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VOLUME 15 ISSUE 1 VERSION 1.0

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Choosing the Power Injection Network Node based on Overall Minimum Losses: The Case of the 216-MW Kribi Natural Gas Power Plant in the Southern Interconnected Grid of Cameroon

By Tabe Moses, Tchuidjan Roger, Ngundam John & Manfouo Hervé
National Advanced School of Engineering - University of Yaounde I, India

Abstract- This paper proposes a method for the choice of the injection node of an incoming power plant into an existing grid. The southern interconnected grid (SIG) of Cameroon is used as an example to demonstrate the advantages of using the proposed methodology.

Given that the minimization of transmission losses constitutes a major cost-saving factor in electricity delivery, this work starts with the hypothesis that, if a power injection busbar is chosen within the existing grid such that the overall transmission losses are kept at a minimum, then it will be close to the load center, it will take care of the capability of the existing network to accommodate the new power injection, it will lead to increased reliability of power supply to several loads by providing for alternative supply routes, as well as result in a good voltage profile in the entire network. This paper therefore presents an approach for the determination of the power injection node of the lastly commissioned 216-MW Kribi natural gas thermal plant in Cameroon, based on the minimization of the overall network power losses.

Keywords: power injection node, minimum network losses, newton-raphson, SIG, songloulou, kribi natural gas thermal plant, cameroon.

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CHOOSINGTHEPOWERINJECTIONNETWORKNODEBASEDONOVERALLMINIMUMLOSSESTHECASEOFTHE216MWKRIBINATURALGASPOWERPLANTINTHESOUTHERNINTERCONNECTEDGRIDOFCAMEROON

Choosing the Power Injection Network Node based on Overall Minimum Losses: The Case of the 216-MW Kribi Natural Gas Power Plant in the Southern Interconnected Grid of Cameroon

Tabe Moses [α], Tchuidjan Roger [σ], Ngundam John [ρ] & Manfouo Hervé [ω]

Abstract- This paper proposes a method for the choice of the injection node of an incoming power plant into an existing grid. The southern interconnected grid (SIG) of Cameroon is used as an example to demonstrate the advantages of using the proposed methodology.

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A Newton-Raphson load-flow solution with 34 busbars for the SIG of Cameroon is first developed in MATLAB, the overall network losses computed for successive injection into each of the existing network nodes, and the power injection busbar for the newly constructed 216-MW Kribi natural gas power plant determined based on the aforementioned criterium. It is observed that the injection node is close to the densely populated industrial city of Douala and the 384-MW reference hydropower plant of Songloulou can run with its full capacity. A comparison with the current interconnection busbar at Mangombe reveals that the cheaper hydro-generation of Songloulou must be reduced by about 76 MW to accommodate the more expensive incoming 216 MW from Kribi in the grid, and the overall network losses are increased by 73 MW. This explains why the Dibamba 84-MW thermal plant in proximity to the current injection node has been tripping off the network whenever Kribi gets connected with Songloulou running at its nominal output. Connecting at the node determined by this method thus makes additional 149 MW available for the consumer. Also, the injection mode determined with the new method is positioned in the SIG such that power supply to most of the loads is possible from two directions, thereby increasing supply reliability for such loads.

Keywords: power injection node, minimum network losses, newton-raphson, SIG, songloulou, kribi natural gas thermal plant, cameroon.

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I. Introduction

With the second highest hydroelectricity potential in Africa of over 50 GW for the already identified 110 potential sites, Cameroon promises to become a prime source of cheap renewable hydroelectricity both for her own economic growth and that of her northern neighbors like Nigeria, Chad, the Central African Republic (CAR), and even Niger. Power exchanges with southern neighbors like Congo, Gabon and Equatorial Guinea should also become necessary for improvement of reliability and sub-regional security. The development of new generation plants dictates a careful choice of the corresponding power injection busbar to ensure the most cost effective solution. The connection point of a new power plant into an existing grid has been given little scientific attention in the relevant literature, focus being given mainly to the determination whether the existing grid is capable of accommodating the new power injection, or what modifications would be required for that, and at what cost. With this approach, only a few busbars close to the targeted main load centre get considered for power injection. In Cameroon, the cost of the interconnection link and the proximity of the interconnection point to an existing supervisory control center have been advanced by the power utility corporation as additional reasons for the choice of a specific power injection node.

Recent problems in the Cameroonian grid with a total generation capacity of little over 1,000 MW and an 84-MW plant being tripped off upon connection of the new 216-MW Kribi plant have led the power unit research team of the National Advanced School of Engineering of the University of Yaounde I to carry out this study and provide more scientific insight into the phenomenon, as well as propose appropriate remedies.

Such proposals promise to be of particular interest in Cameroon whose political leadership aspires to bring the country to economic emergence by the year 2035 with an estimated electrical power consumption of about 6,000 MW [6] by then.

The methodology used consists of determining a load-flow solution for the entire SIG and then using the

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results to compute the overall transmission losses within the grid. This is first done without the incoming Kribi gas power plant. Kribi is then connected successively to all the busbars of the SIG, starting with the current situation of connection at Mangombe, and then comparing the overall losses for all the scenarios. The scenario with the least overall grid transmission losses is determined as the optimum node for the connection of the incoming power plant. For this purpose, a two-level program has been developed that uses the Newton-Raphson method first for the calculation of the load-flow and then a second level uses the load-flow results to compute the total transmission losses for the various injection nodes. The computation methods are presented below.

II. Application of the Newton-Raphson Method to Obtain the Load Flow Solution of the Southern Interconnected Grid of Cameroon [2,3, 5,9,10]

With the Newton-Raphson method the voltage magnitudes and angles at the various busbars are adjusted, causing variations in power until the residual deviation from the set values is reduced to zero. This method results from the development of the Taylor series for an equation f(x) = 0, when successive values are computed from an initial first order approximation as follows:

$$f(x) \approx f(x^k)+f'(x^k).(x^{k+1}-x^k) = 0 \quad (1)$$

Where
$$f'(x) = \frac{\partial f}{\partial x} \quad (2)$$

f′(x) is the Jacobian matrix of f(x). Starting with an initial value x^0, corrections Δx^k are obtained by solving the following system of linear equations:

$$-f'(x^k).\Delta x^k = f(x^k) \quad (3)$$

The new values x^{k+1} are obtained from the relation:

$$x^{k+1} = x^k + \Delta x^k \quad (4)$$

In the test grid, voltage magnitudes and angles have been adjusted based on the following two equations [9]:

$$\Delta P_i = P_i^{spe} - P_i^{cal} = V_i \sum_{j=1}^{n} V_j (G_{ij} \cos\theta_{ij} + B_{ij} \sin\theta_{ij}) \quad (5)$$

$$\Delta Q_i = Q_i^{spe} - Q_i^{cal} = V_i \sum_{j=1}^{n} V_j (G_{ij} \sin\theta_{ij} - B_{ij} \cos\theta_{ij}) \quad (6)$$

With this notation, and dividing the Jacobian matrix into sub matrices, the load-flow problem becomes:

$$\begin{bmatrix}\Delta P\\ \Delta Q\end{bmatrix}^k = \begin{bmatrix}H & N\\ M & L\end{bmatrix}^k . \begin{bmatrix}\Delta V\\ \Delta\theta\end{bmatrix}^k \quad (7)$$

Dividing the variable ΔV by V delivers:

$$\begin{bmatrix}\Delta P\\ \Delta Q\end{bmatrix}^k = \begin{bmatrix}H & N\\ M & L\end{bmatrix}^k . \begin{bmatrix}\frac{\Delta V}{V}\\ \Delta\theta\end{bmatrix}^k \quad (8)$$

The system is thus described by the following matrix equation:

$$\begin{bmatrix}\theta\\ V\end{bmatrix}^k = \begin{bmatrix}\theta\\ V\end{bmatrix}^k + \begin{bmatrix}\Delta\theta\\ \Delta V\end{bmatrix}^k \quad (9)$$

Where:
$$H_{ij} = \frac{dP_i}{d\theta_j}, M_{ij} = \frac{dQ_i}{d\theta_j}, \quad N_{ij} = \frac{dP_i}{dV_j}.V_j, L_{ij} = \frac{dQ_i}{d\theta_j}.V_j, \quad (10)$$

The Jacobian matrix contains the following elements [10]:

For i = j:

$$\begin{aligned} H_{ii} &= -Q_i - B_{ii}.V_i^2,\\ M_{ii} &= P_i - G_{ii}.V_i^2,\\ N_{ii} &= P_i - G_{ii}.V_i^2,\\ L_{ii} &= Q_i - B_{ii}.V_i^2 \end{aligned} \quad (11)$$

For i ≠ j

$$\begin{aligned} H_{ij} &= V_i.V_j (G_{ij} \sin\theta_{ij} - B_{ij} \cos\theta_{ij}),\\ N_{ij} &= V_i.V_j (G_{ij} \cos\theta_{ij} + B_{ij} \sin\theta_{ij}),\\ L_{ij} &= H_{ij},\\ M_{ij} &= -N_{ij}, \end{aligned} \quad (12)$$

The values for active and reactive power at the busbars are obtained from the following relations:

$$P_i = \sum_{k=1}^{n} |V_i||V_k||Y_{ik}| \cos(\delta_k - \delta_i + \gamma_{ik}) \quad (13)$$

$$Q_i = -\sum_{k=1}^{n} |V_i||V_k||Y_{ik}| sin(\delta_k - \delta_i + \gamma_{ik}) \quad (14)$$

Each iteration $\left[\Delta\theta,\ \frac{\Delta V}{V}\right]$ is calculated by solving equation system (3). The process ends when $|\Delta P| \leq \varepsilon$ and $|\Delta Q| \leq \varepsilon$ (where ε is the specified tolerance, often in the order of 10^{-3}).

In this work the Newton-Raphson method has been applied with a MATLAB program to the SIG as depicted in the following flow chart:

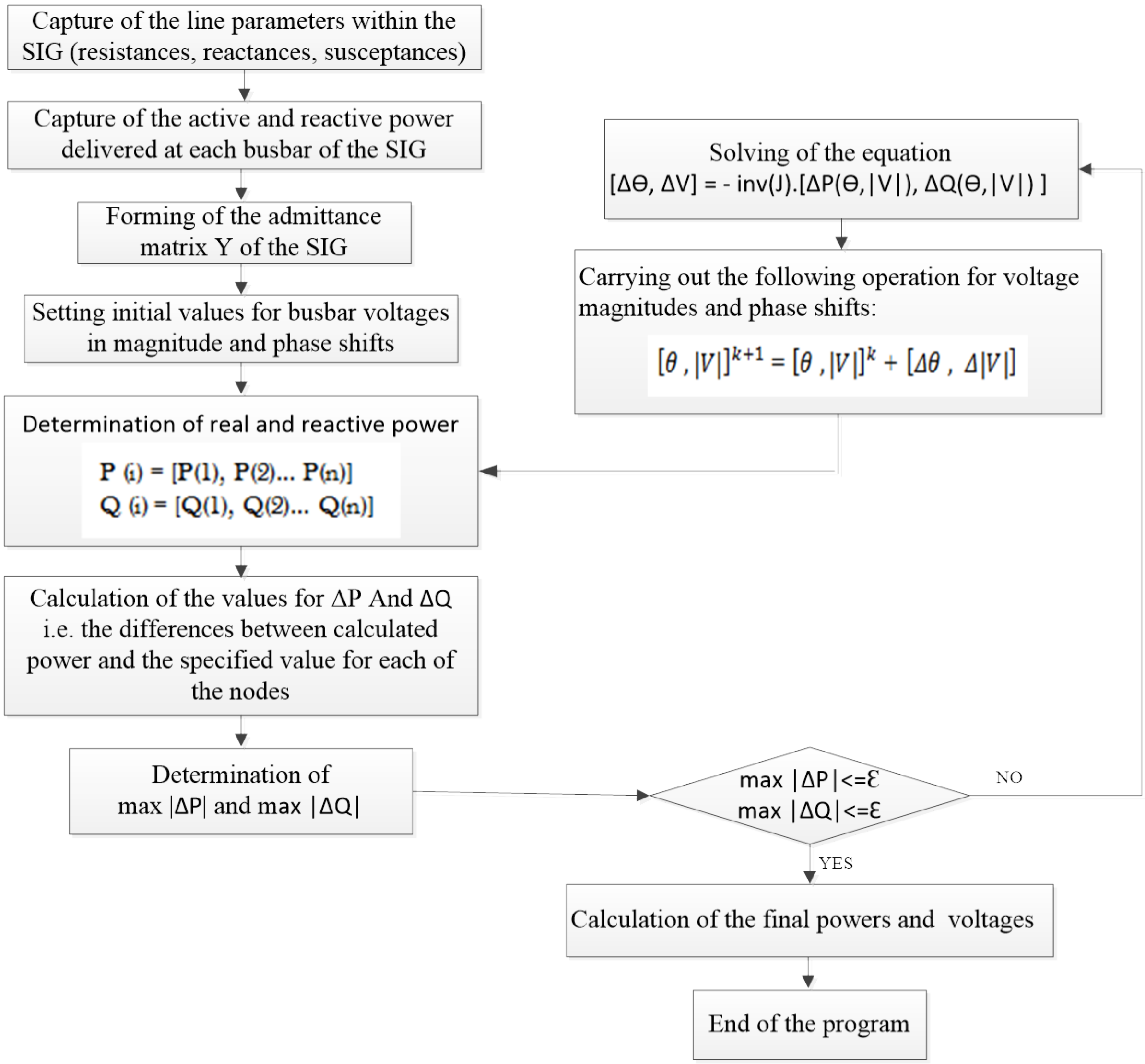


Figure 1 : Flow chart of the Newton-Raphson's method[8, 7]

III. Programming and Use of the Newly Developed Software

The developed software is used to compute the load-flow in the SIG. The level of exactitude of the results is verified using the IEEE 14-bus test network. The load-flow results are hence used to determine the overall transmission losses for that scenario. The software then connects the incoming 216-MW Kribi gas power plant successively to all the busbars of the network and determines the overall transmission losses for each scenario. By comparison of the transmission losses of the various scenarios, the optimum point of new power injection is determined as that for which the total transmission losses are least. In this part a presentation is made on how the software has been written in MATLAB version 7.8.0 and how it is used. The software comprises two menus, the first for load-flow and the second for the determination of transmission losses.

a) The menu for load-flow calculation

The software requires an input of all the electrical parameters of the grid under study, i.e. the SIG of Cameroon in this case. These parameters are:

- The total number of busbars;
- The total number of generation busbars (PV buses);
- The total number of load busbars (PQ buses);

- The complete electrical parameters of each busbar, viz:
  - For the slack bus: the voltage magnitude;
  - For generation busbars (PV buses): the generated and delivered active power, the generated and delivered reactive power and the voltage magnitude;
  - For load buses (PQ buses): the incoming and outgoing active power, the incoming and outgoing reactive power, and also the reactive power injected by shunt capacitors, where applicable;
- The interconnection lines in the grid with their electrical parameters (resistances, reactances, susceptances).

