DESIGN A RENEWABLE ENERGY MODEL BASED-ON MODIFICATION OF IMPEDANCE NETWORK (REM-MIN)

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Abstract

The most energy used nowadays are based on those design and models for producing high energy but with minimizing its effects on the environments. To do so, Renewable Energy Model Based-on Modification of Impedance Network (REM-MIN) is proposed. The mentioned modification could be seen on impedance network, and such network has built based on proposed network flow scheme. In this article, voltage performance analysis is performed based on new criteria called free boost control which has been utilized in almost renewable energy applications. This article also making an analysis of the impact of conventional inverters to overcome the drawback of nowadays source inverters such as VSI, CSI and ZSI by proposing a quasi-Z source inverter (QZSI). The QZSI produce almost inverters operations namely hybrid inverter such as from DC to DC and from AC to AC, and also their hybrid such as from DC to AC and vice versa. Also, it may be used for each buck and boost operation, using the shoot through state. The achieved goals for this paper are producing both main properties which are stability and reliability. The modelling of the proposed model has been built based on MATLAB/Simulink environment.

Keywords: Renewable energy, impedance network, quasi-Z source inverter, stability, reliability.

Introduction

Traditional transformers that are used in various fields these days are considered a group of huge obstacles in terms of the early stages of design as well as the implementation and operation phase. Let's take the VSI model or inverter [1]. It is a high-value capacitor that is connected directly and without any intermediary to the source, taking into account the structure and value of the input voltage, which must be constant with respect to the direct current. As for the number of keys used in this type of inverters, it is six. The switches are a mixture of low-resistance integrated electrical circuits (MOSFET) with diodes that work in parallel and with resistance in parallel to ensure that voltage is obtained in one direction while the electrical current is bidirectional. The high cost, low efficiency and low reliability are considered in addition to the high possibility of a short circuit is the most prominent disadvantage of this design [2].

In CSI type, series connection of large inductance provides high flexibility with source terminals as well as ease and simplicity of DC. As in the previous type, six is the number of switches used in this type of design, except for the MOSFETs present in the previous type, which have been replaced with IGBTs, which are connected in series with a diode [3]. This type has a number of weak points, the most important of which are: The output current is a high-valued continuous current when compared to the source current, and its cost is also high, and the power factor is considered fairly low. There are other disadvantages, including interfering noise and slow dynamic response, and also the efficiency is not acceptable [4].

The ZSI (Z-Source Inverter) is the main controller of the short circuit time as well as the possibility Direct voltage input without the need for the known DC/DC converter. In terms of voltage, operation and voltage boost can be implemented to avoid short circuiting of the inverter. Another advantage that this inverter has is improved reliability because it does not require any other additions [5, 6].

It can also be said that the input current for this type of inverter is intermittent. For those reasons mentioned in the previous lines, QZSI is a form of ZSI. In this model, the input and output stages have the advantages of ZSI. Solar power generation because it is common ground and the input current is continuous used for system computers (power conditioning system) It can be used [7, 8].

QZSI uses a resistive network to reduce size and cost. Optimal design of two capacitors and two inductors is required. First, a method is presented to design an impedance network by approximating the waveforms of capacitor voltage and inductor current during the dark short-circuit period of the ZSI taking into account the capacitor voltage and inductor current ripple [9]. In QZSI, which is DC voltage/AC voltage conversion, a method is presented to organize all network variables into equations of state and then consider the capacitor voltage and inductor current ripple during the dark short circuit time. In addition, a method for designing capacitor and inductor QZSI values using the ratio of resonance frequency and switching frequency with the inductor current ripple component is presented [10]. However, in the current paper, the effect of the internal resistance of the capacitor is not taken into account when designing the parameters inside the impedance network, so there is the problem of serious errors occurring in the calculation of the capacitor voltage ripple component.

1. Related work

In [11], the authors verified the characteristics and features of power electronics that have been used in the production and generation of so-called renewable energy, as well as models that use very high voltage and used in direct current transmission, or what is called for short (HVDC).

In [12], the authors studied and analyzed two different methods of inverters for the purpose of introducing development and modification to the stability property of the proposed system, which is built on high-voltage direct current (VSC-HVDC), by modifying and developing the control parameter and introducing a control loop that is considered additional.

