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Intelligent Composite Compensation Under Load Variation in Power Transmission System.

Abstract: - The power transmission system is in a stressed condition due to the increasing electricity demand. This stress, exacerbated by the deregulated power system environment, necessitates an urgent additional supply to maintain system adequacy. One important initiative to alleviate the transmission burden which meets the load demand can be rectified by composite compensation scheme. This paper showcases intelligent composite compensation under varying loads, emphasizing loss minimization. The approach integrates a loss control scheme involving Distributed Generation (DG) and Optimal Reactive Power Dispatch (ORPD) with multi-DG installation termed composite compensation, employing a novel optimization technique called Integrated Cloning Accelerated Mutation Evolutionary Programming (ICAMEP). The study identifies optimal locations and sizes for composite compensation in the power transmission system, demonstrating its superiority over traditional optimization techniques namely the evolutionary programming (EP) and artificial immune systems (AIS). Results are demonstrated for four cases involving single DG, 3 DGs and composite compensation validated on IEEE 30-Bus Reliability Test System (RTS). ICAMEP is superior over EP and AIS in achieving the highest loss reduction.

Keywords: loss minimization, optimization techniques; evolutionary programming; composite compensation.

I. INTRODUCTION

The past few decades have seen a steady rise in the global demand for electricity due to lot of activities such as urbanization, industrialization and commercialization etc. This may reflect to the increasing demand in current transmission system which resulted in power loss in the power system network. In order to satisfy the rising

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demand for electricity, the conventional method of building new power plants and transmission lines is not practical for several reasons, including high cost, environmental issues, time and technical limitations. One of the compensation techniques such as installation of distributed generation (DG) can be an alternative to optimize the current demand. Distributed generation (DG) in a power system refers to the generation of electricity from many small, decentralized sources located close to the end-users of the electricity [1] or also known as dispersed generation and embedded generation [2]. These sources can include renewable energy technologies like solar panels, wind turbines, small-scale hydroelectric generators, and combined heat and power (CHP) systems, as well as conventional generators such as diesel engines and natural gas turbines [3]-[4]. Distributed generation can provide a range of benefits, including increased energy reliability, reduced transmission and distribution losses, and the potential for cleaner and more sustainable energy production. These benefits could be obtained by optimizing the selection, sizing, and location of DGs in power systems [5]–[7]. It can also enable a more resilient and flexible power system by reducing the dependence on centralized power plants. However, one of the most important aspects of distributed generation plants is the location of the DGs. Improper or non-optimal sizing or location may result in over-compensation or under-compensation of the system [8]. Thus, will result in significant issues for power networks and poor financial returns for DG owners. The electrical grid will be more stable if DG is placed correctly. In an overload situation, it can sustain voltage against a strong voltage backdrop. Conversely, the lines congestion and obstruction are greatly reduced by the Optimal DG Placement. Many studies are primarily concerned with verifying these DG sources so that the placement and size of the renewable energy generators reduce power loss and save generator costs [9]-[10].

Nowadays many optimization techniques have been conducted to solve optimization problems such as the DG installation location and also sizing. Among the most popular approach that was introduced are Evolutionary Programming (EP), Genetic Algorithm (GA), Ant Colony Search (ACS), Particle Swarm Optimization (PSO), and Cuckoo Search (CS), Whale Optimization Algorithm (WOA) in both transmission [11]–[14] and distribution networks [15]–[18] .In this paper, the multi-load variability for composite compensation in the loss control scheme utilizing ICAMEP being used to determine the optimal location and sizing of DG in transmission system. In order to reduce overall power loss under load changes, the composite compensation combines DGs and ORPD into a single common scheme. The IEEE 30-Bus RTS was used to validate the suggested method, and the outcomes are compared between the EP, AIS, and ICAMEP algorithms. The results show that in terms of overall system loss reduction, the suggested ICAMEP approach performed better than earlier algorithms.

II. METHODS AND PROBLEM FORMULATION

This section presents the problem formulation algorithm and the implementation of ICAMEP in optimizing the sizing of compensation components.