After processing the input data above, the software outputs the following results:

- The complete parameters of each of the busbars of the SIG, namely:
  - The active and reactive power injected at each busbar;
  - The voltage magnitude at each busbar;
  - The phase shifts of the various busbar voltages in degrees and radians;
  - The voltage phasor at each busbar;
  - The apparent power injected at each busbar.
- Using the determined complete parameters of all the busbars, the power-flow and transmission power losses are computed and displayed in absolute and relative values.

b) Determination of power-flow and transmission losses within the network [1, 8]

The π model of the transmission is chosen here for the analyses. Firstly, it is assumed that the power-flow is from node i to node j and the apparent power-flow is computed. The opposite direction is then assumed for the flow of power and again the corresponding value for the apparent power determined.

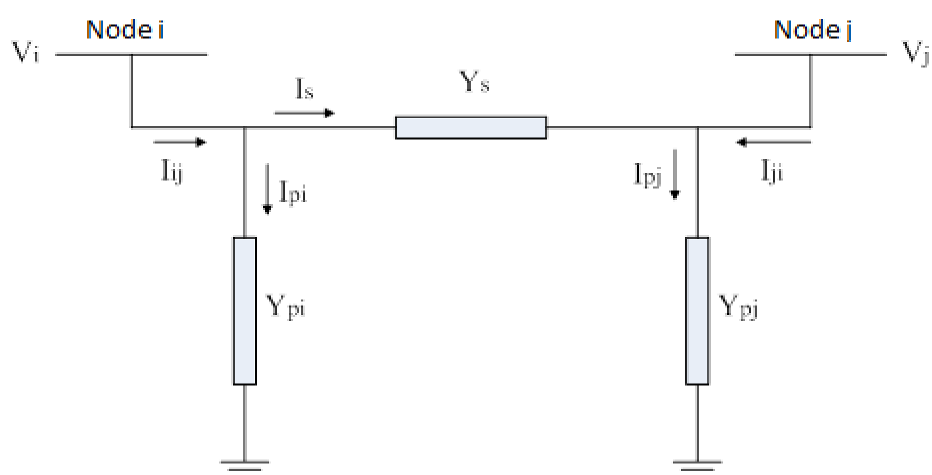


Figure 2 : π-Model of the transmission line [1]

Considering that the current I_{ij} is positive in the indicated direction, then:

$$I_{ij} = I_s + I_{pi} = Y_s(V_i - V_j) + Y_{pi} V_i \quad (15)$$

Similarly, it can be written for the current I_{ji} in the direction shown:

$$I_{ij} = Y_s(V_j - V_i) + Y_{pj} V_j \quad (16)$$

The complex power-flow S_{ij} and S_{ji} as viewed from the busbar i towards busbar j, and from busbar j towards busbar i, can be written:

$$S_{ij} = V_i I_{ij}^* \quad (17)$$

$$S_{ji} = V_j I_{ji}^* \quad (18)$$

The apparent power loss in this network branch (i.e. between nodes i and j) is therefore:

$$\Delta S_{ij} = S_{ij} + S_{ji} \quad (19)$$

The overall losses within the network are hence obtained by summing up the losses in all the network branches.

The percentage loss is thereafter calculated using the relationship:

$$\Delta P_{\%} = \frac{\Delta P}{\sum P_{inj}} * 100\,\% \quad (20)$$

$\Delta P_{\%}$: Relative percent active power lossin the network;

ΔP: Total percent active power loss in the network;

$\sum P_{inj}$: Sum total of active power injections into the network (i.e. differences between generated active power and consumed active power) at each generation busbar, including those of the slack bus.

c) Second Menu: Determination of the optimum interconnection point of an incoming power plant into an existing electricity grid

In this part the software needs:

- The complete parameters of the existing network before the connection of the new power plant as described in part 3-1;
- The parameters of the new plant to be connected, which are:
  - Its generated active power.
  - Its generated reactive power.
  - Its generated voltage.

The procedure used to determine the optimum point of power injection into the existing network by the new power plant is as follows:

i. The software connects the incoming power injection successively to each of the busbars of the existing network, with the exception of the slack bus. The slack bus at Songloulou remains the reference bus throughout the entire process. Noteworthy is however that:

- ✓ If the injection node is a PV bus, then it will remain a PV bus. The active and reactive powers generated by the new plant add to the values of the existing grid. The busbar voltage on the other hand remains same as before connection.
- ✓ If the busbar to which the incoming plant is connected is a PQ bus, it is automatically transformed into a PV bus. The generated powers (active and reactive) of the PV bus thus obtained are those of the incoming plant; the active and reactive powers consumed at the busbar remain the same as the values prior to the connection of the new plant. In this case the number of PV buses increases by one, and at the same time the number of PQ buses reduces by one.

ii. After the connection of the new plant to any busbar of the network, the software calculates the load-flow for the new network configuration using the same methodology as in part 3-1 above. It determines the power-flow and power losses in all network branches and uses that to compute the losses in all the network branches, as well as the percentage power losses. This software thus implements the same operations connecting (after having connected to the preceding busbar) this plant to another node, and as so on, until connection has been done to all the busbars of the network, except the slack bus.

iii. For every connection of the incoming plant to all the busbars of the network, and after performing the load-flow and transmission loss determination in each of the cases, the program stores the percentage losses.

iv. The node with the least value for the percentage loss is thus the optimum point for the power injection by the incoming power plant.

- After performing these operations, the results displayed by the program are as follows:
- A graph showing the percentage losses as a function of the various injection points. After determination of the various percentage losses following the connection of the incoming power plant onto all the busbars of the network, the program draws and displays the graph presenting these losses as a function of various injection nodes. This provides a visual guide permitting the user to judge and decide at a glance on the best power injection busbar.
- Also displayed are the overall losses after connecting the incoming plant to the busbar delivering minimum losses. This delivers an instant evaluation of the influence of connecting the new plant to that particular busbar.
- Power savings as a result of injection at the node delivering minimum overall network losses are also displayed. With a knowledge of the power losses before and after the injection at the busbar delivering minimum losses, the energy savings (these could theoretically be positive or negative!) due to the new choice of the injection nodeare made available.

IV. Application to the Southern Interconnected Grid (SIG) of Cameroon: The Case of the New 216-MW Kribi Gas Power Plant

The southern interconnected grid (SIG) of Cameroon consists of 34 busbars of which one (01) is the reference busbar, eleven (11) are generator busbars and twenty two (22) are load busbars. With two hydropower plants in Songloulou (384 MW) and Edea (264 MW), and three main thermal plants in Limbe (84 MW), Dibamba (86 MW) and the lastly commissioned 216-MW Kribi gas power plant, it produces and handles over 90% of the total consumption of electrical energy in Cameroon. There are also a few diesel driven plants that are used only for short peaking periods.

Without the new Kribi plant and the peaking thermal plants, the southern interconnected grid of Cameroon can be considered in a simplified manner from the SCADA substation of Mangombe as a radial network with two main axes supplying Yaounde and Mbalmayo on the one hand, and Nkongsamba, Bafoussam through to Bamenda on the other hand. This simplification is permissible since all the supplying plants, but for Limbe, are at a distance of less than 80 km (i.e. are linked with electrically short lines!) to Mangombe. The single-line diagram in that case would be as shown below:

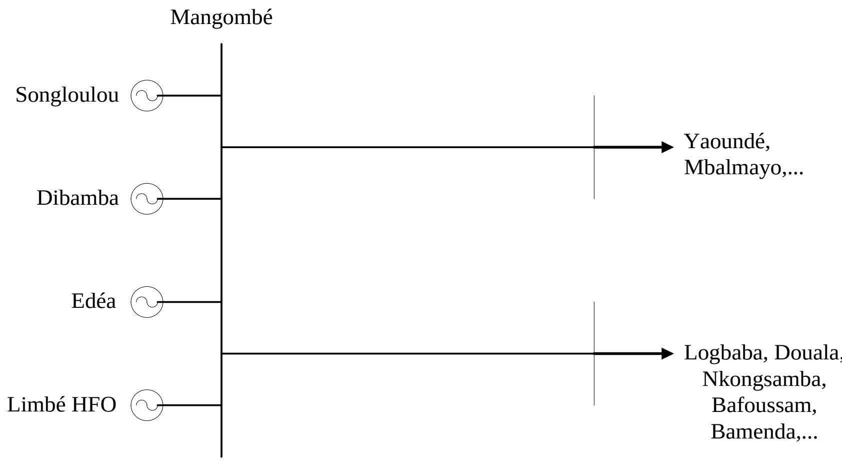
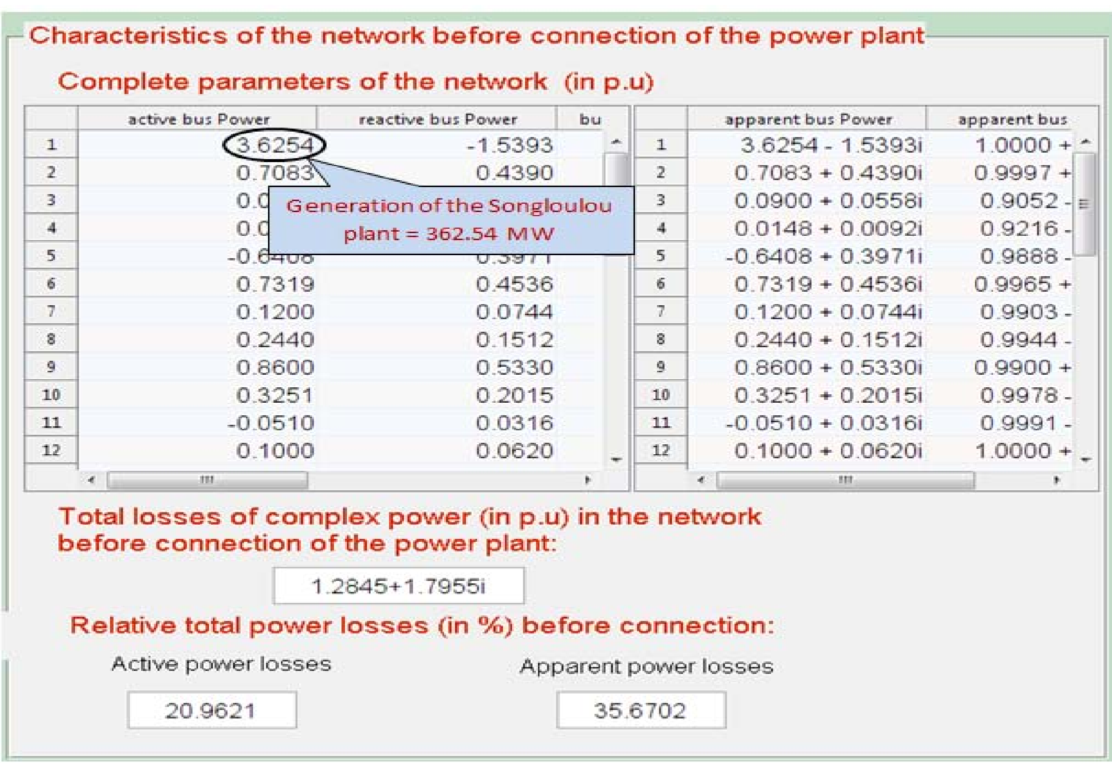


Figure 3 : Simplified one-line diagram of the RIS without the Kribi gas power plant

This diagram of Figure 3 shows the four main generating plants of the SIG connected to the SCADA substation of Mangombe, with two main emanating power corridors, one towards Mbammayo through Yaounde and the other towards Bamenda through Logbaba, Douala, Nkongsamba and Bafoussam. A simulation of this network with the newly developed software tool reveals that the overall losses are at the high level of almost 21% for active power and almost 36% for apparent power. This is far above the recommended highest value of 10% for active power [4], and leads not only to high operational costs but also to big voltage drops within the network.



