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ASSESSMENT OF GRID COLLAPSE BY INJECTING REACTIVE POWER AND USING DC-DC CONVERTOR AND VOLTAGE SOURCE INVERTER FOR INCREASING POTENTIAL OF GRID

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Abstract
In high solar energy regions Photo-voltaic system is the minimum budget source of electrical power. The benefits of photo-voltaic system are like minimum maintenance & non-polluting. Solar energy changes as per temperature &irradiance. Henceforth, we are describing the use of voltage source inverter&dc-dc converter for increasing the active power supply along with reactive power control technique for preventing the grid collapse in this paper.
Keywords: dc-dc converter, reactive power, inverter, grid, power supply

1. INTRODUCTION

More&more photo-voltaic inverters connected grid in recent years have been connected to the power grid due to the rise of new energy generating technologies, making the modelling&stability of new power grids a topic of intense study [1, 2, 3]. It is much easier to model, develop a control strategy for,&do a stability study of photo-voltaic grid-connected inverters when the array is transformed into a variable voltage source [4, 5]. Similarly, the analysis, controller design,&numerical simulation of multi-parallel grid-connected inverters are considerably simplified by correctly simplifying the H-bridge switch circuit&then developing an equivalent model [6]. A solar array is an example of a nonlinear device that, even when simplified, can have a significant effect on the reliability of a model of a photo-voltaic grid-connected inverter. Researchers are increasingly interested in nonlinear models in an effort to improve the accuracy of system models, thanks to the rapidly rising processing capabilities of current microprocessors. More precise modelling for photo-voltaic grid-connected inverter [7,8,9] is possible with the use of nonlinear models of photo-voltaic arrays, which enable investigation of the system's nonlinear properties.

Power switching devices in an inverter circuit are highly nonlinear systems. Bifurcation&chaos, two fundamental physical phenomena, are better revealed when a piecewise smooth model is established [10,11,12,13]. Bifurcation&chaotic behaviours of motor systems [18,19], DC/AC converters [11,13,17],&DC/DC converters [14,15,16] have all been extensively investigated since the 1980s as examples of power electronics systems having the the non-linear dynamic behaviour. Studies has shown that the stability &control of power electronic systems are intrinsically linked to bifurcation&chaotic behaviours [20,21], that the bifurcating behaviour of multi-inverter micro-grids have an intrinsic relation-ship with stability ofsystem [22,23],& in those power electronics systems that control ofchaos is crucial for stability of system [20,21]. Accurate modelling of system, analysis of stability &control, are becoming increasingly vital as the amount of grid-connected inverters in distributed photo-voltaic system is continuously rising. In order to build reliable models of solar grid-connected inverters, it is necessary to take into account both& the switching properties of inverter circuits&the non-linear properties of photo-voltaic arrays.

our primary contributions are the development of a non-linear model forgrid-connected inverters that arephoto-voltaic &the solution of its presumed controller; the examination of the non-linear dynamic behaviour of such inverters via techniques such as bifurcation diagrams , folded diagrams,phase diagrams & time-domain waveforms,&the investigting strategies for selection of control parameters that take advantages of non-linear dynamic behaviour characteristics like bifurcation&chaos. Modeling, optimisation control,&analysisingstability of new energy grid-connected power generating systems distributed on large-scale may benefit from the work presented in this study.

2. DC-DC CONVERTER

Low-power applications that required a greater voltage than a standard DC supply could benefit from a vibrator, a step-up transformer,&a rectifier, all of which were commonplace before the advent of power semiconductors. A motor-generator unit, consisting of an electric motor driving a generator to create the necessary voltage, was commonly utilised in situations calling for a larger power output. (Thegenerator &motor may be 2 distinct machines, or they may be integrated into a single unit "dynamotor" that does not require a power shaft.) Yet, when no other option was there, like when powering a car radio (which utilizes thermionic valves (tubes) which require very higher voltages than accessible from a car battery), these highly inefficient&expensive devices were employed. It was only with the development of power semiconductors&integrated circuits that these methods could be used at a reasonable cost. The DC power source, for instance, is first converted to high-frequency AC as the input of a transformer, which then rectifies the voltage by changing it from AC to DC. However, despite the availability of transistorised power supplies, some amateur radio operators still used vibrator supplies&dynamotors to power mobile transceivers that demanded high voltages. This was despite the fact that by 1976, transistor car radio receivers no longer necessitated high voltages.

