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Reviewed document: **The Role Of Power Electronics (MUHAMMAD TAWQEER) 20-6-2020.docx**
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A total of 145 sentences were analysed. As a result **69** sentences (47.6%) were found in other documents.

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Reference documents

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66 Sentences were found in a text with the title: „***Veda Prakash Galigekere and Marian K. Kazimierczuk Wright ...***", located at:
https://www.magnelab.com/wp-content/uploads/2015/01/Role-of-power-electronics-in-renewable-energy-systems.pdf

65 Sentences were found in a text with the title: „***Microsoft Word - ELEC 56***", located at:
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48 Sentences were found in a text with the title: „***Review on Power Electronics Circuits in Renewable Energy ...***", located at:
http://ijoscience.com/wp-content/uploads/2017/07/akash.pdf

20 Sentences were found in a text with the title: „***PE RE | Wind Power | Photovoltaics***", located at:
https://www.scribd.com/document/322410133/PE-RE

17 Sentences were found in a text with the title: „***Role of Power Electronics in Renewable Energy Systems ...***", located at:
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14 Sentences were found in a text with the title: „***A Survey on Power-Electronics Interface for Renewable Energy Sources***", located at:
https://www.ijert.org/research/a-survey-on-power-electronics-interface-for-renewable-energy-sources-IJERTV4IS030990.pdf

11 Sentences were found in a text with the title: „***Role of power electronics in renewable energy system ...***", located at:
https://www.scribd.com/document/101722877/Role-of-power-electronics-in-renewable-energy-system

11 Sentences were found in a text with the title: „***10.1.1.395.9065.pdf - download***", located at:
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.395.9065&rep=rep1&type=pdf

7 Sentences were found in a text with the title: „***Simulation of Solar Power System IGBT Based Inverter Transition to IGCT to Increase Output Performance***", located at:
https://www.ijsr.net/archive/v4i8/SUB157523.pdf

7 Sentences were found in a text with the title: „***NagaRajuAnnam-DrBhagwanReddyJ-DrSardarAli-51.pdf***", located at:
http://www.ijmetmr.com/olapril2015/NagaRajuAnnam-DrBhagwanReddyJ-DrSardarAli-51.pdf

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5 Sentences were found in a text with the title: „***doc.pdf - art.php***", located at:
http://www.jee.ro/covers/art.php?issue=WN1438788776W55c22ca867606

5 Sentences were found in a text with the title: „***Microsoft Word - jibin-joseph***", located at:
https://pdfs.semanticscholar.org/5a3b/22eb98a22aa5ad6a95b1d71bf75b7ac87ce1.pdf
https://zenodo.org/record/1091914

5 Sentences were found in a text with the title: „***ROLE OF POWER ELECTRONICS IN NON-RENEWABLE AND RENEWABLE ENERGY SYSTEMS***", located at:
https://pdfs.semanticscholar.org/8753/a2fd8a0bc4d49fd7e5d9d912cf9918ec6a33.pdf

5 Sentences were found in a text with the title: „***112.pdf***", located at:
https://ijsr.net/conf/NCKITE2015/112.pdf

4 Sentences were found in a text with the title: „***Wind Energy and Hybrid Generating Systems Controll.pdf***", located at:
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3 Sentences were found in a text with the title: „***ROLE OF POWER ELECTRONICS IN NON-RENEWABLE AND ...***", located at:
https://www.slideshare.net/ijtra/ijtra130527

3 Sentences were found in a text with the title: „***MPhil Power Electronics***", located at:
https://mphilbluecombats.blogspot.com/

2 Sentences were found in a text with the title: „***Impact of power electronics on global warming***", located at:
https://www.slideshare.net/ijreteditor/impact-of-power-electronics-on-global-warming

2 Sentences were found in a text with the title: „***Ijtra130527 by A K PANDEY - Issuu***", located at:
https://issuu.com/ijtra/docs/ijtra130527

2 Sentences were found in a text with the title: „***Renewable Energy and other Alternative Energy Sources: A Review***", located at:
http://www.ijrmee.org/download/browse/Volume_4_Issues/July_17_Volume_4_Issue_7/1517811104_05-07-2017.pdf

2 Sentences were found in a text with the title: „***An Efficient Analog Maximum Power Point Tracking (MPPT ...***", located at:
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2 Sentences were found in a text with the title: „***Veda Prakash Galigekere - R&D Associate Staff Member ...***", located at:
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2 Sentences were found in a text with the title: „***Power Electronics and Its Application to Solar Photovoltaic Systems in India***", located at:
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2 Sentences were found in a text with the title: „***Power electronics in renewable energy systems pdf***", located at:
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▶ In 42 further documents exactly one sentence was found. (click to toggle view)

Subsequent the examined text extract:

The Role Of Power Electronics In Operations Of Energy Systems

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Abstract— The rapid increase in global energy consumption and therefore the impact of greenhouse emissions has accelerated the transition towards greener energy sources. the necessity for distributed generation (DG) employing renewable energy sources such as wind, solar and fuel cells has gained significant momentum. Advanced power electronic systems, affordable high performance devices, and smart energy management principles are deemed to be an integral a part of renewable, green and efficient energy systems. This paper briefly describes the attributes of DG. An summary of wind, fuel cell, solar based energy conversion systems has been presented. A qualitative description of the role of power electronics in wind, solar, and photovoltaic systems has been presented.