Characteristics of the network before connection of the power plant

Complete parameters of the network (in p.u)

	active bus Power	reactive bus Power	bu
1	3.6254	-1.5393	
2	0.7083	0.4390	
3	0.0		
4	0.0		
5	-0.6408	0.3971	
6	0.7319	0.4536	
7	0.1200	0.0744	
8	0.2440	0.1512	
9	0.8600	0.5330	
10	0.3251	0.2015	
11	-0.0510	0.0316	
12	0.1000	0.0620	

Generation of the Songloulou plant = 362.54 MW

	apparent bus Power	apparent bus
1	3.6254 - 1.5393i	1.0000 +
2	0.7083 + 0.4390i	0.9997 +
3	0.0900 + 0.0558i	0.9052 -
4	0.0148 + 0.0092i	0.9216 -
5	-0.6408 + 0.3971i	0.9888 -
6	0.7319 + 0.4536i	0.9965 +
7	0.1200 + 0.0744i	0.9903 -
8	0.2440 + 0.1512i	0.9944 -
9	0.8600 + 0.5330i	0.9900 +
10	0.3251 + 0.2015i	0.9978 -
11	-0.0510 + 0.0316i	0.9991 -
12	0.1000 + 0.0620i	1.0000 +

Total losses of complex power (in p.u) in the network before connection of the power plant:

1.2845+1.7955i

Relative total power losses (in %) before connection:

Active power losses: 20.9621

Apparent power losses: 35.6702

Figure 4 : Results of the simulation of the SIG without the 216-MW Kribi plant

Connecting the incoming Kribi gas power plant onto the Mangombe 225 kV busbar delivers the modified single-line diagram, still of a radial network, shown below:

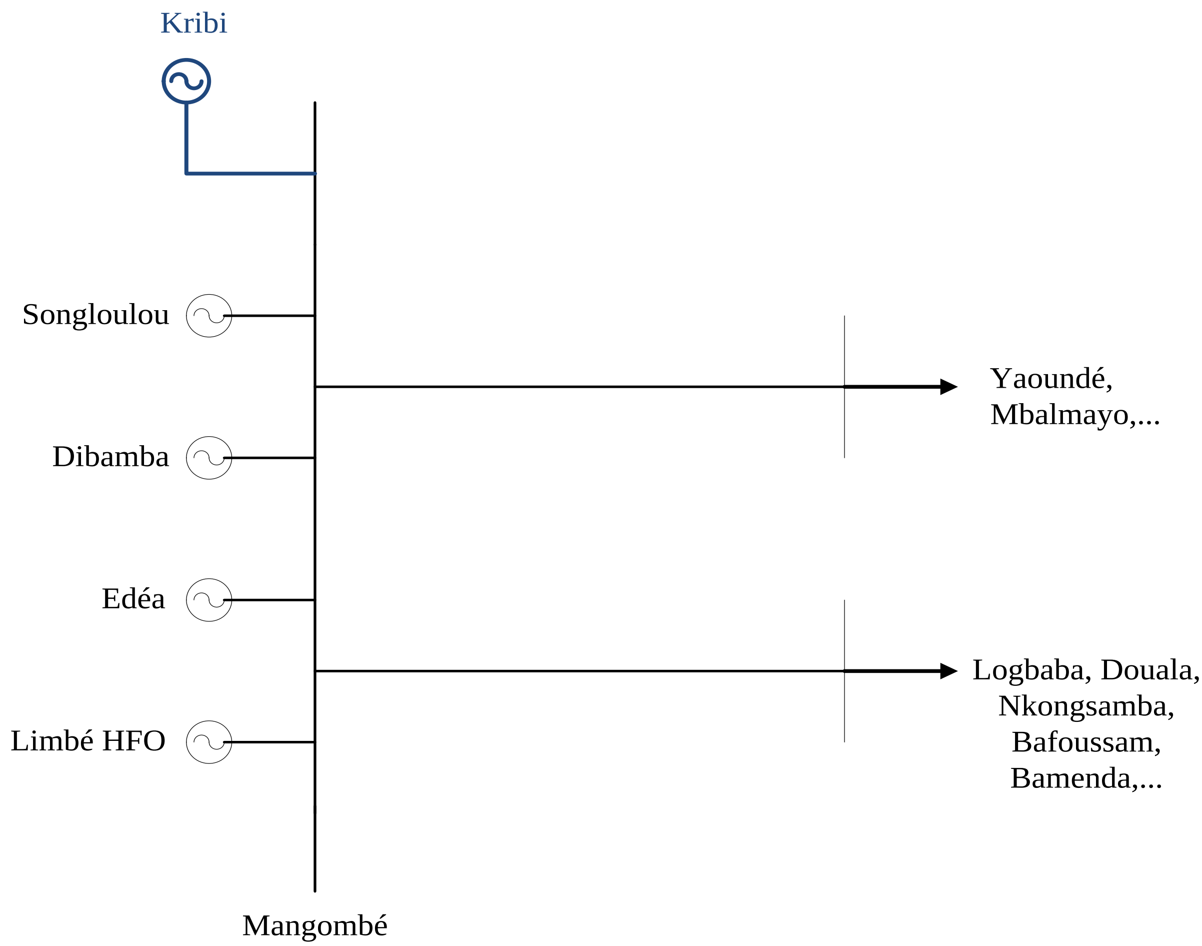


Figure 5 : Simplified one-line diagram of the SIG with Kribi connected to Mangombe

The simulation of this new grid configuration with the new software delivers higher losses than without Kribi connected. The relative active losses climb up from 21 % to 25 %, while the apparent losses move from 36 % to over 38 %.

Also noteworthy is that the generation of the biggest hydropower plant in the SIG, which is serving in the simulations as reference plant, is reduced by almost 91 MW automatically to keep the steady-state stability of the grid. From the point of view of exhausting the cheap hydropower generation for base-case load before turning over to the more expensive forms of electricity generation, this reduction is unacceptable in practice. It has been observed that the connection of Kribi to Mangombe provoked the disconnection of Dibamba, leading to modifications in the sensitivity of supervisory control and protection equipment by the utility company to accommodate the incoming plant. Even though this measure has made it possible to have Kribi running simultaneously with the other four plants, the new software reveals that the price to pay is increased transmission losses of almost 4 %, with a potentially weakened protection scheme.

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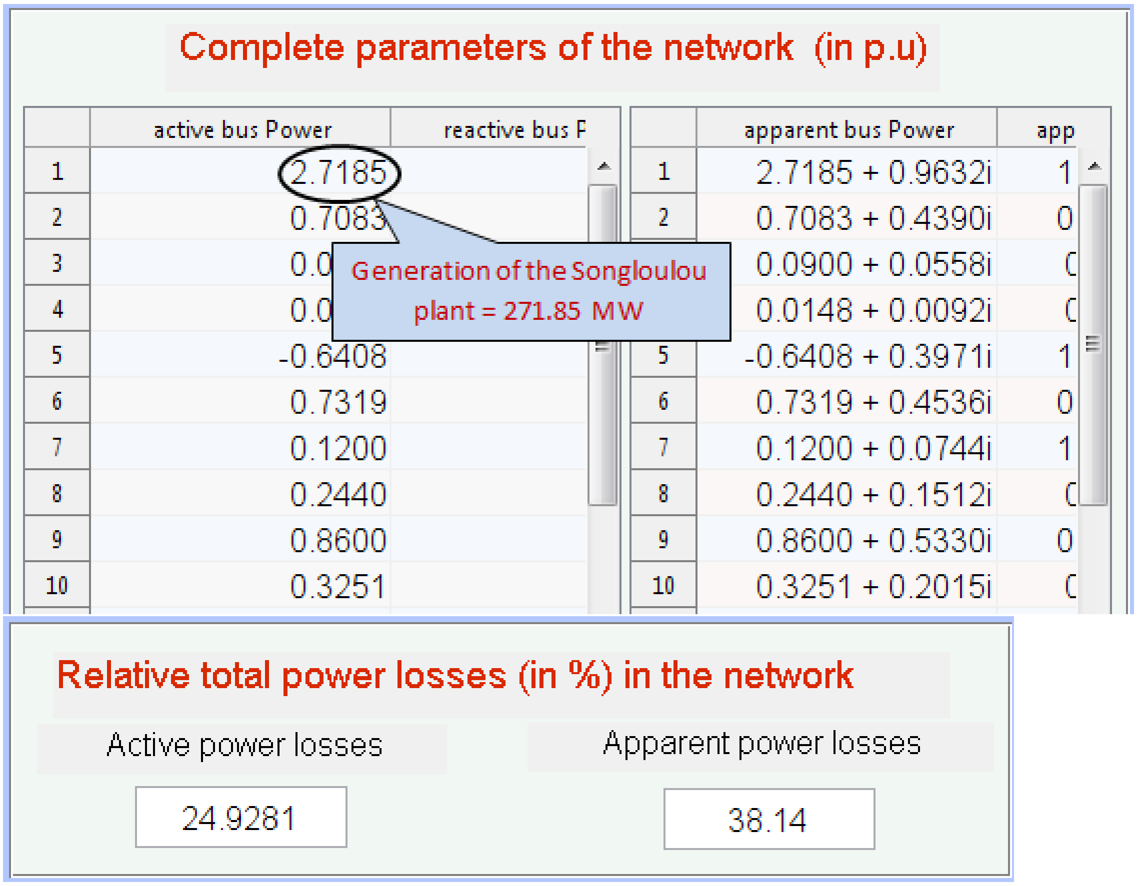

Figure 6 : Results of the simulation of the SIG after the connection of Kribi to Mangombé

Given the above results, the second menu of the new program is used to determine the injection node that produces the smallest overall losses in the SIG. For that purpose, Kribi is connected successively to all the busbars and the overall losses for each scenario computed. Figure 7 below shows a plot of the overall loss per site. Mangombe 225 kV is here site number 22 with a total relative loss of 24.93 %. Node 20 presents the least overall relative loss of 16.14 %. This node is Logbaba 225 KV. This site is thus determined by the new software as the optimum point for power injection of the new 216-MW Kribi gas power plant. The voltage profiles for connection to Mangombe and connection to Logbaba are presented in Table 1 below for purposes of comparison. Although the profiles are generally acceptable for most of the busbars in both cases, i.e. deviations of less than 5 %, the maximum deviation from the nominal value observed at busbar 33 is in the case of connection to Mangombe (-10.78 %) far higher than in the case of connection to Logbaba (-4.42 %). Logbaba therefore clearly offers a better voltage profile in the network.

Table 1 : Voltage profiles for Kribi connected to Mangombe and to Logbaba

Voltage profile for Kribi connected to Mangombe busbar				Voltage profile for Kribi connected to Logbaba busbar			
Node number	Voltage magnitude (in p.u)	Node number	Voltage magnitude (in p.u)	Node number	Voltage magnitude (in p.u)	Node number	Voltage magnitude (in p.u)
1	1	18	0.9947	1	1	18	0.9908
2	1	19	1.0099	2	1	19	0.9881
3	1	20	0.9893	3	1	20	1.0219
4	1	21	0.9909	4	1	21	0.9967
5	1	22	0.9852	5	1	22	1.0159
6	1	23	0.9870	6	1	23	1.0011
7	1	24	0.9767	7	1	24	1.0142

8	1	25	0.9968	8	1	25	0.9968
9	1	26	0.9034	9	1	26	0.9034
10	1	27	0.9640	10	1	27	0.9601
11	1	28	0.9603	11	1	28	0.9603
12	1	29	1.0001	12	1	29	1.0001
13	1	30	0.9981	13	1	30	0.9738
14	1.0396	31	0.9717	14	0.9996	31	0.9717
15	0.9880	32	0.9934	15	0.9947	32	0.9934
16	0.9980	33	0.8922	16	1.0099	33	0.9558
17	0.9929	34	1.0001	17	0.9887	34	0.9902

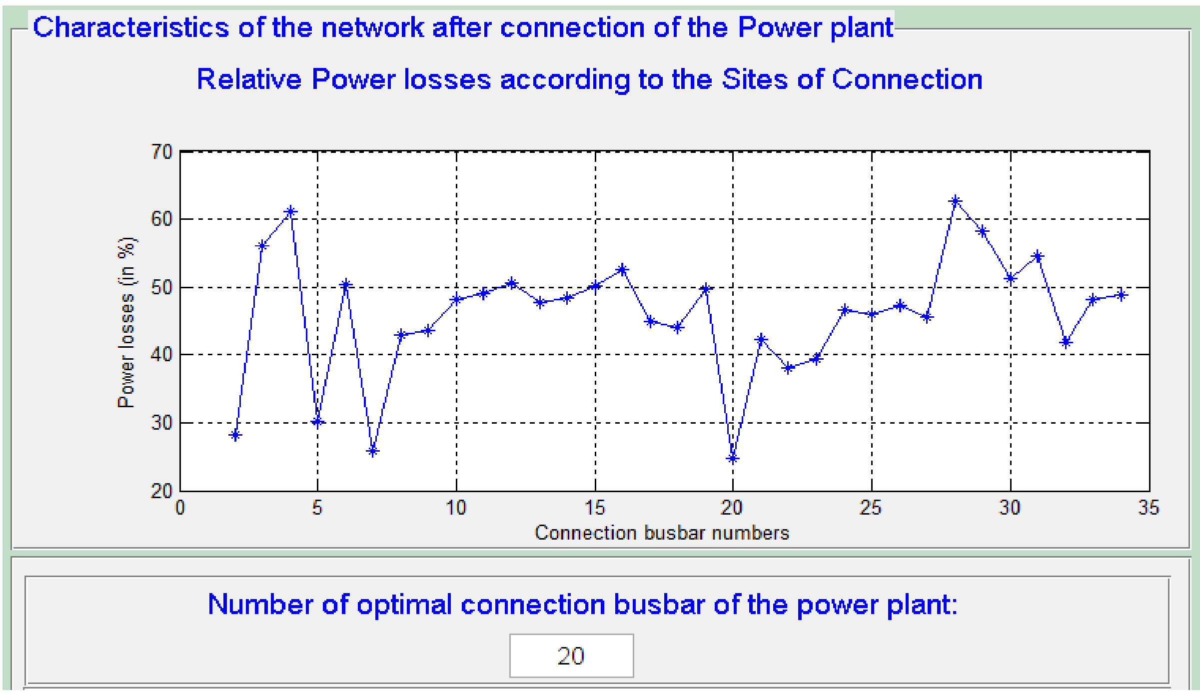

Figure 7 : Results obtained after successively connecting Kribi to all the busbars of the SIG

