**YAYASAN BRATA BHAKTI DAERAH JAWA TIMUR**
**UNIVERSITAS BHAYANGKARA SURABAYA**
**LEMBAGA PENELITIAN DAN PENGABDIAN PADA MASYARAKAT (LPPM)**

Kampus : Jl. A. Yani 114 Surabaya Telp. 031 - 8285602, 8291055, Fax. 031 - 8285601

## SURAT KETERANGAN
Nomor: Sket/ 39 /I/2023/LPPM/UBHARA

Kepala Lembaga Penelitian dan Pengabdian kepada Masyarakat (LPPM) Universitas Bhayangkara Surabaya menerangkan bahwa:

| | | |
|---|---|---|
| Nama | : | Dr. Amirullah, ST, MT. |
| NIP | : | 197705202005011001 |
| NIDN | : | 0020057701 |
| Unit Kerja | : | Universitas Bhayangkara Surabaya |

Benar telah melakukan kegiatan:

1. Mereview makalah jurnal internasional bereputasi berjudul HIGH PERFORMANCE OF POWER TRANSFER IN HYBRID AC–DC MICROGRID WITHOUT STORAGE SYSTEM dari Journal of Engineering Science and Technology (JESTEC), Publisher: Taylor's University Malaysia Tahun 2021, Terindeks Scopus Q2.

2. Telah melakukan korespondensi email dengan editor/pengelola jurnal dalam rangka mereview substansi materi makalah jurnal dalam selang waktu yang telah ditentukan sebelumnya. Bukti korespondensi email dan bukti pendukung adalah benar sudah dilakukan oleh yang bersangkutan serta sudah dilampirkan bersama surat ini.

Demikian surat keterangan ini dibuat untuk kepentingan kelengkapan pengusulan Guru Besar.

Surabaya, 20 Januari 2023
Kepala LPPM
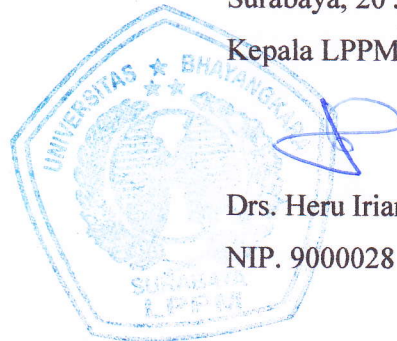
Drs. Heru Irianto, M.Si.
NIP. 9000028

**Lampiran 1**

Bukti Korespondensi Email

dengan Editor/Pengelola

Jurnal

**Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>**

# Paper ID EE20286 /Requesting paper review for JESTEC, First round of Review Process/
15 pesan

**Jestec** <Jestec@taylors.edu.my>                                           26 Januari 2021 pukul 23.38

Dear Dr.

Greetings from the Editorial Board of JESTEC.

The following attached manuscript titled

**HIGH PERFORMANCE OF POWER TRANSFER IN HYBRID AC – DC MICROGRID WITHOUT STORAGE SYSTEM**

has been submitted to JESTEC for consideration for publication, and I am writing to request that you, as an expert in its topic area, review it and make a recommendation regarding its acceptability.

I hope that you will agree to review this manuscript, in which case you will have 2-3 weeks (from the date of this email) to complete the review.

If you would like to have more than 4 weeks to complete the review, could you please indicate the time frame within which you expect to return the review report.

I appreciate your contribution in maintaining the quality and value of JESTEC, and look forward to your response.

Best regards

Some quick guidelines to our respected reviewers

We would appreciate if you take note that whenever appropriate, papers are evaluated on the basis of the following seven criteria. Please try not to focus on the editorial issues/mistakes as too many of them may lead to the author's frustration. We want the authors, when we revise their paper, to focus on our comments/concern related to the seven above-mentioned criteria.

1. **Research question**: why the authors do this research and what is its importance and application.
2. **Novelty**: a paper gives new ideas, derivations, applications that has been not studied before or little- or not in depth-studied.

3. **<span style="color:red">Literature review</span>**: to identify the research gap with recent references from 2010 onwards.

4. **<span style="color:red">Research methodology</span>**: analytical, numerical or experimental or mixed. What is the contribution of the authors, assumptions and/or approximations used, description of apparatus and its limitations, steps of experiments, etc.

5. **<span style="color:red">Quality of results</span>**: and the depth and logic of the discussion.

6. **<span style="color:red">Insight</span>** conveyed and recommendations that might be used by others for future work.

7. **<span style="color:red">English:</span>** used effectively to communicate the ideas and easy to understand with least or no grammatical error or typos.

*Assoc. Prof. Dr. Abdulkareem Sh. Mahdi Al-Obaidi, CEng MIMechE*

*Executive Editor, Journal of Engineering Science & Technology*

*http://jestec.taylors.edu.my*

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**2 lampiran**

**Review Report - 2017.docx**
62K

**EE20286.docx**
1332K

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**Amirullah Ubhara Surabaya** <amirullah@ubhara.ac.id>　　　　27 Januari 2021 pukul 08.42
Kepada: Jestec <Jestec@taylors.edu.my>
Cc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>
Bcc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear Assoc. Prof. Dr. Abdulkareem Sh. Mahdi Al-Obaidi, CEng MIMechE

Executive Editor, Journal of Engineering Science & Technology

http://jestec.taylors.edu.my

Thanks a lot for giving me a chance to review this manuscript.

Please give me time for a week to review this paper.

Dr. Amirullah

[Kutipan teks disembunyikan]

---

**Jestec** <Jestec@taylors.edu.my>　　　　27 Januari 2021 pukul 08.56
Kepada: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear Dr.

Thank you in advance for the support and accepting the review invitation.

Best regards

Abdulkareem

[Kutipan teks disembunyikan]

---

**Amirullah Ubhara Surabaya** <amirullah@ubhara.ac.id>                    27 Januari 2021 pukul 23.11
Kepada: Jestec <Jestec@taylors.edu.my>
Cc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>
Bcc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear *Assoc. Prof. Dr. Abdulkareem Sh. Mahdi Al-Obaidi, CEng MIMechE*

*Executive Editor, Journal of Engineering Science & Technology*

*http://jestec.taylors.edu.my*

Here I send you the review report and point of Paper ID EE20286.

Dr. Amirullah

[Kutipan teks disembunyikan]

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**2 lampiran**

📄 **Jestec_Malaysia_Review_Point_Paper ID EE20286_27 Jan 2020.docx**
15K

📄 **Jestec_Malaysia_Review Report_Paper ID EE20286_27 Jan 2020.docx**
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**Jestec** <Jestec@taylors.edu.my>                                        28 Januari 2021 pukul 06.33
Kepada: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear Dr.

Thank you for your kind email.

We confirm that we received your review report.

We will reply you later with some details.

Best regards

JESTEC Editor

*http://jestec.taylors.edu.my*

[Kutipan teks disembunyikan]

---

**Amirullah Ubhara Surabaya** <amirullah@ubhara.ac.id>                    28 Januari 2021 pukul 13.50
Kepada: Jestec <Jestec@taylors.edu.my>
Cc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>
Bcc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear Jesytec Editor,

I am sorry, I have not only sent the review report but it was also some points of a review result (A-O) in another sheet (two doc files).

Please see my previous email.

Dr. Amirullah
[Kutipan teks disembunyikan]

---

**Jestec** <Jestec@taylors.edu.my>                                      28 Januari 2021 pukul 14.06
Kepada: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear Dr.

I would like to express on behalf of the Review panel our sincere thanks for your effort shown in reviewing this paper. We highly appreciate this effort and support and hope that we may call upon you again to review future manuscripts.

*Kindly accept the attached appreciation letter*.

Best regards

*Assoc. Prof. Dr. Abdulkareem Sh. Mahdi Al-Obaidi, CEng MIMechE*

*Executive Editor, Journal of Engineering Science & Technology*

*http://jestec.taylors.edu.my*

[Kutipan teks disembunyikan]

📄 **AL_Amirullah Ubhara Surabaya_1.pdf**
   87K

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**Jestec** <Jestec@taylors.edu.my>                                      28 Januari 2021 pukul 14.07
Kepada: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Yes, noted

We are aware of this

Thank you for your concern

[Kutipan teks disembunyikan]

---

**Amirullah Ubhara Surabaya** <amirullah@ubhara.ac.id>                    28 Januari 2021 pukul 14.27
Kepada: Jestec <Jestec@taylors.edu.my>
Cc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>
Bcc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear JESTEC Admin,

Thanks a lot for the reviewer certificate and also for the appreciation and offer to review the other JESTEC journals in the future base on my qualifications (Power Quality, Power Electronics, Power Distribution, Harmonic Mitigation, Power Factor Correction, Renewable Energy base Artificial Intelligent).

Dr. Amirullah
Universitas Bhayangkara Surabaya
Surabaya Indonesia

[Kutipan teks disembunyikan]

---

**Amirullah Ubhara Surabaya** <amirullah@ubhara.ac.id>                    28 Januari 2021 pukul 14.29
Kepada: reviews@publons.com
Cc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>
Bcc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

---------- Forwarded message ---------
Dari: **Jestec** <Jestec@taylors.edu.my>
Date: Kam, 28 Jan 2021 pukul 14.06
Subject: RE: Paper ID EE20286 /Requesting paper review for JESTEC, First round of Review Process/
To: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

[Kutipan teks disembunyikan]

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📄 **AL_Amirullah Ubhara Surabaya_1.pdf**
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**Jestec** <Jestec@taylors.edu.my>                    28 Januari 2021 pukul 18.52
Kepada: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Excellent

Thank you

Best regards

JESTEC Editor

[Kutipan teks disembunyikan]

---

**Jestec** <Jestec@taylors.edu.my>                    7 April 2021 pukul 21.51
Kepada: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear Dr.

Your Reviewer number is:   1

The paper you earlier reviewed has been revised according to your comments/concern.

Could you kindly have a look at the revised paper and check whether the author(s) addressed all your comments/concern.

We appreciate receiving your feedback before or latest by **23/4/2021**

Attached for your reference, please find

- the original paper
- your review report
- the revised paper and
- the outlining how the author(s) addressed your and other reviewers' comments.

Thank you

*Assoc. Prof. Dr. Abdulkareem Sh. Mahdi Al-Obaidi, CEng MIMechE*

*Executive Editor, Journal of Engineering Science & Technology*

*http://jestec.taylors.edu.my*

[Kutipan teks disembunyikan]

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**4 lampiran**

📄 **outlining of Review Report_v3.docx**
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📄 **Review Report - 1.docx**
44K

📄 **EE20286 R1.docx**
1634K

📄 **EE20286.docx**
1332K

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**Amirullah Ubhara Surabaya** <amirullah@ubhara.ac.id>                                        8 April 2021 pukul 19.46
Kepada: Jestec <Jestec@taylors.edu.my>
Cc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>
Bcc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear. Assoc. Prof. Dr. Abdulkareem Sh. Mahdi Al-Obaidi, CEng MIMechE

Executive Editor, Journal of Engineering Science & Technology

http://jestec.taylors.edu.my

Here I send you the file outlining how the author(s) addressed your and other reviewers' comments from me as of **1st reviewer.**

**Title of paper:**          HIGH PERFORMANCE OF POWER TRANSFER IN HYBRID AC – DC MICROGRID WITHOUT
STORAGE SYSTEM

The final recommendation for this manuscript is **accepted without modification.**

Dr. Amirullah

Power Quality, Power Distribution, Power Electronic and RES (PV/WT) Research

Universitas Bhayangkara Surabaya

Surabaya Indonesia

[Kutipan teks disembunyikan]

📄 **outlining of Review Report_v3_Amirullah.docx**
58K

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**Jestec** <Jestec@taylors.edu.my>                                             12 April 2021 pukul 06.58
Kepada: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear Dr.

Thank you for your time in reviewing the said paper.

We highly appreciate your support and commitment.

Best regards

JESTEC Editor

[Kutipan teks disembunyikan]

---

**Amirullah Ubhara Surabaya** <amirullah@ubhara.ac.id>                          12 April 2021 pukul 21.38
Kepada: Jestec <Jestec@taylors.edu.my>
Cc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>
Bcc: Amirullah Ubhara Surabaya <amirullah@ubhara.ac.id>

Dear Assoc Prof.

You are welcome.

Dr. Amirullah
Universitas Bhayangkara Surabaya
Indonesia
[Kutipan teks disembunyikan]

# Lampiran 2

Bukti Pendukung

# HIGH PERFORMANCE OF POWER TRANSFER IN HYBRID AC – DC MICROGRID WITHOUT STORAGE SYSTEM

## Abstract

This paper aims to look at the use of an intermittent RES connected to the grid in a hybrid AC-DC microgrid concept, without the use of a storage system. It is known that the intermittent RES sometimes has excess energy and sometimes lack energy, so this condition requires a storage system. A way to solve this problem is used an AC-DC bidirectional converter as an interlinking converter (IC). The IC connected DC sub microgrid and AC sub microgrid and manages the power transfer in the system. The simple vector control method that uses in the IC need three input to makes this equipment work as a rectifier or inverter. The simulation built on Simulink / Matlab and the results prove that the built-in IC works on the systems with stable voltages, frequencies, and the THD is less than 5% that meet the IEEE Standart 519TM-2014 requirements.  The power transfer between AC and DC sub microgrid that manage by the IC describes the efficiency of the IC, it reaches 99,4% as Rectifier and 99,6% as Inverter..

Keywords: Hybrid AC-DC microgrid, power transfer, bidirectional converter, vector control method

## 1. Introduction

Until now, the fulfillment of electrical energy depends on long-distance transmission systems from sources with giant power plants, and electricity generated using AC power (alternating current), but when electricity will enter electronic equipment, AC power is converted to DC power by the adapter, like laptops, handphones, etc. This conversion is inefficient because there is wasted energy. To be efficient, of course, the electrical system must come from a DC source as well, like on DC House [1]. In DC House, the conversion of AC to DC is not needed because electricity from DC House can be directly used. Another major advantage of DC House is flexibility. In its basic design, DC House is designed to be able to receive electricity from any source, such as wind, water, solar and even people who ride bicycles. So, an area can utilize the most abundant potential electricity source. This desire is very difficult to implement, considering the electricity system that is currently developing is the AC system. But, when Lasseter with his new electricity concept, distribution generators that supply the surrounding load into a subsystem or microgrid of the distribution system makes the starting point of change in the conventional electricity [2]. Research on microgrid has been growing in almost two decades. AC microgrid, DC microgrid, and a combination of them was known as hybrid AC-DC microgrids. On AC microgrid there are main buses that use the AC system as well as on DC microgrids where the main bus uses the DC system. In both types of microgrid, both source and load will use the system on the main bus type. Different from AC and DC microgrid, in hybrid AC-DC microgrid, AC load will be connected and supplied with an AC source, and also the DC load which will be connected and supplied with a DC source, because it is directly connected to the same source, this system can reduce the use of converter [3]. This reduction is in line with the reduction of harmonic pollution and increasing the power quality of the system, also increase the installed power [4-6].

In this system there are two central buses, DC bus, and AC bus, and they connected with interlinking converter as illustrated in Fig 1. The interlinking converter has a very important role. This power electronics equipment is expected to be able to flow power from AC microgrid to DC microgrid if the power generated by a DC source cannot supply the load power requirements, conversely, if a DC source produces excess power from the DC load requirements, the interlinking converter must be able to transfer this excess power to the AC microgrid to be traded. For this reason, the interlinking converter should use bidirectional converter, this converter must have the ability to be a rectifier or an inverter, conduct power in both directions properly because in addition to power change there is also load change on the system.
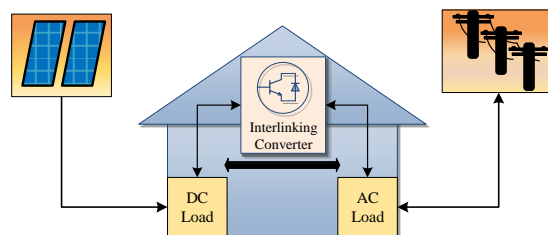


**Fig. 1. Hybrid AC-DC Microgrid**

The converter expected to be able to flow power better from. DC to AC or AC to DC sub microgrid according to the power changes of the sub microgrid. Some previous studies have given results, but need to be improved. The bidirectional converter with only voltage control from AC sub microgrid not yet able to regulate the power flow with changes in power and load conditions, but it can drain the power when a three-phase disturbance occurs [7]. Input control only from the AC sub microgrid side is not enough to make the converter change the mode from rectifier to inverter or vise versa. This research trying to use three inputs from the AC and DC sub microgrid, voltage from DC sub microgrid, voltage and current from AC sub microgrid [8]. The controls able to change the mode of the converter when the current was changed from positive to negative that indicate the current flow is changed, the simulation results show that there is a phase shift of current to the voltage of $180^0$ even there are ripple and overshoot in the experiment. This research was enhanced by adding droop control to the DC input to control the DC voltage. By setting a threshold voltage on the DC voltage it will have a positive or negative value of the reference current and then determine the type of converter operating mode, if the reference current is positive then the converter operates as a rectifier, conversely, if the reference current is negative then the converter will operate as an inverter mode [9]. All this research was built under the vector control method, the voltage from AC sub microgrid used for input in Phase Lock Loop (PLL) and current control.

