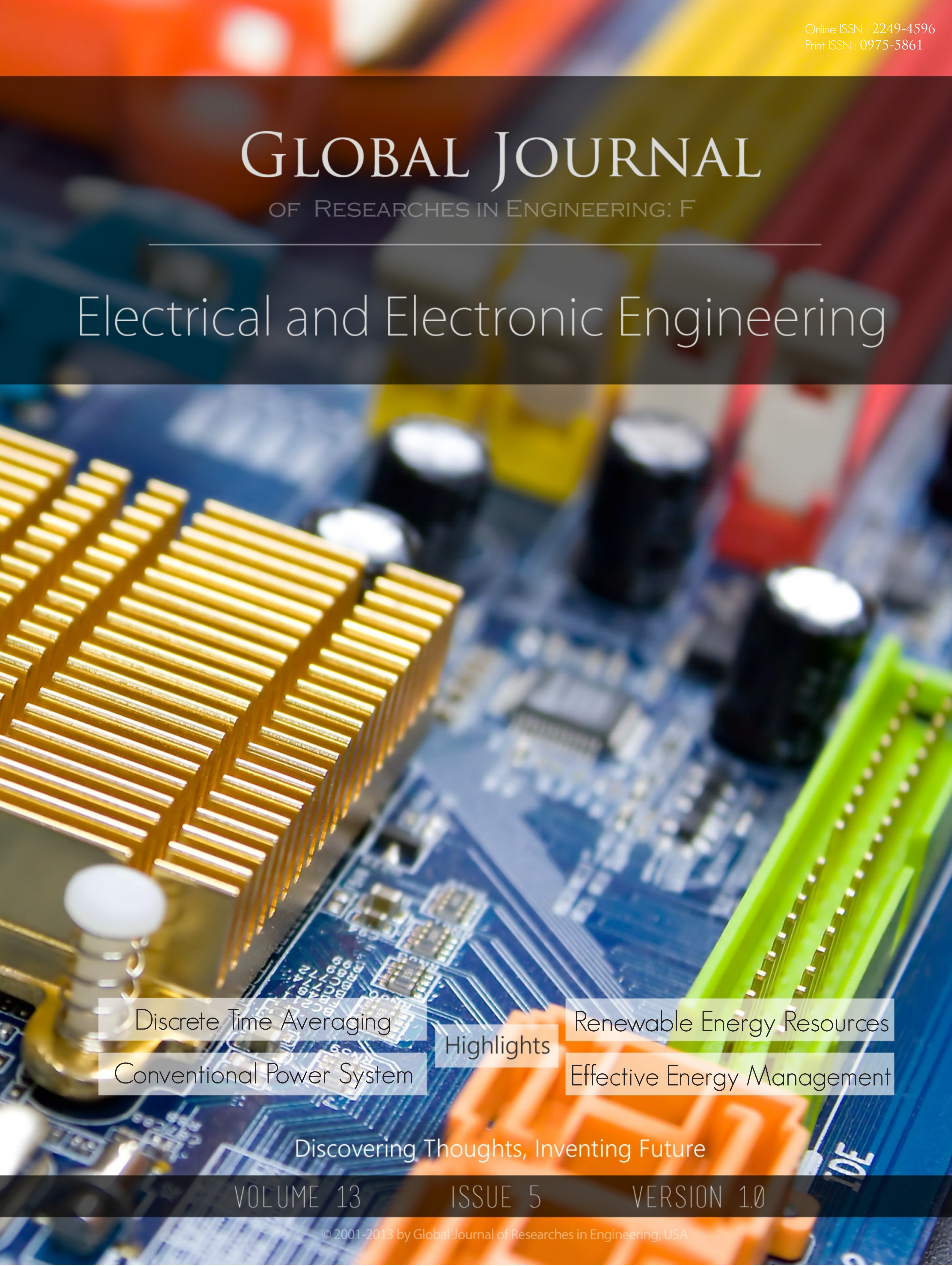

Online ISSN : 2249-4596
Print ISSN : 0975-5861

Global Journal

of Researches in Engineering: F

Electrical and Electronic Engineering

Discrete Time Averaging

Conventional Power System

Highlights

Renewable Energy Resources

Effective Energy Management

Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 5 VERSION 1.0

Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering

Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 13 Issue 5 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals Inc., Headquarters Corporate Office, Cambridge Office Center, II Canal Park, Floor No. 5th, ***Cambridge (Massachusetts)***, Pin: MA 02141
United States
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Open Association of Research Society, Marsh Road, Rainham, Essex, London RM13 8EU
United Kingdom.

Packaging & Continental Dispatching

Global Journals, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investers@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Editorial Board Members (HON.)

Dr. Bart Lambrecht
Director of Research in Accounting and FinanceProfessor of Finance
Lancaster University Management School
BA (Antwerp); MPhil, MA, PhD (Cambridge)

Dr. Carlos García Pont
Associate Professor of Marketing
IESE Business School, University of Navarra
Doctor of Philosophy (Management), Massachusetts Institute of Technology (MIT)
Master in Business Administration, IESE, University of Navarra
Degree in Industrial Engineering, Universitat Politècnica de Catalunya

Dr. Fotini Labropulu
Mathematics - Luther College
University of ReginaPh.D., M.Sc. in Mathematics
B.A. (Honors) in Mathematics
University of Windso

Dr. Lynn Lim
Reader in Business and Marketing
Roehampton University, London
BCom, PGDip, MBA (Distinction), PhD, FHEA

Dr. Mihaly Mezei
ASSOCIATE PROFESSOR
Department of Structural and Chemical Biology, Mount Sinai School of Medical Center
Ph.D., Etvs Lornd University
Postdoctoral Training,
New York University

Dr. Söhnke M. Bartram
Department of Accounting and FinanceLancaster University Management SchoolPh.D. (WHU Koblenz)
MBA/BBA (University of Saarbrücken)

Dr. Miguel Angel Ariño
Professor of Decision Sciences
IESE Business School
Barcelona, Spain (Universidad de Navarra)
CEIBS (China Europe International Business School).
Beijing, Shanghai and Shenzhen
Ph.D. in Mathematics
University of Barcelona
BA in Mathematics (Licenciatura)
University of Barcelona

Philip G. Moscoso
Technology and Operations Management
IESE Business School, University of Navarra
Ph.D in Industrial Engineering and Management, ETH Zurich
M.Sc. in Chemical Engineering, ETH Zurich

Dr. Sanjay Dixit, M.D.
Director, EP Laboratories, Philadelphia VA Medical Center
Cardiovascular Medicine - Cardiac Arrhythmia
Univ of Penn School of Medicine

Dr. Han-Xiang Deng
MD., Ph.D
Associate Professor and Research Department Division of Neuromuscular Medicine
Davee Department of Neurology and Clinical NeuroscienceNorthwestern University
Feinberg School of Medicine

Contents of the Volume

Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 5 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Present Situation of Renewable Energy in Bangladesh: Renewable Energy Resources Existing in Bangladesh

By Md. Saydur Rahman, Sohag Kumar Saha, Md. Rakib Hasan Khan, Ummay Habiba & Sheikh Mobinul Hossen Chowdhury

University of Science & Technology (PUST)

Abstract - Bangladesh is a developing country, it has probability to progress towards increasing the demand of energy .Now a day, Bangladesh is facing energy crisis. In Bangladesh, around 70% of people having lack accesses to electricity and most of them are living in the village. Among them about 40% of them are living in below poverty line. On the other hand climate change puts addition threats to development. To combat these situations, renewable energy technology stands out to be one of the prospective sources to meet its unprecedented energy demand and can contribute to achieve sustainable development as a country has a plentiful supply of renewable sources of energy. This paper investigates the prospect, trend, utilization and its technology as well as reviews the policy and institutions and opportunities of renewable energy technology towards sustainable development and climate change mitigation is context of Bangladesh.

Keywords : renewable energy, solar energy, biogas energy, wind energy, hydro-power energy, geo-thermal energy, tidal energy, bangladesh, ocean wave energy, radiant wave energy.

GJRE-F Classification : FOR Code: 850599

PRESENT SITUATION OF RENEWABLE ENERGY IN BANGLADESH RENEWABLE ENERGY RESOURCES EXISTING IN BANGLADESH

Strictly as per the compliance and regulations of :

Present Situation of Renewable Energy in Bangladesh: Renewable Energy Resources Existing in Bangladesh

Md. Saydur Rahman [α], Sohag Kumar Saha [σ], Md. Rakib Hasan Khan [ρ], Ummay Habiba [ω] & Sheikh Mobinul Hossen Chowdhury [¥]

Abstract - Bangladesh is a developing country, it has probability to progress towards increasing the demand of energy .Now a day, Bangladesh is facing energy crisis. In Bangladesh, around 70% of people having lack accesses to electricity and most of them are living in the village. Among them about 40% of them are living in below poverty line. On the other hand climate change puts addition threats to development. To combat these situations, renewable energy technology stands out to be one of the prospective sources to meet its unprecedented energy demand and can contribute to achieve sustainable development as a country has a plentiful supply of renewable sources of energy. This paper investigates the prospect, trend, utilization and its technology as well as reviews the policy and institutions and opportunities of renewable energy technology towards sustainable development and climate change mitigation is context of Bangladesh.

Keywords : renewable energy, solar energy, biogas energy, wind energy, hydro-power energy, geo-thermal energy, tidal energy, bangladesh, ocean wave energy, radiant wave energy.

I. Introduction

Bangladesh is a developing and a probabilities country. In Bangladesh, there are many natural resources such as coal, gas, petrol. The main source of energy in Bangladesh is Natural gas (24%) which is likely to be depleted by the year 2020[32]. Then Bangladeshis people will be faced some problem. In these case renewable energy helps the people of Bangladesh. People have a large unsatisfied demand of energy, which is growing by 10% yearly[1]. Bangladesh has a vast potential for renewable energy and the natural availability of alternative energy creates opportunities of Growth in power sector. Not only the technologies should be developed to produce energy in an environment friendly manner but also enough importanceshould be given to conserve the energy in most efficient form. The government has issued its vision and policy statement in February 2000, to bring the entire country under electricity service by the year 2020[2]. Recently it has the lowest per capita consumption of commercial energy in south Asia.

Author α σ ρ ω ¥ : Department of Electrical & Electronic Engineering(EEE), Pabna University of Science & Technology (PUST), Pabna-6600, Bangladesh. E-mails : saydurpstueee@gmail.com, engr.sohag.eee@gmail.com, eng.juganto@gmail.com engr.suma.eee@gmail.com, mobinhossen@gmail.com

Presently total generation capacity is 6727 MW. In this capacity 3534 MW is from the public sector which is 53% and 47% respectively of the total generation capacity. To meet the cumulative demand of electricity coal, gas, diesels, are being used to produce electricity. But it is also insufficient. In order to lessen the pressure of power demand on our conventional power plant, renewable energy like wind and solar power can be used[3]. The potential non-exhaustive source of energies, available in the form solar, biogas, hydropower and wind can be harnessed to provide an environmentally sustainable energy security, as well as an affordable power supply to the off-grid rural areas of the country . To this end, effective utilization of renewable energy resources has been adopted as a policy of the Government of Bangladesh.[4]. Different government and nongovernment organizations working separately or jointly to disseminate renewable energy technologies (RET) throughout the reported in the recent literature [5,6] however, prospective planning and comprehensive understanding of this dynamic field requires as well as regressions, in this sector should be continually scrutinized. Motivated by these objectives, we present in this paper a present scenario of the renewable energy related activities in Bangladesh. Based on fieldwork, covering discussions with key figures of the public and private sector, and exhaustive literature review, we demonstrate here the advancement in this field with respect to physical progress, research activities and infrastructural development. Also a comparison of these forms of renewable energy resources in Bangladesh has been drawn on the basis of the output power calculation of each sector.

