Flow Controller and IPFC – Interline Power Flow Controller) [4]. These devices can control the important parameters of energy as line voltage, impedance, angle or active power flow and reactive power flow.

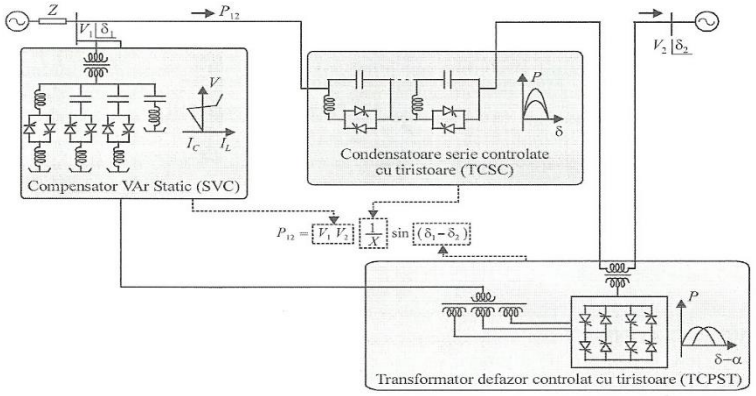


Fig.2. FACTS devices based on the conventional thyristors

3. CONCLUSIONS

Modern power systems are large, interconnected and involves thousands of buses and hundreds of generators. Power system protection devices also form a large part of the system. Environmental as well as economic factors primarily govern the installation of new power system and to transport this power, new transmission line construction are needed to meet the ever increasing load demand.

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