In this paper, the hybrid AC DC microgrid system was built by Simulink / Matlab with the bidirectional converter as an interlinking converter. The converter uses a vector control method that is more simple from others. The voltage from the AC sub microgrid is only used for input in the PLL. This is done to maintain the converter phase shift equal to the network. The built system is connected to a grid without a storage system. The simulation is carried out by providing power and load changes to prove the control performance of the bidirectional converter working properly. The power changes occur as the movement of sunlight curve, followed by changes in the daily load model. Section 2 described the system configuration with the bidirectional converter followed by simulation and discussion in section 3 and the conclusion in section 4.

## 2. Hybrid AC-DC Microgrid with Bidirectional Converter as Interlinking Converter

### 2.1. Hybrid AC-DC microgrid system

In this system consists of 3 large circuits: DC sub microgrid, AC sub microgrid and interlinking converter. The DC sub microgrid consists of DC source inheriting the PV and fuel cell connected with a load, some example for DC load are LED, and modern elevator. In AC sub microgrid side has a grid-connected with many kind of load combination. Because each sub microgrid has a load that must be supply, a good converter is needed that can maintain power stability in the event of a power shortage, especially in the DC sub microgrid, given the intermittent nature of the RES and in this research the system does not use an energy storage system. The use of energy storage system becomes a dilemma when a RES is connected to a stable

grid. As has been widely applied that the use of RES is rarely separated from the energy storage system, where it is used to reserve power requirements because of the intermittent of the RES. However, the energy storage system, like a battery, is not very economical, because the battery has a short lifetime (between 3 and 5 years maximum in rural areas for solar lead-acid batteries which are commonly used for RES), and must be recycled, technology to recycle batteries is very rare so that batteries that are not used will become junk if left longer, and batteries has a big shape, this will certainly harm the environment, chemical pollution, and high investment. Some researchers with their research based on the concept of "flexy energy" proved on techno-economic that a hybrid system between PV and diesel generators without using a storage system has higher effectiveness than stand-alone of diesel generators system [10-13]. As well as has been researched that PV applied on the roof-top or building integrated photovoltaic (BIPV) and grid without storage is techno-economic has high effectiveness because the cost of energy (COE) decreases in line with the increase in power capacity [14]. From all this research, it can be concluded techno-economic that hybrid PV systems can work on the grid or off-grid even without a storage system, but this system requires a converter that not only can flow current properly but also can work as rectifier and inverter so it can maintain voltage and frequency stability, despite changes in power and load.
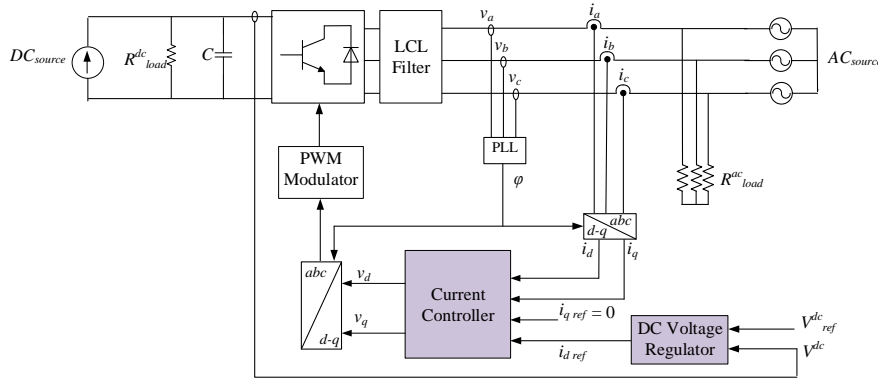


**Fig. 2. Overall configuration of the propost system**

While in the hybrid AC DC microgrid connected to the main utility grid as an AC source. The grid expected to be able to supply real and reactive power to the network both on the AC sub microgrid side and DC sub microgrid system. In this case, beside the grid will maintain the power balance, both active, and reactive power the grid will maintain the stability of the voltage and frequency in the system.

In the hybrid AC DC microgrid, the AC and DC sub microgrid have separate power equations [15]. Regardless of the power loss, the power on the DC sub microgrid with $N_A$ is the number of DC buses. $P_{load}^{dc,h}$ is power demand of $h^{th}$ load in DC sub microgrid. $P_{source}^{dc,h}$ is power generated by $h^{th}$ energy source in DC sub microgrid. $P_{loss}^{dc}$ is power loss in DC sub microgrid and $P_{IC}^{dc}$ is power transfer from AC to DC or DC to AC that through the IC. The power in the DC sub microgrid can be expressed as follows [15-16]:

$$0 = \sum_{h=1}^{N_A} P_{load}^{dc,h} + P_{loss}^{dc} + P_{ic}^{dc} - \sum_{h=1}^{N_A} P_{source}^{dc,h} \qquad (1)$$
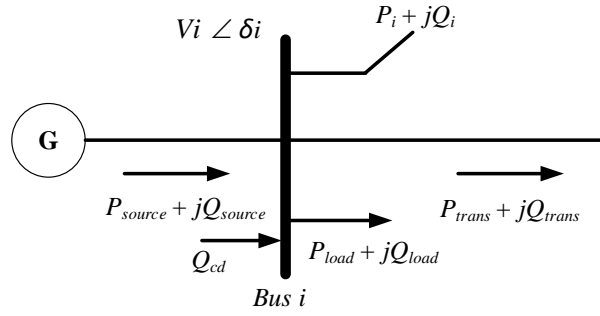
$Vi \angle \delta i$

$P_i + jQ_i$

G

$P_{source} + jQ_{source}$

$P_{trans} + jQ_{trans}$

$Q_{cd}$

$P_{load} + jQ_{load}$

*Bus i*

**Fig. 3. General AC bus presentation**

Where the generator, load, reactive power compensator, AC lines and the converter are connected on the bus *i* as depicted in Fig 3. The active and reactive power balance equations at AC sub microgrid can be expressed as follows [17]:

$$P_{source}^{ac} - P_{load}^{ac} - s_p P_{ic}^{ac} - V_i \sum_{j=1}^{N_B} V_j \left( G_{ij} cos\delta_{ij} + B_{ij} sin\delta_{ij} \right) = 0 \qquad (2)$$

$$Q_{source}^{ac} + Q_{cd} - Q_{load}^{ac} - s_q Q_{ic}^{ac} - V_i \sum_{j=1}^{N_B} V_j \left( G_{ij} sin\delta_{ij} + B_{ij} cos\delta_{ij} \right) = 0 \qquad (3)$$

$P_{source}^{ac} + Q_{source}^{ac}$ and $P_{load}^{ac} + Q_{load}^{ac}$ are complex power of the generator and load respectively. $Q_{cd}$ is the output of the reactive power compensation device, $V_i$ and $\delta_i$ are the voltage magnitude and angle. $G_{ij} + B_{ij}$ where is the *i j* th element of the admittance matrix of the AC power network, $N_B$ is the number of AC buses. $s_p = 0$ and $s_q = 0$ if no converter is connected at bus , $s_p = 1$ and $s_q = 1$ if the converter at bus is a rectifier, $s_p = -1$ and $s_q = -1$ if the converter at bus is an inverter [18]

The voltage line to line ($V_{ab}^{ac}, V_{bc}^{ac}, V_{ca}^{ac}$ ) in the three phase converter with naturally sampled PWM, with the three sinusoidal references displaced in time by 120º [19].

$$V_{ab}^{ac} = M\sqrt{3}V^{dc} \cos(\omega_o t + \frac{\pi}{6}) \qquad (4)$$

$$V_{bc}^{ac} = M\sqrt{3}V^{dc} \cos(\omega_o t - \frac{\pi}{2}) \qquad (5)$$

$$V_{ca}^{ac} = M\sqrt{3}V^{dc} \cos(\omega_o t + \frac{5\pi}{6}) \qquad (6)$$

*M* is the modulation index (the normalized output voltage magnitude) of the IC with the range $0 < M < 1$ and $\omega_o$ is target output angular frequency [18].

The relation between the DC power and the AC active power is a function of the efficiency of the converter, ignoring switching losses in the converter, as follows [14]

$$P^{ac} = \frac{P^{dc}}{\mu^{IC}} \qquad (7)$$

In Eq. 7, $P^{ac}$ and $P^{dc}$ is the power in the AC and DC interface of the IC and $\mu^{IC}$ is the efficiency of the IC.

## 2.2. Propost interlinking converter control

This interlinking converter connects DC sub microgrid and AC sub microgrid. The converter uses 6 transistors (IGBT), the input control comes from both sides, on the side of the AC sub microgrid using current and voltage, and the voltage on the DC sub microgrid side. With inputs that are on the two sides of the converter, the converter can work bidirectionally as a rectifier or inverter, converting DC power into AC power and vice versa, depending on the power situation of both sub microgrids. Described in Fig. 4, the voltage from the AC sub microgrid becomes reference input is of the PLL to synchronize the phase angle. The PLL circuit in this system is modeled as a closed-loop system that monitors the variation of the phase angle using an internal oscillator. The control system adjusts the internal oscillator to keep the phases difference to zero. Using Park Transform, the phase angle generated by the internal oscillator is used to change the three phase voltage from AC sub microgrid into dq coordinates.
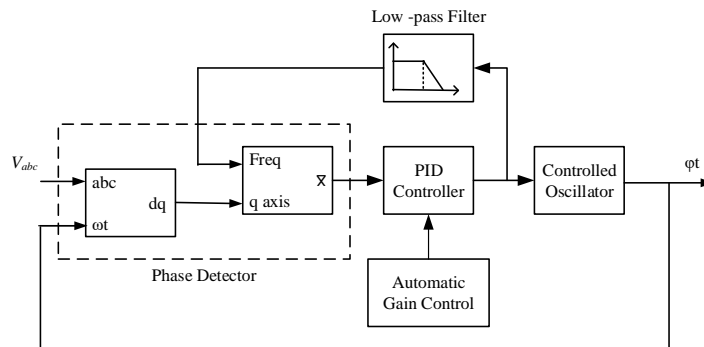


**Fig. 4. Phase lock loop**

The Mean (Variable Frequency) block computes the mean value of the quadrature signal, $f(t)$. This average value is obtained from one frequency cycle of the quadrature signal, with $T = 1/$frequency.

$$Mean\left(f(t)\right) = \frac{1}{T}\int_{(t-T)}^{t} f(t).dt \tag{8}$$

The output of the mean block combine with optional automatic gain control (AGC) becomes the input of the Proportional-Integral-Derivative (PID) controller. This controller keeps the phase difference to 0. The PID output, according to the angular velocity, is filtered and converted to a frequency that is used to find the average value.

While the phase angle generated by PLL is used to transform the abc to dq coordinates or dq to abc coordinates as seen in Fig. 2, the AC sub microgrid current is change to dq coordinate and becomes input of the current control of as seen in Fig. 5.
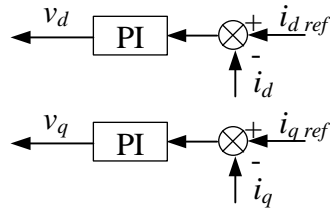
**Fig. 5. Current controller**

The close loop DC voltage is control with the set point of DC reference voltage, which is then controlled by the PI controller and determine with $i_{d\,reff}$ as described in Fig. 6. Besides the PI controller, the value of $i_{d\,reff}$ depends on the limiter. The constant limiter value specified as the maximum and minimum values as in Eq.9.
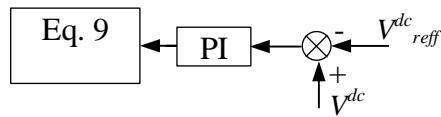


**Fig. 6. DC voltage regulator**

$$i_{d\,reff} = \begin{cases} i_{d\,reff} & ; -C_{min} < i_{d\,reff} < C_{max} \\ -C_{min} & ; \quad i_{d\,reff} < -C_{min} \\ C_{max} & ; \quad i_{d\,reff} > C_{max} \end{cases} \tag{9}$$

The sum of $i_d$ and $i_q$ from the current loop with $i_{d\,reff}$ and $i_{q\,reff}$ are controlled by the PI controller and change to abc coordinate with Park Transformation, before becoming an input of the PWM modulator. Finally, the PWM modulator produces pulses that move the switch on IGBTs in the interlinking converter.

## 3. Results and Discussion

### 3.1. The simulation

The system modeling is done as shown in Fig. 2. During the simulation, there are power changes in DC sub microgrid and load changes on the AC sub microgrid. The simulation is carried out for 6 seconds with a schedule of power changes as shown in Fig. 7 and Fig. 8 there is a schedule of load changes. The change in power gradually follows the gauss curve pattern like the average shape of solar radiation every day.
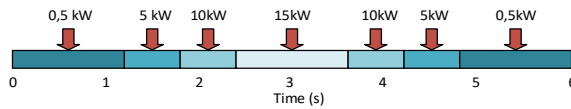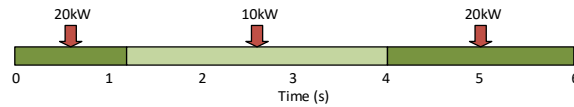


**Fig. 7. The schedule of power changes**

**Fig. 8 The schedule of load changes**

The analysis of the simulation was carried out in 2 places in the DC microgrid and AC microgrid.

### 3.2. DC sub microgrid

With power change at the DC source, there is also a change in current and voltage at the DC sub microgrid, as seen in Fig. 9 for the current and Fig. 10 for the voltage response. When there is a decrease in DC source power that cannot supply dc power load in 0 s until 1,8 s, makes the current becomes negative, this indicates that the dc power load supplied from the IC, it is mean that the IC become rectifier. When the DC power source starts to increase in 1,8 s until 2,4 s, even where the DC source is greater than the DC load, the current becomes positive. In this case, the IC will get power supply from the DC source and make the IC function as an inverter. When the power source decrease but it still bigger than dc load power in 3,6 s until 4,2 s, the current is still positive and the IC still becomes an inverter. It is different when the source power still decreases until less than load power in 4,2 s until 6 s, the current becomes negative and the IC function becomes a rectifier again. Changes in DC power source cause changes in DC voltage, this is normal, because the model of this simulation using a controlled current source module to reflect on resources. Controlled current source module was supplied by $P_{dc}$ as DER that setting like in Fig. 6 and divided with $V_{reff}^{dc}$ that in this simulation was setting in 400 V. Fig. 11 shows the power flow at the DC Source, DC load, and the power transferred through the IC. In this figure, the power comparison was described very clear, when DC power is very small and even close to zero then the IC will transfer power to supply the load power requirements, so the value of the power transfer becomes negative. If the load power is equal to the DC power, the IC does not transfer power, this can be seen from the value of the power transferred by the IC close to zero. Conversely, when the DC power is greater than the load power the power transferred from the IC becomes positive, this indicates that the DC microgrid is delivering power to the IC.
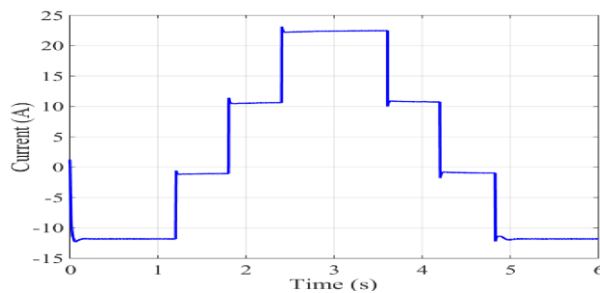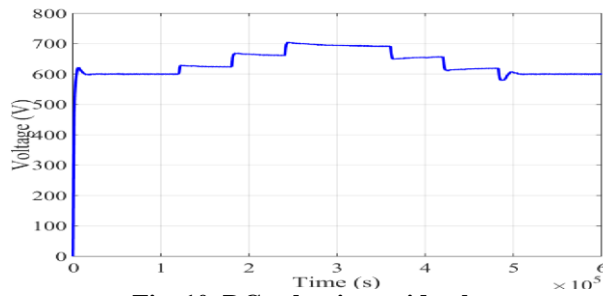


**Fig. 9. DC sub microgrid current**

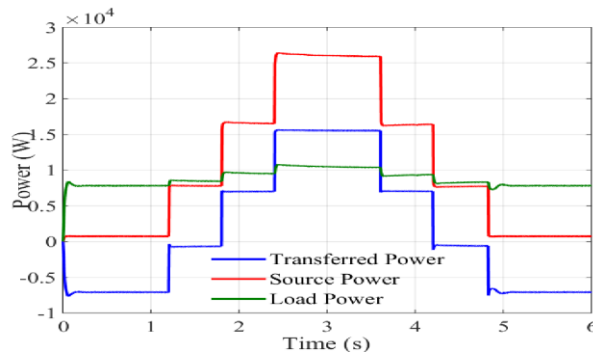**Fig. 10. DC sub microgrid voltage**



**Fig. 11. DC sub microgrid power with DC Voltage Regulator**

**3.2 AC sub Microgrid**

The impact of power changes on the DC source can be seen not only in the DC sub microgrid but also in the AC sub microgrid. Fig. 12 (a) shows the voltage and current that occurs in the AC sub microgrid during the simulation. With power change on the DC sub microgrid and the load on the AC sub microgrid according to Fig. 7 and 8 make the IC function changed as a rectifier or inverter following the changes that occur in the system. In the Fig. 12 (a) to 12 (g) the voltage on the AC sub microgrid is maintained properly despite changes in power and load.

