Power Factor Improvement in Power System with the Integration of Renewable Energy

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***Abstract*—The non-linear constant increment of power demands due to loads caused a complexity in the operation of the power system network and might also cause insecurity without adequate control in the system with large power flows. A successful alternative energy source gives new challenges when connected to the power grid system. It is however that with the presence of environmental conditions, there is a constant fluctuation of generated power from renewable energy sources. This can be explained when wind power is used as a source of injection into an electric grid, where the power quality will be affected due to the fluctuating condition of the nature of the wind and comparatively new types of its generators panel. Power system control is introduced in this matter using a controller known as FACTS (Flexible AC Transmission System). FACTS controllers such as STATCOM (Static Synchronous Compensator) and SSSC (Static Synchronous Series Compensator) can function to be a terminal voltage regulator to the power system and consequently improve the systems' stability and power quality. With the usage of IEEE 14 bus power system network, both the potential STATCOM and SSSC are measured using the controller at high influential locations of the power system.**

***Index Terms*—FACTS; Power Factor Improvement; Power Grid; Renewable Energy Sources.**

I. INTRODUCTION

The problems currently being faced by centralized power generation systems is the shortage of its main energy sources which is generated by fossil fuels. The electrical power losses are significantly caused by the length of the transmission lines. With that, the focus of introducing the integration of renewable energy systems to the grid will lead to massive energy efficiency and reduction of emissions. While there is a substantial increase in the penetration of renewable energy to the grid, quality in the power of the medium to low voltage in the power transmission system becomes a significant area to research on.

Power electric converters are considered to be one of the main aid in the integration of renewable energy systems to the grid. Power electronic converter is used as the main purpose to integrate the distribution in the generation to the grid power factor standards. However, high switching frequency inverter can inject additional harmonics to the system, creating major power quality problems if not carried out correctly [1, 2].

Custom Power Devices (CPD) such as Shunt Active Power Filter (STATCOM or SVC), Series Active Power Filter (SSSC or TCSC), Combination of series and shunt Active Power Filter (UPFC) are the latest development of interfacing devices between distribution supply and consumer appliances to overcome voltage/current disturbances and improves the power quality by compensating the reactive and harmonic power generated or absorbed by the load. Natural resources from solar and wind channels to most promising distributed generation of sources while also raising their penetration level to the grid. Although the benefits of distributed generation include voltage support, diversification of power sources, reduction in transmission and distribution losses and improved reliability, power quality problems are also of growing concern [3].

Creating a hybrid Custom Power Device (CPD) is another alternative solution that fixes the issue of power quality and power stability in the power system grid especially in its power factor. The specialization of this system is that it can detect, analyzed and responded to the many perturbations from the original energy source and renewable energy source using intelligent devices, advanced control methods and digital telecommunications on electrical bus networks. This concept is the outcome of advanced technology and regulation from various stakeholders who are concerned with demand-side management and increased usage of Renewable Energy Source (RES). This system is under development and it is predicted to be a dynamic, reliable, flexible, and diverse, and it can be fully controlled. This new scenario will enable power operators to maximize the power quality, such as in Total Harmonic Distortion (THDi), Power Factor (PF), current and voltage balancing. Therefore, this will give environmental targets and will provide power systems to be more flexible in supporting plug-in distributed generation [4].

II. POWER FLOW STUDY

The power flow study, also known as a base case, is a tool which is significantly important in applying numerical analysis in a power system. Various software applications are used to perform a variety of analysis; such examples are short-circuit fault analysis, stability studies (transient & steady-state), unit commitment and economic load dispatch analysis. Specifically, some programs use linear programming in search of optimal power flow, the conditions which give the lowest cost per kilowatt-hour delivered.

Power systems as well as finding the best operation of existing systems can be expanded in future using power flow or load-flow studies. The primary facts attained from the power flow study is the degree and phase angle of the voltage at each bus and the real and reactive power flowing in each line. Load flow studies are achieved using computer software which simulates actual steady-state power system operating conditions, enabling the evaluation of bus voltage profiles, real and reactive power flow and losses. Directing a load flow study using various scenarios helps to ensure the design of a