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Below are the results obtained when Kribi is connected to the Logbaba 225 kV busbar:

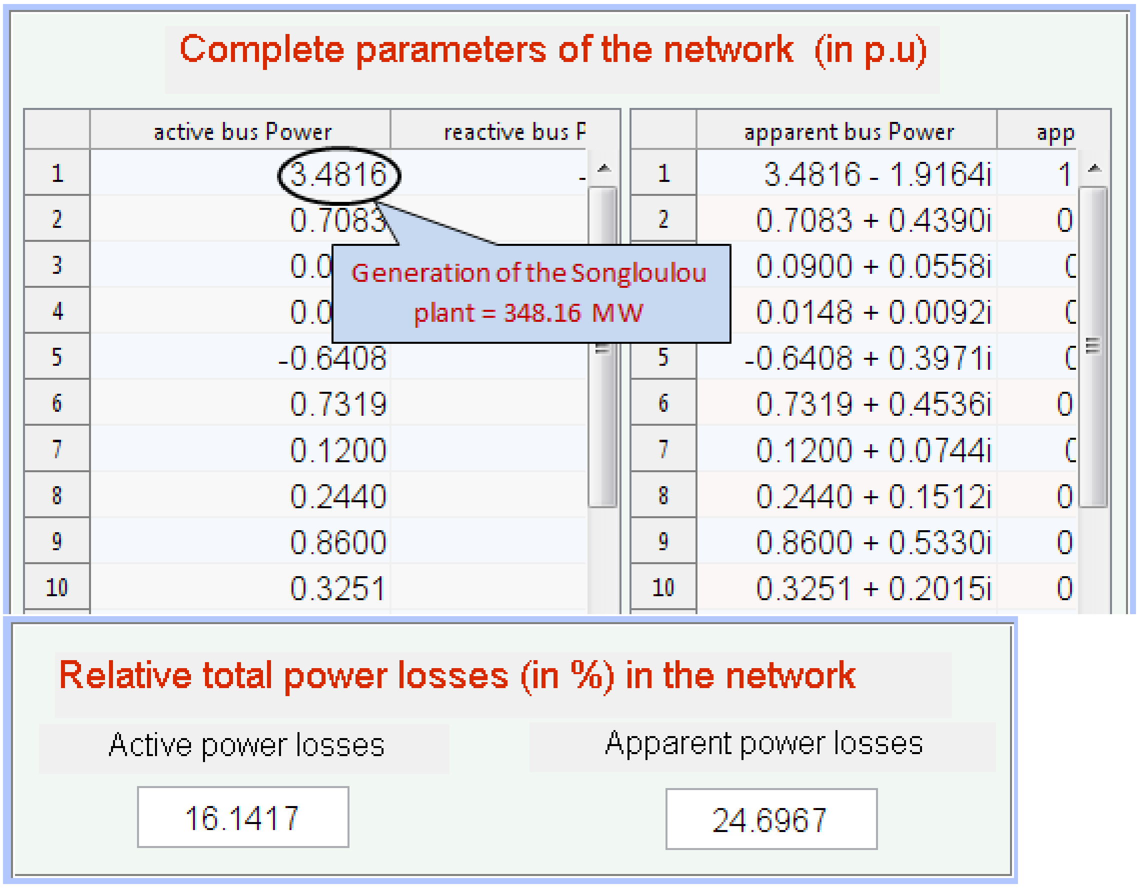

Figure 8 : Results of the simulation of the SIG after connection of Kribi to Logbaba

These results reveal that the cheaper generation of the reference Songloulou hydropower plant increases by 76.31 MW compared to the case when Kribi is connected to Mangombe. In addition, the total relative losses reduce by 8.78 %, corresponding to 72.82 MW. Therefore a total of 149.13 MW of power is made additionally available to the consumer simply by making the right choice of the power injection node with the proposed algorithm as done with the newly developed software, while gaining additionally in voltage profile and supply reliability.

Connecting Kribi to Logbaba modifies the simplified SIG to look thus:

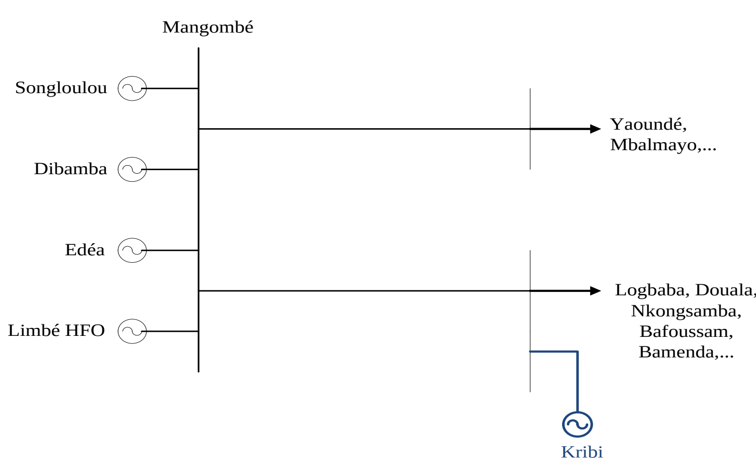

Figure 9 : Simplified one-line diagram of the SIG obtained by connecting Kribi to the Logbaba 225 kV busbar

It is evident that power supply now becomes possible from two directions creating the possibility not only to keep all the power plants running at nominal power, but also to increase the reliability of the power supply within the entire grid, while keeping the transmission losses at a minimum.

V. Conclusion

Points of injection of generated power into existing grids have been based on the power reception capability of the existing local network and the cost minimization of the interconnection link between the new power plant and the injection point close to the main load centre. Using the example of the most recent power plant commissioned in Cameroon, this paper establishes that when the minimization of the overall network losses is set as main criterion for the determination of the power injection node, a solution is obtained that not only takes care additionally of the power handling capability of the local network, but also delivers a good voltage profile while increasing supply reliability. For that purpose, a load-flow solution in MATLAB for the 34-busbar southern interconnected grid of Cameroon has been developed, tested and confirmed with results of the 14-bus IEEE test network. It is then used to determine the total transmission losses of the grid. The minimization of the overall grid transmission losses being a major cost saving factor in grid operation, this method will henceforth prove very useful in generation expansion projects.

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Performance Analysis of Quantum Dot Intermediate Band Solar Cell (QD IBSC)

By Nezam Uddin, Md.Motiur Rahman, Tanvir Ahmed & Atiqulislam
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Abstract- Now-a-days quantum dot intermediate band solar cell (QD IBSC) is the most promising approach for increasing the efficiency of the solar cell. In this paper InxGa1-xN &GaAs based p-i-n reference cell and quantum dot intermediate band solar cell where AlxGa1-xAs is used in window layer have been studied for high efficiency and evaluated the performance with various parameters. Here quantum dots of InAs&InN are placed in the i-layer of p-i-n reference cell. V-I characteristics of p-i-n reference cell using GaAs, AlxGa1-xAs is observed & maximum efficiency & the short circuit current density is found 32.87% & 350 A/m2 respectively. Also an increased efficiency of 41.45% & short circuit current density of about 466.07 A/m2 is to be found for same structure using InxGa1-xN material. Maximum efficiency & short circuit current is to be found 58.77% & 649 A/m2 respectively for InxGa1-xN based QD IBSC and 51.59% & 543.36 A/m2 for GaAs based QD IBSC respectively. Comparing all the results we have found that InxGa1-xN based Quantum dot intermediate band solar cell offers the better efficiency.

Keywords: reference cell, QD IBSC, window, solar cell efficiency.

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I. Introduction

The average worldwide power consumption was 1.6×10^{13} W in 2006 [1]. Every day the total solar radiation incident on earth at sea level is approximately 2×10^{17} W, which is over 12500 times the average worldwide power consumption in 2006. This shows the solar energy hasgreat potential in supplying energy to the world in comparison with the fossil fuel. But the drawback of Solar Cell is its high cost per KWH of energy production resulting from low efficiency. The efficiency limit of conventional single gap solar cells is 40.7%.The intermediate band solar cell (IBSC) is a new photovoltaic device with a 63.2% theoretical efficiency limit [2]. Because Intermediate band (IB) solar cells can increase the current of solar cells whereas the voltage would not be decreased [3].

In case of IBSC, the photons whose energy is below the band gap energy of the material can be exploited. This kind of absorption of below band gap energy photons takes place from the valence band to the intermediate band (IB) and from the IB to the conduction band [4]. For implementing the IBSC concept, there are two approach available. The most efficient approach is based on the use of quantum dots, the IB arising from the confined energy levels of the electrons in the dots. Quantum dots have led to devices that demonstrate the physical operation principles of the IB concept and have allowed identification of the problems to be solved to achieve actual high efficiencies[5]. For this purpose different combination of different materials can be used. To improve the efficiency InAs/AlGaAs QD-based IBSCs has been designed. It overcomes the problems encountered in InAs/GaAsQD-based IBSCs. In this paper the comparison between p-i-n reference solar cell and QD IBSC are performed by modeling the p-i-n reference solar cell as well as the QD IBSC with different materials.

II. Model of a Reference Cell with a Depleted I-Layer

In this paper a model of a single band gap reference p-i-n solar cell with anti-reflective coating (ARC), window, p+-, p, i, n and n+-layers is presented along with a model of an intermediate band solar cell. The model of the intermediate band solar cell contains the same layers as the reference cell, but with the i-layer now having an intermediate energy band in the band gap .Intermediate band can be formed by many ways, quantum dot intermediate band solar cell is one of them & it is the most promising approach to form intermediate band. In this paper the intermediate band can be created by introducing quantum dots to the i-layer. In this paper all the layers in the reference cell are made of GaAs, AlGaAs or InGaN. At the top of the cell we find the front contacts and an anti-reflective coating minimizing the reflection losses. A GaAs-cap layer is then placed as a barrier against oxidation since the following AlGaAs window layer oxides easily. This high band gap window layer reduces the front surface recombination. Beneath the window layer we find a heavily doped p+-layer which further reduces the front surface recombination. The p- and n-layers are then placed with an intrinsic layer sandwiched in between. A heavily doped n+-layer is placed beneath the n-layer to reduce the back surface recombination. At the bottom on the cell we find the substrate where the upper layers are deposited on and where the back contact is placed.

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Figure 1 : Structure of the p-i-n reference cell

III. Our Proposed Model

a) Materials used for the proposed model

Maximum efficiency of p-n solar cell is 22% [7] and for 3-layer p-i-n solar cell is to found 23.45% only from the MATLAB simulation result. But seven layer p-i-n reference solar cell offers high efficiency than both p-n and p-i-n solar cell. For the performance analysis we choose different materials for different layers for different types of solar cell. The materials used for the proposed model are given below.

Table 1 : Materials of the proposed model

Type of solar cell	Material used in all layer except window	Material used in window layer	Dot material
p-i-n reference	GaAs	AlGaAs	……..
p-i-n reference	InGaN	AlGaAs	……..
QD IBSC	GaAs	AlGaAs	InAs
QD IBSC	InGaN	AlGaAs	InAs

b) Proposed width of various layers

The variations of the width of different layers affect the performance of the solar cell. We choose a fixed width for different layers for the convenience of comparing the performance of different type of solar cells. The proposed width of various layers are given in table 2.