***Keywords*—Distributed Generation, photovoltaic.**

Introduction.

We noted that, the Power Consumption is increasing day to day in the world. Official estimates indicate a 44 percent increase in global energy consumption during the amount 2006 - 2030. It are often said that fossil fuels (liquid, coal and natural gas) are the first energy source for this day world. The increasing number of industrialization, Sustained urbanization and penetration of electricity has led to unprecedented dependency on fossil fuels. Presently, the foremost important concerns regarding fossil fuels are the green house gas emissions and therefore the irreversible depletion of natural resources. supported the official energy statistics from the United States government , the global CO2 emissions will increase by 39 percent to succeed in 40.4 billion metric tons from 2006 to 2030 [1].

The quest for cleaner and more reliable energy sources has considerable implications to the prevailing power transmission and distribution system also . Traditionally bulk of the facility is generated and distributed to the massive load centers via transmission lines. The transfer of power was always a method , from the utilities to the consumers. In the immediate future, renewable energy sources cannot support the whole grid by themselves [1]. they need to be connected to the most grid acting as auxiliary power sources reducing the burden on the first power generation units. they might also be employed to serve load units isolated from the most grid. an influence system employing wind powered turbines, cell based sources, micro generators, and photovoltaic systems augmenting the most power lines will constitute a distributed power generation (DG) system. During a DG system end users needn't be passive consumers, they will move suppliers to the grid. Conventionally, important parameters of power delivered (frequency and voltage) are monitored and controlled by the massive power generator units (usually consisting of synchronous generators). Just in case of DG systems, the facility electronic interface has got to regulate the voltage, frequency, and power to link the energy source to the grid.

The main target is going to be on high power density, robust dc- ac and ac-ac modules with complex control and safety requirements.

This paper presents a number of the wants of the facility electronic interface as applicable with reference to wind, fuel cell, and photovoltaic power generation units and qualitatively examines the prevailing power electronic topologies which will be used. Energy storage is additionally vital for DG;

however, this paper focuses solely on the facility electronics aspects of DG. Section 2 presents a summary of wind generation and therefore the associated challenges. Section 3 and 4 present overviews on power generation supported fuel cells and photovoltaic and its implication on the associated power electronic circuits respectively. Section 5 presents the conclusion.

WIND ENERGY SYSTEMS:

Wind energy has the most important share within the renewable energy sector [1], [3]. Over the past 20 years, grid connected wind capacity has quite doubled and therefore the cost of power generated from wind energy based systems has reduced to one-sixth of the corresponding value within the early 1980s [3]. The important features related to a wind energy conversion system are:

Available wind energy

Type of turbine employed

Type of electrical generator and power electronic circuitry employed for interfacing with the grid.

Figure. 2.1(Wind energy conversion based on variable speed)

Wind energy – Wind speeds, atmospheric pressure, atmospheric temperature, earth surface temperature etc., are highly inter- linked parameters. Thanks to the inherent complexity, it is unrealistic to expect an exact physics based prediction methodology for wind intensity/sustainability. However, distribution based models are proposed, and employed to predict the sustainability of wind energy conversion systems [4]. The comprehensive detail of the wind energy resources is beyond the scope of this paper. Supported studies it's been reported that the variation of the mean output power from a 20 year period to subsequent features a variance of but 0.1 [4]. It is often concluded with reasonable confidence that wind energy may be a dependable source of unpolluted energy.

Based on the aerodynamic principle utilized, wind turbines are classified into drag based and lift based turbines. supported the mechanical structure, they're classified into horizontal axis and vertical axis wind turbines. With reference to the rotation of the rotor, wind turbines are classified into fixed speed and variable speed turbines. Presently the main target is on horizontal axis, lift based variable speed wind turbines [2], [3]. Power electronic circuits play an important enabling role in variable speed based wind energy conversion systems.Fixed speed wind turbines are simple to work, reliable and robust. However grid frequency keeps the rotor speed constant. As result, they can't follow the optimal aerodynamic efficiency point. Just in case of varying wind speeds, fixed speed wind turbines cannot trace the optimal power extraction point. Wind turbines, power electronic circuitry partially or completely decouples the rotor mechanical frequency from the grid electrical frequency, enabling the variable speed operation during variable speed. The sort of electrical generator employed and therefore the grid conditions dictate

the requirements of the facility electronic (PE) interface. Fig.2.1 shows the wind energy conversion system at Variable speed. The electrical generator doubled the fed-induction of variable speed of wind energy conversion systems [5]. Fig. 2.2 depicts a doubly- fed- induction- generator where the rotor circuit is controlled by the facility converter system via the slip rings and therefore the stator circuit is connected to the grid. This method is advantageous because the power converter has got to handle a fraction ~ 25% - 50 you look after the entire power of the system [5]. The facility converter system employs a rotor side ac- dc converter, a dc link capacitor, and a dc- ac inverter connected to the grid as shown in Fig 2.2.