In [13], the authors presented a model based on multiple levels of the inverter, which is called (MLI) for short, by using a hybrid renewable energy equipment (HRES) and then building a hybrid renewable energy generation system from natural energies, which are wind energy in addition to Solar energy all have reflectors with different and high levels: 13, 17, and 19 levels.
In [14], the emphasis has been placed on the importance of using models of transformers and inverters that have the ability to program and which the user determines himself through interaction interfaces designed for this purpose. In this study, some recommendations were also put forward by considering the application of user-defined relay characteristics, which can be proven as a strong protection plan to deal with protection challenges in solar energy system developments used today or that may be used in the near or distant future.
In [15], the researchers collected and investigated the most important information about the private hybrid grid in the renewable energy system that was proposed and built, in addition to carrying out control operations taking into account the economic characteristic. As it is known that the hybrid system is called solar energy and wind energy, the system proposed in this study supports both in a fundamental way. In this study, hybrid renewable energy was studied, as well as an analysis of the solar energy network in addition to wind turbines.
In [16], the paper focuses on monitoring technology in the renewable energy system. It also reviews the study of simultaneous broadband phase measurement techniques and simultaneous waveform measurement techniques. Then, early warning systems and operating applications were presented.
In [17], the study reviews a comprehensive study of special protection systems for renewable energy networks, including small grids and transmission and distribution models. The visual scope of the improved and advanced protection systems to provide reliability for the power grids of the proposed renewable energy system was also displayed.
In [18], the authors proposed a control system related to the hybrid microgrid for a renewable energy system. To achieve the goal of selecting a highly effective control system, an analysis system was built for the purpose of providing the possibility of connecting a voltage with the direct current system for the purpose of reducing recycling power. Maximum power point tracking (MPPT) techniques have also been used for hybrid systems, which, as is known, include photovoltaic station systems and wind turbines for the purpose of extracting maximum energy.
In [19], the system proposed in this article has all the capabilities to provide treatment for all possible scenarios of a renewable energy system that was built based on radio systems for grid communications in synchronization and harmony of different energy sources.
In [20], The two most important rules has studied in this article, known in microgrids for renewable energy systems were presented: the first rule: consistent power loss (CPLR) and the second rule: consistent impedance (CIR) based on the sub-oscillation analysis model.

3- Method

By depending on network flow strategies, the proposed impedance network QZSI based has built. To do so, let take top view for one of the proposed network flows as shown in figure 1.

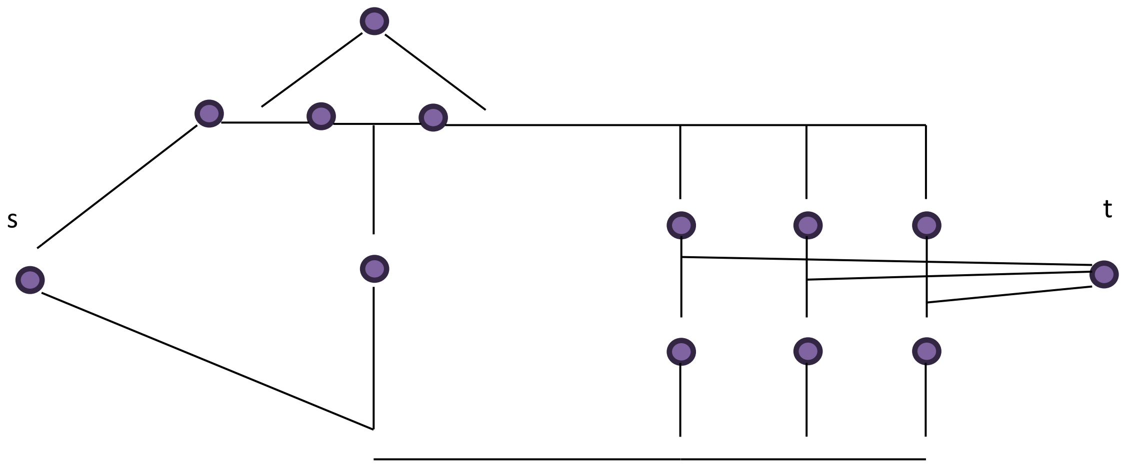

Figure 1: Proposed network flow example.

The shortest paths and minimum spanning trees have been taken in to the consecrations with the edge weights of a given graph. In this directed weighted graph G, the two distinguished vertices s (the source) and t (the sink) represent the began and the end of current flow respectively. The given edges as unidirectional with its weight. The question is: how the maximum current in the given network flow could be start from the source s and collected in the destination t? In order to deal with the given question, let's introduce the most important definition. The definition is a flow network, it can be defined as is a directed graph G = (V,E) with recognized vertices s (the source) and t (the sink), in such vertices the edge (u,v) belongs to E with positive current I(u,v). Here, the most important point is that E should not be consist of both (u,v) and (v,u) [21].
From the above fresh starting point, The QZSI proposed network with the main modifications on classic QZSI has made by introducing some of formal inverter operations namely hybrid inverter such as from DC to DC and from AC to AC, and also their hybrid such as from DC to AC and vice versa [22] as shown in figure 2.