Different things happen to the current, the AC sub microgrid current changed not only in its magnitude but also a phase angle shift. Fig 12 (b) until 12 (f) is an enlargement of the Fig. 12 (a), which is cut every second to show the current changes. Enlargement from 0 s to 1 s is described in Fig. 12 (b), in this figure the voltage and current are stable because there is still no power or load change. The voltage and current are in a different phase, it indicates that the IC in rectifier mode. Power from DC source is insufficient to supply the DC load power requirements and thus requires power supply from the AC sub microgrid. In Fig. 12 (c) especially at 1.2 s to 1,8 s the DC power start increases almost match to the load requirements, the current near to zero, indicating that there is less power flow from the IC to the load, and there has been a phase shift between current and voltage around 90°.
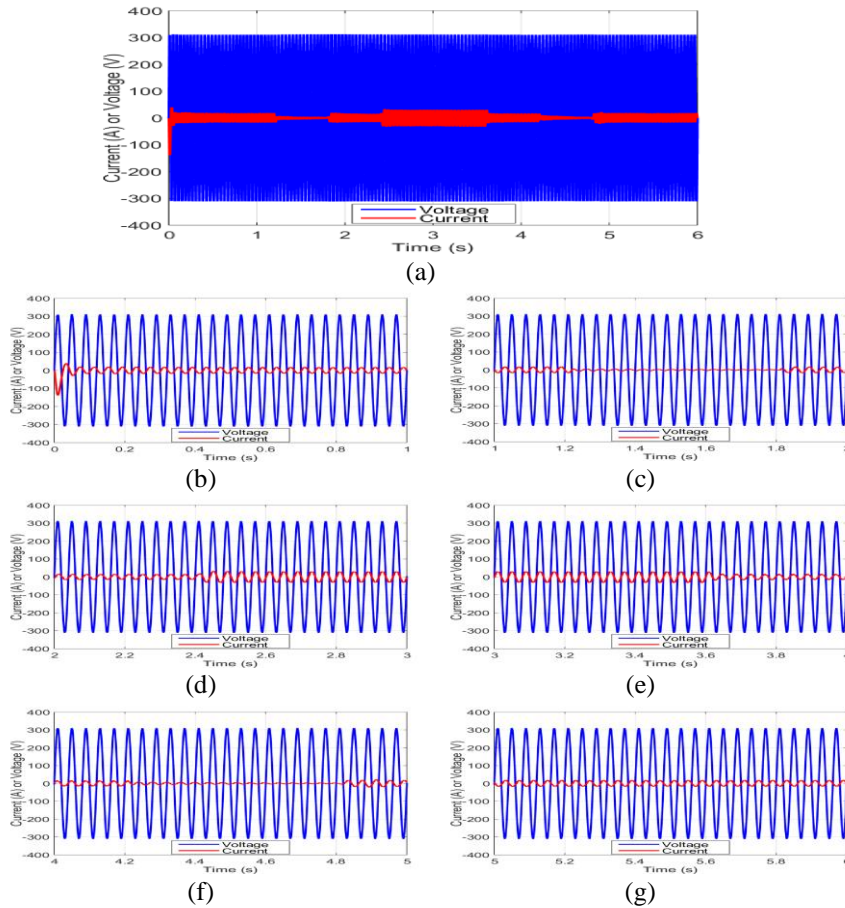
Fig. 12. Voltage and current in AC sub microgrid (a) Result of the whole simulation, (b) The result from 0 to 1 (s), (c) The result from 1 to 2 (s), (d) The result from 2 to 3 (s), (e) The result from 3 to 4 (s), (f) The result from 4 to 5 (s), (g) The result from 5 to 6 (s)

At 1.8 s, there was a power increase in the DC sub microgrid which exceeds the DC load requirements. This excess power flowing through the IC to AC sub microgrid and the function of the IC changes to an inverter, in this case, the current and voltage in one phase. In Fig. 12 (d) there was a DC power increase again at 2.4 s this changes the amount of current but does not change the IC function. In the 3.6 s, there was a reduction in DC power, the current also decreases but does not change the IC function because there is still power transfer from IC to AC sub microgrid. The current is still one phase with the voltage, this is shown in Fig. 12 (e). In Fig. 12 (f) show a reduction in DC power source at 4.2 s to 4.8 s that the DC power only supplies DC load requirements. This power reduction causes the IC cannot supply power to the AC sub microgrid. At this time the current almost zero, and there is a phase shift with a voltage of around 90°. Then the DC power decreases again at 4.8

s shown in Fig. 12 (g) until the DC source is unable to supply the load power requirements. This power reduction causes a phase shift between current and voltage of $180^o$, the IC changes to a rectifier [8, 9, 20].

Besides the voltage and current that can show the change of IC function, the active power flow also can do that. In Fig. 13 illustrates the comparison of active power at load, source, and power transferred to DC sub microgrid. The DC power changes make the power transferred in the AC sub microgrid become negative that is mean the IC transferred the power into the DC sub microgrid, the IC becomes rectifier, and vise versa when the transferred power becomes positive that is mean the IC transfer power into AC sub microgrid, the IC becomes inverter.
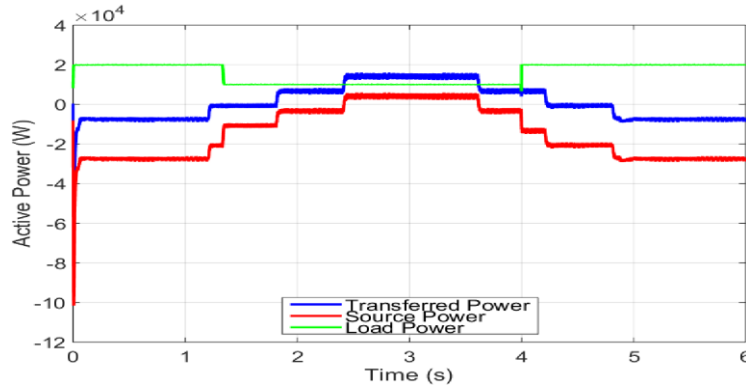


**Fig. 13. Comparative of active power in AC sub microgrid**

The AC source power is negative, means the grid supplies power to the system, and when the DC power increase, the grid gets power supply from the system, it changes the AC power source to positive. The Load changes during simulation that occur on the AC sub microgrid as a scenario in Fig. 8  do not have much impact on the power transferred to the DC sub microgrid. Fig. 14 shows the reactive power during the simulation. Reactive power at the source and interface converter on the AC side follows the power changes that happen at the DC sub microgrid. They have the same value until difficult to recognize.

In Fig. 15 shows the reactive power that occur in the load. In this simulation, there are three load combinations, the first is starting from 0 s to 1,2 s, there is a combination between resistive and inductor, the second is starting from 1,2 s to 4 s, that there is only resistive, and the third is starting from 4 s to 6 s,  there is a combination between resistive and capacitor. The value of the reactive power in this system was very small when compared to the active power.
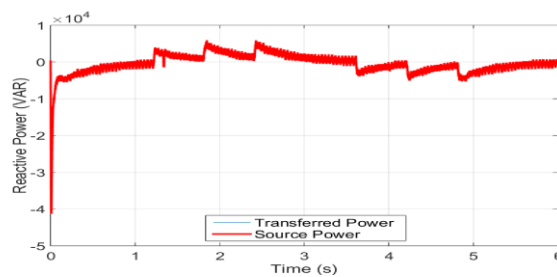


**Fig. 14. The transferred and source reactive power in AC sub microgrid**
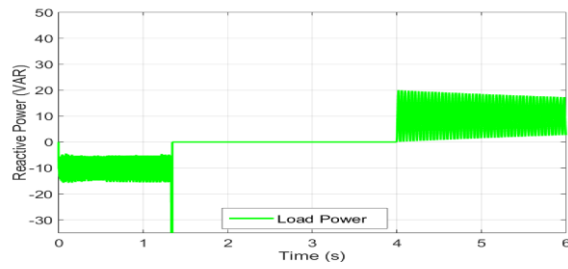
**Fig. 15. The load reactive power in AC sub microgrid**

Table 1. Show the efficiency of the converter in a rectifier and inverter. This table proves that the converter can work very efficiently because the efficiency of the converter is very high.
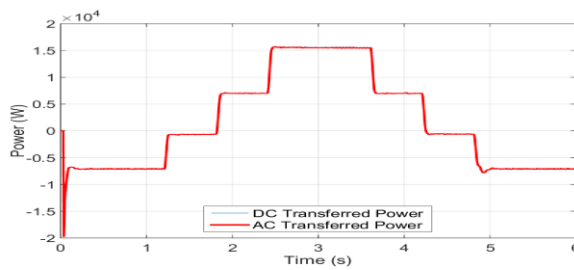


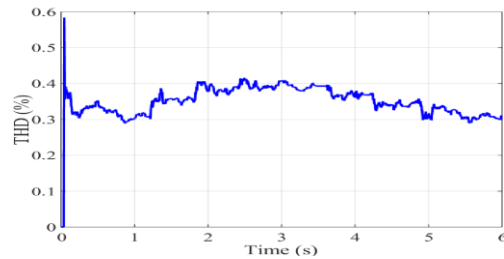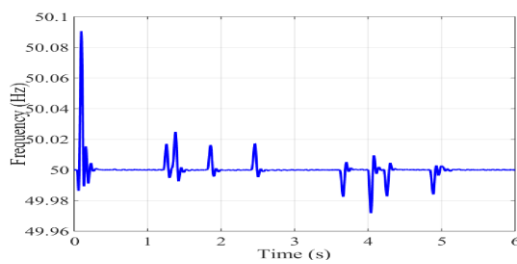**Fig. 16 The comparative of AC and DC transferred power**



**Fig. 17. THD**



**Fig. 18. Frequency of the system**

**Table 1. The IC Eficiency**

| $P^{dc}_{source}$ | $P^{dc}$ | $P^{ac}$ | $\mu^{IC}$ | IC Mode |
|---|---|---|---|---|
| **0,5 10³** | -6335 | -6374 | 99,4% | Rectifier |
| **5 10³** | -67,99 | -84,94 | 80,04 % | Rectifier |
| **10 10³** | 8682 | 8642 | 99,5% | Inverter |
| **15 10³** | 18980 | 18910 | 99,6% | Inverter |

Changes that occur in the system during the simulation affect to the system harmonics, although not significant, this can be seen from Fig. 17. It is seen that the total harmonic distortion (THD) value shows the changes following the power changes that occur in the DC sub microgrid. The THD value during the simulation takes no more than 5% as required by the IEEE Std 519TM-2014 standardization. Likewise, what happened at the system frequency during simulation, the frequency value was relatively stable, 50 Hz, although there was a ripple when there was a power change in the DC sub microgrid, this can be seen from the simulation results in Fig. 18.

## 4. Conclusions

In this paper, the AC-DC hybrid microgrid system has been built using a bidirectional converter that functions as an IC.

- IC is built with a very simple vector control method, but the simulation results show that the system can work very well because ICs with high efficiency can be a rectifier or inverter to respond the power changes that occur in the system. The efficiency of the IC reaches 99,4% as rectifier and 99,6% as inverter.
- Load changes that occur in the AC sub microgrid do not affect the power transferred through the IC but occur in the grid or AC source.
- Despite changes in power and load, the voltage and frequency on the system remain stable, THD is no more than 5%.

The power transfer between AC and DC sub microgrid that manage by the IC that based on bidirectional converters make the system stable. The IC can transfer power, either active or reactive power from the DC sub microgrid to the AC sub microgrid and vice versa. So it can be said that this system has a high performance in power transfer.

**Nomenclatures**

**Abbreviations**

AC          Alternating Current
DC          Direc Current
RES        Renewable Energy Source
IC          Interlinking Converter
THD        Total Harmonic Distortion
IEEE       Institute of Electrical and Electronics Engineers
PLL        Phase Lock Loop
PV          Photovoltaic
LED        Light Emitting Diode

| BIPV | Building Integrated Photovoltaic |
|------|-----------------------------------|
| COE | Cost of Energy |
| PWM | Pulse Width Modulation |
| IGBT | Insulated Gate Bipolar Transistor |
| AGC | Automatic Gain Control |
| PID | Proportional Integral Derivative |
| DER | Distributed Energy Resources |

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## *Appendix A*

## The Simulation Model and Parameter

### A.1 Model of the Simulation

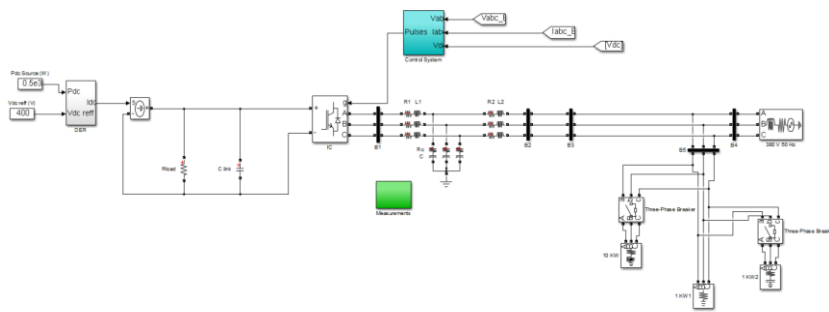The simulation using Simulink / Matlab, and the model Simulink described in Fig. A-1.



**Fig. A-1 Model of the simulation**

## A.2 Parameter of the Simulation

This is parameter of the simulation: In the three phase sources: RMS voltage 380 volt (line –line), 50 Hz; In the LCL filter and DC link: converter side inductance $L_1$ = 1 mH converter side resistance, $R_1$ = 0,5 Ω, grid side inductance $L_2$ = 1 mH, grid side resistance $R_2$ = 0,5 Ω, shunt capacitance $C_2$ = 1 μF, shunt resistance $R_2$ = 2 Ω, Capacitor filter C = 1500 μF; In DC source and load: DC load resistance $R_{dc}$ = 46 Ω; DC voltage $V_{DCreff}$ = 400 volt

## *Appendix B*

## The Simulationts Measurement Results and Calculations

### B.1 DC sub Microgrid Data

The data in Table B-1 displays the voltage, current and power generated from the measurement of every change in DC sub microgrid. The data is taken at the source, load and interface of the converter on the DC side.

**Table B-1. DC sub microgrid data**

| DC Source | DC Source | | | DC Load | | | DC Transferred | | |
|---|---|---|---|---|---|---|---|---|---|
| | V | I | P | V | I | P | V | I | P |
| $0,5 \cdot 10^3$ | 601 | 1,25 | 751,3 | 601 | 13,07 | 7852 | 601 | -10,54 | -6335 |
| $5 \cdot 10^3$ | 619,4 | 12,5 | 7743 | 619,4 | 13,47 | 8341 | 619,4 | -0,109 | -67,99 |
| $10 \cdot 10^3$ | 659,3 | 25 | 16480 | 659,3 | 14,33 | 9451 | 659,3 | 13,17 | 8682 |
| $15 \cdot 10^3$ | 693,7 | 37,5 | 26010 | 693,7 | 15,08 | 10460 | 693,7 | 27,36 | 18980 |

### B.2 AC sub microgrid data

These measurements are made for any changes in DC power. Whereas the active and reactive power values from the data in table B-2 are obtained from calculations using the formula as in Eq. B-1 for active power and Eq. B-2 for reactive power.

$$P = V_a I_a + V_b I_b + V_c I_c \qquad \text{(B-1)}$$
$$Q = (\frac{1}{\sqrt{3}}(V_{bc}I_a + V_{ca}I_b + V_{ab}I_c)) \qquad \text{(B-2)}$$

Where $V_a, V_b, V_c$ are the phase voltage to the ground. $I_a, I_b, I_c$ are the phase current, $V_{ab}, V_{bc}, V_{ca}$ are inter-phase voltages.