While a linear regulator or even a resistor could be used to convert a greater voltage into a lower one, they wasted energy in the form of heat. It wasn't until the advent of solid-state switch-mode circuits that this problem was solved Uses

3. DC BOOST CONVERTER TOPOLOGY IN PHOTO-VOLTAIC SYSTEM

The components of a DC-DC boost converter are depicted in Figure 1 below, from left to right: power switch (M), diode (D), inductor (L), capacitor (C), switching controller,&load (R). You can use this design to connect a low-voltage photo-voltaic array to a high-voltage battery bank input or any DC load [24]. The output voltage from the DC-DC boost converter will be higher than the input voltage. The controller will activate&deactivate the switch to regulate the voltage increase from the input to the desired output. Energy can be stored in the inductor when the switch is activated&the diode is in reverse bias. The capacitor will therefore serve as a source of current for the load. When the power is cut off, the inductor's stored electrical energy is discharged into the capacitor&load. Both continuous-conduction mode (CCM)&discontinuous-conduction mode (DCM) are supported by DC-DC boost converters (DCM). Inductor current is non-zero while the DC-DC boost converter is operating in CCM but returns to zero after each switching cycle when operating in DCM, [25]. Harmonic reduction, power factor correction, zero voltage control,&load balancing are just some of the applications of recent DC-DC boost converter research [26-28].

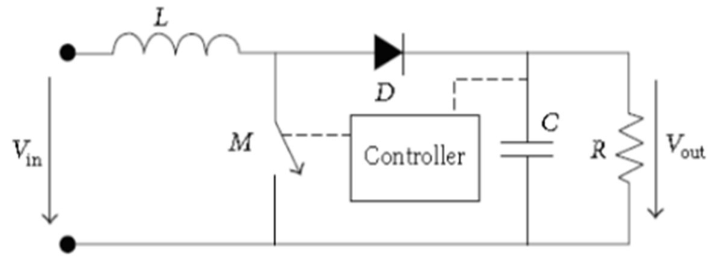

FIGURE 1: CIRCUIT OF DC-DC CONVERTER (29,30)

Voltage source inverters for generating active power

According to recent statistics, PV's primary use is in tying into the power grid in industrialised countries like Japan, the United States,&Europe [31]. The federal government&municipal energy providers in Germany are supporting a programme to install photo-voltaic systems in schools,&the country as a whole has a total of 100,000 solar rooftops [31].

However, at the present time, the vast majority of inverters used to link photo-voltaic to the electric power grid are CSI inverters that operate at unity power factor. When just the active power is sent to the distribution grid, the power factor of the photo-voltaic system using this inverter will drop to its lowest value. As a result, the electric grid will continue to supply the reactive power required by the local charges via the capacitor connected to the primary of the distribution grid or the substation. Yet, this is a drawback of photo-voltaic systems because they are rendered ineffective when the insolation is low or at night. At this time, all power comes from the utility company's electrical system. In addition, nighttime shutoff of the photo-voltaic makes regulating it trickier. Reactive power can be created&absorbed using the available capacity of the inverter at a given moment in line with the demand of the electric power grid if the VSI photo-voltaic solar system connected to the electric power grid is applied instead of the CSI [32].

Power generation&consumption can be analysed with an inverter in the same way as a synchronous machine with an infinite bus. Yet, the inverter displays a more rapid dynamic since the rotor's inertia is not present. Yet, the need to have the inverter act like a synchronous machine makes the inverter's control dependent on the grid voltage signal's feedback.

Unlike synchronous machines, which have a direct relationship between active power&the phase changes of generator voltages, power inverters have no such relationship between the amplitude of the output voltage&the reactive power. So, the control system must establish these connections between the inverter&the infinite bus to ensure reliable functioning.

The equations (1)&(2) can be used to determine the active&reactive powers sent by the electrical grid [33].

$$P = \frac{V_i V_s}{2\pi f L_C} sen\delta = P_{MAX} sen\delta \qquad (1)$$

$$Q = \frac{V_i^2}{2\pi f L_C} - \frac{V_i V_s}{2\pi f L_C}\cos\delta \qquad (2)$$

An inverter&the electrical grid must have a voltage amplitude difference for reactive energy transfer to occur. In a phase-matching situation where Vi is greater than Vs, the inverter contributes only reactive power to the grid (capacitive mode). In contrast, the inverter draws reactive power from the grid if the voltage Vi is less than the voltage Vs while still being in phase (inductive mode).