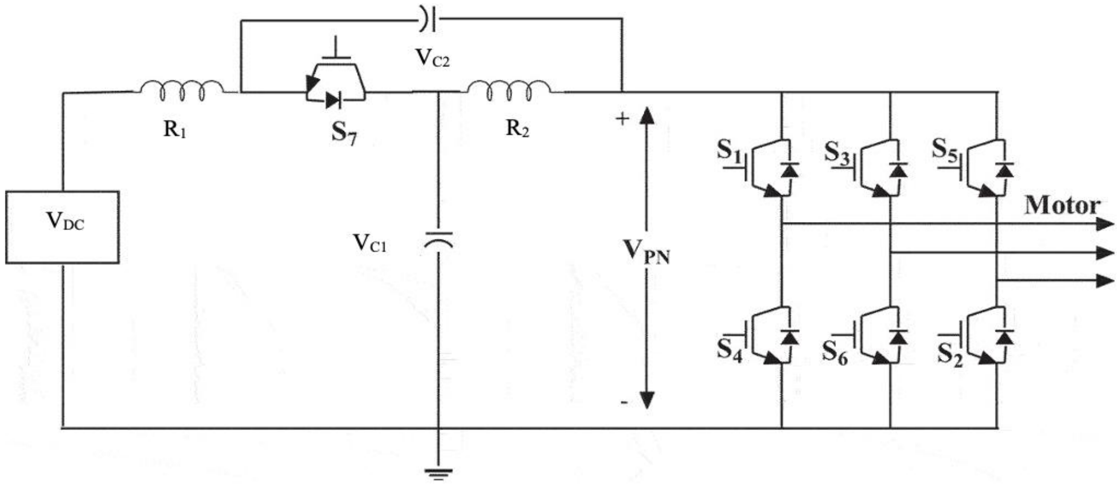

Figure 2: Proposed QZSI network based on the proposed flow network example.

The proposed QZSI network has been built based on the given proposed network flow and the parameters utilized to reach the main goal by achieving voltage performance analysis and perform widely inverters processes called hybrid inverter i.e., from DC to DC and from AC to AC, and again the hybrid like from DC to AC and vice versa. Table 1 lists the main used parameters in the given proposed QZSI network and their specifications.

The mathematical work for the proposed QZSI network consists of some evaluations of different parameters such as voltages across inductors, and capacitors V_{R1}, V_{R2}, V_{C1}, V_{C2}, the output of QZSI namely V_{PN}, the currents I_{R1}, I_{R2}, I_{C1}, I_{C2}, modulation index m, boost factor B, minimum inductance value for continuous current L_m, inductor values R_1, R_2, capacitances C_1 and C_2. The following equations determine the design values [23, 24].

$$V_{R1} = V_{in} - V_{C1} = - V_{C2} \tag{1}$$
$$V = V_{C1} - V_{R2} = V_{C1} + V_{C2} \tag{2}$$

As $V_{diode} = 0$

$$V_{R1} = V_{C2} + V_{in} \tag{3}$$
$$V_{R2} = V_{C1} \tag{4}$$

As $V_{PN} = 0$

$$V_{diode} = -(V_{C1} + V_{C2}) \tag{5}$$
$$V_{C1} = \frac{1-D}{1-2D} V_{in} \tag{6}$$
$$V_{C2} = \frac{D}{1-2D} V_{in} \tag{7}$$
$$V_{PN} = V_{C1} + V_{C2} \tag{8}$$

2. Experiments and Results

To validate the proposed converter, an experimental setup is designed on MATLAB simulation. With an input voltage equal to 38 volts, with two loads equals 35 µH and two equal capacitors equal to 275 µF as shown in table 1.

Table 1: Parameters and their specifications of the proposed QZSI network.

Parameters	Specifications
V_{in}	38 V
R_1=R_2	35 µH
C_1=C_2	275 µF

Based on the proposed QZSI small network and the given parameters values, figure 3 shows the voltage comparison between the classic QZSI and the proposed QZSI and it is noticed that the range of the proposed one located in accepted range with less vibration.