Table B-2 is the result of voltage, current, in the source, load, and interface converter measurements on the AC side

**Table B-2. AC sub microgrid data**

| DC Source | | Voltage | | | Current | | | Power | |
|---|---|---|---|---|---|---|---|---|---|
| | | $V_a$ | $V_b$ | $V_c$ | $I_a$ | $I_b$ | $I_c$ | P | Q |
| **0,5 10³** | **Source** | -1,106 | -268,6 | 269,7 | 3,304 | 50,6 | -53,9 | -28140 | -1440 |
| | **Load** | 269,7 | -268,6 | -1,106 | 37,35 | -37,17 | -0,179 | 20050 | -12,18 |
| | **Transf erred** | 199,7 | -401,2 | 201,5 | 6,132 | 10,56 | -16,69 | -6374 | -7912 |
| **5 10³** | **Source** | -0,841 | -267,1 | 268 | 1,495 | 36,95 | -38,45 | -20170 | -637,7 |
| | **Load** | 268 | -267,1 | -0,841 | 37,11 | -36,98 | -0,139 | 19820 | -10,53 |
| | **Transf erred** | 205,8 | -413,4 | 207,6 | 2,896 | 0,128 4 | -3,025 | -84,94 | -2120 |
| **10 10³** | **Source** | -2,63 | -266,8 | 269,4 | 1,07 | 24,8 | -25,87 | -13590 | -381,4 |
| | **Load** | 269,4 | -266,8 | -2,63 | 37,31 | -36,93 | -0,388 | 19910 | -11,13 |
| | **Transf erred** | 219,1 | -438,2 | 219,1 | 2,604 | -13,15 | 10,54 | 8642 | 3013 |
| **15 10³** | **Source** | -1,266 | -268,2 | 269,5 | -1,599 | 11,75 | -10,15 | -5882 | 768,4 |
| | **Load** | 269,5 | -268,2 | -1,266 | 37,32 | -37,12 | -0,201 | 20010 | -12,1 |
| | **Transf erred** | 231,8 | -461,7 | 229,9 | 1,111 | -27,34 | 26,23 | 18910 | 10090 |

# REVIEW FORM

**Title of paper:**

For sections A & B, please tick a number from 0 to 5, where 0 = strongly disagree and 5 = strongly agree.

## A. Technical aspects

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. The paper is within the scope of the Journal. | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ☑ 4 | ☐ 5 |
| 2. The paper is original. | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ☑ 4 | ☐ 5 |
| 3. The paper is free of technical errors. | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ☑ 4 | ☐ 5 |

## B. Communications aspects

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. The paper is clearly readable. | ☐ 0 | ☐ 1 | ☐ 2 | ☑ 3 | ☐ 4 | ☐ 5 |
| 2. The figures are clear & do clearly convey the intended message. | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ☑ 4 | ☐ 5 |
| 3. The length of the paper is appropriate. | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ☑ 4 | ☐ 5 |

## C. Comments to the authors (You may use another sheet of paper.)

A. Describe the abbreviation of AC-DC and THD in abstract **(Page 1).**

B. Mention in Fig. 1 where the position of the PV and micro-grid is **(Page 1).**

C. Please mention the novelty of your proposed model (interlinking converter) deeply in one paragraph excluded the sections of your manuscript. What are the important parameters which you will search to make the reader sure this paper has a significant contribution, (2) Illustrate them in a table base on the previous researcher in references, (2) Please used the proposed method in the present tense? (3) Please use the abbreviation table at the end of the last paragraph **(Page 3).**

D. **(1)** The font in Fig 2 is too small, please enlarge them and also the figure. (2) Please explain the paragraph that the notation and parameter circuit in Fig. 2 have described in the appendix section **(Page 4).**

E. Please add Fig 3 with a flow-chart diagram to show the reader more understand the explaining of your proposed model, power transfer, and selected case (duration time simulation, rectifier mode, and inverter mode) and the searched parameter base on the aim of this paper (Pac, Pdc, and efficiency). Explain also the diagram in single paragraph **(Page 5).**

F. The font in Fig 4 is too small, please enlarge them and also the figure. It is better for you to use Visio drawing and not using by Microsoft drawing in order to make Fig. 4 clearly **(Page. 6).**

G. Please make Fig. 6 more proportional **(Page 7).**

H. Except Fig. 7 and Fig. 8, Fig. 9 to Fig. 18 are not clear please copy all figure from Matlab Figure and do not use paint-brush. Enlarged also the font on these figures, (2) Enlarge the font and dimension of Fig. 7 and Fig. 8 **(Page 8).**

I. Zoom Fig 13 in the middle of simulation time (t = 0.3) and describe in one paragraph a comparison of active power performance between Ptrans, Ps, and PL **(Page 11).**

J. Erase the legend in Fig. 15 because this figure has only single simulation figure **(Page 12).**

K. Please describe in detail (single paragraph) where are the best and lowest efficiency performances base on Pdc source and IC

modes. (2) In Fig 17, you describe the harmonic THD performance of your proposed model but in the analysis, you don't mention how much is the THD value (lowest and highest nominal THD) **(Page 13).**

L. This paper only describes the best performances of your proposed method, now please add this section (conclusion) with future work to assistant the readers that your research has some weaknesses and eligible to continue **(Page 13).**

M. Please enlarge Matlab/Simulink in Fig. A-1. **(Page 15).**

N. Please show the unit of table parameters. For example I (Ampere or Amp), V (Volt), and P (Watt) **(Page 16).**

O. Please show the unit of table parameters. For example Ia (Ampere or Amp), Va (Volt), P (Watt), and Q (VAR) **(Page 17).**

## D. Recommendation (Tick one)

| | |
|---|---|
| 1. Accepted without modifications. | ☐ |
| 2. Accepted with minor corrections. | ☑ |
| 3. Accepted with major modification. | ☐ |
| 4. Rejected. | ☐ |

## E. Comments to the editors (These comments will not be sent to the authors)

## OUTLINING HOW THE ISSUES ARE ADDRESSED

| Title of paper: | HIGH PERFORMANCE OF POWER TRANSFER IN HYBRID AC – DC MICROGRID WITHOUT STORAGE SYSTEM |
|---|---|

1. Address all the concerns/recommendations of the reviewers.
2. All amendments made are to be highlighted in red color in the revised paper.

**Reviewer # 1**

| Final Recommendation Please tick | Accepted without modification ☑ | Accepted with minor corrections ☐ | Accepted with major modification ☐ | Rejected ☐ |
|---|---|---|---|---|

| Comments | Addressed (Y/N) | Reply/Action taken |
|---|---|---|
| 1. **Describe the abbreviation of AC-DC and THD in abstract (Page 1).**<br>**Comments :**<br>Abbreviation has been described and in order to prevent repetition, each abbreviation has been explained in the abbreviation box located after the conclusion | Y | |
| 2. **Mention in Fig. 1 where the position of the PV and micro-grid is (Page 1).**<br>**Comments :**<br>Fig. 1 has been changed with DC and AC sub microgrid information | Y | |
| 3. **Please mention the novelty of your proposed model (interlinking converter) deeply in one paragraph excluded the sections of your manuscript. What are the important parameters which you will search to make the reader sure this paper has a significant contribution, (2) Illustrate them in a table base on the previous researcher in references, (2) Please used the proposed method in the present tense? (3) Please use the abbreviation table at the end of the last paragraph (Page 3).**<br>**Comments :**<br>Thank you very much for the suggestion of creating a comparison table, as this makes it easier for the reader to understand the development of the method we are proposed. We have added Table 1 which contains the comparison of methods from previous studies along with the results | Y | |

| | | | |
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| | obtained. And the novelty of this research has been explained in the abstract and introduction to the last paragraph. | | |
| 4. | **(1) The font in Fig 2 is too small, please enlarge them and also the figure. (2) Please explain the paragraph that the notation and parameter circuit in Fig. 2 have described in the appendix section (Page 4).**<br><br>**Comments :**<br><br>Fig. 2 has been changed with enlarge the figure and font | γ | |
| 5. | **Please add Fig 3 with a flow-chart diagram to show the reader more understand the explaining of your proposed model, power transfer, and selected case (duration time simulation, rectifier mode, and inverter mode) and the searched parameter base on the aim of this paper (Pac, Pdc, and efficiency). Explain also the diagram in single paragraph (Page 5).**<br><br>**Comments:**<br><br>We have added a description and simulation flowcart in Section 3 | γ | |
| 6. | **The font in Fig 4 is too small, please enlarge them and also the figure. It is better for you to use Visio drawing and not using by Microsoft drawing in order to make Fig. 4 clearly (Page. 6).**<br><br>**Comments :**<br><br>Fig. 4 has been changed with enlarge the figure and font | γ | |
| 7. | **Please make Fig. 6 more proportional (Page 7).**<br><br>**Comments :**<br><br>Fig. 6 has been changed more proportional | γ | |
| 8. | **Except Fig. 7 and Fig. 8, Fig. 9 to Fig. 18 are not clear please copy all figure from Matlab Figure and do not use paint-brush. Enlarged also the font on these figures, (2) Enlarge the font and dimension of Fig. 7 and Fig. 8 (Page 8).**<br><br>**Comments :**<br><br>Fig. 7 and Fig. 8 has been changed with enlarge the figure and font. Fig 9 to Fig 18 has been copy from Matlab Figure. | γ | |
| 9. | **Zoom Fig 13 in the middle of simulation time (t = 0.3) and describe in one paragraph a comparison of active power performance between Ptrans, Ps, and PL (Page 11).**<br><br>**Comments :** | γ | |

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| Fig. 13 has been changed to Fig. 14, the figure has been zoom in 1 s to 1,5 s and the explanation about the comparison has been writened in page 13 | | |
| **10.** **Erase the legend in Fig. 15 because this figure has only single simulation figure (Page 12).** <br><br> **Comments :** <br> The legend in Fig. 15 has been erased | ɣ | |
| **11.** **Please describe in detail (single paragraph) where are the best and lowest efficiency performances base on Pdc source and IC modes. (2) In Fig 17, you describe the harmonic THD performance of your proposed model but in the analysis, you don't mention how much is the THD value (lowest and highest nominal THD) (Page 13).** <br><br> **Comments :** <br> The explanation regarding the efficiency of IC and TDH has been explained on the page 15 | ɣ | |
| **12.** **This paper only describes the best performances of your proposed method, now please add this section (conclusion) with future work to assistant the readers that your research has some weaknesses and eligible to continue (Page 13).** <br><br> **Comments :** <br> I have added an explanation regarding the continuation of this research in part 3 especially the last paragraph (Page 15) | ɣ | |
| **13.** **Please enlarge Matlab/Simulink in Fig. A-1. (Page 15).** <br><br> **Comments :** <br> The Fig. A-1 has been enlarge | ɣ | |
| **14.** **Please show the unit of table parameters. For example I (Ampere or Amp), V (Volt), and P (Watt) (Page 16).** <br><br> **Comments :** <br> The unit of the parameters in the Table B–1 has been added | ɣ | |
| **15.** **Please show the unit of table parameters. For example Ia (Ampere or Amp), Va (Volt), P (Watt), and Q (VAR) (Page 17).** <br><br> **Comments :** <br> The unit of the parameters in Table B-2 has been added, and to improve the appearance of the table, the old Table B-2 has been split into 2, Table B-2 and Table B-3 | ɣ | |

*(Please add more rows if needed)*

| Reviewer # 2 | | | | |
|---|---|---|---|---|
| **Final Recommendation Please tick** | **Accepted without modification** ☐ | **Accepted with minor corrections** ☐ | **Accepted with major modification** ☐ | **Rejected** ☐ |

| Comments | Addressed (Y/N) | Reply/Action taken |
|---|---|---|
| 1. **I recommend the authors to improve the presentation of the paper.** <br> **Comments :** <br> Thank you very much for the recommendations, I really hope that the reviews and advice from all reviewers give a very significant improvement for my papers. | | |
| 2. **The authors must be added section to describe the Related Works.** <br> **Comments :** <br> I have presented a comparison of research on bidirectional converters carried out by previous researchers in tabular form, Table 1. From the table, it can be seen how the methods and results of research on bidirectional converters that have been carried out by previous researches. So that there appears to be a difference in the methods and results of the research that we present. | | |
| 3. **The entitled of " Fig. 2. Overall configuration of the propost system", must be correct to " Fig. 2. The overall configuration of the proposed system"** <br> **Comments :** <br> I have been changed the entitled of "Fig. 2. Overall configuration of the propost system"to "Fig. 2. The overall configuration of the proposed system" | | |
| 4. **The abbreviations must be standardized, either all abbreviations italics or all of the abbreviations without italics** <br> **Comments :** <br> we have tried to standardize the existing abbreviations and all the abbreviations has been explained in the abbreviation box located after the conclusion in page 16. | | |
| 5. **the entitled of " 2.2.Propost interlinking converter control", must be correct to "2.2.Proposed interlinking converter control"** <br> **Comments :** <br> I have been changed the entitled of "2.2 Propost interlinking converter control" to "2.2.Proposed interlinking converter control" | | |
| 6. **Authors must develop original image/figures with high resolution for proper rendering of the final published paper and should not distort on zooming.** <br> **Comments :** | | |

| | | | |
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| | I have increased the figure resolution and not distort the zooming from most existing figure to make it look better on the final published paper. | | |
| 7. | **The research paper should be written in perspective of third person. Words such as 'I' 'we' 'our' etc. needs to be avoided.** <br> **Comments :** <br> I have tried to sort out subjective words that should not be used in scientific articles | | |
| 8. | **Refer some quantitative results highlights in the abstract. Be more assertive, not only generalities** <br> **Comments :** <br> I have refined the abstract to make it less general. I explain the methods used, information on the simulation and technical advantages of the research. | | |
| 9. | **English language and style are fine/minor spell check required** <br> **Comments :** <br> Thank you very much for the support, I will pay attention to details or spell check Grammar of the English language that I use. | | |
| 10. | **Please note the inconsistencies in the way of writing the article in the References section and adjust it to the requirements of the publishing house.** <br> **Comments :** <br> I have tried to adjust the References writing as requirements by the publishing house. | | |
| 11. | **Overall, I have the impression that the work is closer to the technical description of the proposed system (perhaps even much better than the one used so far, but it is difficult to state due to the lack of research results) than to the research article.** <br> **Comments :** <br> Thank you for the advice. For now, what I write in this paper is the result of our research, if there are many shortcomings, I really need support so that the results of this research become good research article. | | |
| 12. | **The author should highlight its technical advantages.** <br> **Comments :** <br> The technical advantages have been described in the abstract, introduction and conclusion. Even in the introduction, we also compare it with some previous researchers. | | |

*(Please add more rows if needed)*

| Reviewer # 3 | | | | |
|---|---|---|---|---|
| **Final Recommendation** <br> **Please tick** | **Accepted without modification** <br> ☐ | **Accepted with minor corrections** <br> ☐ | **Accepted with major modification** <br> ☐ | **Rejected** <br> ☐ |

| Comments | Addressed (Y/N) | Reply/Action taken |
|---|---|---|
| 1. **The introduction is well organized and relevant literature works are commented. It could be interesting to summarize the commented literature works in a table to have a clear comparison between all. This could also help precisely formulating the contribution of the paper with respect to previous works.**<br>**Comments :**<br>We have added Table 1 which contains the comparison of methods from previous studies along with the results obtained. And the novelty of this research has been explained in the introduction to the last paragraph. | | |
| 2. **The authors must compare the result of the proposed method with conventional methods.**<br>**Comments :**<br>I have presented a comparison of research on bidirectional converters carried out by previous researchers in tabular form, Table 1. From the table, it can be seen how the methods and results of research on bidirectional converters that have been carried out by previous researches. So that there appears to be a difference in the methods and results of the research that we present. | | |
| 3. **All the figures need to be captioned. The figures should be numbered consecutive to each-other and independent of the sections. (Example: Fig.1 _____, Fig.2 _____, Fig.3 _____ etc.)**<br>**Comments :**<br>I have captioned all the figures, and corrected the figure's text as suggested | | |
| 4. **Image format of the tables is not acceptable. Author can use Microsoft Office tools to create the tables. The text labels in the tables must be clearly visible.**<br>**Comments :**<br>Table B-1 and B-2 have been improve, and the old Table B-2 has been split into 2, Table B-2 and Table B-3 | | |
| 5. **All the listed references must be properly cited in the body of the paper using the numbered format of journal.**<br>**Comments :**<br>The references has been listed and cited in the body of the paper using a journal format | | |
| 6. **It is expected to see a more insightful discussion about the results obtained. A section must be added before the conclusion section to discuss the results obtained. It is relevant to see specific improvement figures and percentages rather than general** | | |

| | Addressed (Y/N) | Reply/Action taken |
|---|---|---|
| **conclusion. It is important to conceive clearly the improvement introduced by the proposed control method compared to the conventional method.**<br>**Comments :**<br>The results of several reviews and input from reviewers made improvements in the performance of the paper, including in the discussion of research results. As for the comparison of methods and results against conventional methods we have written in tabular form, Table 1 | | |
| 7. **The paper writing needs improvement. Please proof read the paper and avoid using long sentences.**<br>**Comments :**<br>This paper has been proof reading. | | |
| 8. **The study should be in combination with the actual problems, simulation parameters are obviously divorced from reality.**<br>**Comments :**<br>The study we conducted has attempted to approach reality, but it is still very far from the real situation in the field, for that it is necessary to carry out further studies of this research, and we have written this in section 4, in the last paragraph (page 15) | | |
| 9. **The authors must added future works**<br>**Comments :**<br>We have added information regarding further research in section 4, especially the last paragraph (page 15) | | |