Active power transition between the inverter&the electric grid can be accomplished if the inverter is equipped with a store or energy generator equipment (battery, fuel cell, or solar system) in the DC side. The phase difference between voltages Vi&Vs can be used to modulate the active power change. In this case, the output voltage is generated later&at the same magnitude as the grid voltage if active power absorption is desired, with the direction of active power flow being defined as having been from the grid to the inverter. Also, the inverter can provide active electricity to the grid because its output voltage is pre-produced&of the same magnitude as the grid voltage. As the DC side energy generation or storage device can be suitably designed, this function is feasible. Hence, active power is absorbed or generated when the voltage Vi is delayed or advanced from Vs (by an angle smaller than 90o) while maintaining the same voltage magnitude.

The primary function of the inverter's control system is to maintain a constant voltage across the DC bus capacitor, where the photo-voltaic is connected, by adjusting the power angle in response to the energy supplied by the photo-voltaic system. As a result, depending on the amount of energy being created, it either contributes more or less active power to the electric grid. Its power varies with the amount of sunlight available. In addition, the system aims to modify the magnitude of the voltage vector at the inverter terminals so that the inverters can either take reactive power from the grid or supply it. When the photo-voltaic is producing little to no energy, such as during cloudy weather or at night, the grid's downtime is put to good use. This can be accomplished by modifying the active Ip&reactive Iq components of the current vector I, which represent the active&reactive power flows between the equipment&the electric grid, respectively.The entire system consists of photo-voltaic cells, a DC/DC boost converter, a DC capacitor (Cdc), a high-frequency switching frequency (fs) that is controlled by pulse width modulation, a filter, an AC coupling inductor (LC), voltage&current sensors,&a control unit. Figure 2 depicts the internal organisation of this system.

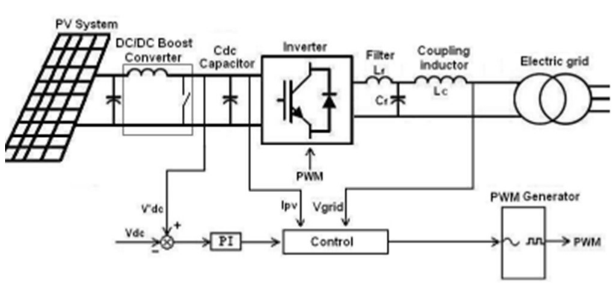

Figure 2 Grid-connected photo-voltaic power system&controller

Reactive power injection

The continuously rising level of penetration of (PV) photo-voltaic systems demonstrates the immense potential for renewable energy integration into the grid made possible by advances in power electronics technology, which in turn increases grid decentralisation&susceptibility. So, in order to accommodate an increase in photo-voltaic installations, sophisticated control strategies that are in line with grid requirements or regulations are necessary. Current regulations mandate that photo-voltaic systems de-energize local loads during grid abnormal events such as voltage drops&frequency fluctuations. Meanwhile, in order to comply with those grid requirements, most systems must use Maximum Power Point Tracking (MPPT) control to operate at unity power factor to get the most power out of their photo-voltaic panels. In the case of a low penetration degree of photo-voltaic systems, those grid requirements hold true,&this includes the most often used single-phase systems.

A growing number of photo-voltaic installations, however, will disrupt power grids. beacause to the photo-voltaic solar sources inter-mittent nature&un-balance amid photo-voltaic load needs &supply issues like voltage rises or potential over-loading may emerge at grid feeders that are distributed, especially whenever penetration level that is extremely high of photo-voltaic system is attained. Possible solutions includinglowering installations &restrictive feed-in maximumised power from photo-voltaic system, in most nations, such as Germany both of these counter for fulfilling the purpose of carbon reduction, by allowing for a extended extensive use of renewable energy sources. Large-scale photo-voltaic systems in these nations are expected to contribute to voltage regulation by absorbing or injecting reactive power as a kind of grid supportstatic in nature, hence they have proposed certain grid criteria for these systems.