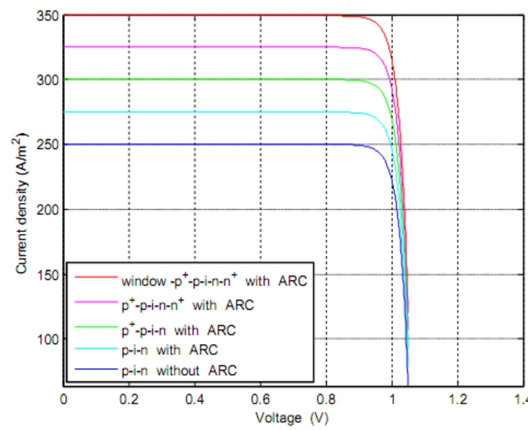
Table 2 : Proposed width of different layers

Layers	width(nm)
Window	5
p+	100
p	200
i	300
n	300
n+	100

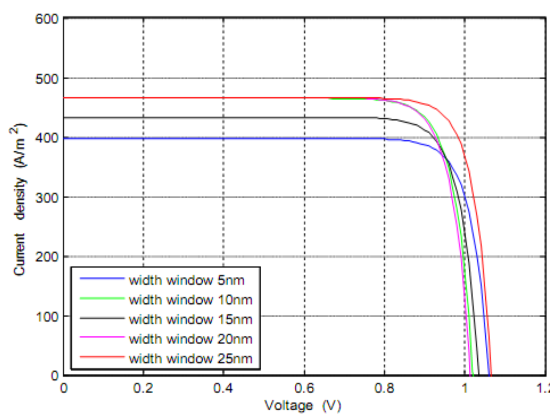
IV. Numerical Results and Discusion

a) Modeled device for p-i-n reference cell

The performance of the modeled device for p-i-n reference cell is shown here. From fig 2 we can see that, increasing the number of layer in solar cell, increases the efficiency. Here two devices p-i-n reference cell of GaAs, AlxGa1-xAs and InxGa1-xN are used.



(a)



(b)

Figure 2 : Current voltage characteristics of p-i-n solar cells with different additional layers for (a) AlGaAs at window layer & GaAs at other layer. (b) InGaN used in all layer except window layer

b) Modeled device QD IBSC

Here the modeled device of In Ga N and Ga As are used. The Intermediate band is depleted by quantum dot by the materials In As for Ga As and In N for In GaN. Increasing the width of the IB, the efficiency increases for both cases. But the efficiency is found more for In Ga N due to more short circuit current density which is due to additional carrier generation.

Performance of (a) QD IBSC (for dotmaterial InAs) and (b) InGaN based QD IBSC

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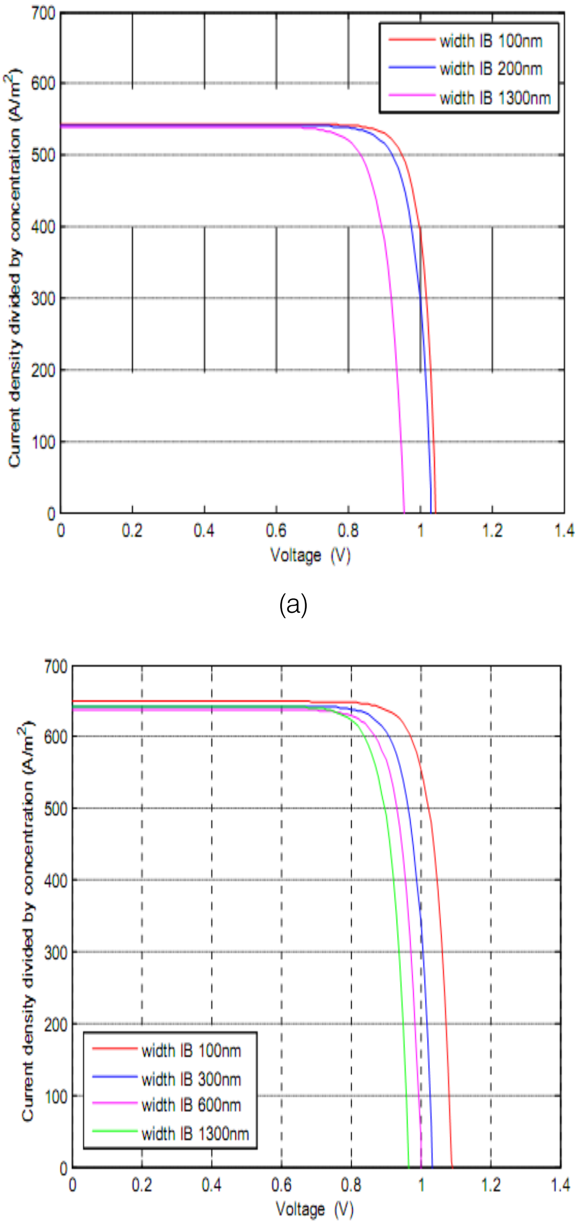

(a)

(b)

Figure 3 : Current-voltage characteristics of (a) QD IBSC for dot material InAs and (b) InGaN based QD IBSC for dot material InN

V. Comparision of the p-i-n Reference Cell & QD IBSC

From the VI characteristics curve we can calculate the efficiency of solar cell. The efficiency for different types of solar cell of different materials are shown in table 3.

Table 3 : Data for comparison of the p-i-n reference solar cell & QD IBSC

Type of solar cell	Material used in all layer except window	Material used in window layer	Dot material	Efficiency (%)
p-i-n reference	GaAs	AlGaAs	……..	32.87
p-i-n reference	InGaN	AlGaAs	……..	41.45
QD IBSC	GaAs	AlGaAs	InAs	51.59
QD IBSC	InGaN	AlGaAs	InN	58.77

VI. Conclusion

The model of the intermediate band solar cell contains the same layers as the reference cell, but with the i-layer now having an intermediate energy band in the band gap. Both of the solar cells are theoretically studied & their performance is evaluated by using MATLAB simulation. In case of p-i-n reference solar cell the efficiency is 32.87% for Ga As, Al Ga As material. We got increased efficiency of 10.87% for using InGaN in the i layer of the p-i-n reference solar cell than the GaAs, AlGaAs based p-i-n reference solar cell. In GaN has high mobility and low surface recombination velocity of 1000 cm/s than Al Ga As. So it has high photocurrent values and as well as high efficiency Dot material of InAs and InN having bandgap of 36eV and 0.70eV respectively are used. This small band gap dot is placed to the large band gap Ga As of 1.42eV. Short circuit current density & efficiency is increased for QD IBSC. Maximum efficiencies for QD IBSC using GaAs, Al GaAs and In GaN, Al GaN material system are found to be 51.59% and 58.77% respectively and performance evaluation against some parameter changes is also performed. An increased efficiency of about 7.18% for In GaN based QD IBSC is found than that of GaAs based QD IBSC. Summarizing all the simulation results we can conclude that In GaN based QD IBSC offers better efficiency.

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Designing of 3D Transistor based Home Appliances for Low Power Dissipation through Cost Analysis

By Prashant Kumar "FARSE" & Dr. Ajita Pathak
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Abstract- With the reference for need of human beings to develop the low power dissipation based device which operates in very low power and reduce the cost for operation and design of device. This paper is an attempt to introduce the reader into the world of VLSI Technology and its implementation on Fabrication for designing the device. Our endeavor is to create the new invention on device which features very low power dissipation and cost reduction in designing this type of transistor through fabrication process for starting the revolution in the field of consumer electronics.

Keywords: introduction, description of 3D transistor, critical role of transistor, application in home appliances, theoretical specification and analysis, practical specification and analysis, process of fabrication, result and conclusion.

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Keywords: introduction, description of 3D transistor, critical role of transistor, application in home appliances, theoretical specification and analysis, practical specification and analysis, process of fabrication, result and conclusion.

I. Introduction

The Electronic devices play a very important role in fabrication and designing through operation in VLSI Technology as the feature of Low Power Dissipation and Size Reduction in Device. This VLSI Technology provides the various future aspects for Low Power Dissipation and Cost Reduction in operation or design aspects for fabrication. This technology provides the platform for various Researchers to enable this technology operating on nano watts of power with very small size performing the features.

The fabrication of VLSI Technology based on the Compact Size, Integration of Components and packaged Multiple Components in a Silicon Chip with Silicon Vias Technology. The 3D Transistor provides the fabrication up to 16 nm technology through feasibility in consumer electronics based devices. The present Fabrication Technology which fabricates up to 32 nm of technology for designing the layout of transistor. The components used for fabrication of Home Appliances based device is a microcontroller based application that provides the key features for using very less components and reduction in size of transistors.

This technology provides the various concepts for designing aspect, low power dissipation and reduction in size for packaging of transistors. The packaging of transistor is based on various aspects for designing, small size and low power dissipation in transistor characteristics.

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II. Description of 3D Transistor

The 3D Transistor is the transistor that supports the 16 nm technology for designing aspects through packaging and integration density of Integrated Circuits. The 3D Transistor provides the technology for operating the home appliances based devices like Television, Cell Phone, Refrigerator, Air Conditioner, Computer Peripherals and Electronic Tablets to perform this technology with low cost design, transistor packaging and reduction in size of transistors. The term low cost design refers to that its manufacturing cost will be very less and it can be around 10% of original price. The design and implementation process for making 3D Transistor is based on the software based fabrication process which provides the novel 3D Transistor at 22 nm technalogy for provide the computer applications in microprocessor based devices. The 3D Transistor provide this features for 16 nm technology at home appliances based applications in microcontroller based devices. The 3D Transistor is the transistor that provides the VLSI Technology up to 22 nm size for microprocessor based devices and 16 nm for microcontroller based devices.

The 3D Transistor is based on Three Dimensional View for changing the structure of Gate with increasing its height and reducing its length for inventing the features of operation of two transistor in single Silicon Substrate. This terminology provide the various features for reduction in size, low power dissipation, less packaging density and easily designing of circuits that give the digital processing for operation of signals. The manufacturing device from this technology (3D Transistor) is based on digital aspects for analyzing and removes the analog system portion in the electronic circuits. This technology provide the easy level for processing of digital signals that would be much easier for analyzing and synthesizing the electronic circuits through this technology of 3D or FinFET Transistor in the application of consumer electronics based device. This 3D Transistor has shown similarities as FinFET Transistor because its size of "Gate" Structure which structured as "Fin" shape of fish that provide the practical aspects view for designing this type of transistor in different fabrication labs of different countries.

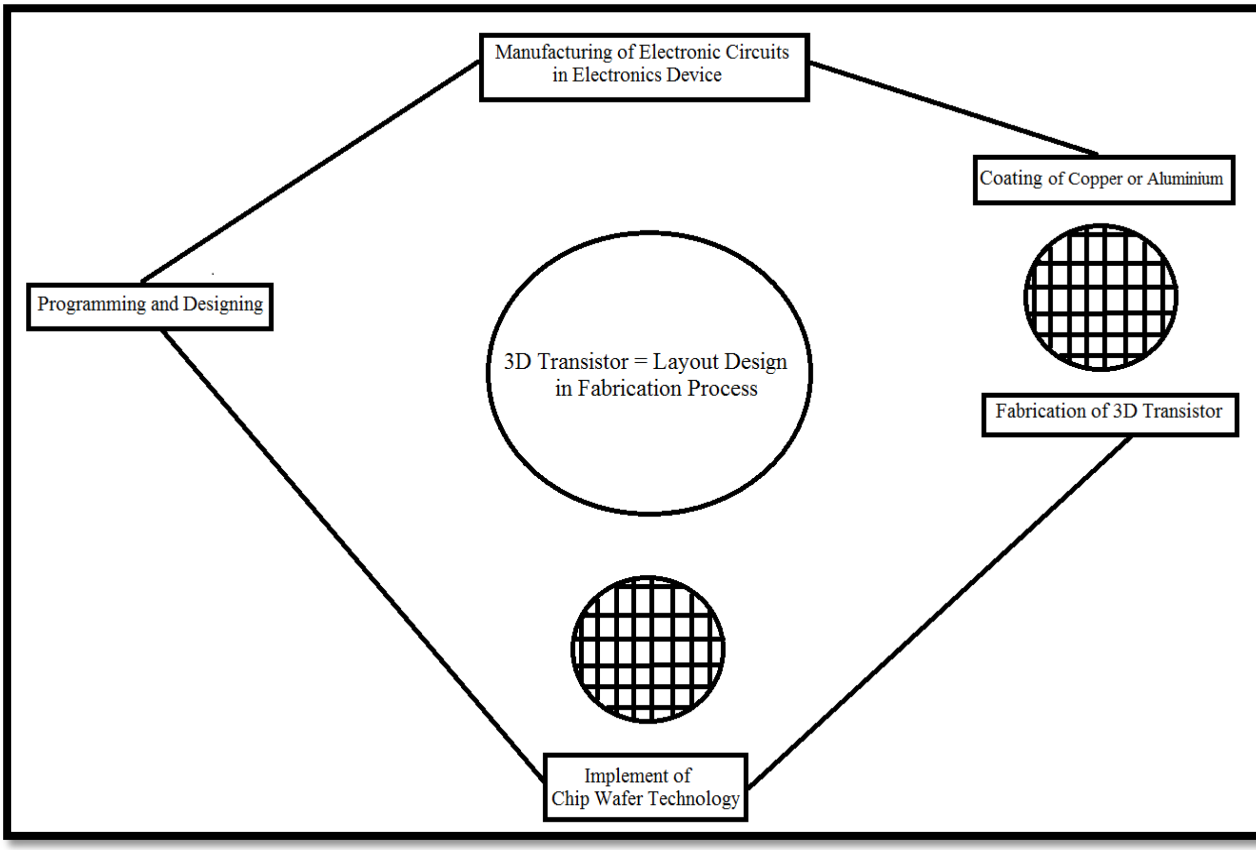

Figure 1 : Operation Process for 3D Transistor in Fabrication of Semiconductor Device

III. Critical Role of Transistor

The Critical Role of Transistor depends on the designing of "Gate" Structure which tends to change the structure of transistor for performing the new invention in this transistor that can work in all electronic circuits based on home appliances. This is the Critical Role of Transistor that performs the changing of Gate Structure provide the new structure and operation of this new innovative 3D Transistor.