*(Please add more rows if needed)*

| Reviewer # 4 | | | | |
|---|---|---|---|---|
| **Final Recommendation Please tick** | **Accepted without modification**<br>☐ | **Accepted with minor corrections**<br>☐ | **Accepted with major modification**<br>☐ | **Rejected**<br>☐ |

| Comments | Addressed (Y/N) | Reply/Action taken |
|---|---|---|
| 1. **This research application is clear but its importance is not purposed on paper. The correlation of this research must be delivered**<br>**Comments :**<br>Thank you for the suggestions, this suggestion is almost the same as the suggestions of several reviewers, for that we have made improvements, this can be seen in the abstract and introduction. | | |
| 2. **A paper doesn't give new ideas. It is derivations and applications of previous research.**<br>**Comments :**<br>This study does have very slight differences compared to the previous studies because the basis of methods we use are the same, PWM modulation and the abc to | | |

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| dq transformation which are very commonly used. The difference from other researchers is that the input voltage from the AC sub microgrid is only used for PLL input, this is done only to equalize the phase difference between the converter and the grid. We have also used this method in our paper [11]. This study is a continuation of our previous paper with grid-connected systems and the addition of power and load change cases. | | |
| **3. The research gap is not yet visible from several references are referred.**<br>**Comments :**<br>The references we use really support the research we do. Maybe some references that seem unrelated to our research are references related to battery usage in PV and grid systems. This reference is very supportive of the research we have done. | | |
| **4. The contribution of this research must also be clearly communicated.**<br>**Comments :**<br>The contributions of this research have been described in the abstract and introduction. Even in the introduction, we also compare it with some previous researchers. | | |
| **5. The depth and logic of the discussion have been fairly well described.**<br>**Comments :**<br>Thank you very much for the support, I really hope that the reviews and advice from all reviewers give a very significant improvement for my papers. | | |
| **6. The research recommendations should also be presented in this paper.**<br>**Comments :**<br>We have added information regarding further research in section 4, especially the last paragraph (page 15) | | |

*(Please add more rows if needed)*

| Reviewer # 5 | | | | |
|---|---|---|---|---|
| **Final Recommendation**<br>**Please tick** | **Accepted without modification**<br>☐ | **Accepted with minor corrections**<br>☐ | **Accepted with major modification**<br>☐ | **Rejected**<br>☐ |

| Comments | Addressed (Y/N) | Reply/Action taken |
|---|---|---|
| **1. This paper gives new ideas, derivations, applications that has been not studied before or little or not in depth studied. Show the novelty that you offer in this research?**<br>**Comments :** | | |

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| | The novelty of this research have been described in the abstract and introduction. Even in the introduction, we also compare it with some previous researchers. | | |
| 2. | **The power transfer between the AC and DC sub-microgrids managed by a two-way converter-based IC (actually I don't agree with the Interlink Converter abbreviated IC) makes the system stable (fill in the conclusion), but in fact there is control, both PID and PI that are used. Is the stability of the system not due to the controls designed in the system?**<br>**Comments :**<br>I totally agree with your opinion regarding the stability of the system. As discussed in Section 2, the stability of this system is greatly helped by the existence of a strong grid connection, but I have difficulty in finding the right words to describe the benefits of IC on the system. As a solution I replaced it with "The power transfer between AC and DC sub microgrid that manages by the IC that is based on bidirectional converters make the system run well, power requirements can be met despite the lack of power, especially in the DC sub microgrid" | | |
| 3. | **Provide an explanation of Figure 2 as the research to be proposed**<br>**Comments :**<br>We have added a description of Figure 2. | | |
| 4. | **I haven't found a vector control method, please write down both the source and the method?**<br>**Comments :**<br>I'm sorry that I mispronounced the name of the method I used, because what I actually used was the vector transformation of abc to dq and vice versa. This transformation method uses the Park and Clarke transforms which are very commonly used in vector arrangement as same as PWM modulator. For that reason I did not discuss it specifically like the other components contained in the converter control. I already changed the use of the word vector control. Thank you very much for the correction. | | |

*(Please add more rows if needed)*

| **Reviewer # 6** | | | | |
|---|---|---|---|---|
| **Final Recommendation Please tick** | **Accepted without modification**<br>☐ | **Accepted with minor corrections**<br>☐ | **Accepted with major modification**<br>☐ | **Rejected**<br>☐ |
| **Comments** | | **Addressed (Y/N)** | **Reply/Action taken** | |
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## Reviewer # 7

| Final Recommendation Please tick | Accepted without modification ☐ | Accepted with minor corrections ☐ | Accepted with major modification ☐ | Rejected ☐ |
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| Comments | | Addressed (Y/N) | Reply/Action taken |
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## Reviewer # 8

| Final Recommendation Please tick | Accepted without modification ☐ | Accepted with minor corrections ☐ | Accepted with major modification ☐ | Rejected ☐ |
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| Comments | | Addressed (Y/N) | Reply/Action taken |
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| 18. | | | |
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## Reviewer # 9

| Final Recommendation Please tick | Accepted without modification ☐ | Accepted with minor corrections ☐ | Accepted with major modification ☐ | Rejected ☐ |
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| Comments | | Addressed (Y/N) | Reply/Action taken |
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| 22. | | | |
| 23. | | | |
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*(Please add more rows if needed)*

## Reviewer # 10

| Final Recommendation Please tick | Accepted without modification ☐ | Accepted with minor corrections ☐ | Accepted with major modification ☐ | Rejected ☐ |
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| Comments | Addressed (Y/N) | Reply/Action taken |
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| 26. | | |
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# HIGH PERFORMANCE OF POWER TRANSFER IN HYBRID AC – DC MICROGRID WITHOUT STORAGE SYSTEM

## Abstract

This paper aims to look at the use of an intermittent renewable energy source (RES) connected to the grid in a hybrid alternating current (AC) – direct current (DC) microgrid concept, without the use of a storage system. It is known that the intermittent RES sometimes has excess energy and sometimes lack energy, so this condition requires a storage system. A way to solve this problem is used an AC-DC bidirectional converter as an interlinking converter (IC). The IC connected DC sub microgrid and AC sub microgrid and manages the power transfer in the system. The control uses three inputs, the voltage from the DC sub microgrid, the voltage and current from the AC sub microgrid. The control uses SPWM modulation and also the abc to dq transformation methods. What is new from this research is that the voltage from the AC sub microgrid is only used for input to the phase lock loop (PLL). This is done to maintain the converter phase shift equal to the network. The simulation built on Simulink / Matlab and by adding changes to the DC source and the load on the AC sub microgrid. The results prove that the built-in IC works on the systems with stable voltages, frequencies, and the total harmonic distortion (THD) is less than 8% that meet the Institute of Electrical and Electronics Engineers (IEEE) Standart 519TM-2014 requirements. The power transfer between AC and DC sub microgrid that manages by the IC describes the efficiency of the IC, it reaches 99,4% as a rectifier and 99,6% as an inverter and the mode switching occurred without delay and overshoot.

Keywords: Hybrid AC-DC microgrid, power transfer, bidirectional converter, vector control method

## 1. Introduction

Until now, the fulfillment of electrical energy depends on long-distance transmission systems from sources with giant power plants, and electricity generated using AC power, but when electricity will enter electronic equipment, AC power is converted to DC power by the adapter, like laptops, handphones, etc. This conversion is inefficient because there is wasted energy. To be efficient, of course, the electrical system must come from a DC source as well, like on DC House [1]. In DC House, the conversion of AC to DC is not needed because electricity from DC House can be directly used. Another major advantage of DC House is flexibility. In its basic design, DC House is designed to be able to receive electricity from any source, such as wind, water, solar and even people who ride bicycles. So, an area can utilize the most abundant potential electricity source. This desire is very difficult to implement, considering the electricity system that is currently developing is the AC system. A new electricity concept, distribution generators that supply the surrounding load into a subsystem or microgrid of the distribution system makes the starting point of change in the conventional electricity [2]. Research on microgrid has been growing in almost two decades. AC microgrid, DC microgrid, and a combination of them was known as hybrid AC-DC microgrids. On AC microgrid there are main buses that use the AC system as well as on DC microgrids where the main bus uses the DC system. In both types of microgrid, both source and load will use the system on the main bus type. Different from AC and DC microgrid, in hybrid AC-DC microgrid, AC load will be connected and supplied with an AC source, and also the DC load which will be connected and supplied with a DC source, because it is directly connected to the same source, this system can reduce the use of converter [3]. This reduction is in line with the reduction of harmonic pollution and increasing the power quality of the system, also increase the installed power [4-6].

In this system there are two central buses, DC bus, and AC bus, and they connected with interlinking converter as illustrated in Fig. 1. The interlinking converter has a very important role. This power electronics equipment is expected to be able to flow power from AC microgrid to DC microgrid if the power generated by a DC source cannot supply the load power requirements, conversely, if a DC source produces excess power from the DC load requirements, the interlinking converter must be able to transfer this excess power to the AC microgrid to be traded. For this reason, the interlinking converter should use bidirectional converter, this converter must have the ability to be a rectifier or an inverter, conduct power in both directions properly because in addition to power change there is also load change on the system.
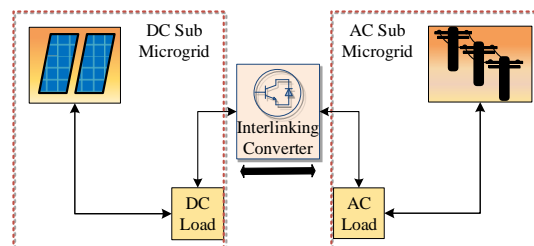


**Fig. 1. Hybrid AC-DC Microgrid**

The converter expected to be able to flow power better from. DC to AC or AC to DC sub microgrid according to the power changes of the sub microgrid. Some previous studies have given results, but need to be improved. The bidirectional converter with only voltage control from AC sub microgrid not yet able to regulate the power flow with changes in power and load conditions, but it can drain the power when a three-phase disturbance occurs [7]. Input control only from the AC sub microgrid side is not enough to make the converter change the mode from rectifier to inverter or vise versa.

**Table 1. The Comparison proposed study and previous**

| No | Authors | Methods | Change mode | Delay | Over shoot |
|----|---------|---------|-------------|-------|------------|
| 1 | Lili Huang, et al [8] | SVPWM modulation, transformation abc to dq, and switch | NA | NA | NA |
| 2 | Xiong Liu, et al [12] | PWM modulation, transformation abc to dq Coordination between boost and main converter | √ | √ | √ |
| 3 | Azrita Alias, et al [14] | Change the IGBT topology and switching technique | √ | - | - |
| 4 | A. Mohammed, Elshaer, et al [9] | SPWM modulation and transformation abc to dq. The voltage from the AC side used for input in the PLL and current control | √ | √ | - |
| 5 | Poh Chiang Loh, et al [13] | PWM modulation, transformation abc, to dq. Droop control in DC and AC sub sides | √ | √ | - |
| 6 | Navid Eghtedarpour, et al [6] | PWM modulation, transformation abc, to dq. Two-stage modified droop control | √ | √ | √ |
| 7 | Xiancheng Zheng, et al [10] | SPWM modulation, Transformation abc to dq. Droop control in the DC side | √ | √ | - |
| 8 | Hasti Afianti, et al [7] | PWM modulation, Transformation abc to dq. Input from AC terminal voltage | NA | NA | NA |
| 9 | Hasti Afianti, et al [11] | PWM modulation, Transformation abc to dq. The AC terminal voltage is only used for input in the PLL | √ | - | - |
| 10 | Proposed Mehod | Nama Metode (Kelebihan dr Method 1-9) | | | |

Ceritakan detail kelebihan metode 10 dibandingkan metode 1-9. (Satu-Satu)

Note : NA = not available

Some researches trying to use three inputs from the AC and DC sub microgrid, voltage from DC sub microgrid, voltage and current from AC sub microgrid and other modification [8-11]. The controls able to change the mode of the converter when the current was changed from positive to negative that indicate the current flow is changed, the simulation results show that there is a phase shift of current to the voltage of $180^0$ even there are delay and overshoot in the simulation. Several studies using the calculation of active, reactive power and other modifications as a control for bidirectional converters have also been carried out and provide results [6], [12, 13]. The development of the method used in the bidirectional converter of the other research is presented in Table 1. It shows comparisons of methods and results for several previous studies.

In this paper, the hybrid AC DC microgrid system was built by Simulink/ Matlab with the bidirectional converter as an interlinking converter. The built system is connected to a grid without a storage system. The IC control uses three inputs, the voltage from the DC sub microgrid, the voltage and current from the AC sub microgrid. The methods used SPWM modulation and the abc to dq transformation and vice versa. What is new from this research is the voltage of the AC sub microgrid is only used for input on the phase lock loop (PLL). This is done to maintain the converter phase shift equal to the network. This study complements previous research by connecting the system to the grid and adding variations in power and load changes. The simulation is carried out by providing power and load changes to prove the control performance of the bidirectional converter working without delay and overshoot when mode switching occurs in the converter. This paper consists of several sections, in section 2 described the system configuration with the bidirectional converter followed by simulation and discussion in section 3 and the conclusion in section 4.

## 2.  Hybrid  AC-DC microgrid with bidirectional converter as interlinking converter

### 2.1. Hybrid AC-DC microgrid system

In this system consists of 3 large circuits: DC sub microgrid, AC sub microgrid and interlinking converter. The DC sub microgrid consists of DC source inheriting the photovoltaic (PV) and fuel cell connected with a load, some example for DC load are light emitting diode (LED), and modern elevator. In AC sub microgrid side has a grid-connected with many kind of load combination. Because each sub microgrid has a load that must be supply, a  good converter is needed that can maintain power stability in the event of a power shortage, especially in the DC sub microgrid, given the intermittent nature of the RES and in this research the system does not use an energy storage system. The use of energy storage system becomes a dilemma when a RES is connected to a stable grid. As has been widely applied that the use of RES is rarely separated from the energy storage system, where it is used to reserve power requirements because of the intermittent of the RES. However, the energy storage system, like a battery, is not very economical, because the battery has a short lifetime (between 3 and 5 years maximum in rural areas for solar lead-acid batteries which are commonly used for RES), and must be recycled, technology to recycle

batteries is very rare so that batteries that are not used will become junk if left longer, and batteries has a big shape, this will certainly harm the environment, chemical pollution, and high investment. Some researchers with their research based on the concept of "flexy energy" proved on techno-economic that a hybrid system between PV and diesel generators without using a storage system has higher effectiveness than stand-alone of diesel generators system [15-18]. As well as has been researched that PV applied on the roof-top or building integrated photovoltaic (BIPV) and grid without storage is techno-economic has high effectiveness because the cost of energy (COE) decreases in line with the increase in power capacity [19]. From all this research, it can be concluded techno-economic that hybrid PV systems can work on the grid or off-grid even without a storage system, but this system requires a converter that not only can flow current properly but also can work as rectifier and inverter so it can maintain voltage and frequency stability, despite changes in power and load.
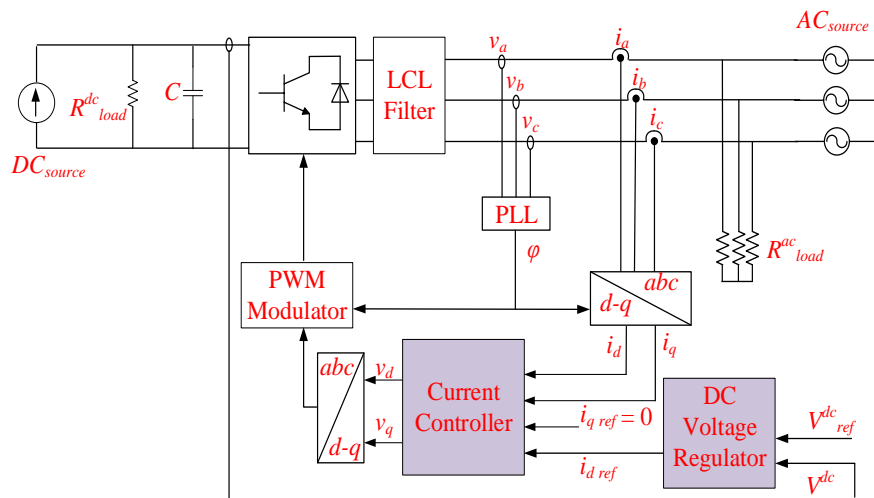


**Fig. 2. The overall configuration of the proposed system**

While in the hybrid AC DC microgrid connected to the main utility grid as an AC source. The grid expected to be able to supply active and reactive power to the network both on the AC sub microgrid side and DC sub microgrid system. In this case, beside the grid will maintain the power balance, both active, and reactive power, the grid will maintain the stability of the voltage and frequency in the system. Figure 2 shows a series of systems built in this study. In the DC sub microgrid, there is a DC source with a load and a capacitor link. In the AC sub microgrid, there is also an AC source in this case in the form of a grid, load, and LCL filter. The notation and parameters used in the system are listed in Appendix A. To connect the two sub microgrids, there is an interlinking converter with the controls described in section 2.2.