II. Solar Energy in Bangladesh

Bangladesh is a subtropical country, 70% of year sunlight is dropped in Bangladesh. For this reason, we can use solar panels to produce electricity largely. Solar radiation varies from season to season in Bangladesh. Bangladesh receives an average daily solar radiation of 4-6.5 kWh/m2. Maximum amount and minimum on November-December-January in the following figure1 [7]. Renewable Energy Research Centre (RERC), Dhaka University is the only source which has got long term measured data of Dhaka Solar

Global Journal of Researches in Engineering (F) Volume XIII Issue V Version I Year 2013

Energy can be a great source for solving the power crisis in Bangladesh. Bangladesh is situated between 20.30 and 26.38 degrees north latitude and 88.04 and 92.44 degrees east which is an ideal location for solar energy utilization.

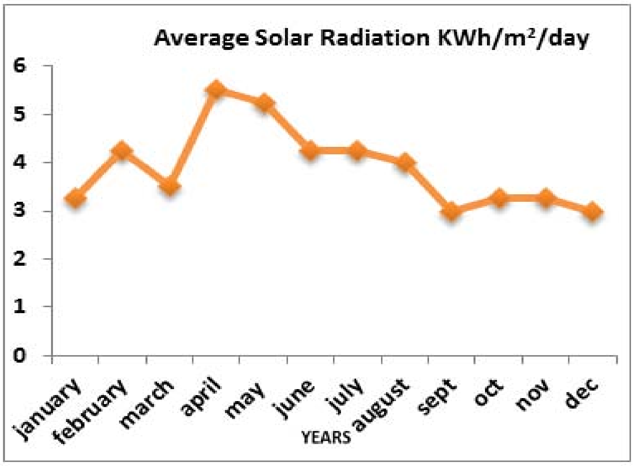

Fig. 1 : Monthly average solar radiation profile in Bangladesh

At this position, the highest and the lowest intensity of direct radiation in W/m^2 are also shown in the following figure2 [8]. So Bangladesh is in a perfect location. In fact, the Bangladesh government has recently taken many steps to encourage people to use photovoltaic energy. Almost every newly built apartment buildings are now using solar panels along with the grid connection to get support during the load shedding period. Even in the rural areas, some NGO's have been working to provide solar panels to the villagers at a cheap price.

Figure-3[9]. Shows that the approximate division wise SHSs installation. The figure3.illuminates that the distribution of the SHSs is highest in Dhaka district whereas lowest in the Sylhet. Now solar power can be calculated from the following equation: Solar power, P_{solar} = (Area per sq- ft × watts per sq-ft).

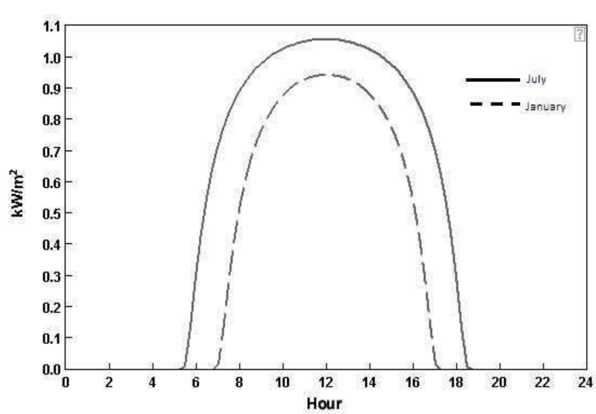

Fig. 2 : The highest and lowest intensity of direct radiation in W/m^2

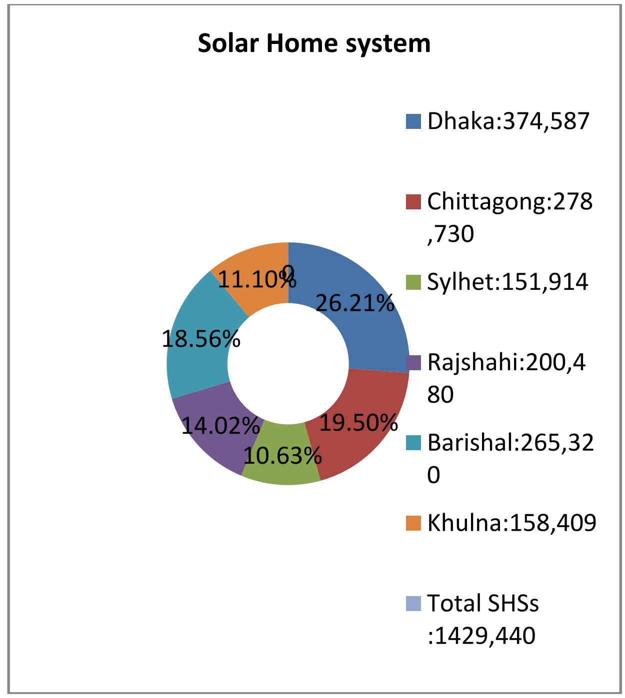

Fig. 3 : Distribution of solar Home system in six divisions of Bangladesh to January2013 [9]

III. Present Condition of Wind Energy

Wind power is the conversion of wind energy by wind turbines into a useful form, such as electricity or mechanical energy. The power is directly proportional to the velocity of the wind. Large scale wind farms are connected to the local power transmission network with small turbines used to provide electricity to isolated areas. Bangladesh is in the midst of a severe energy and power supply crisis, one of the worst in South Asia. Bangladesh has a 724km long coastline and many small islands in the Bay of Bengal, where strong southwesterly trade wind and sea-breeze blow in the summer months and there is a gentle northeasterly trade wind and land breeze in winter months [11]. Along the coastal area of Bangladesh, the annual average wind speed at 30m height is more than 5 m/s [10]. Wind speed in northeastern parts in Bangladesh is above 4.5 m/s while for the other parts of the country wind speed is around 3.5 m/s [10,12]. Some measurements were made by F. Rahman in some coastal areas followed by a year's measurement in Patenga (Chittagong) at a height of 20 m in 1995. It was found that wind speed is higher than the values obtained by the meteorological department. This led to a year-long systematic wind speed study at seven coastal sites in 1996-1997 at a height of 25 m. Bangladesh power development board (BPDB) installed a 160feet tower at the Muhuri Dam site in the Feni district in May 2003. Two high resolution anemometers were installed on this tower, one anemometer at 80 feet and the anemometer at 160 feet height. One wind vane has been installed at 80feet height. The average wind speed, till to date, at the Muhuri Dam areas is found to be as 6.50 m/s and the wind power density varies from 100 to 250 Watt/m2 in the coastal regions of Bangladesh. For the financial viability of the grid connected wind turbines, the required annual average wind speed is 6 m/s. So, the wind speeds aren't charging for the grid connected wind energy projects in the areas of the Muhuri Dam, Feni. This site is large enough for the larger wind energy projects. Bangladesh Power development board (BPDB) implemented a 1000kW capacity wind battery hybrid power project on the kutubdia island (Bay of Bengal) in the Cox's bazaar district. Under this project, total 50 nos. Of 20 kW capacity stand-alone type wind turbines are being installed. The total capacity of all the wind turbines being stored in a battery bank. WBHPP was officially started on March 30,2008[14]. In another project, Bangladesh power development board (BPDB) has implemented a 0.90MW capacity of the grid connected wind energy (GCWE) at the Muhuri Dam areas in the Feni district in 2004. This is the first ever GCWE project in Bangladesh. Thus generating electricity from wind in the coastal areas can be transmitted to other regions of the country through the high voltage transmission lines. Very little operation and maintenance will be required during the whole life time of wind turbines and no fuel will be required for generating electricity from wind [15].

Table 1 : Feasibility of wind condition at different places of Bangladesh [13]

Site	Reference height(m)	Annual average wind speed(m/s)
Cox's Bazar	10	2.42
Sandip Island	5	2.16
Teknaf	5	2.16
Patenga Airport	5	2.45
Comilla Airport	6	2.21
Khepupara	10	2.36
Kutubdia Island	6	2.09
Bhola Island	7	2.44
Hatia Island	6	2.08

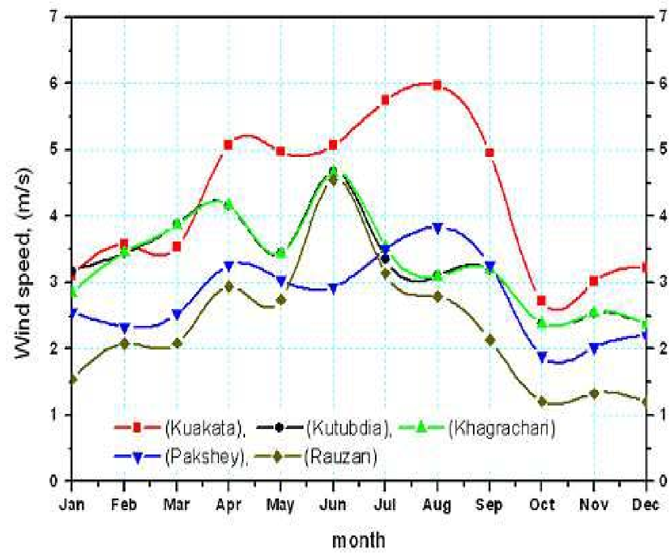

Fig. 4 : Monthly variation of wind speed in five selected sites

From the above figure4, we can see that maximum velocity (5.98 m/s) in the month of August in the place of Kuakata and the minimum velocity (1.20m/s) in the month of December in the place of Rauzan.

Wind power will be calculated from the following equation: $P = (1/2) \times \rho \times A \times V^3$(in Watts)

Where,

A=area perpendicular to the direction of flow (in m2),

V=wind velocity (ms-1), ρ =density of air (in Kgm-3) and

P=power generation.

Figure 5 : Wind turbines of 1000kw capacity WBHPP at Kutubdia Island, Cox's Bazaar district (Bay of Bengal)

IV. Biogas Energy

Biogas is one kind of a gas which produced by the biological breakdown of organic matter in the absence of Oxygen. Organic wastes such as dead plant and animal material. Animal dung, and Kitchen waste can be converted into a gaseous fuel called biogas. Biogas originates from biogenic material and is a type of biofuel [16]. Major components of biogas are 40-70% methane (CH4), 30-60% carbon dioxide (CO2) and other gases (1-5%) [17]. It also contains several trace gases like Hydrogen sulfide (H2S), Nitrogen (N2), Ammonia (NH3). and Carbon monoxide (CO) [18]. A biogas based electricity generation system consist of a digester, a biogas collection tank, a generator as well as the piping and controls required for successful operation. The biogas is produced in the anaerobic digester, where anaerobic fermentation takes place which is provided every day with livestock manure in the form of cattle dung. Poultry droppings etc. Grameen Shakti is one of the most uttered NGO in the field of biogas. They have completed 13,500 biogas plants [19]. Recently Seed Bangla Foundation has proposed a 25 KW Biogas based Power plant in Rajshahi [20]. IDCOL. A Government owned investment Company fixed a target to set up 37,669 biogas plants in Bangladesh by 2012, under its National Domestic Biogas and Manure Programmers (NDBMP). It has also set a target of 25% of the total target of biogas plants in the northern region which is yet to be brought under the national gas grid [21]. Besides working in partnership with IDCOL. Some organizations have constructed domestic biogas plants with their own funds. These are Greameen Shakti (3,664 plants), BRAC (3,664 plants of their own), and some other private organizations which promote biogas plants independently [23]. Moreover, since May 2011, IDCOL along with its partner organizations has installed 18,713 biogas plants in different parts of Bangladesh [22].