Power loss is a major issue in the power system. This phenomenon is due to the disturbance in voltage and current, as both are related. The problem formulations can be stated by eqn. (1), which represents the minimization of active power transmission loss [19].

$$f(x) = min\left(\sum_{j=1}^{nbr} P_{LOSS}\right)$$
$$f(x) = min\left(\sum_{j=1}^{nbr} (I_1^2 R_1 + I_2^2 R_2 + \dots I_j^2 R_j\right) \quad (1)$$

Where:

nbr = Number of transmission lines or branches in the system

The fitness function, i.e. the power loss can also be presented as follows:-

(2)

$$P_{loss} = \sum_{k=1}^{Nl} g_k(\, t_k V_i) + \, V_j^2 - \, 2t_k V_i V_j \, cos\emptyset_{ij}$$

Where:

Nl = Number of transmission line

g_k = Conductance line; V_i & V_j = voltage magnitude

$\emptyset_{ij}$ = Voltage angle between difference busses i and j

A general load variation on transmission loss at before optimization and post optimization is illustrated in Fig.1.

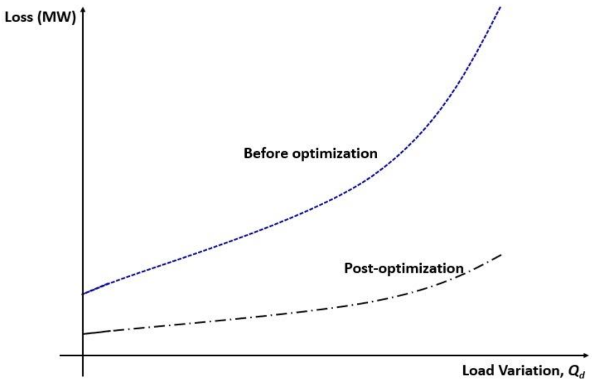

Figure 1: A general load variation on transmission loss.

Variation in reactive load in a power system can have an effect on transmission and distribution losses. The power that alternates between the source and the load without being utilized by any electrical equipment is referred to as reactive power. It is essential to keep voltage levels stable and to power inductive loads such as motors, transformers, and fluorescent lighting. Variations in reactive load have an impact on the system's power factor. A low power factor shows that a substantial quantity of reactive power is being taken, resulting in greater system losses [20]-[21]. As seen in Figure 1, the increase in reactive power generates an increase in real power loss. Without compensation, the loss profile is high. The profile of loss is reduced when appropriate corrective action is implemented as a compensating effort, as seen in the figure. The compensating effort could be DG installation, ORPD system, or in this study, a composite compensation that incorporates both DG installation and ORPD scheme. The ORPD received much attention for improving the power system operation loss and enhance voltage stability of the system by some important control variables such as generator voltage magnitudes, transformer tap setting etc [22]. Effects of reactive load variation on power system losses can lead to increase in transmission line losses. Reactive power utilises some of the available transmission capacity while doing no beneficial work. When reactive loads fluctuate, voltage drops, and line currents increase. Higher line currents cause larger resistance losses in transmission lines, known as I^2R losses. This, in turn, raises the overall system losses. On the other hand. It also causes to the increase in transformer losses. Transformer losses are also larger when running under reactive loads. Reactive power also increases magnetising currents in transformers, resulting in greater core and winding losses. These losses contribute to a drop in transformer efficiency and the overall efficiency of the power system. Power system operators utilize few methods such as power factor correction, capacitor banks, and voltage regulation techniques to minimize the negative impacts of reactive load changes [23]-[24]. These procedures help to control reactive power flow, keep voltage levels within acceptable limits, and reduce power system losses. Figure 1 shows the effect of load fluctuation on transmission loss. When compared to the pre-compensation condition, the loss profile will be smaller with the compensation process.