In the hybrid AC DC microgrid, the AC and DC sub microgrid have separate power equations [20]. Regardless of the power loss, the power on the DC sub microgrid with $N_A$ is the number of DC buses. $P_{load}^{dc,h}$ is power demand of $h^{th}$ load in

DC sub microgrid. $P_{source}^{dc,h}$ is power generated by $h^{th}$ energy source in DC sub microgrid. $P_{loss}^{dc}$ is power loss in DC sub microgrid and $P_{IC}^{dc}$ is power transfer from AC to DC or DC to AC that through the IC. The power in the DC sub microgrid can be expressed as follows [20, 21]:

$$0 = \sum_{h=1}^{N_A} P_{load}^{dc,h} + P_{loss}^{dc} + P_{ic}^{dc} - \sum_{h=1}^{N_A} P_{source}^{dc,h} \qquad (1)$$

Where the generator, load, reactive power compensator, AC lines and the converter are connected on the bus $i$ as depicted in Fig 3. The active and reactive power balance equations at AC sub microgrid can be expressed as follows [22]:

$$P_{source}^{ac} - P_{load}^{ac} - s_p P_{ic}^{ac} - V_i \sum_{j=1}^{N_B} V_j \left( G_{ij} cos\delta_{ij} + B_{ij} sin\delta_{ij} \right) = 0 \qquad (2)$$

$$Q_{source}^{ac} + Q_{cd} - Q_{load}^{ac} - s_q Q_{ic}^{ac} - V_i \sum_{j=1}^{N_B} V_j \left( G_{ij} sin\delta_{ij} + B_{ij} cos\delta_{ij} \right) = 0 \qquad (3)$$
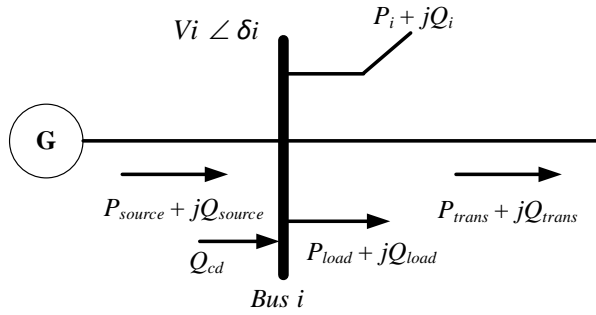


**Fig. 3. General AC bus presentation**

$P_{source}^{ac} + Q_{source}^{ac}$ and $P_{load}^{ac} + Q_{load}^{ac}$ are complex power of the generator and load respectively. $Q_{cd}$ is the output of the reactive power compensation device, $V_i$ and $\delta_i$ are the voltage magnitude and angle. $G_{ij} + B_{ij}$ where is the $i\,j$ th element of the admittance matrix of the AC power network, $N_B$ is the number of AC buses. $s_p = 0$ and $s_q = 0$ if no converter is connected at bus , $s_p = 1$ and $s_q = 1$ if the converter at bus is a rectifier, $s_p = -1$ and $s_q = -1$ if the converter at bus is an inverter [23]

The voltage line to line $(V_{ab}^{ac}, V_{bc}^{ac}, V_{ca}^{ac})$ in the three phase converter with naturally sampled PWM, with the three sinusoidal references displaced in time by 120º [24].

$$V_{ab}^{ac} = M\sqrt{3}V^{dc} \cos(\omega_o t + \frac{\pi}{6}) \qquad (4)$$

$$V_{bc}^{ac} = M\sqrt{3}V^{dc} \cos(\omega_o t - \frac{\pi}{2}) \qquad (5)$$

$$V_{ca}^{ac} = M\sqrt{3}V^{dc} \cos(\omega_o t + \frac{5\pi}{6}) \qquad (6)$$

*M* is the modulation index (the normalized output voltage magnitude) of the IC with the range $0 < M < 1$ and $\omega_o$ is target output angular frequency [23].

The relation between the DC power and the AC active power is a function of the efficiency of the converter, ignoring switching losses in the converter, as follows [19].

$$P^{ac} = \frac{P^{dc}}{\mu^{IC}} \tag{7}$$

In Eq. 7, $P^{ac}$ and $P^{dc}$ is the power in the AC and DC interface of the IC and $\mu^{IC}$ is the efficiency of the IC.

## 2.2. Proposed interlinking converter control

This interlinking converter connects DC sub microgrid and AC sub microgrid. The converter uses 6 insulated gate bipolar transistor (IGBT), the input control comes from both sides, on the side of the AC sub microgrid using current and voltage, and the voltage on the DC sub microgrid side. With inputs that are on the two sides of the converter, the converter can work bidirectionally as a rectifier or inverter, converting DC power into AC power and vice versa, depending on the power situation of both sub microgrids. Described in Fig. 4, the voltage from the AC sub microgrid becomes reference input is of the PLL to synchronize the phase angle. The PLL circuit in this system is modeled as a closed-loop system that monitors the variation of the phase angle using an internal oscillator. The control system adjusts the internal oscillator to keep the phases difference to zero. Using Park Transform, the phase angle generated by the internal oscillator is used to change the three phase voltage from AC sub microgrid into dq coordinates.



**Fig. 4. Phase lock loop**

The Mean (Variable Frequency) block computes the mean value of the quadrature signal, $f(t)$. This average value is obtained from one frequency cycle of the quadrature signal, with $T = 1/$frequency.

$$Mean\left(f(t)\right) = \frac{1}{T}\int_{(t-T)}^{t} f(t).dt \tag{8}$$

The output of the mean block combine with optional automatic gain control (AGC) becomes the input of the proportional integral derivative (PID) controller. This controller keeps the phase difference to 0. The PID output, according to the angular velocity, is filtered and converted to a frequency that is used to find the average value. While the phase angle generated by PLL is used to transform the abc to dq coordinates or dq to abc coordinates as seen in Fig. 2, the AC sub microgrid current is change to dq coordinate and becomes input of the current control of as seen in Fig. 5.



**Fig. 5. Current controller**

The close loop DC voltage is control with the set point of DC reference voltage, which is then controlled by the PI controller and determine with $i_{d\ reff}$ as described in Fig. 6. Besides the PI controller, the value of $i_{d\ reff}$ depends on the limiter. The constant limiter value specified as the maximum and minimum values as in Eq.9.



**Fig. 6. DC voltage regulator**

$$i_{d\ reff} = \begin{cases} i_{d\ reff} & ; -C_{min} < i_{d\ reff} < C_{max} \\ -C_{min} & ; \quad i_{d\ reff} < -C_{min} \\ C_{max} & ; \quad i_{d\ reff} > C_{max} \end{cases} \tag{9}$$

The sum of $i_d$ and $i_q$ from the current loop with $i_{d\ reff}$ and $i_{q\ reff}$ are controlled by the PI controller and change to abc coordinate with Park Transformation, before becoming an input of the PWM modulator. Finally, the PWM modulator produces pulses that move the switch on IGBTs in the interlinking converter.

## 3. Results and discussion

### 3.1. The simulation

The system modeling is done as shown in Fig. 2. During the simulation, there are power changes in DC sub microgrid and load changes on the AC sub microgrid. The simulation is carried out for 6 seconds with a schedule of power changes as shown in Fig. 7 and Fig. 8 there is a schedule of load changes. The change in power gradually follows the gauss curve pattern like the average shape of solar radiation every day.

0,5 kW   5,5 kW   10 kW      15 kW        10 kW   5,5 kW      0,5 kW

0          1          2          3          4          5          6

Time (s)

**Fig. 7. The schedule of power changes**

20 kW                  10 kW                    20 kW

0          1          2          3          4          5          6

Time (s)

**Fig. 8. The schedule of load changes**

The analysis of the simulation was carried out in 2 places in the DC microgrid and AC microgrid. The flowchart of the simulation shown in Fig. 9, from the flowchart It appears that the mode change on the IC is very dependent on the source and load conditions on the DC sub microgrid.
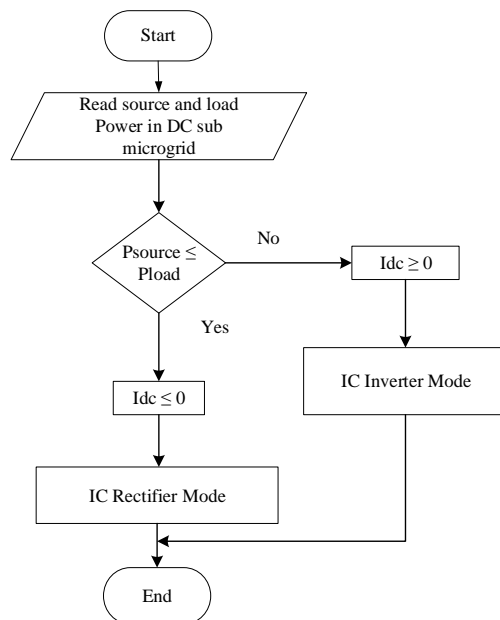
**Fig. 9. Flowchart of the simulation**

### 3.2. DC sub microgrid

With power change at the DC source, there is also a change in current and voltage at the DC sub microgrid, as seen in Fig. 10 for the current and Fig. 11 for the voltage response. When there is a decrease in DC source power that cannot supply dc power load in 0 s until 1,8 s, makes the current becomes negative, this indicates

that the dc power load supplied from the IC, it is mean that the IC become rectifier. When the DC power source starts to increase in 1,8 s until 2,4 s, even where the DC source is greater than the DC load, the current becomes positive. In this case, the IC will get power supply from the DC source and make the IC function as an inverter. When the power source decrease but it still bigger than dc load power in 3,6 s until 4,2 s, the current is still positive and the IC still becomes an inverter. It is different when the source power still decreases until less than load power in 4,2 s until 6 s, the current becomes negative and the IC function becomes a rectifier again. Changes in DC power source cause changes in DC voltage, this is normal, because the model of this simulation using a controlled current source module to reflect on resources. Controlled current source module was supplied by $P_{dc}$ as DER that setting like in Fig. 6 and divided with $V_{reff}^{dc}$ that in this simulation was setting in 400 V. Fig. 12 shows the power flow at the DC Source, DC load, and the power transferred through the IC. In this figure, the power comparison was described very clear, when DC power is very small and even close to zero then the IC will transfer power to supply the load power requirements, so the value of the power transfer becomes negative. If the load power is equal to the DC power, the IC does not transfer power, this can be seen from the value of the power transferred by the IC close to zero. Conversely, when the DC power is greater than the load power the power transferred from the IC becomes positive, this indicates that the DC microgrid is delivering power to the IC.
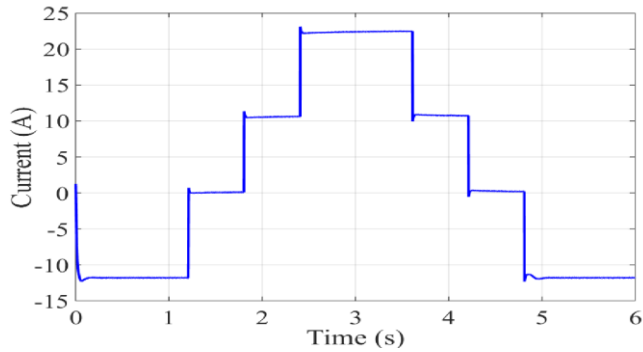


**Fig. 10. DC sub microgrid current**
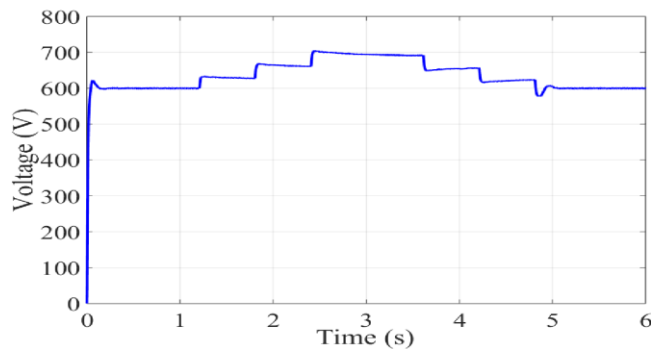


**Fig. 11. DC sub microgrid voltage**
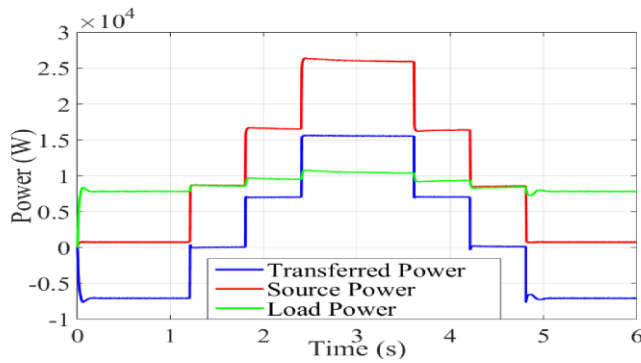
**Fig. 12. DC sub microgrid power with DC Voltage Regulator**

**3.2 AC sub Microgrid**

The impact of power changes on the DC source can be seen not only in the DC sub microgrid but also in the AC sub microgrid. Fig. 13(a) shows the voltage and current that occurs in the AC sub microgrid during the simulation. With power change on the DC sub microgrid and the load on the AC sub microgrid according to Figs. 7 and 8 make the IC function changed as a rectifier or inverter following the changes that occur in the system. In the Fig. 13(a) to Fig. 13(g) the voltage on the AC sub microgrid is maintained properly despite changes in power and load.

Different things happen to the current, the AC sub microgrid current changed not only in its magnitude but also a phase angle shift. Fig 13(b) until Fig. 13(f) is an enlargement of the Fig. 13(a), which is cut every second to show the current changes. Enlargement from 0 s to 1 s is described in Fig. 13(b), in this figure the voltage and current are stable because there is still no power or load change. The voltage and current are in a different phase, it indicates that the IC in rectifier mode. Power from DC source is insufficient to supply the DC load power requirements and thus requires power supply from the AC sub microgrid. In Fig. 13(c) especially at 1.2 s to 1,8 s the DC power start increases almost match to the load requirements, the current near to zero, indicating that there is less power flow from the IC to the load, and there has been a phase shift between current and voltage around 90°.