In our Human Body, the Brain is the most essential and important organ for controlling all the body parts. This terminology also related with 3D Transistor for the designing of "Gate" Structure (main part of transistor) tends to change the structure, operations and size density of this innovative 3D Transistor which is applicable for operating a Home Appliances based device in the field of Consumer Electronics. The use of this technology in Consumer Electronics will reduce its manufacturing cost or original price for less operations, reduction in size of transistor and easy smooth designing of electronic circuits through using this Silicon Vias Technology in fabrication of 3D Transistor based Home Appliances.

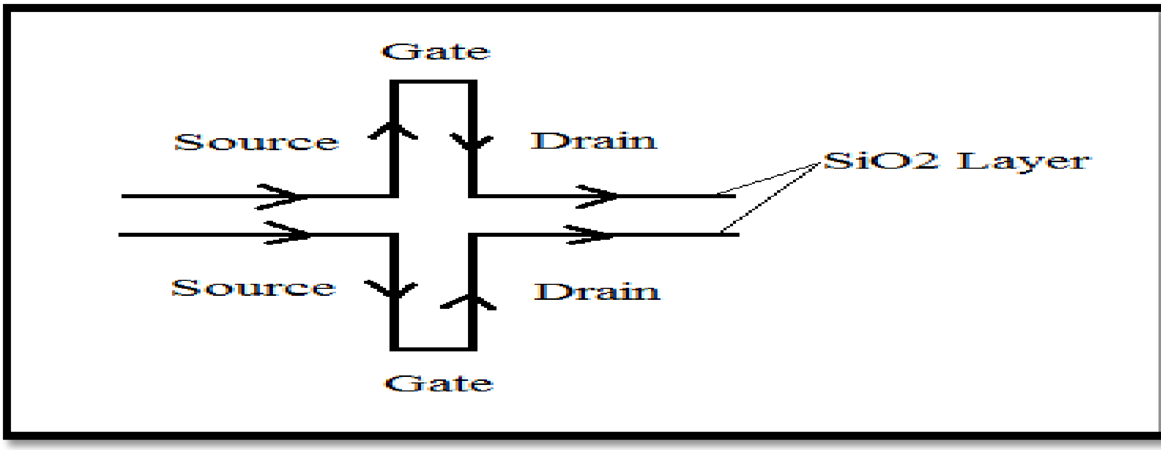

Figure 2 : Critical Role and Operation of 3D Transistor

IV. Application in Home Appliances

The 3D Transistor provides the various aspects and features in applications of home appliances. The device which has fabricated from 3D Transistor through Silicon Vias Technology provide the feature of high speed efficiency, increasing clock speed, low power consumption, very low manufacturing cost, easy smooth designing of circuits, enable of digital processing, unsupported the analog components, reduction in size, easy analyzing and synthesizing of electronic circuits. The application of 3D Transistor provides the various features and advantages:

a) Television

This device provide the high speed efficiency, very low power dissipation, high screen resolution display, high graphics and improvement in visualization characteristics for better quality videos and pictures.

b) Cell Phone

Cell Phone provide the features of high speed processing, ultra low power dissipation, high screen display resolution, very high speed signal processing, implement to 5G and 6G mobile communication technology for future prospective.

c) Electronic Tablet

Electronic Tablet performs the high speed internet processing, high screen resolution display, better quality resolution of video and pictures, virtual gaming zone, implement to 5G and 6G mobile communication for processing of networks.

d) Computer Peripherals

The Computer Peripherals perform the high speed processing, increase the clock speed up to 20-50 GHz, increase the RAM (processing speed) and implement Fifth Generation of Humanoid Computing Devices.

e) Air Conditioner and Refrigerator

Air Conditioner and Refrigerator perform the various features for digital processing, very low power dissipation (enable for operation through DC Source) and sixth sense features for operating the device through user friendly manner and cost reduction for manufacturing the device.

V. Theoretical Specification and Analysis

The theoretical specification and analysis of 3D Transistor based on the various features for designing, operations, implement on fabrication and change the fabrication structure. This strategy provide the theoretical details for the operation of present layout of 2D Transistor and design prospective layout of 3D Transistor. The 3D Transistor provides increase in height of Gate which tends to increase in height of Oxidation Layer and operating this 3D Transistor as operation of two transistors in single Silicon Substrate for the enhancement of Source and Drain in 3D Transistor which will have fabricated by Silicon Vias Technology. The 2D Transistor provides the Gate designing on the basis of MOSFET or MESFET or IGFET Structure which could developed by fabrication process.

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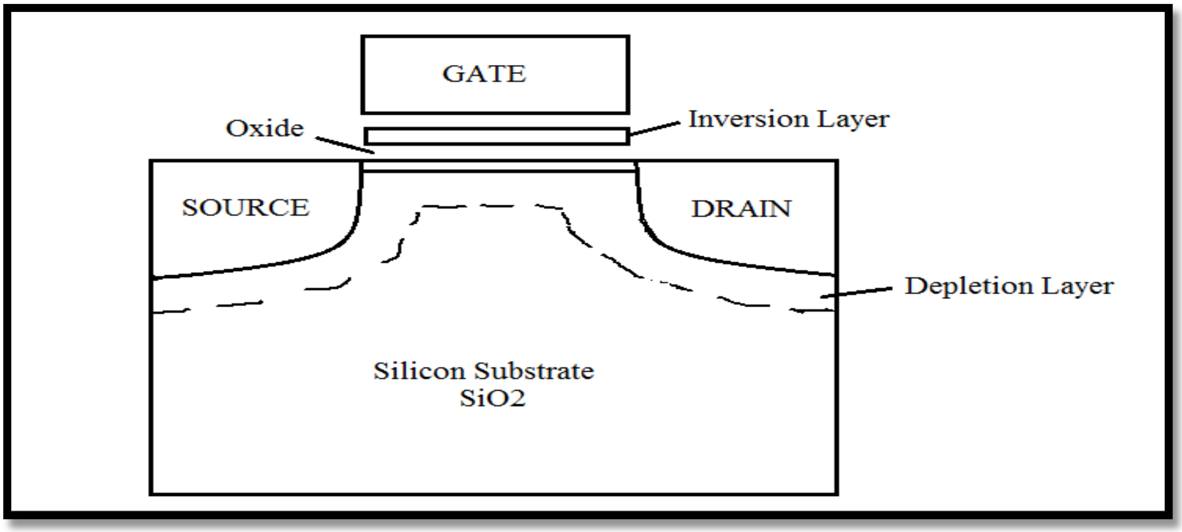

Figure 3 : Schematic Diagram and Front View of 2D Transistor

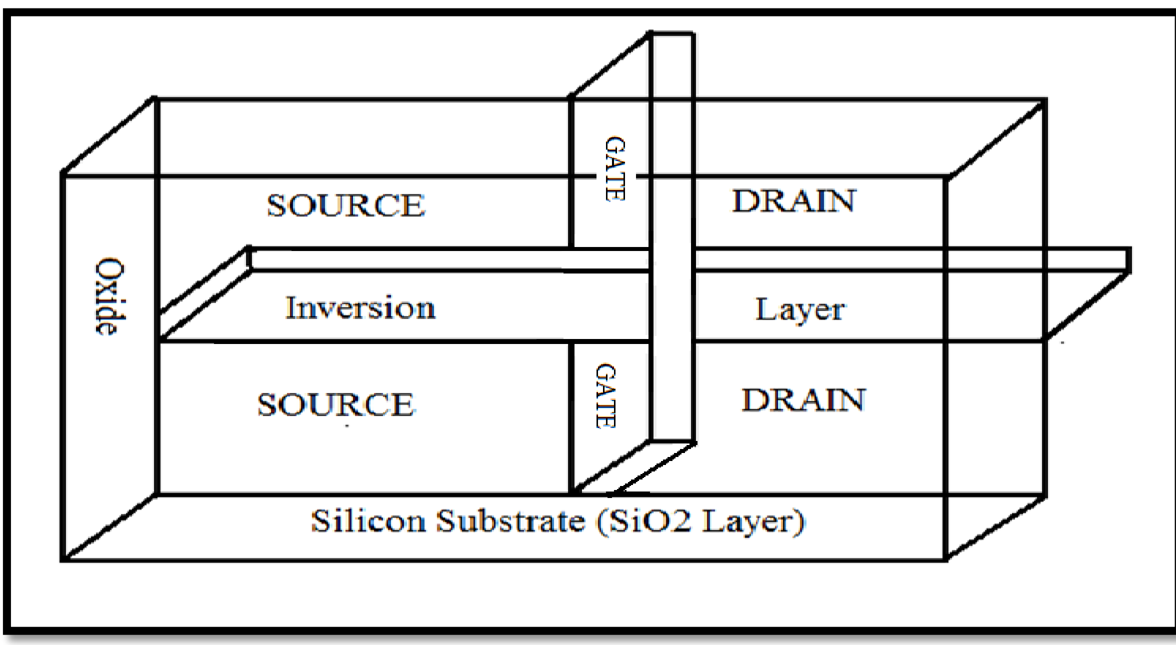

Figure 4 : Schematic Diagram and Front View of 3D Transistor

VI. Practical Specification and Analysis

This Specification and Analysis provide the practical aspects and application for fabrication of new innovative 3D Transistor through designing aspects, low power dissipation and reduction in size of transistor. The practical specification of this terminology performed in Silvaco TCAD (Technology Computer Aided Design) Software which provides the positive results for operation in low power consumption and size of transistors. The practical analysis of transistor performed on the Athena Simulator which simulates the virtual operation and provides the position expression of results for using this technology through fabrication of 3D Transistor that perform the various features and advantages of home appliances based devices. The designing of MOSFET based on this technology provide the various features and positive aspects for fabricating the innovative 3D Transistor which is very useful for mankind of human beings.

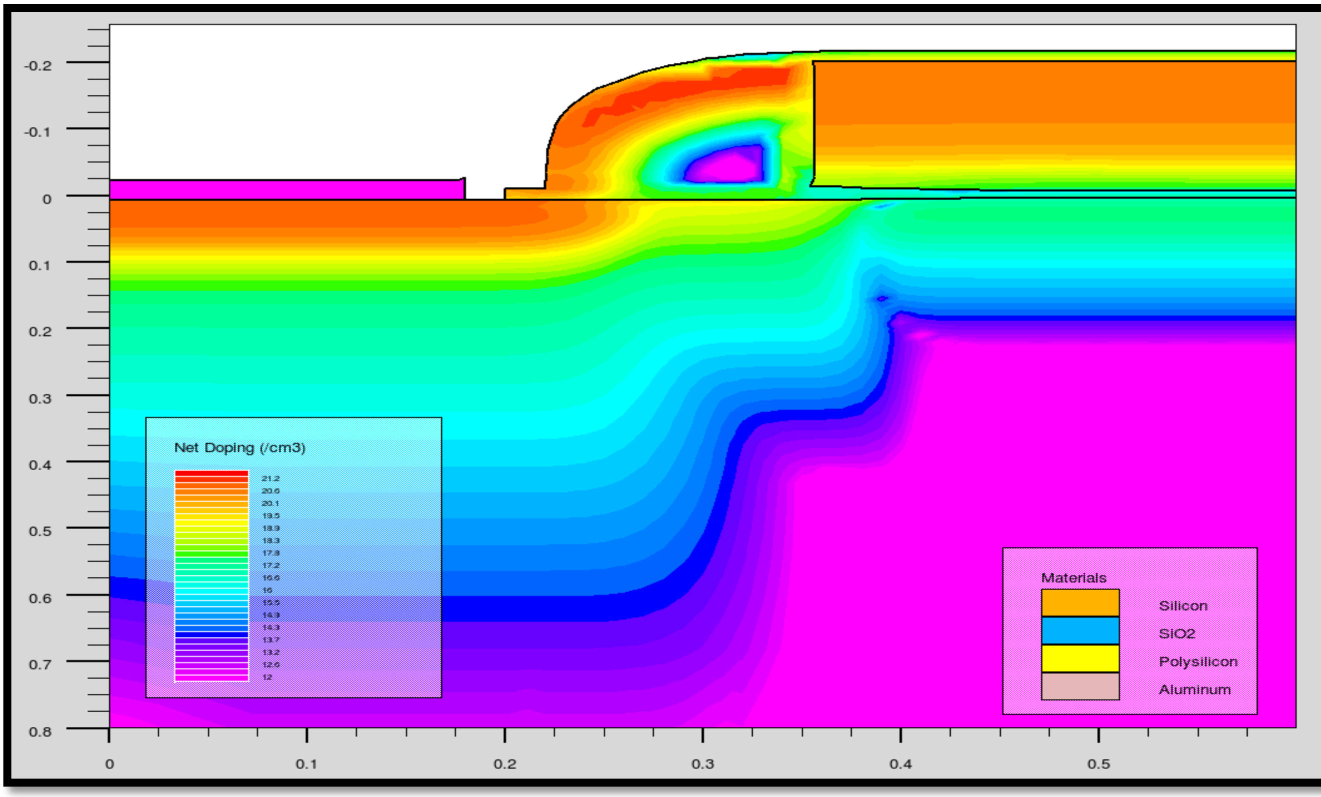

Figure 5 : Gate-Source Design of MOSFET Based 3D Transistor upto 10nm Design Scale