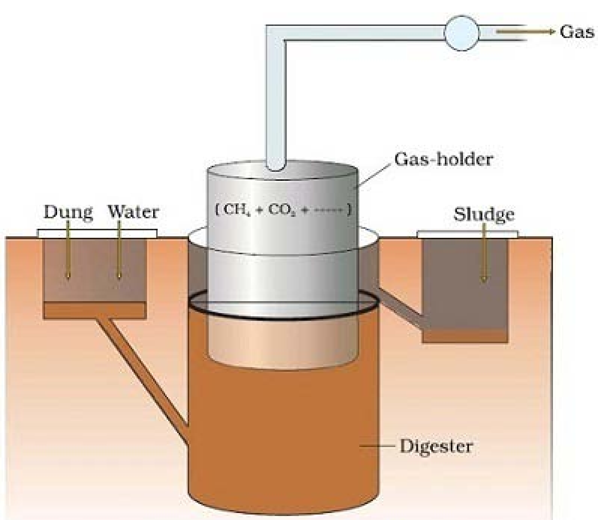

Fig. 6 : Construction of a Typpical Biogas Plant

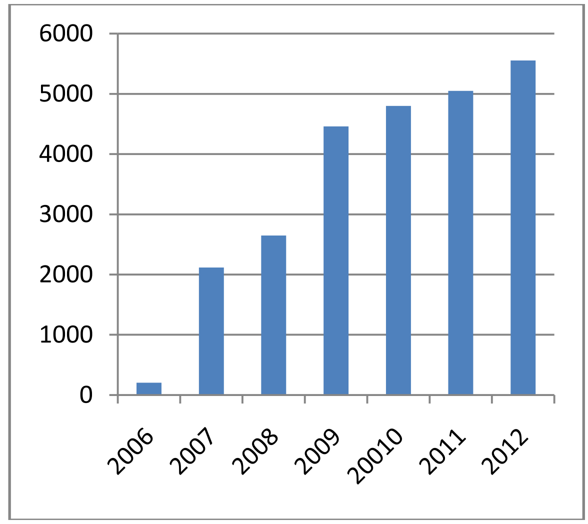

Fig. 7 : Biogas plants constraction in Bangladesh under NDBMP[33]

Graph details:
In 2006: Total biogas plants installed in BD=205.
In2007: Total biogas plants installed in BD =2116.
In2008: Total biogas plants installed in BD =2648.
In2009: Total biogas plants installed in BD =4459.
In2010: Total biogas plants installed in BD =4800.
In2011: Total biogas plants installed in BD =5049.
In2012: Total biogas plants installed in BD =5555.

V. Ocean Wave Energy

Ocean wave energy is generated directly from the waves of the oceans. It is another special type of renewable energy which helps to decrease the harmful emissions of greenhouse gases associated with the generation of power. It can be potentially a significant source of electricity in Bangladesh. Though the main purpose of ocean wave energy is electricity generation, it can also be used for the pumping of water, water desalination etc.[24]."The oscillating Water Column method is technically feasible and becoming economically attractive in this purpose. This type of wave energy harnessing device is being commissioned by several countries such as the United Kingdom (500KW), Ireland (3.5MW), Norway (100KW), India (150 KW) etc. Bangladesh has ocean wave energy from the Bay of Bengal.

VI. Tidal Power

Tidal power can be generated in two ways, 1. Tidal stream generators 2. Barrage generation. The power created though tidal generators are generally more environmentally friendly and causes less impact on established ecosystems. Similar to a wind turbine, many tidal stream generators rotate under water and is driven by the swiftly moving dense water Tidal power or Tidal energy is a form of hydropower that converts the energy of tides into electrical power. As the tides are more predictable than wind and sunlight, tidal energy can easily be generated from the changing sea levels. The coastal area of Bangladesh has a tidal rise and fall of between 2 to 5 meters [25]. Among these coastal areas, with 5 meter tides experienced, sandwip has the best prospect to generate tidal energy [25]. Bangladesh can generate tidal power from these coastal tidal resources by applying Low head tidal movements and Medium head tidal movements, Low head tidal movements which uses tides of height within 2m to 5m can be used in areas like Khulna, Barisal, Bagerhat, Satkhira and Cox's Bazaar regions and the height tidal movements which use a more than 5m of tides can be mainly used in Sandwip. So we can say that with suitable tidal height available, this can be a great source of energy for Bangladesh.

VII. Geothermal Energy

Geothermal energy is a very powerful and efficient way to extract a renewable energy from the earth through natural process. This can be performed on a small scale to provide heat for a residential unit, or on a very large scale for energy production through a geothermal power plant. Geothermal power is cost effective, reliable and environmentally friendly but it has previously been geographically limited to areas near tectonic plate boundaries. With this technology, we can use the steam and hot water produced inside the earth's surface to generate electricity. Geothermal energy is generated about 4,000 miles below the surface, in the earth's core [26]. The process takes place due to the slow decay of radioactive particles, the high temperature produced inside the earth and it happens in all rocks [26]. About 10,715 megawatts (MW) of geothermal energy is generated in 24 countries worldwide [26]. The northern districts of Bangladesh show the prospect to explore the geothermal resources. The demand for electricity in urban as well as in the rural areas is increasing, but our production of electricity is not increasing. The rural demand for electricity can be covered by the production of electricity through geothermal energy.The electricity demand of urban areas can be met then by these saved electricity which is supposed to be provided in the rural areas. Geothermal energy can balance the electricity consumption in these two areas. According to Reference [27], a Dhaka based private company namely Anglo MGH Energy has initiated a project to set up the country's first geothermal power plant with a capacity to produce 200 MW of electricity close to Saland in Thakurgaon district. They have planned to set up 28 deep tube wells to lift hot steam and the lifted steam will be used to run a turbine and the turbine is connected to the generator to generate electricity [27]. From the above discussion it is clear that geothermal energy can also be a great source of harnessing electrical energy in Bangladesh.

VIII. Hydro Power

Kinetic energy from flowing or falling water is exploited in hydropower plants to generate electricity. Hydropower plants are classified into two categories: 1. Large hydropower plants (>10 MW), usually with reservoirs, that can not only produce electrical energy Continuously, but also are able to adjust their output according to electricity demand and 2. Small hydropower plants (<10 MW) that are less flexible with respect to load or demand fluctuation due to their dependence on the water resource [28]. In Bangladesh about 1.4 trillion cubic meters (m^3) of water flows through the country in an average water year. Major rivers of the country have a high rate of water flow of about 5 to 6 months during monsoon season, which is substantially reduced in winter season. More than 90% of Bangladesh's rivers originate outside the country, due to which proper planning of water resource is difficult without neighboring countries' cooperation. Downstream water sharing with India is a highly contentious issue in Bangladesh. The annual average rainfall is about 2,300 mm, which varies from 1,200 mm in the north-west to 5,800 mm in the northeast. Most of the rainfall (about 80%) occurs during the months of May/June to September/October [29]. At present only 230 MW of hydro power is utilized in Karnaphuli, Rangamati hydro station, which the only hydroelectric power plant operated by BPDB [30]. Micro-hydro and mini-hydro have limited potential in Bangladesh, with the exception of Chittagong and the Chittagong hill tracts. Hydropower assessments have identified some possible sites from 10 kW to 5 MW but no appreciable capacity has yet been installed [31].

IX. Calculation of the Total Power

The individual power equations and total power equation are given below:

Solar power, P_{solar} = (Area per sq- ft × watts per sq-ft)

Wind power, $P_{wind} = (1/2) \times \rho \times A \times V^3$

Where,

A=area perpendicular to the direction of flow (m^2),

V=wind velocity (in ms-1),

ρ =density of air which is about 1.2 Kgm-3.

Biogas generator power, $P_{biogas}(W)$ =

$$\frac{50\% \text{ of } 100 \text{ kgs pes day animal waste } \times 1000}{2 \text{ kgs animal waste per kwh } \times 5 \text{ hours operation a day per year}}$$

Hydro power, P_{hydro} (W) = H × Q × g × 1000
Where, H=Gross water head (in meter),
Q=Flow of water (in m3/sec) and
g=Gravitation force i.e. 9.81 (in ms-2)
Now,
The total power, PT (W) $=P_{solar} + P_{wind} + P_{hydro} + P_{biogas}$

X. Conclusion

The summary of this paper exhibits that, there is a considerable opportunity of Bangladesh to meet its future power demand and thus economic growth through renewable resources. Renewable energy sources discussed above can help Bangladesh to produce more power in order to reduce Load-shedding problem. Time has come to look forward and work with these renewable energy fields to produce electricity rather than depending wholly on conventional method. With the help of these resources Bangladesh can generate electricity &May able to meet the required demand in the future. Therefore, the Government and the Private sector should work hand to hand to emphasize more on renewable energy sources to produce electricity to solve our power crisis problem.

References Références Referencias

1. http://en.wikipedia.org/wiki/Bangladesh.
2. "Bangladesh Gazette: Renewable Energy Policy of Bangladesh 2008", published in November 06, 2008. http://lib.pmo.gov.bd/.pdf
3. http://www.powerdivision.gov.bd/index.php?page_id=263
4. Ministry of Power, Energy and Mineral Resources, Govt. of the People's Republic of Bangladesh, *Renewable energy policy of Bangladesh*, Dhaka, Bangladesh, Nov. 2008.
5. A.K.M. Sadrul Islam, M. Islam and Tazmilur Rahman, "Effective renewable energy activities in Bangladesh," *Renewable Energy*, vol. 31, no. 5, pp. 677-688, Apr. 2006.
6. M.A.R. Sarkar, M. Ehsan and M.A. Islam, "Issues relating to energy conservation and renewable energy in Bangladesh," *Energy for Sustainable Development,* vol. 7, no. 2, pp. 77-87,Jun. 2003.
7. KhairulAnam, Husnain-Al-Bustam, "Power Crisis & Its Solution through Renewable Energy in Bangladesh", Cyber Journals: Multidisciplinary Journals in Science & Technology, Journal of Selected Areas in Renewable and Sustainable Energy (JRSE), and September-2011.
8. KazyFayeenShariar, Enaiyat Ghani Ovy, Kazi Tabassum Aziz Hossainy, "Closed Environment Design of Solar Collector Trough is using lenss and reflectors", World Renewable Energy Congress 2011, Sweden.
9. Renewable energy projects, IDCOL solar energy program, (2012, March). URL: http://www.idcol.org/prjshsm2004.php.
10. M.J. Khan, M.T. Iqbal, S. Mahboob, "A wind map of Bangladesh," Renewable Energy (2004),Volume: 29, Issue: 5, Publisher: Elsevier, Pages: 643-660, ISSN: 09601481, DOI: 10.1016/j.Renene.2003.10.002.
11. Dr. A. Hossain, "Wind Energy in Bangladesh," Sustainable Development Networking Program.
12. T.V. Ramachandra, B.V. Shruti, "Wind energy potential mappings in Karnataka, India, using GIS," Energy Conversion and Management 46 (2005) 1561-1578, doi:10.1016/j.enconman.2004.07.009.
13. M. S. Kaiser, M. A. Rahman, M. M. Rahman, and S. A. Sharna, "Wind energy assessment for the coastal part of Bangladesh," Journal of Engineering and Applied Sciences, vol. 1, no. 2, pp. 87-92, **(for feasible chart).**
14. Islam, A., M. Islam, and T. Rahman, "Effectiverenewable energy activities in Bangladesh. Renewable Energy", **31**(5): p. 677-688, 2006.
15. M. S. Kaiser, M. A. Rahman, M. M. Rahman, and S. A.Sharna, "Wind energy assessment for the coastal part of Bangladesh," Journal of Engineering and Applied Sciences, vol. 1, no. 2, pp. 87-92, 2006..
16. Website of Wikipedia on biogas. Available at: http://en.wikipedia.org/wiki/Biogas.
17. U. Rehling, Small biogas plants. Sustainable energy systems and management (SESAM), University of Flensburg, Germany, 2001.
18. Description of the biggest production in an agricultural biogas plant. Available at:http://www.bios-bioenergy.at/en/electricity-from-biomass/biogas.
19. A successful Renewable Energy Program in Bangladesh, "International Conference on Conservation, Energy Efficiency & Solar," Organized by Pakistan Engineering Council and USAID October 25-29, 2010, Islamabad, Pakistan.
20. Seed Bangla website. Available at: http://www.seedbangla.com.
21. The Financial Express. Available at:http://www.thefinancialexpressbd.com/more.php?date=2011-02-06&news_id=125260.
22. Infrastructure Development Company Limited (IDCOL). Availableat: http://www.idcol.org/biogass_installation.php.
23. M. ZunaidBaten, E.M. Amin, A. Sharin, R. Islam, S. A. Chowdhury, "Renewable Energy Scenario of Bangladesh: Physical Perspective," International Conference on the Developments in Renewable Energy Technology (ICDRT) 2009, Dhaka, Bangladesh.
24. Banglapedia, National Encyclopedia of Bangladesh. Available at: http://www.bpedia. org/R_0175.php

25. Md. Mahbubuzzaman, M. Shahidul Islam, Md. Mahfuzar Rahman, "Harnessing tidal power", News Paper Article, The Daily Star. Available at: http://www.thedailystar.net/newDesign/print_nes.php?nid=146470.
26. Ingvar B. Fridleifsson, RuggeroBertani, Ernst Huenges, John W. Lund, ArniRagnarsson, RybachLadislaus (2008-02-11), O. Hohmeyer and T. Trittin, ed., *The possible role and contribution of geothermal energy to themitigation of climate change*, Luebeck, Germany, pp. 59–80, retrieved 2009- 04-06.
27. Anglo MGH Energy Plans to set up Bangladesh's first geothermal power plant. Available at: http://www.powereng.com/articles/2011/03/anglo-mghenergy- plans.html
28. M. A. H. Mondal, "Implications of renewable energy technologies in the Bangladesh power sector: long-term planning strategies," Ph.D. dissertation, Dept. of Ecology and Natural Resources Management, ZEF, University of Bonn, Germany, Jul. 2010.
29. A. K. Azad (2011), "A Review on Renewable Power Sources: Prospects of Bangladesh and Scotland," EBook, St. Andrew's University, Scotland, UK. Available:http://pdfmio.com/download/renewablepower.
30. S. Moury, and R Ahshan, "A feasibility study of an on-grid solar home system in Bangladesh," Proc. of the IEEE ICDRET, Dhaka, Dec. 2009.
31. Renewable Energy Policy of Bangladesh, Power Division, Ministry of Power, Energy and Mineral Resources, Bangladesh, Nov. 2008.
32. Prospect of solar energy in Bangladesh prepared by Dhaka University.
33. SNV Domestic biogas news letter, issue 4, January 2011.