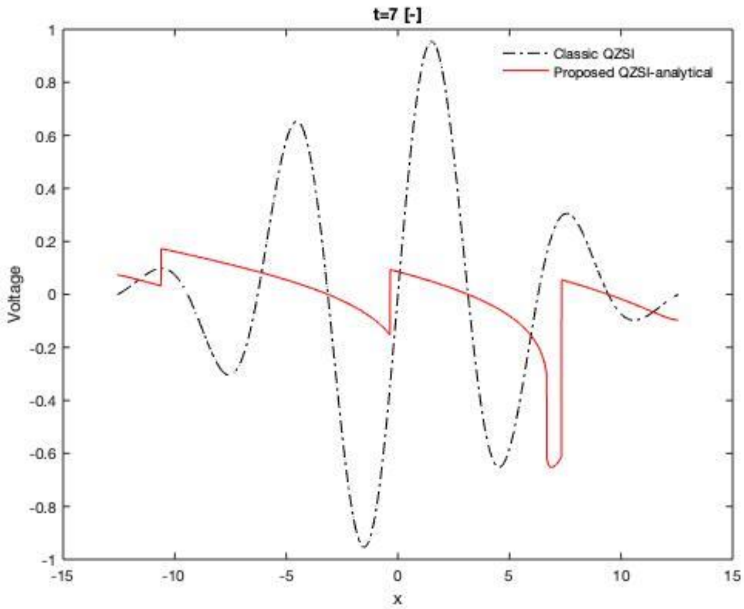

Figure 3: Proposed network flow example.

For complete analysis, figure 4 present the output voltage and voltage phased and it is easy to see the great stability for the proposed system which because of the accurate design for the small network for QZSI.

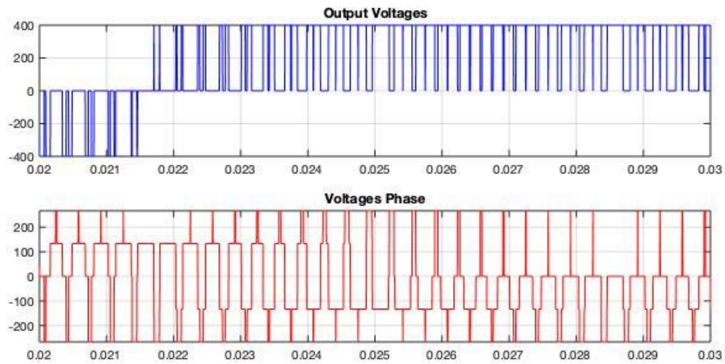

Figure 4: Output voltage and voltage phase for proposed QZSI small network.

After running the complete proposed QZSI network with their filter, capacitor and load it is important to examine the voltage and see if it is working within power supply voltage or not to ensure the reliability, which is the main goal behind the proposed QZSI network as shown in figure 5.

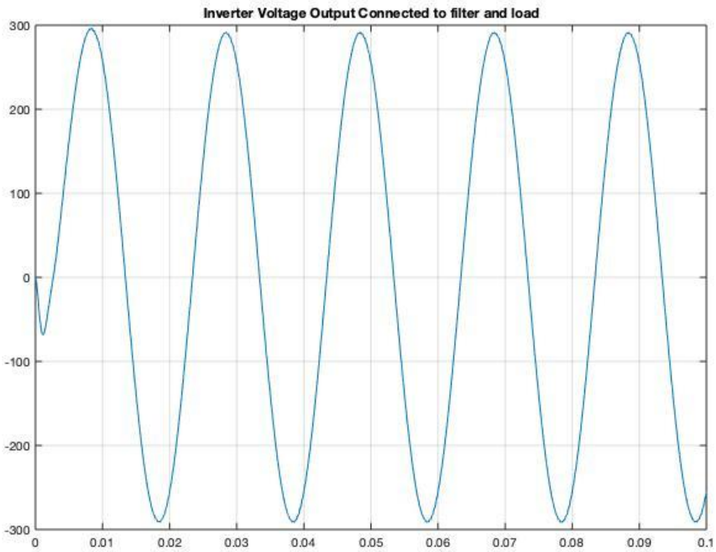

Figure 5: Invertor voltage output connected to filter and load.

3. Conclusion and Future Works

In this paper, it was proposed to build a small network for QZSI based on the network flow model, by making some modifications and changes by connecting the renewable energy source with an expansion and load circuit using external converters such as DC to DC and from AC to AC. This paper aims to study and analyze the influences and factors affecting the proposed microgrid system for the QZS inverter. Acceptable results were obtained by comparing the results obtained based on the proposed system with the classical QZSI system through the characteristics of stability and reliability, which were achieved using a simulation system using MATLAB.

As recommended for future work, we suggest using wind turbines in addition to a renewable energy cell system, as well as using high advanced levels, for example 11 levels or 13 levels.

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