Figure 2.2 (variable wind energy conversion system with limited range)

Figure 2.3 (wind energy conversion with fully variable system)

The rotor side converter controls the speed and torque of the rotor and therefore the stator side converter maintains a continuing voltage across the dc-link capacitor, regardless of the magnitude of the rotor power. This method is more efficient than the fixed speed system; however, it doesn't reflect the possible optimal efficiency. By employing a full-scale ac-ac converter system the turbine are often completely decoupled from the grid, enabling a wider range of optimal operation. Such a scheme is depicted in Fig.2.3. The variable frequency ac is fed to the three-phase ac- dc- ac converter by the turbine. The generator side ac-dc converter is controlled to get a predetermined value at the terminal of the dc-link capacitor. The dc voltage is then inverted employing a six-switch dc-ac inverter. Inversion is inherently buck operation hence the turbine side ac- dc converter has got to ensure sufficient voltage level is obtained so as to integrate with the grid. If additional boosting of the voltage is required, a further dc-dc boost converter is often employed. This increases the general cost and complexity. To beat the shortcomings a Z source inverter based conversion system is often employed [9]. Z source inverter may be a relatively new topology and has the subsequent advantages over the traditional

Voltage source/current source inverters:

Buck-boost ability

Inherent short protection thanks to Z- source configuration

Improved EMI as dead bands aren't required.

Figure 2.4 (variable speed wind energy conversion system based on Z-source)

Z-source inverter based wind generation conversion systems are relatively new; however, researches are investigating its applicability. The wind energy system based on A Z-source converter has been studied and showed in [9]. a Z-source based wind energy conversion system showed in fig 2.4. A three-phase ac- ac Z-source converter based on single stage is presented in [10]. A qualitative summary of the wind energy conversion systems is represented in the given table 1.

Table 1

(Qualitative summary of wind energy conversion systems)

WEC based on	Generator	Grid Integration	Key Points

Fixed Speed System	Induction Generator	Direct	Constant Speed simple low Controllability
Partially variable system	Doubly Fed Induction generator	Ac-dc-ac voltage source converter	Highly controllable vector control of active and reactive power
Fully variable system	Induction or synchronous generator	Ac-dc-ac voltage source converter	Highly controllable wide range speed For Z-source short circuit protection is improved EMI feature.

FUEL CELL SYSTEMS:

Non-toxic energy, cells offer clean, at relatively good energy densities (higher than lead-acid battery) and high reliability. Fuel cells cannot store energy as against a battery; however, they will continually produce electricity. Presently the fuel cells being popularly used are:

Solid oxide

Molten carbonate

Proton exchange membrane

Phosphoric acid

Aqueous alkaline

The efficiency of cell systems is ~ 50 %. Alongside heat recovery systems the efficiency are often as high as ~ 80 % [2]. Description of the electrochemical process involved within the power generation process of a cell is beyond the scope of this paper. This section briefly describes the electrical characteristics of fuel cells and their implications on the facility electronic interface circuitry. Fig. 3.1 shows the general V-I characteristics.

Figure 3.1(General characteristics curve of Voltage and Current)

Figure 3.2. (Energy conversion system based on fuel cell)

dc-ac –ac Conversion

dc-ac-ac Conversion

Figure 3.3 (Energy Conversion using dc-dc converter 3 phase)

The main drawbacks of fuel cells are:

Mostly fuel cell are unable to store energy and difficult to cold start.

Output voltage is low varies with the load - requires a lift stage with regulation.

It has low slew rate hampers dynamic performance, needs backup energy storage.

Due to the above mentioned reasons, auxiliary energy storage alongside PE based power conditioning is important to understand a practical cell based system. The output voltage is low dc and in many cases line frequency ac is required (grid integration), this needs voltage intensify and dc-ac inversion. To meet the dynamic load changes, energy copy (battery or ultra- capacitor) is required. Various dc- dc converter topologies, dc-ac inversion methods are evaluated for this purpose by researchers within the past [2], [11], and [12].