Global Journal of Researches in Engineering (F) Volume XIII Issue V Version I Year 2013

This page is intentionally left blank

Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 5 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Discrete Time Averaging of Non-Ideal PWM DC-DC Converters Operating in DCM with Feedback

By Mohammed S. Al-Numay & N. M. Adamali Shah
King Saud University

Abstract - This paper presents a one-cycle-average (OCA) discrete-time model for PWM switched dc-dc converters operating in discontinuous conduction mode (DCM). The closed-loop system is considered in the presence of circuit parasitic. This model provides the exact OCA values of the output voltage and inductor current considering the conduction losses in the switching stage components. It also provides the exact discrete-time mathematical representation of the average values of other internal signals with little increase in simulation time. It is compared to some existing averaged models in terms of accuracy and speed through simulation results of boost converter.

GJRE-F Classification : FOR Code: 090699

DISCRETE TIME AVERAGING OF NON-IDEAL PWM DC-DC CONVERTERS OPERATING IN DCM WITH FEEDBACK

Strictly as per the compliance and regulations of :

Discrete Time Averaging of Non-Ideal PWM DC-DC Converters Operating in DCM with Feedback

Mohammed S. Al-Numay [α] & N. M. Adamali Shah [σ]

Abstract - This paper presents a one-cycle-average (OCA) discrete-time model for PWM switched dc-dc converters operating in discontinuous conduction mode (DCM). The closed-loop system is considered in the presence of circuit parasitic. This model provides the exact OCA values of the output voltage and inductor current considering the conduction losses in the switching stage components. It also provides the exact discrete-time mathematical representation of the average values of other internal signals with little increase in simulation time. It is compared to some existing averaged models in terms of accuracy and speed through simulation results of boost converter.

I. Introduction

DC-DC converters are widely used in various applications. These converters are usually operated in two modes of operation, namely continuous and discontinuous conduction modes [1]. The discontinuous conduction mode of operation of the converter is most frequently used for light load applications. It is also useful for extracting maximum power efficiently from the solar panel [2, 3].

Due to various applications and needs of dc-dc converter operating in DCM, it is very essential to have a proper analytical model for this mode of operation for the analysis and design. The literature shows that more effort has been taken in this view for past three decades [2, 4].

One of the most widely used techniques in the design procedure in power electronics is averaging technique. This technique provides the basic analytical foundation for the most power electronic design. In fact classical averaging procedure is not suitable when there are state discontinuities. At high switching operations the periodic solution has some amplitude ripple, and these ripples are not considered in the classical averaging theory. Due to this it has been found that the directly obtained averaged models are inaccurate for the converters operated in DCM [4]. This has inculcated to take efforts to obtain more accurate averaging method.

In the continuous-time averaging procedure, each circuit topology is modeled separately and then combined in on approximated model [4, 5]. The duty cycle is a discrete-time variable, but treated as a continuous time variable in the existing continuous-time averaged models. Thus the orbital nature of the periodic solution is not obtained. Intern the periodic solution of the converters is averaged to equilibrium to form a nominal solution. In contrast, no such approximations are made in the sample date model. This provides the most accurate result, which replicates the actual behavior of PWM systems and is also suitable for digital control process. Sampled-data models allow us to focus on cycle -to-cycle behavior, ignoring intra cycle ripples. This makes them effective in general simulation, analysis and design. These models predict the values of signals at the beginning of each switching period, which most of the times represent peaks or valleys of the signals rather than average values. To better understand the average behavior of the system, a discrete-time model for the OCA signals was presented in [6].

In this paper, a sampled-data model for nonideal closed loop PWM converters operating in DCM is formulated. This gives the exact discrete-time mathematical representation of the values of the output and internal signals at constant frequency. A discrete-time model to provide the one-cycle-average (OCA) signals of the non ideal closed loop PWM converters operating in DCM is proposed. This model provides the exact discrete-time mathematical representation of the averaged values of the output signal at each switching period. It also provides the average values of other internal signals with little increase in simulation time. The main motivation for the new model is based on the fact that, in many power electronic applications, it is the average values of the voltage and current rather than their instantaneous values that are of greatest interest. In addition to that, the existing models are extended to accommodate for conduction losses. Numerical simulations show the accuracy of the propose model.

II. Existing Average Models

The modeling method is validated by a non-ideal boost converter with feedback as shown in Figure 1 for the different existing averaging methods and presented in this section.

Author α σ : Department of Electrical Engineering, King Saud University Riyadh, Saudi Arabia 11421.

Global Journal of Researches in Engineering (F) Volume XIII Issue V Version I Year 2013

a) Switched Model

Let $u(t) \in R^m$ is the input vector, $x(t) \in R^n$ is the state vector, $y(t) \in R^p$ is the output vector while T_s denotes the length of a switching cycle. Then the DCM PWM converter can be described as [7].

$$\dot{x}(t) = \begin{cases} A_1x(t)+B_1u(t) \;; & t \in \tau_1 \\ A_2x(t)+B_2u(t) \;; & t \in \tau_2 \\ A_3x(t)+B_3u(t) \;; & t \in \tau_3 \end{cases} \quad (1)$$

$$y(t) = \begin{cases} C_1x(t) \;, & t \in \tau_1 \\ C_2x(t) \;, & t \in \tau_2 \\ C_3x(t) \;, & t \in \tau_3 \end{cases} \quad (2)$$

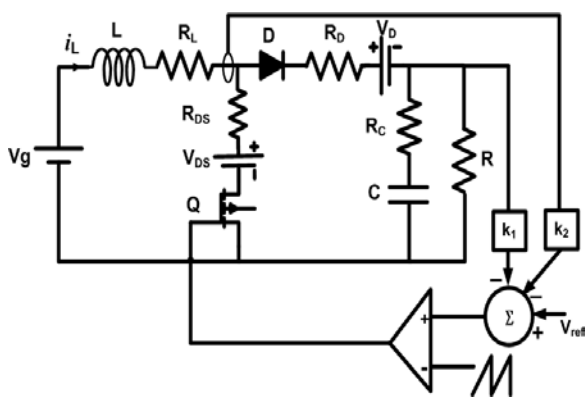

Figure 1 : Boost converter with parasitics

Where The system switches between three topologies (A_1, B_1, C_1), (A_2, B_2, C_2), and (A_3, B_3, C_3), with switching intervals determined by

$$\begin{aligned} \tau_1 &:= kT_s \le t < kT_s + d_k^1 T_s \\ \tau_2 &:= kT_s + d_k^1 T_s \le t < kT_s + (d_k^1 + d_k^2)T_s \\ \tau_3 &:= kT_s + (d_k^1 + d_k^2)T_s \le t < kT_s + T_s \end{aligned}$$

Where $(d_k^1 + d_k^2) \in [0, 1]$ are the switch duty ratios, and k is the discrete-time index. All auxiliary inputs will be assumed to be piecewise constants, i.e. $u(t) = u_k$ for all $t \in [kT_s\,(k+1)T_s)$. This assumption is not necessary and is made for convenience only; more general cases would only require more complex notations.

This is the exact switching model which will be used as the base model for comparison of different methods. The control scheme given in is applied, where is $m(t) = V_{ref} - k_1 i(t) - k_2 v(t)$ $V_{ref} = 0.13$, $k_1 = 0.174$, and $k_2 = -0\;0435$ as in [8].

b) DCM State-Space Average Model (SSA)

In the conventional state-space averaging method the averaged model for DCM has been presented previously in numerous publications [2]. The converters state-space equation in this mode is given by

$$\begin{aligned} \dot{x}(t) &= [d_1A_1 + d_2A_2 + (1-d_1-d_2)A_3]x(t) \\ &\quad + [d_1B_1 + d_2B_2 + (1-d_1-d_2)B_3]u(t) \end{aligned} \quad (3)$$

The problem with the state-space averaging approach in DCM is that we are averaging just the matrix parameters, and not necessarily the state variable themselves. It is intended that (3) will apply when the true average of each state variable is used, but the average inductor current depends on the parameters and duty ratios. Considering this, the modified state-space averaged model that would correctly predict the behavior in DCM for the boost converter is given as [2].

$$\begin{aligned} \dot{x}(t) &= [d_1A_1 + d_2A_2 + (1-d_1-d_2)A_3]Mx(t) \\ &\quad + [d_1B_1 + d_2B_2 + (1-d_1-d_2)B_3]u(t) \end{aligned} \quad (4)$$

Where M is the modification Matrix and its given by

$$M = \begin{bmatrix} \frac{1}{d_1+d_2} & 0 \\ 0 & 1 \end{bmatrix} \quad (5)$$

Where d_1 and d_2 are the duty ratios and d_2 can be determined as follows

$$d_2 = \frac{2Li_L}{d_1T_sV_g} - d_1 \quad (6)$$

Based on (4), (5) and (6) the averaged model can also be derived considering non-ideality in the switching stage components, and is given by

$$\begin{aligned} \frac{di_L}{dt} &= \frac{(R_L+R_{DS})(R+R_C)(V_gd_1^2T_s)}{2L^2(R+R_C)} \\ &\quad - \frac{((R_L+R_D)(R+R_C)+RR_C)(2i_CL - d_1^2V_gT_s)}{2L^2(R+R_C)} \\ &\quad - \frac{(2i_LL - d_1^2V_gT_s)RV_C}{LV_gd_1T_s(R+R_C)} \\ &\quad + \frac{2i_LLV_g - d_1^2V_{DS}V_gT_s - 2i_LLV_D + d_1^2V_gV_DT_s}{LV_gd_1T_s} \\ \frac{dv_C}{dt} &= \frac{1}{C(R+R_C)}\left[Ri_L - V_C - \frac{d_1^2V_gT_sR}{2L}\right] \end{aligned}$$

c) Conventional Discrete-Time Model

The conventional discrete-time mode (CDTM) is given by [4]

$$x_{k+1} = \mathcal{A}(d_k^1, d_k^2)x_k + \mathcal{B}(d_k^1, d_k^2)u_k \quad (7)$$

Where the input nonlinearities $A(d^1, d^2)$ and $B(d^1, d^2)$ are given by

$$\mathcal{A}(d^1, d^2) := \Phi_3\Phi_2\Phi_1 \quad (8)$$

$$\mathcal{B}(d^1, d^2) := \Phi_3(\Phi_2\Gamma_1 + \Gamma_2) + \Gamma_3 \quad (9)$$