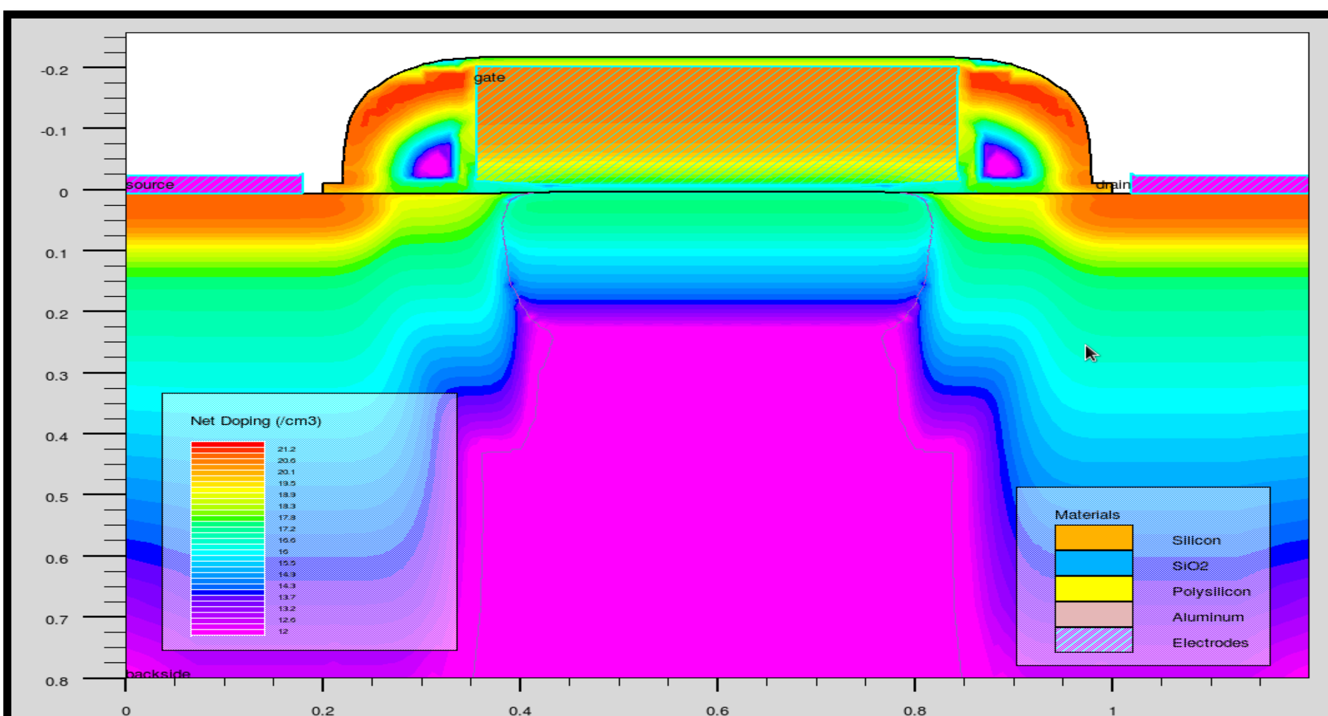

Figure 6 : MOSFET Design Fabrication Through 3D Transistor upto20 nm Design Scale

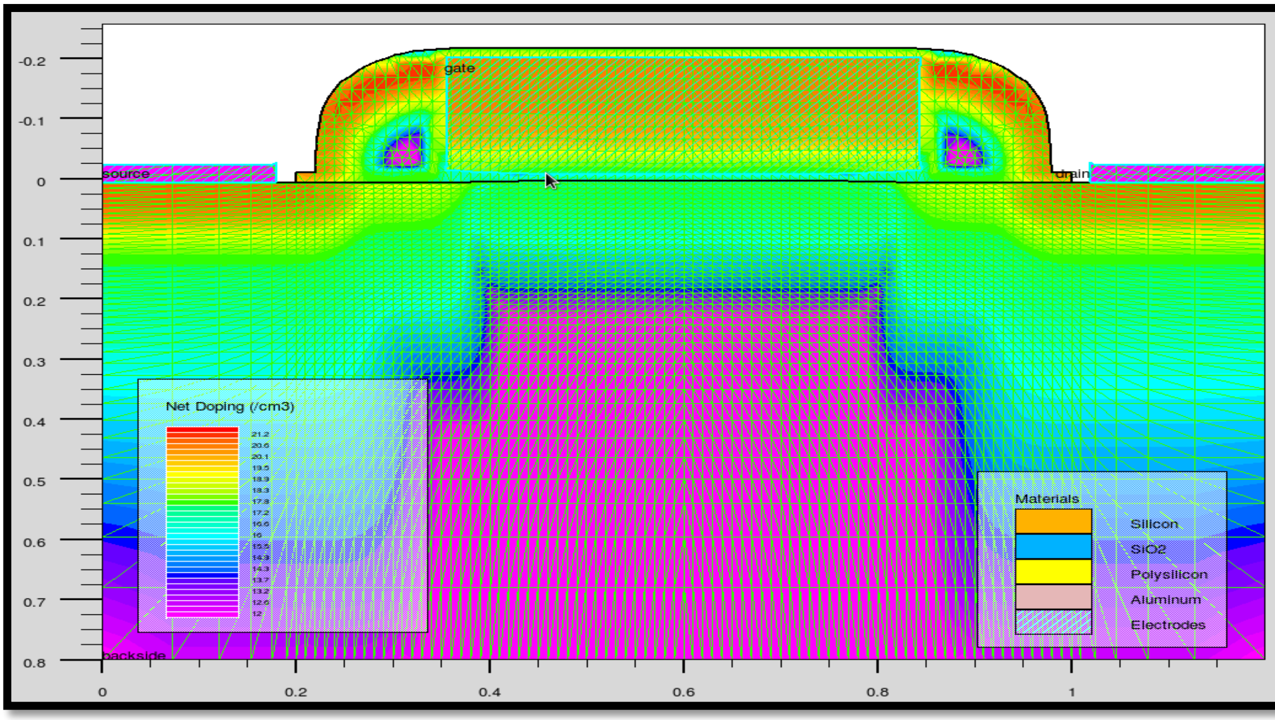

Figure 7 : MOSFET Design Fabrication through 3D Transistor in Grid Scale for Low Power Consumption Device

VII. Process of Fabrication

The process of fabrication is based on the following features that implements through Silicon Vias Technology for converting the design layout of project to fabrication of transistors. These processes can be defined in various small following points which tend to characterize this process are:

a) Programming or Designing of Electronic Circuits through HDL (Hardware Descriptive Language) Design Software.

b) Implementation of Chip Wafer Technology which termed as Silicon Vias Technology.

c) Formation of Silicon Capsules through Normal Sand or Silica.

d) Cutting these Silicon Wafers into slices of Wafers.

e) Doping Process for addition of impurities to make semiconductor which perform the special characteristics.

f) Provide the layer of Photo Resistive Material for welling in Photo Lithography Process.

g) Photolithography Process for bombardment of Ultraviolet Rays and assigned Contacts and Holes in Semiconductor.

h) Implement the programming or designing of electronic circuits for fabricating the layout of 3D Transistor.

i) Etching Process for removal of impurities in Photolithography Process through Cleaning Wafer as Washing, Chemical and Heat Treatment.

j) Coating on layer of Copper or Aluminum Metal on both side of Wafer which termed as Gate Structure in Transistor.

k) Fabrication of Electronic Circuits by cutting wafers and packed with suitable device.

l) Formation of Electronic Circuits by Chip Wafer Technology which is known as Silicon Vias Technology.

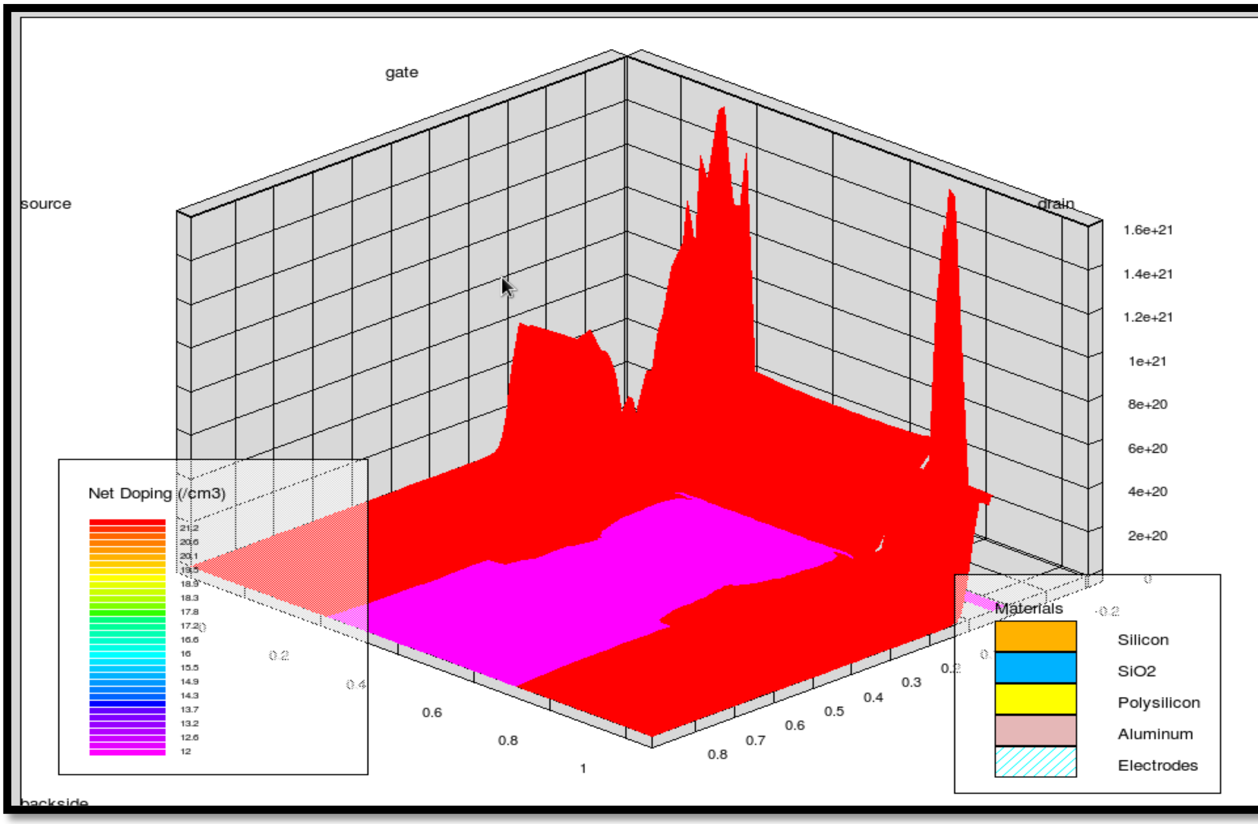

Figure 8 : Layout Image of MOSFET Fabricating Through 3D Transistor

These are the process which tends to fabricate the 3D Transistor through Silicon Vias Technology that operates in very low power dissipation, reduction in size and easy smooth design of circuits for the digital processing of signals in home appliances for making a digitalized and smart generation.

VIII. Result and Conclusion

From here, I have now discussed all the points related to 3D Transistor based Home Appliances for low power dissipation, reduction in size through cost analysis and synthesis for the testing of electronic circuits fabricated from layout of 3D Transistor to become the most efficient technologies in future prospective. This terminology will create a new revolution in the production of Consumer electronics based devices which reduces manufacturing cost, high processing speed of device and easiest complexity of transistor to be packaged on a electronic circuit through inventing the digital revolution of generation in the field of electronics.

The 3D Transistor based Home Appliance is the starting era of technology for designing the home appliance based devices which invents for being applicable this technology to home appliances. The present scenario of technologies which are applicable for this Silicon Vias Process manufactures the Microprocessor, Microcontroller, Integrated Circuits and Embedded System based Devices which is a very complex processing device. This technology of 3D Transistor provide the various aspects for designing and implementing the electronic circuit through Silicon Vias Technology which tends to low power dissipation, high processing speed, easier packaging of device and reduction in size to become the digital generation of revolution in the world.

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Review of Power Control Mechanisms in Cellular System

By Tondare S. M., Veeresh G. K. & Kejkar A. S.
S.T.C.F.E. Kolpa, India

Abstract- Here an advanced tutorial on power control issues in all generations of cellular system has been presented. Power control represents a key degree of freedom in design of cellular system, offering substantial benefits for efficient and fair of operation of the system, especially in energy efficient designs. It also supports several functionalities including QoS, bit error rate optimization and energy efficient designs in all stages of cellular system. Taking energy efficiency into account, performance of different power control algorithms have been analyzed as a function of transmitted power with some interesting results.

Keywords: *power control, cellular networks, 2G, 3G, QoS.*

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Review of Power Control Mechanisms in Cellular System

Tondare S. M. [α], Veeresh G. K. [σ] & Kejkar A. S. [ρ]

Abstract- Here an advanced tutorial on power control issues in all generations of cellular system has been presented. Power control represents a key degree of freedom in design of cellular system, offering substantial benefits for efficient and fair of operation of the system, especially in energy efficient designs. It also supports several functionalities including QoS, bit error rate optimization and energy efficient designs in all stages of cellular system. Taking energy efficiency into account, performance of different power control algorithms have been analyzed as a function of transmitted power with some interesting results.