Due to limited boosting capability of non-isolated boost converters, isolated versions are preferred (turns ratio are often utilized to reinforce the general boost). This also provides electrical isolation improving the general reliability. Fig. 6 shows two methods of obtaining usable ac output from the cell

. In Fig 3.2 (a), the dc output from the cell is first inverted employing a conventional voltage source (VSI) inverter or a current source inverter (CSI) then the ac voltage is stepped up employing a transformer. Inversion from dc to ac employing VSI is inherently a buck operation hence this method invariably requires a transformer. In Fig. 3.2 (b), the cell output voltage is stepped up employing a dc-dc converter then the stepped-up dc voltage is inverted to line frequency ac. Conventionally this method has been more popular due to the absence of transformer and therefore the controllability of the dc-dc converter.

The features and options for isolated dc-dc convertor are discussed below [15].

Forward converter – suffers from restrained duty cycle and requires an Excitation resetting tertiary winding.

Push pull – requires center-tap transformer, not ideally fitted to high power applications.

Full bridge converter – suitable for cell applications. Compared to half-bridge dc-dc converter it's more components however the device current stresses are lesser.

Half-bridge dc-dc converter – is compatible for cell applications. H- Bridge based soft-switching series resonant converter is more suited for high efficiency. the opposite advantages of this topology include inherent short protection and no saturation problem of the transformer.

Figure. 3.4 (Energy conversion system of fuel cell employing Z-source converter)

Traditionally for dc-ac conversion three phase, six- switch VSI are used extensively. This system is well established and therefore the control strategies are well developed too. The most drawback of VSI is that its operation is inherently a step down operation. Z-source inverter presented in [8] has boost feature into the VSI without altering the inherent features of the VSI. This topology appears to be very useful for cell and other renewable energy applications. Fig. 3.3 shows cell energy conversion with a current-fed full-bridge dc-dc full bridge converter and a standard dc-ac VSI. Fig. 3.4 shows a cell energy conversion system employing a Z-source dc-ac inverter.

Most of the important time power-electronic enabled energy systems have energy backup within the sort of a capacitor bank, ultra-capacitor, or A battery to reinforce the first energy source like during dynamic loads. In dc-ac grid connected inverter based systems, since the grid voltage level and frequency are fixed the control variable is restricted to being the present. The important and therefore the apparent power being injected into or drawn from the grid need to monitored and controlled using complex control strategies.

PHOTOVOLTAIC ENERGY CONVERSION SYSTEMS:

Photovoltaic energy systems contain arrays of solar cells which create electricity from irradiated light. The yield of the photovoltaic systems (PV) is primarily hooked in to the intensity and duration of illumination. PV offers clean, emission-less, noise- free energy conversion, without involving any active system. Since its all electric it's a high life time (> 20 years) [2]. Tons of labor is being done to reinforce the efficiency of the photovoltaic cell which is that the building block of PV. During this regard the main target is especially on electro-physics and materials domain. A number of the prevailing PVs and their efficiencies are [2]:

Crystalline and multi-crystalline solar cells with efficiencies of ~11 %.

Thin film amorphous Silicon with an efficiency of ~10%.

Thin- film Copper Indium Dieseline having an efficiency of ~12%.

Thin film cadmium telluride with an efficiency of ~9%.

PV panels are formed by connecting a particular number of solar cells serial. Since the cells are connected serial to create up the terminal voltage, the present flowing is set by the weakest photovoltaic cell [2], [13]. Parallel connection of the cells would solve the low current issue but the following voltage is extremely low (< 5 V). These panels are further connected serial to reinforce the facility handling ability. the whole PV system are often seen as a network of small dc energy sources with PE power conditioning interfaces employed to enhance the efficiency and reliability of the system.

The role of PE is mainly:

To interconnect the individual solar panels – two solar panels can't be identical hence a dc-dc converter interfacing the 2 will help maintain the specified current and voltage, and with regulation improve the general efficiency.

Several non-isolated dc-dc converters are employed for this purpose. Buck, buck-boost, boost, and Cuk topologies with suitable modifications are often employed for this purpose [13].

To interface the dc output of the PV system to the load or grid - This includes the previously discussed topics of dc-dc- ac and dc-ac-ac conversion. The topology for fuel-cell system grid interconnection correlates to the grid interconnection of PV based system as well including the usage of the Z- source inverter.

CONCLUSION:

The importance of renewable energy mostly based on energy conversion systems, and distributed power generation has been reiterated. a quick overview of the wind energy basics and therefore the existing PE interface requirements and techniques are addressed qualitatively. The essential electrical characteristics of cell and photovoltaic based systems are presented. The various methods of integrating these systems to the grid are briefly described. The advantage of employing a Z- source inverter over a standard dc- ac VSI has been emphasized. It are often concluded that with the advancements being made within the area of renewable energy and distributed power generation power electronics features a demanding and important role within the way forward for efficient power generation and distribution.

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