The arguments d^1T_s, d^2T_s, and $(1-d^1-d^2)T_s$ for $(\Phi_1, \Phi_2, \Phi_3, \Gamma_1, \Gamma_2$ and $\Gamma_3)$, respectively are omitted from the above equations for notation simplicity. Where

$$\begin{aligned}\Phi_i(t) &:= e^{A_i t}\\ \Gamma_i(t) &:= \int_0^t e^{A_i \tau} b_i d\tau\end{aligned}$$

III. Proposed Model

This section introduces the new averaged discrete-time model for closed loop PWM dc-dc converter operating in DCM considering conduction losses. Description of the original system and derivation of the proposed model are discussed here. The one-cycle average (OCA) representation of the output signal [6] is given by

$$y^*(t) := \frac{1}{T_s}\int_{t-T_s}^{t} y(\tau)d\tau. \tag{10}$$

The signal, $y^*(t)$ is used to develop a new discrete-time model for PWM converters operating in DCM. This model provides the basis for discrete-time simulation of the averaged value of any state in the DCM PWM system, even during transient non-periodic operating conditions.

a) Proposed OCA Discrete-Time Model

It is desired to compute, without approximation, the evolution of all system variables at the sampling instants, $t = kT_s$ assuming three different topologies for the system. Since the state and output equations (1) - (2) are piecewise-linear with respect to time t, the desired discrete-time model can be obtained symbolically. Using the notation, $x_k := x(kT_s)$ and $y_k^* := y^*(kT_s)$, the result is the OCA large signal model

$$\begin{aligned}x_{k+1} &= \mathcal{A}(d_k^1, d_k^2)x_k + \mathcal{B}(d_k^1, d_k^2)u_k \qquad (11)\\ y_{k+1}^* &= \mathcal{C}(d_k^1, d_k^2)x_k + \mathcal{D}(d_k^1, d_k^2)u_k \qquad (12)\end{aligned}$$

Where the input nonlinearities $A(d^1, d^2)$, $B(d^1, d^2)$, $C(d^1, d^2)$ and $D(d^1, d^2)$ are given by

$$\begin{aligned}\mathcal{A}(d^1, d^2) &:= \Phi_3\Phi_2\Phi_1\\ \mathcal{B}(d^1, d^2) &:= \Phi_3(\Phi_2\Gamma_1 + \Gamma_2) + \Gamma_3\\ \mathcal{C}(d^1, d^2) &:= C_1\Phi_1^* + C_2\Phi_2^*\Phi_1 + C_3\Phi_3^*\Phi_2\Phi_1\\ \mathcal{D}(d^1, d^2) &:= C_1\Gamma_1^* + C_2(\Phi_2^*\Gamma_1 + \Gamma_2^*)\\ &\quad + C_3(\Phi_3^*(\Phi_2\Gamma_1 + \Gamma_2) + \Gamma_3^*)\end{aligned}$$

The arguments d^1T_s, d^2T_s, and $(1-d^1-d^2)T_s$ for (Φ_1, Φ_1^*, Γ and Γ_1^*), (Φ_2 , Φ_2^*, Γ_2 and Γ_2^*) and (Φ_3, Φ_3^*, Γ_3 and Γ_3^*) respectively are omitted from the above equations for notation simplicity. Where

$$\begin{aligned}\Phi_i(t) &:= e^{A_i t}\\ \Gamma_i(t) &:= \int_0^t e^{A_i \tau} b_i d\tau\end{aligned}$$

$$\begin{aligned}\Phi_i^*(t) &:= \frac{1}{T_s}\int_0^t \Phi_i(\tau)d\tau\\ \Gamma_i^*(t) &:= \frac{1}{T_s}\int_0^t \Gamma_i(\tau)d\tau.\end{aligned}$$

Note that the averaging operation adds "sensor" dynamics to the system; as a consequence, the largesignal model (11) - (12) is not in standard statespace form. By defining the augmented state vector $x^* \in R^{n+p}$ such that

$$x_{k+1}^* := \begin{bmatrix} x_{k+1} \\ \mathcal{C}(d_k^1, d_k^2)x_k + \mathcal{D}(d_k^1, d_k^2)u_k \end{bmatrix} \tag{13}$$

An equivalent (but standard form) representation of the OCA large-signal model is given by:

$$\begin{aligned}x_{k+1}^* &= \mathcal{A}^*(d_k^1, d_k^2)x_k^* + \mathcal{B}^*(d_k^1, d_k^2)u_k \qquad (14)\\ y_k^* &= \mathcal{C}^* x_k^* \qquad (15)\end{aligned}$$

Where

$$\begin{aligned}\mathcal{A}^*(d^1, d^2) &:= \begin{bmatrix} \mathcal{A}(d^1, d^2) & 0_{n\times p} \\ \mathcal{C}(d^1, d^2) & 0_{p\times p}\end{bmatrix}\\ \mathcal{B}^*(d^1, d^2) &:= \begin{bmatrix} \mathcal{B}(d^1, d^2) \\ \mathcal{D}(d^1, d^2)\end{bmatrix}\\ \mathcal{C}^*(d^1, d^2) &:= \begin{bmatrix} 0_{p\times n} & I_{p\times p}\end{bmatrix}\end{aligned}$$

Note that not only the OCA values of output signal will be available but also the values of the signals (without averaging) at the beginning of every switching period as well.

b) Feedback Computation

The modulation signal for feedback control is $m(t) = V_{ref} - k_1 i(t) - k_2 v(t) = V_{ref} - Kx(t)$ and the duty ratio at each switching period is $d_k = \frac{t^*}{T_s}$. The time instant t* at which the modulation signal crosses

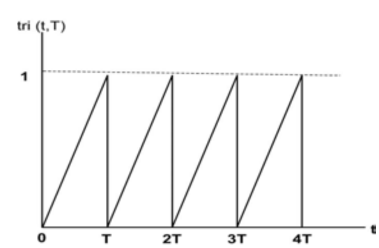

Figure 2 : PWM sawtooth function

the sawtooth is computed by solving the nonlinear equation

$$\begin{aligned}tri(t^*, T_s) &= V_{ref} - Kx(kT_s + t^*)\\ &= V_{ref} - K\{\Phi_1(t^*)x_k + \Gamma_1(t^*)u_k\} \qquad (16)\end{aligned}$$

at each time instant k, where the sawtooth function is shown in Figure 2 and mathematically represented by tri

$t, T_s) = \frac{t}{T_s} -$ floor $(\frac{t}{T_s})$. For reasonably high switching frequency, the value of $x(kT + t^*)$ can be approximated by neglecting the higher order terms in the Taylor expansion of the nonlinear functions Φ_1 and Γ_1. That is

$$\Phi_1(t^*) = I + A_1 t^* + \frac{A_1^2}{2!} t^{*^2} + \ldots \approx I + A_1 t^* \quad (17)$$

$$\Gamma_1(t^*) = (It^* + A_1 \frac{t^{*^2}}{2!} + \ldots) B_1 \approx It^* B_1 \quad (18)$$

And hence, a good approximation of (16) becomes

$$tri(t^*, T_s) \approx V_{ref} - K\{(I + A_1 t^*)x_k + B_1 t^* u_k\} \quad (19)$$

Noting that $tri(t^*, T_s)$ equals to $\frac{t}{T_s}$ for $t^* \in (kT_s, (k+1)T_s]$, we get

$$\frac{t^*}{T_s} \approx V_{ref} - K\{(I + A_1 t^*)x_k + B_1 t^* u_k\} \quad (20)$$

or

$$d_k = \frac{t^*}{T_s} \approx \frac{V_{ref} - Kx_k}{KT_s(A_1 x_k + B_1 u_k) + 1} \quad (21)$$

Which provides a closed from solution for d_k. The duty ratio d_k can be computed without approximation by solving the nonlinear equation for t^*.

IV. Numerical Example

To compare existing models with DCM OCA model, consider a Boost converter with feedback considering conduction loss shown in Figure 1. The input is u = V_g and state variables are $x_1 = i_L$ and $x_2 = v_C$. Where $R = 30\ \Omega$, $L = 75\ \mu$H, $C = 4.4\ \mu$F, $V_g = 5$V, and $T_s = 50\ \mu$s.The values of the parasitics used in the example are $R_L = 0.0176\ \Omega$, $R_C = 30\ m\Omega$, $R_{DS} = 0.17\ \Omega$, $R_D = 0.15\ \Omega$, $V_{DS} = 0.17$ V, and V_D =0.4V. The three periodical switching operating stages and the state equation are given below. In the resulting operating mode, these three operating stages are periodically

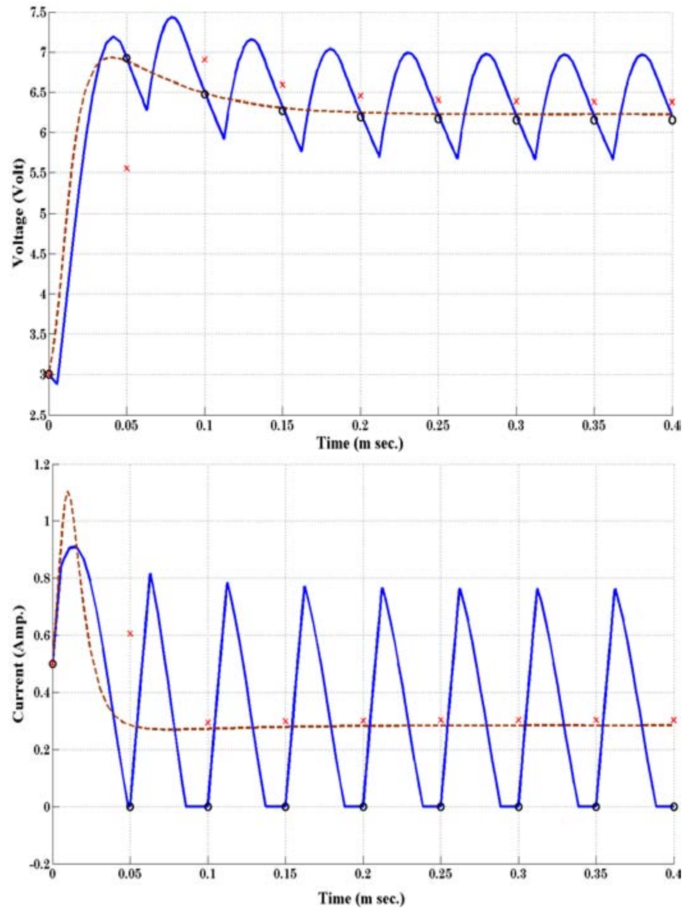

Figure 3 : Comparison of DCM simulation of non-ideal closed loop boost converter

—: switched mode ; --: DCM SSA
○: CDTM ; ×: DCM OCA

switched and they are looped correspondingly. The state space matrices A_1,A_2,A_3,B_1,B_2,B_3,C_1,C_2, and C_3 are defined as

$$A_1 = \begin{bmatrix} -\frac{(R_L+R_{DS})}{L} & 0 \\ 0 & -\frac{1}{(R+R_C)C} \end{bmatrix};$$

$$A_2 = \begin{bmatrix} -\frac{(R_L+R_D)(R+R_C)+RR_C}{L(R+R_C)} & -\frac{R}{L(R+R_C)} \\ \frac{R}{C(R+R_C)} & -\frac{1}{C(R+R_C)} \end{bmatrix};$$

$$A_3 = \begin{bmatrix} -\frac{(R_L+R_{DS})}{L} & 0 \\ 0 & -\frac{1}{(R+R_C)C} \end{bmatrix};$$

$$B_1 = \begin{bmatrix} \frac{1}{L} & -\frac{1}{L} & 0 \\ 0 & 0 & 0 \end{bmatrix}; \quad B_2 = \begin{bmatrix} \frac{1}{L} & 0 & -\frac{1}{L} \\ 0 & 0 & 0 \end{bmatrix};$$