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I. Introduction

With the rapid development of information & communication technologies (ICT) particularly the wireless communication technologies, the energy consumption has grown up to 163 PJ that leads to emission of around 32.9 million tones of CO_2 & it is around 2% of worldwide CO_2 emission [1-3]. With the increasing demand for wireless services and ongoing 3G, upcoming 4G, the subscriber base is expected to be more than one billion. This growth will require 1, 00,000 more stations to ensure network availity [2]. Due to rapid increase in number of users, it is causing burden on network operators form economical perspectives and environmental perspectives. Economical perspectives in terms power consumption. A fundamental component of radio resource management is transmitter power control. It is well known that minimizing interference using power control increases capacity [4] and also extends battery life.

Considering this factor, it becomes quiet necessary to study the power allocation and power control schemes adopted in all generations of cellular system. This paper surveys and gives overviews of power allocation and distribution/control schemes. Power control mechanisms have played an important role in the success of digital cellular system. Power control offers substantial benefits for the efficient and fair operation of the cellular system, supports QoS adaption Like rate control [5], bit error rate and energy efficient design in all stages of cellular system. Power control has mainly used to guarantee the signal interference ratio of an ongoing connection resulting in a higher utilization of quality of service [6]. power control was, is and (we strongly believe that it) will remain one of the most important radio resource management techniques in wireless networks, as it mitigates the consequences of two fundamental limitations of wireless networks as Radio spectrum, though non exhaustible, is both a limited and–often–underutilized resource. This makes interference and interference mitigation critically important for wireless networks and Mobile wireless devices, such as mobile phones, Personal Digital Assistants (PDAs) etc., have significant limitations on the duration of their “talk time,” as the “life” of their battery is limited. As technology improvements in the direction of prolonging battery life are slower than advances in communications, this constraint continues to have dramatic impact, particularly for uplink transmissions (from mobile nodes to base stations) [7].

The reminder of this paper is organized as follows, in section II we present the different power allocation schemes used in cellular system. In section III we will discuss about power control schemes adopted in all generations of cellular system. Results on different power control mechanisms also presented in section IV in terms of energy efficiency. Finally conclusions of the survey are presented in section V.

II. Power Allocation / Control Schemes in Cellular System

Transmission power represents a key degree of freedom in the design of wireless networks. In both cellular and ad hoc networks, power control helps with several functionalities like interference management due to broadcast nature of wireless communication ,signal interfere with each other, energy management due to limited battery power in mobile terminals or any handheld devices and connectivity management. Different power control schemes has been discussed as below.

a) Fixed Power Allocation Scheme

Fixed power allocation schemes keep power control target values constant regardless traffic load. In this scheme, all the signals from the MSs within the coverage area are power controlled such that the receiver at BS maintain equal received bit-energy for

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every mobile no matter what transmission rate it uses. Equal bit energy strategy implies the received SIR is the same for all types of media at one time instant. This scheme doesn't balance well the natural dissimilarity between voice and data traffic. In our multi-media system high-rate data traffic with lower BER requirements and lower-rate voice traffic with higher BER requirements are transmitted through the same channel. Clearly, the interference that voice users can tolerate and the one that data users can tolerate are different. Moreover the interference that data users cause to voice users is also different from the interference that voice users cause to data users. Hence the performance of the more vulnerable traffic may degrade drastically when the user number is increased [8].

b) Adaptive Power Allocation Schemes

The difference between adaptive power control and fixed power allocation lies in the dynamic power allocation during a dynamic traffic situation. With fixed power allocation the allocated power level is fixed for each type of media, no matter what kind of traffic profile it is. While with adaptive power allocation, the target power level is changed as traffic load changes. However the decision of power allocation is done on the basis of traffic pay load i.e. either strength based optimal power allocation scheme, with this strategy, strength-based power control is used for individual traffic. At the mean time, traffics are grouped into two groups according to its priority. Those media with a set maximum allowed BER are media with high priority, and media without set maximum are media with low priority. The proposed power control method is to maximize throughput or minimize BER of media with low priority while maintaining the required BER of media with high priority or strength and SIR-based optimal power allocation scheme, this Scheme [8] uses strength based power control for data users and SIR-based power control for voice users. The objective is to always guarantee to meet the minimum required voice quality and reserve the highest possible system capacity to data users. In other words, the system adjusts the relationship between data users and voice users according to the system traffic load in order to make the BER of voice users equal to the required value. This scheme outperforms equal bit-energy strategy in both non-fading and fading channel. Besides, this scheme can take advantage of graceful degradation characteristics, so that the system can accommodate more users with just a little bit performance degradation [8 & 9].

c) Canonical Power Control Scheme

A more general framework on convergence analysis is given that builds on the standard interference function in [10]. The authors define a broader class of synchronous and totally asynchronous power control algorithms known as the canonical algorithms.

d) Stochastic Power Control Scheme

There are two types of stochastic dynamics often modeled in wireless cellular networks [5]. One is channel variations and the other is user mobility. Robustness against these dynamics has been analyzed and algorithms leveraging them have been designed. In this [5] a stochastic approximation based, on-line algorithm for controlling transmitter powers, using a fixed step size that provides weak convergence and faster response to time-varying channel conditions has been proposed.

e) Binary Power Control Scheme

Binary power control is a power control scheme with only two allowable power values, usually P_{min} (0) or P_{max} (1). Hence a link can either transmit at a full power or be switched off completely. Binary power control (BPC) has the advantage of leading towards simpler or even distributed power control algorithms. For N > 2 we propose a strategy based on checking the corners of the domain resulting from the power constraints to perform BPC. We identify scenarios in which binary power allocation can be proven optimal also for arbitrary N [11, 12] as

$$P_{min} \leq P \leq P_{max} \qquad (1)$$

III. Power Control in all Generations of Cellular System

Power control implementations in cellular systems often consist of Open-loop power control (OLPC) and Closed-loop power control (CLPC). The closed loop power control accomplishes close estimate to the desired level at the receivers of mobile stations. The receivers constantly observe the received signal quality (may be reflected by signal strength, i.e. signal-to-interference ratio (SIR), bit error rate (BER), and delay) and determine appropriate power control commands. A feedback channel is necessary to transmit these commands to the senders for power adjustments. The open loop power control does not need a feedback channel. The transmitting power level adjustment is determined based on the estimation of the channel quality of the opposite direction stations. The estimation error of the open loop power control can be rather high, especially when the forward link and the reverse link are not highly correlated.

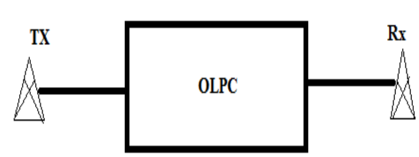

Fig. 1 : Schematic of open loop power control scheme

Fig. 2 : Schematic of closed loop power control scheme

CLPC schemes are more expensive to implement and are most beneficial in the uplink communication or for a Frequency Division Duplex (FDD) system where uplink and downlink are on different frequencies and the channel on the two links are uncorrelated with respect to fast fading. Typically, tolerance levels for OLPC are in the range 9-12dB and tolerance levels for CLPC in the range 1-2dB.

a) Power control in 2G Networks

The 2G systems were primarily designed for voice which is generated at a fixed bit rate, and the power control mechanisms were geared towards targeting a fixed SIR, determined by the quality of voice that needs to be supported. The GSM [13] based 2G standard is an orthogonal scheme where the MSs within a sector are allocated a separate time and frequency slot for both uplink and downlink. Maintaining orthogonality between MSs of the same sector implies that the time-frequency resource for each MS is limited and the SIR requirement for voice communication is higher in comparison to IS-95. These rules out frequency reuse of one in GSM systems. The non-existence of inter-sector interference from the immediate neighbors of a sector and the non-existence of intra-cell interference due to the orthogonality of MSs within a sector imply that the need for CLPC in GSM standard is less in comparison to IS-95. As such, GSM implements a CLPC scheme both on the uplink as well as the downlink with updates every 480ms based on two parameters referred to as "RxLev" and "RxQual". The "RxLev" is the receive power level and the "RxQual" is the receive signal quality in terms of SIR or BER.

The base station controls the power output of the mobile, keeping the GSM power level sufficient to maintain a good signal to noise ratio, while not too high to reduce interference, overloading, and also to preserve the battery life. A table of GSM power levels is defined, and the base station controls the power of the mobile by sending a GSM "power level" number. The mobile then adjusts its power accordingly. In virtually all cases the increment between the different power level numbers is 2dB.The accuracies required for GSM power control are relatively stringent. At the maximum power levels they are typically required to be controlled to within +/- 2 dB, whereas this relaxes to +/- 5 dB at the lower levels.

Table 1 : Comparison of Power Level No with Power Level Output for Diff GSM Bands

Power level No.	Power level output DBM		
	GSM 900	GSM 1800	GSM 1900
2	39	26	26
3	37	24	24
4	35	22	22
5	33	20	20
6	31	18	18

a) Power control in 3G networks

Qualcomm proposed an OLPC scheme for a CDMA based cellular system where the transmit power is set inversely proportional to the received power [14]. The OLPC scheme was augmented by a CLPC scheme where they receive powers were equalized through a 1-bit feedback [15]. This power control solution to the near-far problem was instrumental in enabling the success of CDMA networks.

In [16] author has proposed an algorithm based on an adaptive modification of the transmitted power update step size. In this, the Adaptive-Step Power Control Algorithm, which could be easily implemented, is an interesting variant of the one-bit command PC of WCDMA System. The quicker convergence of the proposed ASPC (with regard to the present version of power control in WCDMA) may give a capacity increase.

b) Power Control in Wi-Fi Networks

The 802.11 standard implements a MAC algorithm that involves carrier sense and exponential back off and does not dictate any explicit power control scheme. Researchers have attempted to remedy the situation by proposing various MAC layer schemes that can be implemented on top of the PHY layer. One such mechanism is for the receiver to send back the power level of data transmission in a control channel at the maximum power, in response to intention of data transmission indicated by the transmitter. However, transmitting data and control channel at different power levels results in inefficient operation in an unplanned spread of APs. Improvements to this scheme were suggested in [17] to get around the problem by occasionally transmitting data at the maximum power to prevent neighboring APs from taking over the channel.

IV. RESULTS AND DISCUSSION

Based on the different power control schemes presented in above section, we will investigate the performance considering a binary power control scheme assuming a signal undergoes various radio propagation uncertainties. However the performance is measured in terms of energy efficiency which is quiet closely related with power distribution and can be expressed as,

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$$\eta = \frac{channel\ capacity}{total\ power\ transmittd} \quad (2)$$

$$\eta = \frac{\sum_{i=1}^{N} \log_2(1+\frac{S_i}{n_o})}{P_{total}} \quad (3)$$

Where η is the energy efficiency, S_i is the received signal and n_o is the AWGN in wireless sub-channel.

Fig.3 shows the energy efficiency comparison of EEBPCB [3], BPC [12] and EEBPC algorithm [19] and average power control algorithm [18] as a function of total transmitted power. Here as the signal transmitted power increase, the energy efficiency goes on decreasing. However BPC, EEBPC and EEBPCB algorithms shows significant improvement in energy efficiency in comparison with average power control algorithm.

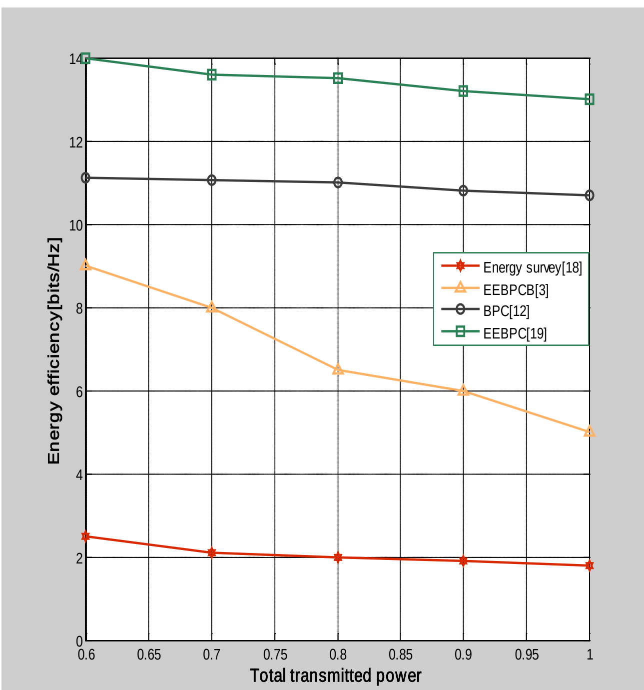

Fig. 3 : Energy efficiency comparison of Avg. power control algorithm, BPC, EEBPC and EEBPCB algorithms with different transmitted power

V. Conclusion

This paper provides an overview of the different power allocation schemes adopted in cellular system along with power control mechanisms. The exact impact of the power control mechanisms has been analyzed. By reviewing some fundamental approaches, we have presented results showing the exact impact of the power control schemes on the design of energy efficient design.

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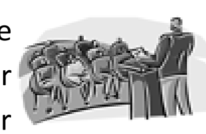

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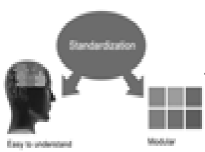

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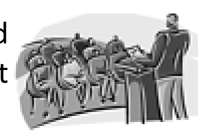

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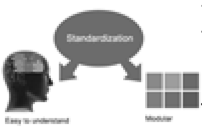

After nomination of your institution as “Institutional Fellow” and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.

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4. Manuscript’s Category,

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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.

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)

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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

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