At 1.8 s, there was a power increase in the DC sub microgrid which exceeds the DC load requirements. This excess power flowing through the IC to AC sub microgrid and the function of the IC changes to an inverter, in this case, the current and voltage in one phase. In Fig. 13(d) there was a DC power increase again at 2.4 s this changes the amount of current but does not change the IC function. In the 3.6 s, there was a reduction in DC power, the current also decreases but does not change the IC function because there is still power transfer from IC to AC sub microgrid. The current is still one phase with the voltage, this is shown in Fig. 13(e). In Fig. 13(f) show a reduction in DC power source at 4.2 s to 4.8 s that the DC power only supplies DC load requirements. This power reduction causes the IC cannot supply power to the AC sub microgrid. At this time the current almost zero, and there is a phase shift with a voltage of around 90°. Then the DC power decreases again at 4.8 s shown in Fig. 13(g) until the DC source is unable to supply the load power

requirements. This power reduction causes a phase shift between current and voltage of 180º, the IC changes to a rectifier.
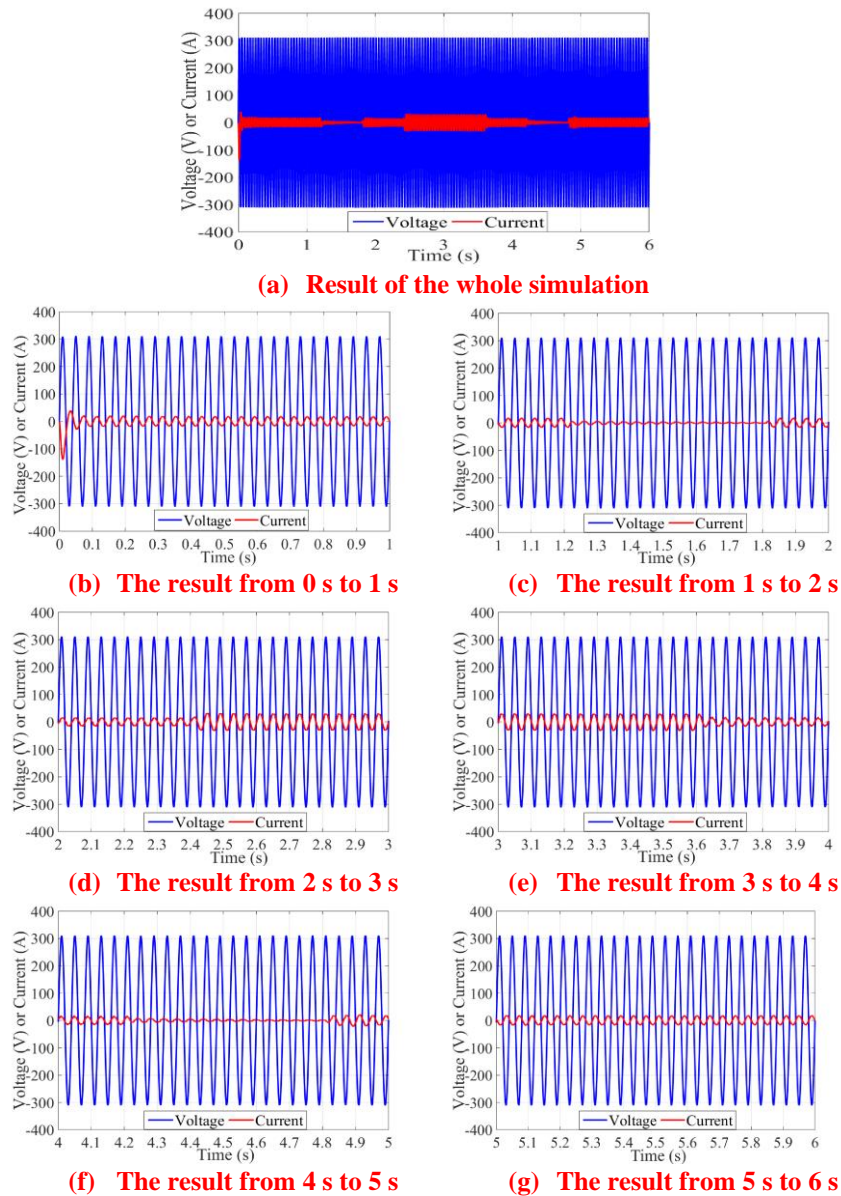


**(a)  Result of the whole simulation**



**(b)  The result from 0 s to 1 s**



**(c)  The result from 1 s to 2 s**



**(d)  The result from 2 s to 3 s**



**(e)  The result from 3 s to 4 s**



**(f)  The result from 4 s to 5 s**



**(g)  The result from 5 s to 6 s**

**Fig. 13. Voltage and current in AC sub microgrid**

Besides the voltage and current that can show the change of IC function, the active power flow also can do that. In Fig. 14 illustrates the comparison of active power at load, source, and power transferred to DC sub microgrid. The DC power changes make the power transferred in the AC sub microgrid become negative that is mean the IC transferred the power into the DC sub microgrid, the IC becomes

rectifier, and vise versa when the transferred power becomes positive that is mean the IC transfer power into AC sub microgrid, the IC becomes inverter.
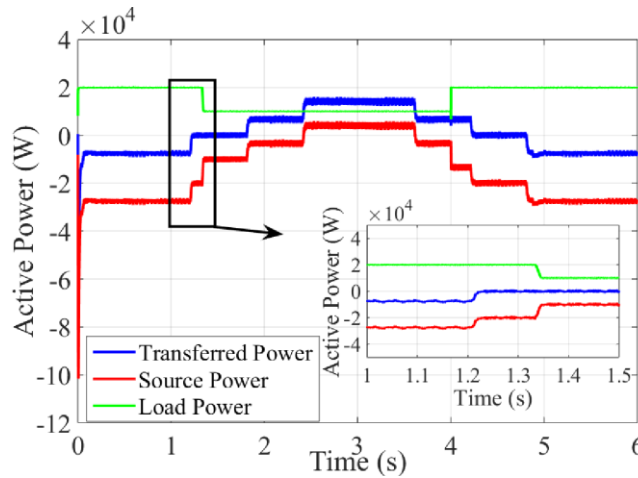


**Fig. 14. Comparative of active power in AC sub microgrid**

The AC source power is negative, means the grid supplies power to the system, and when the DC power increase, the grid gets power supply from the system, it changes the AC power source to positive. The Load changes during simulation that occur on the AC sub microgrid as a scenario in Fig. 8  do not have much impact on the power transferred to the DC sub microgrid. But with the change in load on the AC sub microgrid, it can be seen that even though the power transferred is not sufficient for the load requirements, the power requirements at the load will be met by the source power from the AC sub microgrid, in this case, the grid.

Figure 15 shows the reactive power during the simulation. Reactive power at the source and interface converter on the AC side follows the power changes that happen at the DC sub microgrid. They have the same value until difficult to recognize. When there is a decrease in the load power on the AC sub microgrid, it will have an overshoot effect even though it is small on the reactive power from the source.
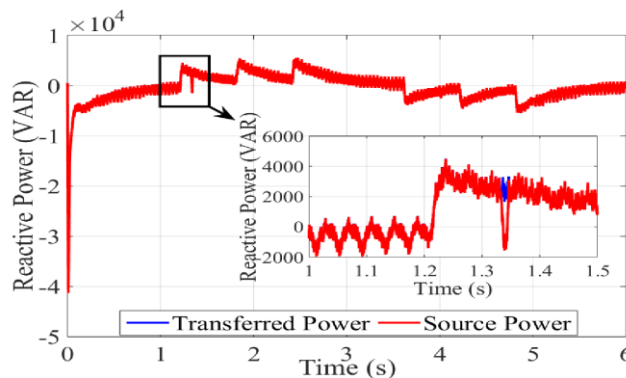


**Fig. 15. The transferred and source reactive power in AC sub microgrid**

Figure 16 shows the reactive power that occur in the load. In this simulation, there are three load combinations, the first is starting from 0 s to 1,2 s, there is a combination between resistive and inductor, the second is starting from 1,2 s to 4 s, that there is only resistive, and the third is starting from 4 s to 6 s,  there is a combination between resistive and capacitor. The value of the reactive power in this system was very small when compared to the active power.
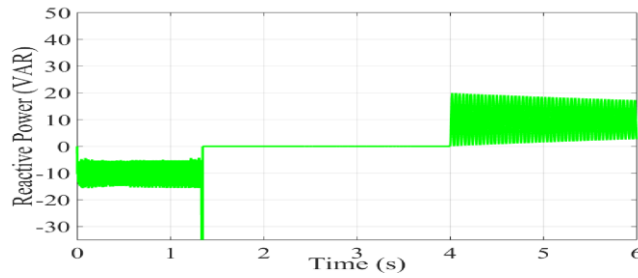


**Fig. 16. The load reactive power in AC sub microgrid**
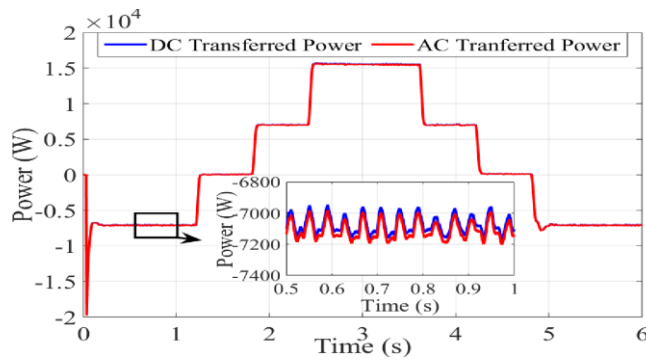


**Fig. 17 The comparative of AC and DC transferred power**
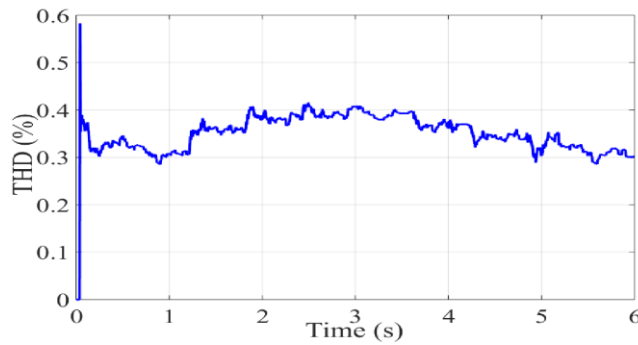


**Fig. 18. THD**
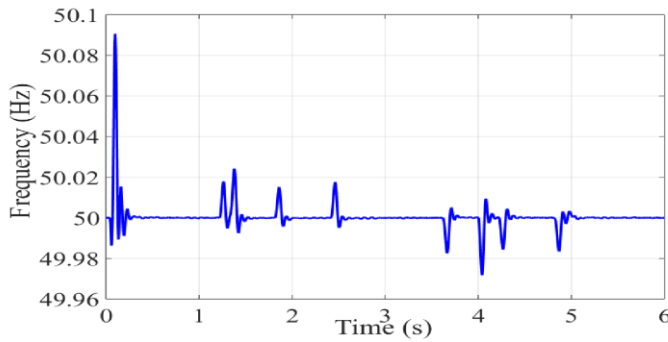
**Fig. 19. Frequency of the system**

**Table 2. The IC Eficiency**

| $P^{dc}_{source}$ | $P^{dc}$ | $P^{ac}$ | $\mu^{IC}$ | IC Mode |
|---|---|---|---|---|
| **0,5 $10^3$** | -6335 | -6374 | 99,4% | Rectifier |
| **5,5 $10^3$** | -67,99 | -84,94 | 80,04 % | Rectifier |
| **10 $10^3$** | 8682 | 8642 | 99,5% | Inverter |
| **15 $10^3$** | 18980 | 18910 | 99,6% | Inverter |

Figure 17 shows the comparison of the power transferred by DC sub microgrid and AC sub microgrid. It can be seen from the picture that the power transferred between the two sub microgrids is almost the same and can even be said to be the same because the power difference is very small. Changes that occur in the system during the simulation affect to the system harmonics, although not significant, this can be seen from Fig. 18. It is seen that the THD value shows the changes following the power changes that occur in the DC sub microgrid. The THD value during the simulation takes no more than 8%, as in t = 3 s, at that time the THD system was only 0.4%. This is in accordance with the provisions of the IEEE Std 519TM-2014 standardization, where at a voltage of less than or equal to 1KV, the THD cannot be more than 8%. Likewise, what happened at the system frequency during simulation, the frequency value was relatively stable, as in the t = 3 s, it can be seen that the frequency is 50 Hz, although there was a ripple when there was a power change in the DC sub microgrid, this can be seen from the simulation results in Fig. 19.

Table 2. Show the efficiency of the converter in a rectifier and inverter. This table proves that the converter can work very efficiently because the efficiency of the converter is very high. However, this converter still has difficulties in transferring power in low power conditions or when the DC sub microgrid lacks power. This can be seen from its rather low efficiency of 80.04% at a sub-microgrid DC power of 5.5 kW compared to its efficiency at 15 kW which is 99.6%. Simulations are carried out by changing the power with a graded pattern and loads with a pattern similar to the daily load, but this is still far from being compared to the real conditions in the field. The further research is needed using real data for the simulation and if it is possible, implementation can be carried out.

## 4. Conclusions

In this paper, the AC-DC hybrid microgrid system has been built using a bidirectional converter that functions as an IC.

- IC is built with a very simple with transformation abc to dq method, but the simulation results show that the system can work very well because ICs with high efficiency can be a rectifier or inverter to respond the power changes that occur in the system without delay and overshoot. The efficiency of the IC reaches 99,4% as rectifier and 99,6% as inverter.
- Load changes that occur in the AC sub microgrid do not affect the power transferred through the IC but occur in the grid or AC source.
- Despite changes in power and load, the voltage and frequency on the system remain stable, THD is no more than 8%.

The power transfer between AC and DC sub microgrid that manage by the IC that based on bidirectional converters make the system run well, power requirement can be met despite the lack of power, especially in the DC sub microgrid. The IC can transfer power, either active or reactive power from the DC sub microgrid to the AC sub microgrid and vice versa. So it can be said that this system has a high performance in power transfer.

---

### Nomenclatures

#### Abbreviations

| | |
|---|---|
| AC | Alternating Current |
| DC | Direc Current |
| RES | Renewable Energy Source |
| IC | Interlinking Converter |
| THD | Total Harmonic Distortion |
| IEEE | Institute of Electrical and Electronics Engineers |
| PLL | Phase Lock Loop |
| PV | Photovoltaic |
| LED | Light Emitting Diode |
| BIPV | Building Integrated Photovoltaic |
| COE | Cost of Energy |
| PWM | Pulse Width Modulation |
| IGBT | Insulated Gate Bipolar Transistor |
| AGC | Automatic Gain Control |
| PID | Proportional Integral Derivative |
| DER | Distributed Energy Resources |

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## *Appendix A*

## The Simulation Model and Parameter

### A.1 Model of the Simulation

The simulation using Simulink / Matlab, and the model Simulink described in Fig. A-1.
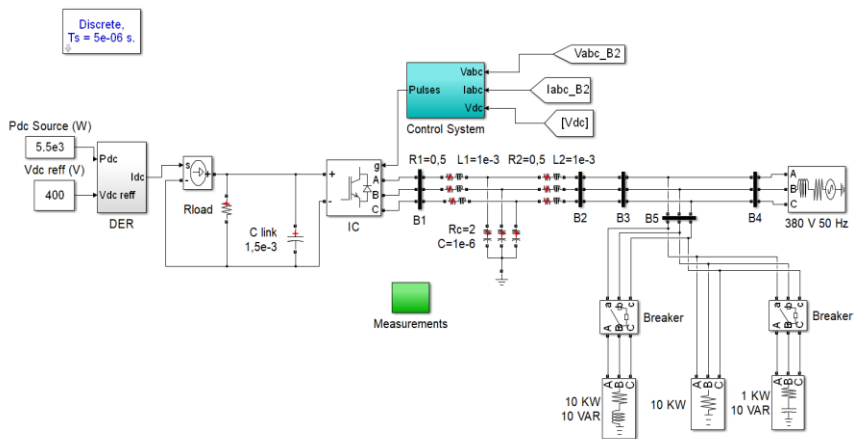


**Fig. A-1 Model of the simulation**

## A.2 Parameter of the Simulation

This is parameter of the simulation: In the three phase sources: RMS voltage 380 volt (line –line), 50 Hz; In the LCL filter and DC link: converter side inductance $L_1$ = 1 mH converter side resistance, $R_1 = 0,5\ \Omega$, grid side inductance $L_2 = 1$ mH, grid side resistance $R_2 = 0,5\ \Omega$, shunt capacitance $C_2 = 1\ \mu F$, shunt resistance $R_2 = 2\ \Omega$, Capacitor filter C = 1500 µF; In DC source and load: DC load resistance $R_{dc} = 46\ \Omega$; DC voltage $V_{DCreff} = 400$ volt

## *Appendix B*

## The Simulationts Measurement Results and Calculations

### B.1 DC sub Microgrid Data

The data in Table B-1 displays the voltage, current and power generated from the measurement of every change in DC sub microgrid. The data is taken at the source, load and interface of the converter on the DC side.

**Table B-1. DC sub microgrid data**

| DC Source (Watt) | DC Source | | | DC Load | | | DC Transferred | | |
|---|---|---|---|---|---|---|---|---|---|
| | V (Volt) | I (Amp) | P (Watt) | V (Volt) | I (Amp) | P (Watt) | V (Volt) | I (Amp) | P (Watt) |
| $0,5\ 10^3$ | 601 | 1,25 | 751,3 | 601 | 13,07 | 7852 | 601 | -10,54 | -6335 |
| $5\ 10^3$ | 619,4 | 12,5 | 7743 | 619,4 | 13,47 | 8341 | 619,4 | -0,109 | -67,99 |
| $10\ 10^3$ | 659,3 | 25 | 16480 | 659,3 | 14,33 | 9451 | 659,3 | 13,17 | 8682 |
| $15\ 10^3$ | 693,7 | 37,5 | 26010 | 693,7 | 15,08 | 10460 | 693,7 | 27,36 | 18980 |

### B.2 AC sub microgrid data

Table B-2 is the result of voltage, current, in the source, load, and interface converter measurements on the AC side

**Table B-2. AC sub microgrid voltage and current data**

| DC Source (KWatt) | | Voltage | | | Current | | |
|---|---|---|---|---|---|---|---|
| | | $V_a$ (Volt) | $V_b$ (Volt) | $V_c$ (Volt) | $I_a$ (Amp) | $I_b$ (Amp) | $I_c$ (Amp) |
| 0,5 | Source | -1,106 | -268,6 | 269,7 | 3,304 | 50,6 | -53,9 |
| | Load | 269,7 | -268,6 | -1,106 | 37,35 | -37,17 | -0,179 |
| | Transferred | 199,7 | -401,2 | 201,5 | 6,132 | 10,56 | -16,69 |
| 5 | Source | -0,841 | -267,1 | 268 | 1,495 | 36,95 | -38,45 |
| | Load | 268 | -267,1 | -0,841 | 37,11 | -36,98 | -0,139 |
| | Transferred | 205,8 | -413,4 | 207,6 | 2,896 | 0,1284 | -3,025 |
| 10 | Source | -2,63 | -266,8 | 269,4 | 1,07 | 24,8 | -25,87 |
| | Load | 269,4 | -266,8 | -2,63 | 37,31 | -36,93 | -0,388 |
| | Transferred | 219,1 | -438,2 | 219,1 | 2,604 | -13,15 | 10,54 |
| 15 | Source | -1,266 | -268,2 | 269,5 | -1,599 | 11,75 | -10,15 |
| | Load | 269,5 | -268,2 | -1,266 | 37,32 | -37,12 | -0,201 |
| | Transferred | 231,8 | -461,7 | 229,9 | 1,111 | -27,34 | 26,23 |

These measurements are made for any changes in DC power. Whereas the active and reactive power values from the data in table B-2 are obtained from calculations using the formula as in Eq. B-1 for active power and Eq. B-2 for reactive power.

$$P = V_a I_a + V_b I_b + V_c I_c \tag{B-1}$$
$$Q = (\frac{1}{\sqrt{3}}(V_{bc}I_a + V_{ca}I_b + V_{ab}I_c)) \tag{B-2}$$

Where $V_a, V_b, V_c$ are the phase voltage to the ground. $I_a, I_b, I_c$ are the phase current, $V_{ab}, V_{bc}, V_{ca}$ are inter-phase voltages.