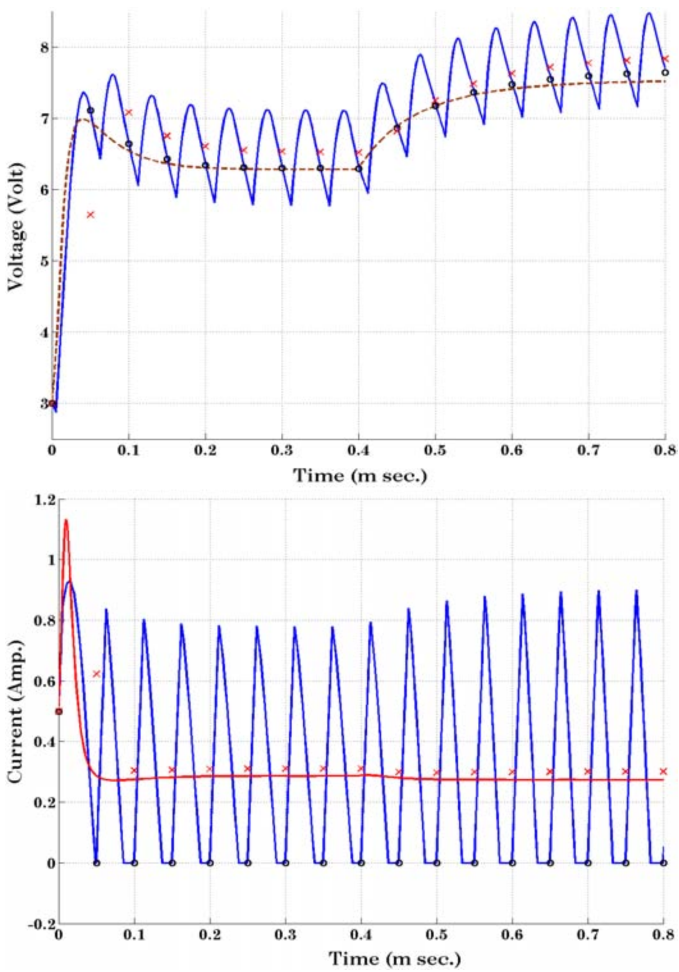

Figure 4 : Comparison of DCM simulation of non-ideal closed loop boost converter with variable\ load resistance

–: switched mode ; -- : DCM SSA

∘ : CDTM ; × : DCM OCA

$$B_3 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}; \quad C_1 = \begin{bmatrix} 0 & \frac{R}{R+R_C} \end{bmatrix};$$

$$C_2 = \begin{bmatrix} \frac{RR_C}{R+R_C} & \frac{R}{R+R_C} \end{bmatrix}; \quad C_3 = \begin{bmatrix} 0 & \frac{R}{R+R_C} \end{bmatrix}$$

and $u(t)$ is given by

$$u(t) = \begin{bmatrix} V_g & V_{DS} & V_D \end{bmatrix}' \tag{22}$$

It should be noted that no approximation is made in deriving the new discrete-time model, and all simulations were performed using Matlab. To show the accuracy and speed of the proposed model, the steady state average values of the proposed model are compared to most commonly used existing models (switched, SSA and CDTM). The results of switched model, SSA, CDTM and the proposed OCA model for the boost converter operating in DCM are shown in Figure 3. In the figure, current and voltage waveforms are represented. The steady-state values of output voltage for different models are $v_C = 6.225V$ for SSA, $v_C = 6.15V$ for CDTM, and $v_C = 6.375V$ for OCA model. It is obvious that the steady state values computed by the proposed method is by far closer to the steady state average values of interest to PWM converter design.

a) Effect of change in load

To study the effect of load resistance on the simulation results, a step change on the load resistance R from 30 Ω to 45 Ω at time instant, *t* = 0.4 ms has been simulated and the results are shown in Figure 4. It can be observed that the average values produced by SSA model depends on the load resistance. On the other hand the proposed model provides the same accuracy of waveforms regardless of the change in load resistance.

V. Conclusion

This paper presents a conventional discrete-time model and a one-cycle-average discrete-time model for closed loop PWM converters operating in DCM with non-ideality in the switching stage components is formulated. These models provide the exact discrete time mathematical representation of the instantaneous / averaged values of the output signal respectively. The DCM OCA model proposed here also provides the average values of other internal signals with little increase in simulation time. It is also compared to existing models extended to accommodate for conduction losses, through a numerical example of boost converter. The numerical simulation results show the accuracy and speed of the OCA discrete-time model for PWM converter operating in the DCM for non ideal condition. Table I summarizes the normalized simulation times for boost converter operating in DCM for different simulation methods.

Table 1 : Simulation times for closed loop boost converter

Method	Normalized Simulation Time
Switched	45
SSA	1
CDTM	8.54
DCM OCA	9.12

References Références Referencias

1. N. Femia and V. Tucci : On the Modeling of PWM Converters for Large Signal Analysis in Discontinuous Conduction Mode, IEEE Transactions on Power Electronics, vol. 9, no. 5, pp. 487–496, September 1994.

2. J. Sun, D. M. Mitchell, M. F. Greuel, P. T. Krein and R. M. Bass: Averaged Modeling of PWM Converters Operating in Discontinuous Conduction Mode, IEEE Transactions on Power Electronics, vol. 16, pp. 482–492, April 2001.
3. K. K. Tse, M. T. Ho, Henry S. H. Chung, and S. Y. (Ron) Hui: A Novel Maximum Power Point Tracker for PV Panels Using Switching Frequency Modulation, IEEE Transactions on Power Electronics, vol. 17, no. 6, pp. 980–989, November 2002.
4. D. Maksimovic and S. Cuk: A Unified Analysis of PWM Converters in Discontinuous Modes, IEEE Transactions on Power Electronics, vol. 6, no. 3, pp. 476–490, July 1991.
5. A. Davoudi, J. Jatskevich, and T. D. Rybel: Numerical state-space average-values modeling of PWM DC-DC Converters Operating in DCM and CCM, IEEE Transactions on Power Electronics, vol. 21, no. 4, pp. 1003-1012, July 2006.
6. M. S. Al-Numay: Averaged Discrete-Time Model for Fast simulation of PWM Converters in DCM, International Journal of Modeling and Simulation, vol.29, no. 1, pp. 46–51, 2009.
7. J. G. Kassakian, M. F. Schlecht, and G. C. Verghese: Principles of Power Electronics Reading, MA: Addison Wesley, 1991.
8. B. Lehman, and R. M. Bass: Switching Frequency Dependent Averaged Models for PWM DC-DC Converters, IEEE Transactions on Power Electronics, vol. 11, no. 1, pp. 89-98, January 1996.

Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 5 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Transient Stability Improvement of a Conventional Power System by Superconducting Fault Current Limiter

By Apurbo Biswas, Md. Elias Khan & Utpal Sarker
Khulna University of Engineering & Technology (KUET)

Abstract - Occurrence of faults in a power system causes transients which decrease transient stability of that system. Superconducting fault current limiter (SFCL) is a promising solution to reduce and control this fault (short circuit current) which is inevitable to electric power systems due to growing interconnection of electrical power systems. In this paper, a simulated proof of the capability of SFCL in improving the system transient stability is revealed. At first a SFCL model is designed using simulink. Then, that model is introduced in a so-called three phase system. After that, the system is taken under different fault conditions to investigate transient stability for each. Finally, it is shown from the simulation result that, the system transient stability has improved.

Keywords : transient stability; superconducting fault current limiter; power system; simulink/simpower system.

GJRE-F Classification : FOR Code: 090607

TRANSIENT STABILITY IMPROVEMENT OF A CONVENTIONAL POWER SYSTEM BY SUPERCONDUCTING FAULT CURRENT LIMITER

Strictly as per the compliance and regulations of :

Transient Stability Improvement of a Conventional Power System by Superconducting Fault Current Limiter

Apurbo Biswas [α], Md. Elias Khan [σ] & Utpal Sarker [ρ]

Abstract - Occurrence of faults in a power system causes transients which decrease transient stability of that system. Superconducting fault current limiter (SFCL) is a promising solution to reduce and control this fault (short circuit current) which is inevitable to electric power systems due to growing interconnection of electrical power systems. In this paper, a simulated proof of the capability of SFCL in improving the system transient stability is revealed. At first a SFCL model is designed using simulink. Then, that model is introduced in a so-called three phase system. After that, the system is taken under different fault conditions to investigate transient stability for each. Finally, it is shown from the simulation result that, the system transient stability has improved.

Keywords : transient stability; superconducting fault current limiter; power system; simulink/simpower system.

I. Introduction

Due to increased customer requirements and advanced technological enhancements, the demand for electric power is increasing. Thus, power systems are becoming larger and more interconnected day by day. As a result, the fault current increases and transient stability problems has drawn attention. Excessive fault currents cause stresses and lead to high electrical, mechanical and thermal instabilities of electric networks. Consequently, in order to maintain the stability of power system, replacement of equipment or updating the configuration of the system will be needed in substations. This ultimately leads to low reliability and lower operational flexibility. Furthermore, it is also not economically viable to design the switchgear for every system with different capacity that can maintain sound power system stability. Still now, mechanisms like transformer with high impedance, split bus burs and fuses have been applied to reduce the magnitude of fault currents. But the uses of those devices lessen the reliability of the system and raise the power loss [1]. But a Superconductive fault current limiter (SFCL) can be a dependable alternative to substitute the aforesaid conventional devices. In addition, SFCL ensures the improvement of transient stability of power system by dropping the level of fault current in a rapid and efficient approach.

An SFCL has virtually zero resistance at normal operating conditions. But in the occasion of a short circuit, due to the increasing temperature of the SFCL, the shift from the superconducting status into normal conducting status offers maximum preferred impedance to electric networks instantaneously, which limits the current more rapid and effective way. After the clearance of fault, the resistance of SFCL goes to zero level owing to the decreasing temperature of the SFCL [2-7]. Thus the SFCL is invisible and harmless when the grid is operating at steady state condition.

In this paper, a SFCL model is intended using Matlab Simulink. Then that model is introduced in a conventional three phase system. Finally, its transient stability at different fault conditions is studied.

II. Superconducting Fault Current Limiter

SFCL is an electronic device based on the principle of superconductivity. The hypothesis of using the superconductors to hold electric power and to bound peak current level has been around since the innovation of superconductors and the realization that they have extreme non-linear properties. More explicitly, the current limiting behavior depends on their nonlinear response to current, temperature and magnetic field variations. These three parameters possibly cause a transition between and the normal conducting and the superconducting system, when they are increased. Generally, three types of SFCL have been developed so far, they are: reactor-type, transformer-type and resistor-type. In this paper, resistor-type SFCL has been modeled based on [8] and [9] which illustrate the experimental studies for superconducting properties of SFCL being applied to three phase power distribution systems. Quench and recovery characteristics are modeled based on [10]. The impedance of SFCL according to time t is specified by (1).

Author α σ ρ : Department of Electrical and Electronic Engineering, Khulna University of Engineering & Technology (KUET), Khulna, Bangladesh. E-mail : eliaskhaneee@hotmail.com

$$R_{SFCL} = \begin{cases} 0, & (t_0 > t) \\ R_m\left[1-\exp(-\dfrac{t-t_0}{T_{sc}})\right]^{\frac{1}{2}}, & (t_0 \le t < t_1) \\ a_1(t-t_1)+b_1, & (t_1 \le t < t_2) \\ a_2(t-t_2)+b_2, & (t_2 \le t) \end{cases} \quad (1)$$

Here, the maximum resistance of the SFCL in the quenching condition is expressed by R_m, where, T_{sc} is the time constant. Moreover, t_0 indicates the time to start the quenching. In addition, t_1 and t_2 are expressing the first and second recovery times.

Figure 1 interprets quenching and recovery characteristics of the SFCL derived from (1). It is clear from Fig. 1 that at normal operating condition impedance of SFCL is zero. But when fault takes place at t=1s, quenching progression starts and then impedance goes to its peak value. After recovery of fault impedance again goes back to zero.

III. Modeling and Simulaton

a) SFCL Modeling

SFCL was designed with the help of Simulink/SimPowerSystem. To design this resistive-type SFCL, four fundamental parameters are used. The parameters are given below with their values:

Transition or response time = 2ms, maximum impedance= 20Ω & minimum impedance= 0.01Ω, recovery time =10ms, triggering current =550A.

In Fig. 2, a resistive characteristic table is shown using these parameters. In this figure, to specify the transition or response time and recovery time of SFCL, step block and transport delay block are used respectively.