Moreover, grid variations may be induced by the tripping off of an asembled photo-voltaic system due to protectionthat is anti-islanding, which could result in more severe events, such as a power outage [35]- [37]. Therefore, it's preferable for upcoming-generation photo-voltaic systems for stabilise the grid in the event of failures& prevent the loss of massive photo-voltaic generation systems theyshould provide grid support that is dynamic in the form of Low-Voltage Ride-Through (LVRT) with Reactive Power Injection (RPI) in response to any kind of disturbances in grid. In Italy, for instance, LVRT capacity is required for all generation systems with an aggregate output greater than 6 kW [34]. For grid-connected photo-voltaic systems&other medium- or high-voltage systems in Germany, it has been effective for some time. Grid code updates occur in other nations at the same rate. These regulations were initially implemented for wind turbine systems but are now typically applied to all photo-voltaic systems, including photo-voltaic modules.

The anti-islanding condition is obviously broken by the addition of the LVRT function. So, as depicted in Fig. 3, grid enhancement needs to take compatibility between those two functions into account.

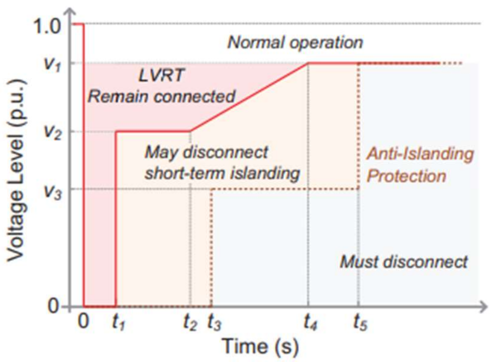

Figure 3: Recommendations for achieving low-voltage through &anti-isolation with single-phase photo-voltaic systems hooked up to low-voltage grids.

Reactive power

There is no useful work done by reactive power as it oscillates between the generator&the load. Yet, reactive power is essential for system voltage regulation, motor magnetization,&the efficient transfer of active power in an alternating current (AC) circuit.

Reactive power is a type of power that is used to maintain the voltage level in the grid. In photo-voltaic systems, reactive power supply can be used to adjust the voltage&current to match the requirements of the grid. Reactive power can be supplied by devices called reactive power compensators, such as capacitors&inductors.

When a photo-voltaic system connected with the grid, it can create fluctuations involtage that can lead to instability in the grid. Reactive power compensators can help stabilize the grid by supplying or absorbing reactive power as needed. If the photo-voltaic system is generating more power than the grid can handle, the reactive power compensators can help absorb the excess power to maintain stability. Conversely, if the photo-voltaic system is not generating enough power, the compensators can help supply the necessary reactive power for maintaining the voltage level.

Reactive power control

The contribution of reactive power of photo-voltaic system is particular according to the regulations of current,&moreover, the size of the voltage at the connection point is what set-point is dependent on, thus care must be taken when implementing either method of reactive power control. But, in this paragraph, we will focus mostly on the controller design process. In order to manage reactive power via, as stated in (5), a straightforward calculation can be performed to determine the mandatory reference reactive power&then translated into reference current along the q axis. Due to the leakage inductance of the transformer, filter capacitor,&reactor, the reactive power generated by the VSC & the reactive power observed by the grid are not equal. Thus, reactive power may be regulated more effectively with the help of a second control loop. Iqref is the output of a controller that measures the difference amid the reference reactive power &measured reactive power. The reactive power controller is derived via a direct synthesis process that, like the Fc(s) design procedure, results in a first-order transfer function in closed-loop.

Managing the Alternating Current bus voltage is another option for regulating reactive power use. In this method, $i_q$ref is achieved by routing the voltage differential among the alternating current vehicle&the reference value via a controller. Forconstructing an AC voltage controller, a few presumptions must be made. Despite the fact that is no longer a rigid grid, any momentary excursions in the angle of frequency of a PLL out-put are ignored.

Conclusion

For future alternating current&direct current applications using energy sources that are renewable, this paper provides an overview of dc-dc converters to acquire step-up voltages in large amount with minimal losses, to optimise power,&systems connected with grid to be utilized in micro-grids. Active electricity can be supplied to the grid from a DC source via an inverter. With this setup, the photo-voltaic module doubles as the DC source&is connected to the inverter. Active, reactive, &apparent power profiles under varying generation conditions are analysed by computational simulations .Also we conclude that using the reactive power injecting technique can reduce the voltage level&hence reduce the grid collapse cases.

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