Table B-3 is the result of active and reactive power in the source, load, and interface converter on the AC side

**Table B-3. AC sub microgrid power data**

| DC Source (KWatt) | | Power | |
|---|---|---|---|
| | | **P** (Watt) | **Q** (VAR) |
| 0,5 | Source | -28140 | -1440 |
| | Load | 20050 | -12,18 |
| | Transferred | -6374 | -7912 |
| 5 | Source | -20170 | -637,7 |
| | Load | 19820 | -10,53 |
| | Transferred | -84,94 | -2120 |
| 10 | Source | -13590 | -381,4 |
| | Load | 19910 | -11,13 |
| | Transferred | 8642 | 3013 |
| 15 | Source | -5882 | 768,4 |
| | Load | 20010 | -12,1 |
| | Transferred | 18910 | 10090 |
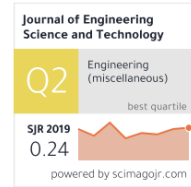
**Thursday, January 28, 2021**

**<u>Letter of Appreciation</u>**

**Dear Dr. Amirullah Ubhara Surabaya,**

On behalf of the Editorial Board, I would like to thank you for your contribution in reviewing the following paper submitted to our journal.

*HIGH PERFORMANCE OF POWER TRANSFER IN*
*HYBRID AC – DC MICROGRID WITHOUT STORAGE SYSTEM*

I am confident that with your continuous support and commitment, we will be able to maintain the quality and value of JESTEC.

With best regards

Yours sincerely

*Associate Professor Dr. Abdulkareem Sh. Mahdi Al-Obaidi, CEng MIMechE*
*Executive Editor, Journal of Engineering Science & Technology*
*http://jestec.taylors.edu.my/*

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  Selangor DE
  Malaysia

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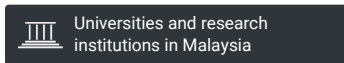
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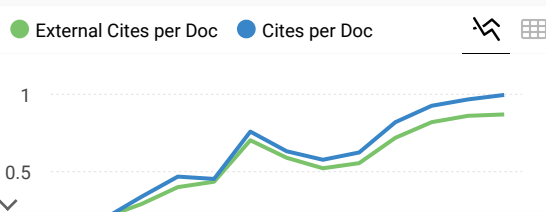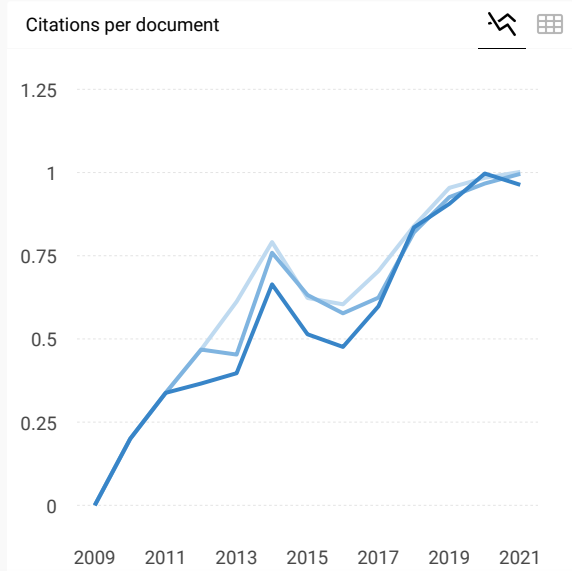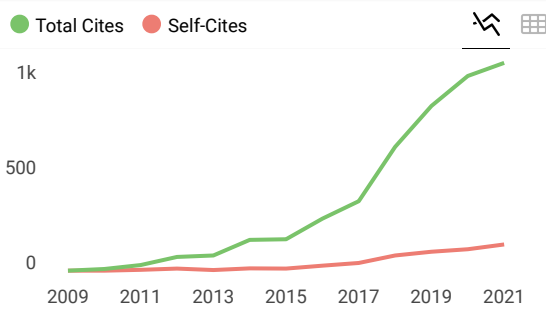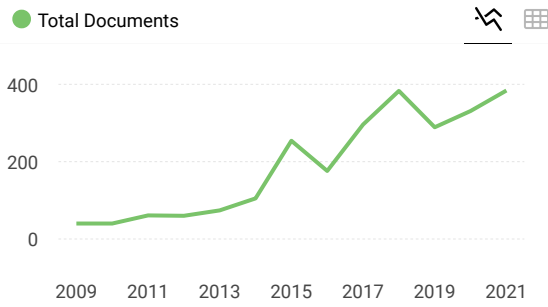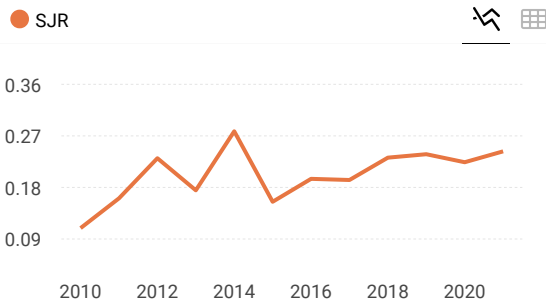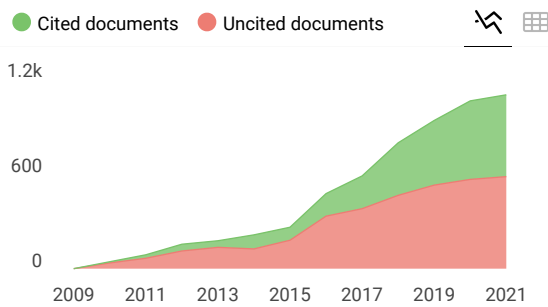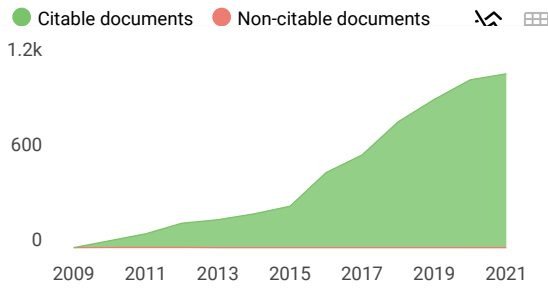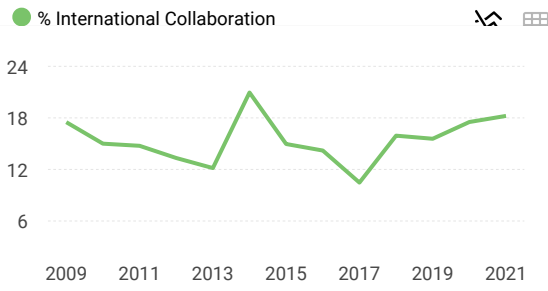


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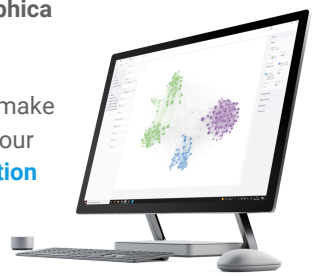0.24

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best regards

asmaa

← reply

**Melanie Ortiz**   4 months ago

Dear Asmaa,
Thank you for contacting us. Unfortunately, SCImago cannot help you with your request.
SJR is committed to help decision-making through scientometric indicators.
Best Regards, SCImago Team

**M.Sivasankara Rao**   2 years ago

present how much time it will take to get acceptance and publication in this journal.

← reply

**Melanie Ortiz**   2 years ago

Dear M.Sivasankara,
Thank you for contacting us.
Unfortunately, we cannot help you with your request.
Best Regards, SCImago Team

**Ponum Almas**   2 years ago

hello ,
is this impact factor journal ? what is the publication fee for an aticle ? is there any discout for developing countries ?

← reply

**Melanie Ortiz**   2 years ago

journal's website or contact directly with the editorial staff.
Best Regards, SCImago Team

**daus** 2 years ago

this is ecsi journal, not scie

↩ reply

**Melanie Ortiz** 2 years ago

Dear Daus, thanks for your participation! Best Regards, SCImago Team

**kartik** 2 years ago

Hi,
Can i know what is the current Quartile ranking for this journal for the year 2020? tq

↩ reply

**Melanie Ortiz** 2 years ago

Dear Kartik,
Thank you for contacting us. You can consult that information just above. The SJR for 2019 was released on 11 June 2020.
Best Regards, SCImago Team

**Raghad Hameed Ahmed** 2 years ago

good greeting
What is the time required to obtain a research acceptance letter.

↩ reply

**Melanie Ortiz** 2 years ago

Dear Raghad,
thank you for contacting us

**deepthi** 2 years ago

Hi,

Is it okey to cite an unpublished work can in the manuscript?

↩ reply

**Melanie Ortiz** 2 years ago

Dear Deepthi, thank you very much for your comment. Unfortunately, we cannot help you with your request, we suggest you contact the journal's editorial staff so they could inform you more deeply. Best Regards, SCImago Team

**M.K.** 3 years ago

Dear Melanie
I have submitted a paper for this journal about 6 months ago, and I did not receive the decision yet.The problem is the website of this journal does show any contact details except the email of the Executive Editor, who did not respond to my emails since May 2020. Do you know any other contact details for this journal please?


Best regards
M.K.

↩ reply

**Melanie Ortiz** 2 years ago

Dear M.K.,

Thank you for contacting us. Unfortunately, it seems that there is no other email contact shown in their website.

Best Regards, SCImago Team

**Dr. Vijaya Shetty S** 3 years ago

**K. Bhatti**  3 years ago

It's 300USD per article.

**Melanie Ortiz**  3 years ago

Dear Dr. Vijaya,
thank you for contacting us.
Unfortunately, we cannot help you with your request, we suggest you visit the journal's homepage or contact the journal's editorial staff , so they could inform you more deeply.
Best Regards, SCImago Team

**Waleed**  3 years ago

Why there is no response to our emails? Someone should tell them that other OA journals respond very fast. It is really a negative point about their performance.Pay attention to your costumers.

← reply

**Nibras Khalid**  3 years ago

Hello,
I submitted a manuscript for publication more than a week ago, but I haven't received a confirmation email of delivery. Is there a way to know if all the required documents have been received??

← reply

**Melanie Ortiz**  3 years ago

Dear Nibras,
thank you for contacting us.
Unfortunately, we cannot help you with your request, we suggest you contact the journal's editorial staff , so they could inform you more deeply.
Best Regards, SCImago Team

**Phyu Phyu Thin**  3 years ago

Dear Sir,

⌄

S

**sukanto wiryono** 3 years ago

Dear Melanie Ortiz

Please inform me, is this JESTEC indexed by Q2 Scopus?

Thanks you

**Melanie Ortiz** 3 years ago

Dear Sukanto, thank you very much for your comment, unfortunately we cannot help you with your request. We suggest you to consult the Scopus database directly. Keep in mind that the SJR is a static image (the update is made one time per year) of a database (Scopus) which is changing every day. The SJR's Quartile for 2018 is available just above.
Best Regards, SCImago Team

**Melanie Ortiz** 3 years ago

Dear Phyu,
thank you for contacting us.
We are sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.
Unfortunately, we cannot help you with your request, we suggest you to visit the journal's homepage (See submission/author guidelines) or contact the journal's editorial staff , so they could inform you more deeply.
Best Regards, SCImago Team

B

**B G Shivaleelavathi** 3 years ago

Sir/Madam,
i want to submit review paper. what is procedure.

↩ reply

**Melanie Ortiz** 3 years ago

**F**

**Frans** 3 years ago

I want to know, what is journal not a notification after submitting?
Thank you

↰ reply

**K**

**kareem** 3 years ago

Dear Scopus people
I want to if this journal consdiered as an ISI journal and what is its impact factor.
Thanks

↰ reply

**Melanie Ortiz** 3 years ago

Dear Kareem, SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR. Check our web to locate the journal. We suggest you to consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

**N**

**Nacer** 3 years ago

Dear Abdulkareem

Please informe me if the publication is free or not?

Best regards

↰ reply

**A**

**abdulkareem** 3 years ago

no, it is not free, USD300/aper

**N**

**Nacer** 3 years ago

**Melanie Ortiz** 3 years ago

Dear Nacer, SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR. Check our web to locate the journal. We suggest you to consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

S **supreetha B.S** 3 years ago

I have published my research work in JESTEC. It is a quality journal with systematic review process.I received review comments from 5 reviewers and i answered all the comments and finally after 2 round review process my paper was accepted. Thanks to Dr.Abdulkareem Sh Mahdi Al-obaidi

↩ reply

V **VIJAY B G** 2 years ago

Hello madam, could you please tell me is their any processing charges that you have paid? also suggest some good Scopus indexed journal to publish my paper.
Thank you

**Sudhakiran Gunda** 2 years ago

Could you please tell me the duration for this entire process.
I would like to know the time taken for publication.

Thankyou

**Melanie Ortiz** 3 years ago

Dear Supreetha, thanks for your participation! Best Regards, SCImago Team

K **Khaled** 3 years ago

Hello there!
I have a little question about the publication process timeline, Can i know please how long will take between sending an article and ( journal answer by acceptance/rejection) and finally the paper's online availability ????

**Khaled** 3 years ago

Thanks alot for your valuable response
Are there any publication fees or not ???????

**Ali** 3 years ago

Dear khaled
The timeline for publishing in this journal about 2-3 months for final acceptance and may be 9 months for online publication
with my regards

SCImago Team

**Melanie Ortiz** 3 years ago

Dear Ali, thanks for your participation! Best Regards, SCImago Team

SCImago Team

**Melanie Ortiz** 3 years ago

Dear Khaled,
thank you for contacting us.
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You can see the updated journal's information just above .
Best Regards, SCImago Team

**ASWANT KUMAR SHARMA** 3 years ago

I have published a paper with JESTEC in a proper time line. It is good if JESTEC provide DOI for article published with them

← reply

**Malathi Kunnudaiyan** 2 years ago

Have paid any fees for the publication sir?

**R** **rati saluja** 3 years ago

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Hats off

A happy author

↩ reply

**M** **Melva Silitonga** 4 years ago

This journal template has been used for the 2019 Kyoto APLSBE template that I have participated in, I am interested in the content of this journal and wish for publication in this journal

↩ reply

**W** **Wajde Alyhya** 4 years ago

Hi
I sent a manuscript for publication in this journal and I received two months later seven reviewers' comments. I answered all their comments, however, I have not received an acceptance or rejection letter till now. I sent more than one emails regarding the status of my manuscript without an answer. I do not know what to do after nearly more than 6 months of waiting.

↩ reply

**A** **Abdulkareem Sh. Mahdi Al-Obaidi** 3 years ago

Dear Wajde
We thank you for the comment.
As you mentioned your experience with JESTEC, i wonder why you did not mention that your paper is accepted and will be published soon.
It is good to give negative feedback for improvment, we thank you but it is also fair to tell positive feedback, right?

˅

**Emmanuel** 4 years ago

@ Elena:I humbly suggest that the web link of all journals should be published alongside their name.This will eliminate the faking of journals in your data base.

← reply

**Wajde Alyhya** 4 years ago

Dear All
Could you please tell me how long it takes to be accepted and published online.
Thanks

← reply

**Dr. mohammed alwazzan** 4 years ago

3 to 4 month

SCImago Team

**Elena Corera** 4 years ago

Dear Wadje, in the link below you will find the information corresponding to the author's instructions of this journal. Best regards, SCImago Team
http://jestec.taylors.edu.my/instructions.html

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