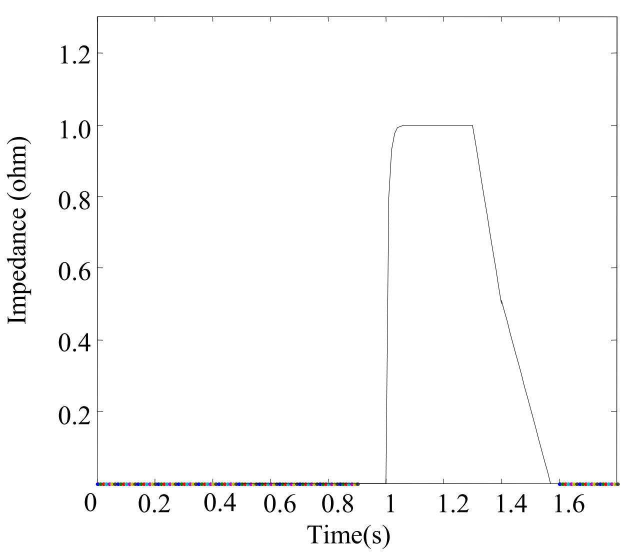

Figure 1 : Quench and Recovery Characteristics of SFCL

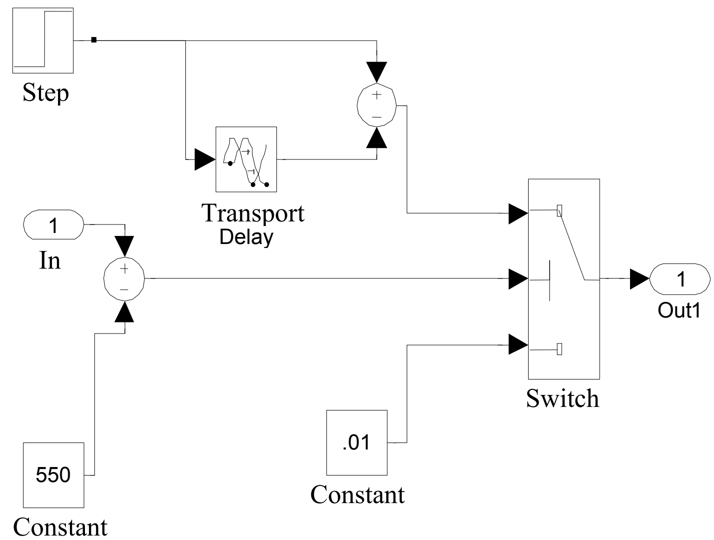

Figure 2 : Resistive SFCL characteristics table

To determine the minimum or maximum impedance to output switch block is used. In figure 3 , simulation model of SFCL is shown. Here the RMS value of the incoming current is calculated using RMS block. To reduce harmonics, first order filter is used. The induced fault current causes voltage sag. To compensate this controlled voltage source is connected.

The developed SFCL model in Simulink/SimPowersystem works as follows: At first, the model measures the RMS value of the current passing in the system. Then, with the result of comparison between the current and the characteristics table shown in figure 2, the model decides whether the impedance level of SFCL goes maximum or minimum. SFCL's resistance remains minimum, if the passing current is below the triggering current level; on the other hand, if current exceeds triggering current its resistance reaches to the maximum impedance level.

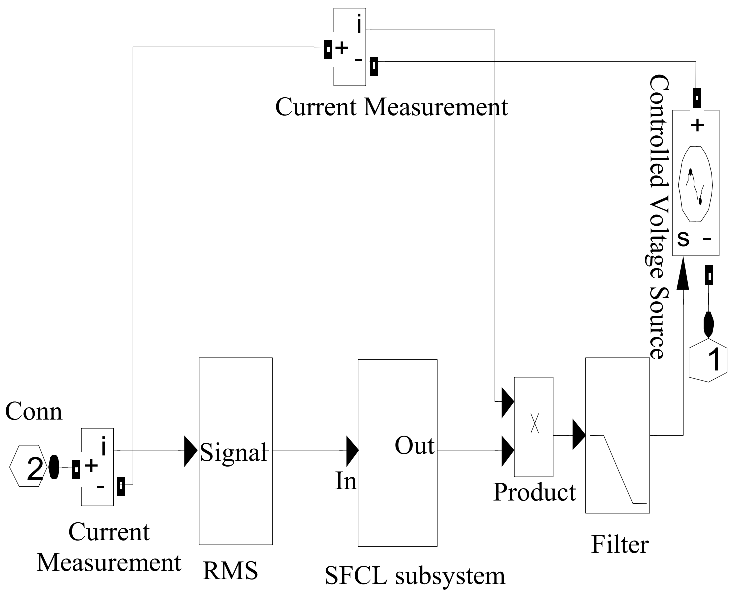

Figure 3 : SFCL model in Simulink

As a result, the increased impedance limits the short circuit fault current. However, SFCL's resistance again goes minimum when current is lower than triggering current level.

b) Modeling and simulation of projected System

Here, a typical three phase system is designed using Simulink/SimPower system which is given in Fig. 4 for the purpose of examining transient stability. Generation capacity of this system is about 105 MW. Here a conventional synchronous machine is generating the power. The machine is rated as 130 MVA. The generation voltage is 20 KV. A 20/154 KV transformer is stepping up the voltage which is connected to a large industrial load.

Then the system is taken under four types of faults (with and without using SFCL) which are:

1. Three-phase- to-ground fault
2. Double line-to-ground fault
3. Line-to-line fault
4. Single line-to-ground fault

A fault block is used to introduce these faults which is shown in Fig. 5. Then a SFCL is added in the system for same condition that is shown in Fig. 6.

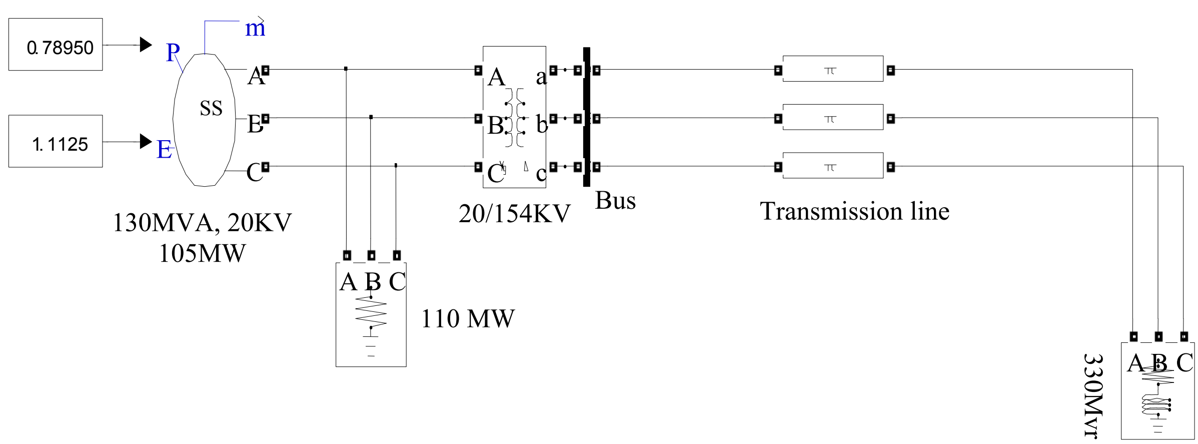

Figure 4 : Anticipated three phase system

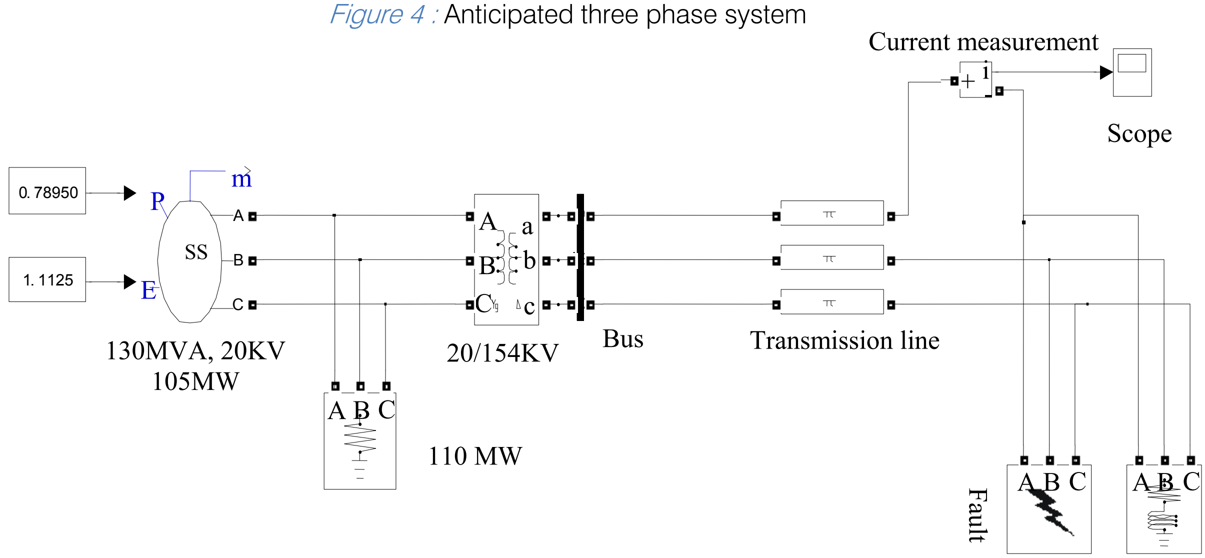

Figure 5 : System during the occurrence of fault without SFCL

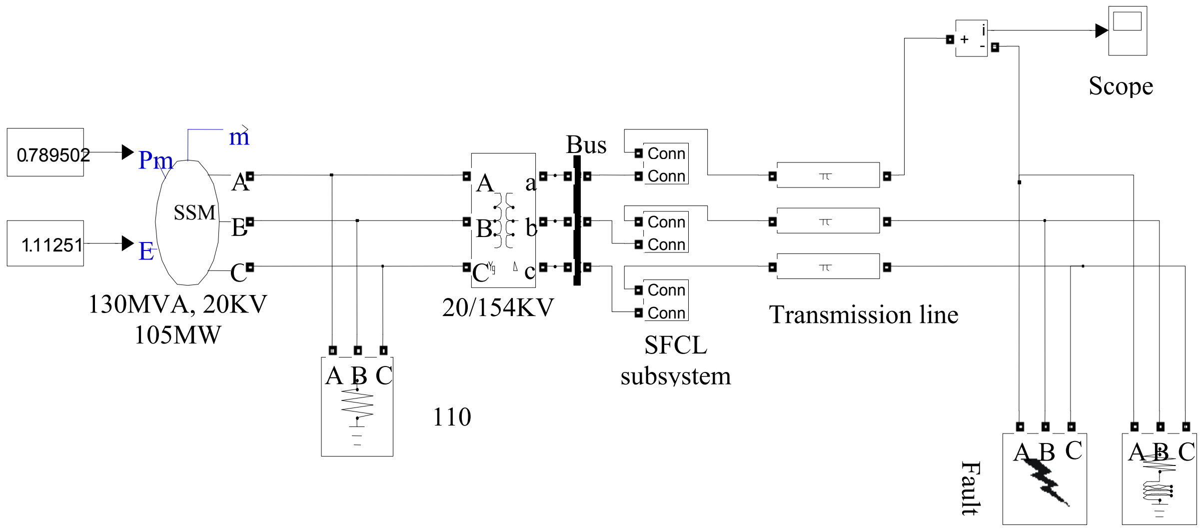

Figure 6 : System during the occurrence of fault with SFCL

IV. Result and Discussion

The excellent transient stability improvement behavior of SFCL is studied in this paper. In a conventional power system shown in Fig. 4, various types of faults are made occurred with and without SFCL shown in Fig. 5 and Fig. 6 respectively. The effect of these faults is depicted in Fig. 7, Fig. 8, Fig. 9 and Fig. 10. From these figures it is clearly seen that, fault current is reduced drastically due to the use of SFCL. It is also clear from Table I. It shows the value of fault current with and without SFCL.

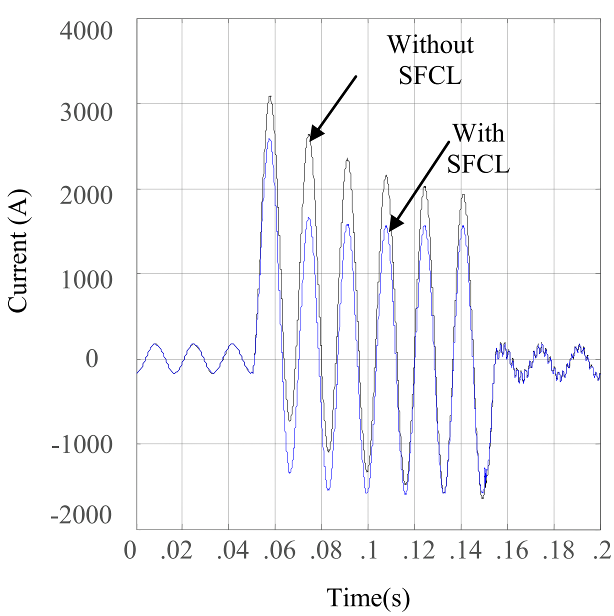

Figure 7 : Fault current for three phase to ground fault

Fault current is responsible for decreasing transient stability of a system. Lower the fault current higher the transient stability. As SFCL reduces the fault current level tremendously therefore, improves transient stability in a great extent.

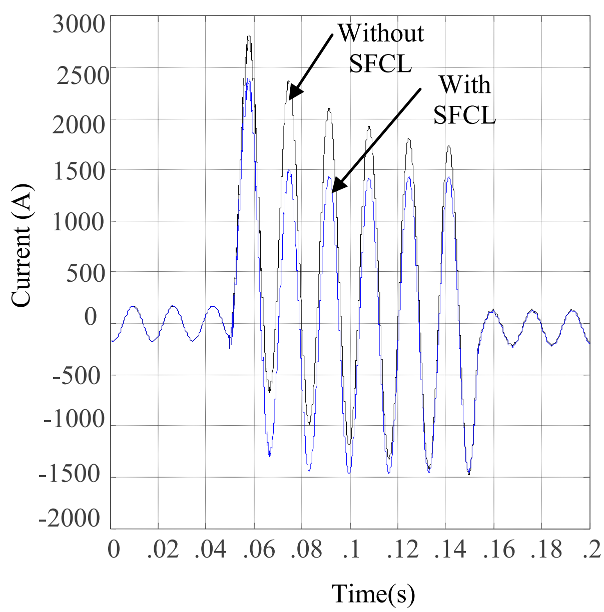

Figure 8 : Fault current for double line to ground fault

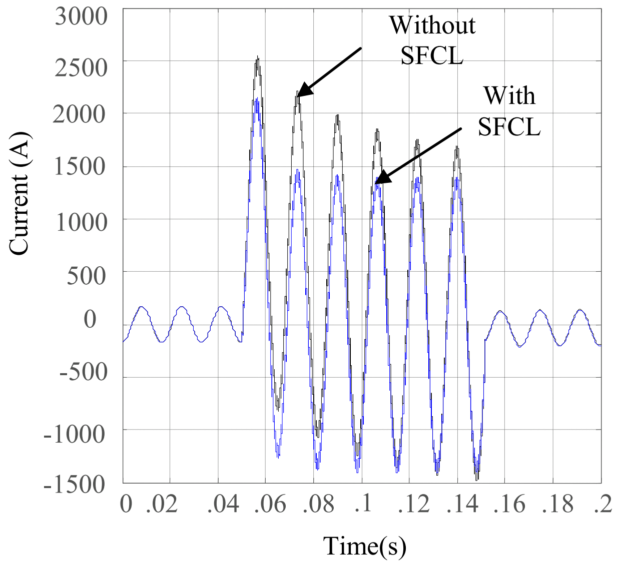

Figure 9 : Fault current for line to line fault

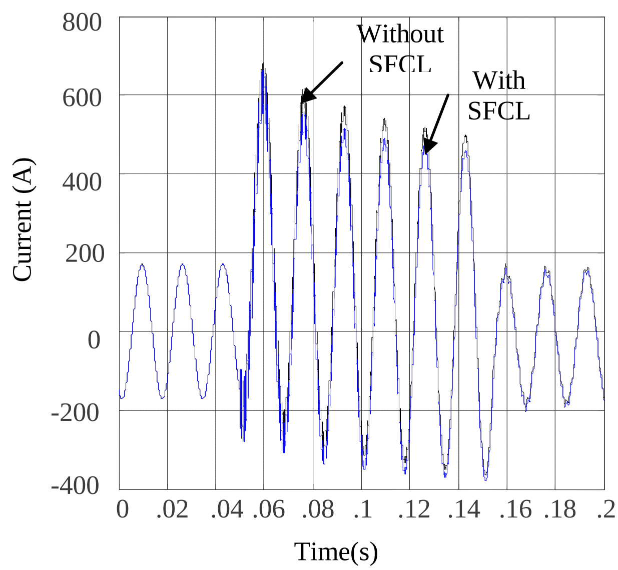

Figure 10 : Fault current for single line to ground fault

Table I : Fault current value with and without SFCL for different faults

Types of Faults	Magnitude of Fault Current (Ampere)	
	Without SFCL	*With SFCL*
Three phase to ground fault	3100-2200	1600
Double line to ground fault	2750-1850	1400
Line to line fault	2520-1750	1350
Single line to ground fault	700-550	500

V. Conclusion

This paper has successfully shown the simulated proof of the ability of SFCL to improve the power system transient stability. Four case studies are taken into account and for each of them it is shown that, SFCL has tremendous competence of suppressing the fault current quasi instantaneously, which leads the system to more reliable and stable condition. Nevertheless, the launching of SFCL in a system requires perfect co-ordination with other protective device otherwise it will mess the original setting values of these devices and the effect of SFCL will be useless. Thus proper co-ordination will make it more convenient for bettering transient stability.

References Références Referencias

1. M. Noe and M. Strurer, "High-temperature superconductor fault currentimiters: Concepts, applications, and development status," Supercond. Sci.Technol., vol. 20, no. 3, pp. R15–R29, Mar. 2007.
2. S. W. Yim, H. R. Kim, O. B. Hyun, and J. Sim, "Quench and recovery characteristics of Au/YBCO thin film type SFCL," Phys. C, vol. 463–465, pp. 1172–1175, Oct. 2007.
3. H.-R. Kim, H.-S. Choi, H.-R. Lim, I.-S. Kim, and O.-B. Hyun, "Resistanceof superconducting fault current limiters based on YBa2Cu3O7 thin films after quench completion," Phys. C, vol. 372–376, pp. 1606–1609, Aug. 2002.
4. H.-R. Kim, S.-W. Yim, S.-Y. Oh, and O.-B. Hyun, "Recovery in superconducting fault current limiter at low applied voltages," IEEE Trans. Appl. Supercond., vol. 18, no. 2, pp. 656–659, Jun. 2008.
5. H.-R. Kim, O.-B. Hyun, H.-S. Choi, S.-D. Cha, and J.-M. Oh, "Resistance development in superconducting fault current limiters prior to quench completion," IEEE Trans. Appl. Supercond., vol. 13, no. 2, pp. 2032–2035, Jun. 2003.
6. B. W. Lee, K. B. Park, J. Sim, I. S. Oh, H. G. Lee, H. R. Kim, and O. B. Hyun, "Design and experiments of novel hybrid type superconducting fault current limiters," IEEE Trans. Appl. Supercond., vol. 18, no. 2, pp. 624–627, Jun. 2008.
7. G.-H. Lee, K.-B. Park, J. Sim, Y.-G. Kim, I.-S. Oh, O.-B. Hyun, and B.-W. Lee, "Hybrid superconducting fault current limiter of the first half cycle non-limiting type," IEEE Trans. Appl. Supercond., vol. 19, no. 3, pp. 1888–1891, Jun. 2009.
8. J.-S. Kim, S.-H. Lim, and J.-F. Moon et al., "Analysis on the protective coordination on neutral line of main transformer in power distribution substation with superconducting fault current limiter," The Trans. on the Korean Institute of Electrical Engineers, vol. 58, no. 11, pp. 2089–2094, Nov. 2009.

9. H. R. Kim, S. W. Yim, and O. B. Hyun et al., "Anlaysis on recovery characteristics of superconducting fault current limiters," presented at the Conference on Magnet Technology, Philadelphia, Aug. 27–31, 2007, MT-20
10. B. W. Lee, K. B. Park, and J. Sim et al. , "Design and experiments of novel hybrid type superconducting fault current limiters," IEEE Trans.Appl. Supercond., vol.18, no. 2, pp. 624–627, June 2008.

.

Global Journals Inc. (US) Guidelines Handbook 2013

www.GlobalJournals.org

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (FARSE)

- 'FARSE' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'FARSE" can be added to name in the following manner. eg. Dr. John E. Hall, Ph.D., FARSE or William Walldroff Ph. D., M.S., FARSE
- Being FARSE is a respectful honor. It authenticates your research activities. After becoming FARSE, you can use 'FARSE' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 60% Discount will be provided to FARSE members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- FARSE will be given a renowned, secure, free professional email address with 100 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, Spam Assassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- FARSE member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 15% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
- Eg. If we had taken 420 USD from author, we can send 63 USD to your account.
- FARSE member can apply for free approval, grading and certification of some of their Educational and Institutional Degrees from Global Journals Inc. (US) and Open Association of Research, Society U.S.A.
- After you are FARSE. You can send us scanned copy of all of your documents. We will verify, grade and certify them within a month. It will be based on your academic records, quality of research papers published by you, and 50 more criteria. This is beneficial for your job interviews as recruiting organization need not just rely on you for authenticity and your unknown qualities, you would have authentic ranks of all of your documents. Our scale is unique worldwide.
- FARSE member can proceed to get benefits of free research podcasting in Global Research Radio with their research documents, slides and online movies.
- After your publication anywhere in the world, you can upload you research paper with your recorded voice or you can use our professional RJs to record your paper their voice. We can also stream your conference videos and display your slides online.
- FARSE will be eligible for free application of Standardization of their Researches by Open Scientific Standards. Standardization is next step and level after publishing in a journal. A team of research and professional will work with you to take your research to its next level, which is worldwide open standardization.

- FARSE is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), FARSE can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 80% of its earning by Global Journals Inc. (US) will be transferred to FARSE member's bank account after certain threshold balance. There is no time limit for collection. FARSE member can decide its price and we can help in decision.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (MARSE)

- 'MARSE' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'MARSE" can be added to name in the following manner. eg. Dr. John E. Hall, Ph.D., MARSE or William Walldroff Ph. D., M.S., MARSE
- Being MARSE is a respectful honor. It authenticates your research activities. After becoming MARSE, you can use 'MARSE' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 40% Discount will be provided to MARSE members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- MARSE will be given a renowned, secure, free professional email address with 30 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, SpamAssassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- MARSE member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 10% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
- MARSE member can apply for free approval, grading and certification of some of their Educational and Institutional Degrees from Global Journals Inc. (US) and Open Association of Research,Society U.S.A.
- MARSE is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), MARSE can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 40% of its earning by Global Journals Inc. (US) will be transferred to MARSE member's bank account after certain threshold balance. There is no time limit for collection. MARSE member can decide its price and we can help in decision.

ANNUAL MEMBER

- Annual Member will be authorized to receive e-Journal GJRE for one year (subscription for one year).
- The member will be allotted free 1 GB Web-space along with subDomain to contribute and participate in our activities.
- A professional email address will be allotted free 500 MB email space.

PAPER PUBLICATION

- The members can publish paper once. The paper will be sent to two-peer reviewer. The paper will be published after the acceptance of peer reviewers and Editorial Board.

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

MANUSCRIPT STYLE INSTRUCTION **(Must be strictly followed)**

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, “Abstract” word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

You must strictly follow above Author Guidelines before submitting your paper or else we will not at all be responsible for any corrections in future in any of the way.

Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29.Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before
Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.
- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

save our planet

Global Journal of Researches in Engineering

Visit us on the Web at www.GlobalJournals.org | www.EngineeringResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9755861