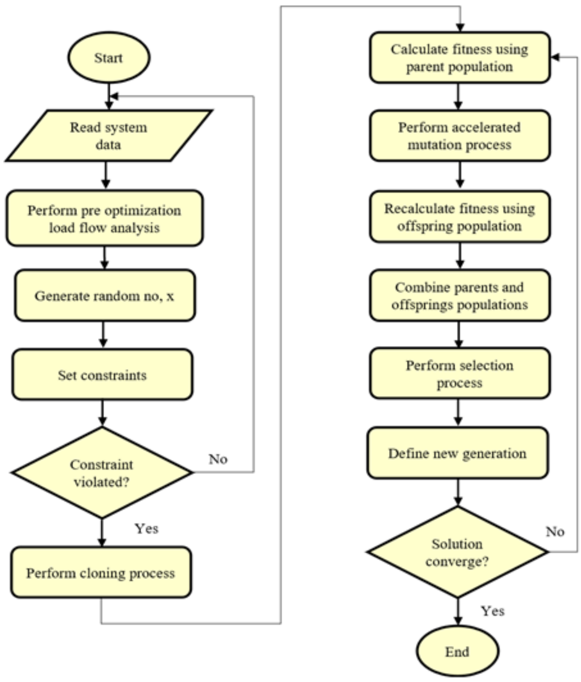

Figure 3: Flowchart for the proposed ICAMEP

III. COMPOSITE COMPENSATION IN POWER SYSTEM

Power system compensation is crucial to ensure that the utility can continue to function in high-demand situations. Composite compensation is the sum of several compensation attempts. DG is combined with ORPD in this study to reduce transmission loss in power system. The installation of DG will provide more power to the entire system. The composite compensation strategy as in Figure 2 shows the integration of DG & ORPD for optimal location and sizing of multi-DG installation and also the sizing of generator at buses 2, 5, 8, 11 and 13 in IEEE 30 Bus RTS. The system consists of 24 load buses, 41 transmission lines, and 6 generator buses [25]. In this study, DG Type 1 is used in order to obtain the real power, to be injected into the system for loss reduction. The ORPD scheme involves the dispatch of VAR element at the generator buses as a compensation initiative in Q injection. The main purpose of the ORPD is basically to reduce active power loss and to improve voltage profile.

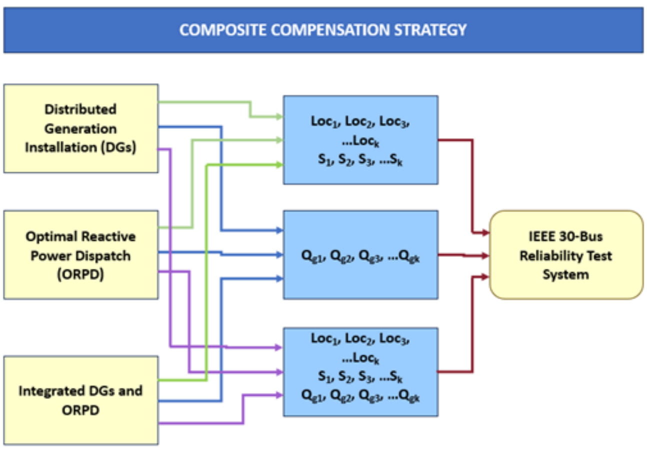

Figure 2: Composite Compensation Strategy

D. PROPOSED INTEGRATED CLONAL ACCELERATED MUTATION EVOLUTIONARY PROGRAMMING (ICAMEP)

Figure 3 illustrates the flowchart for the proposed ICAMEP optimization technique. ICAMEP integrates the traditional EP with the cloning and accelerated mutation elements to improve the optimization process in the traditional EP. It is used to find the best solution by iteratively applying mutation and acceleration approaches on a group of potential solutions to a given problem.

ICAMEP strives to improve the proficiency and effectiveness of evolutionary algorithms by employing specific mutation and acceleration. The operators are as follows: -

1. Read System Data

In this phase, the system data is retrieved in the form of line data and bus data. All the data involved the generator, loads, transmission lines, sending and receiving buses and all the limits.

2. Perform Pre-Optimization Flow Process

In this phase, before optimization process is conducted normal AC load flow is performed in order to record the pre-opt loss or pre-opt fitness value. This value becomes the benchmarked so that the fitness values during initialization process are within the pre-set constraints.

3. Random Number Generation

Using uniformly distributed random number generator, the control variables for the random location and size of the compensating devices are created to start the initialization individuals which satisfy the predetermined inequality constraints. For the first iteration, 20 individuals (parents) are generated for each control variable. The total loss of the system before optimization, $P_{pre\text{-}opt}$ is calculated as the reference value. The random number will be assigned as sizing (x_1, x_2, x_3,...x_n) and location (*loc1*, *loc2*, *loc3*,…loc_n). The general equation [26] is shown below :-

$$x_{nk} = \begin{bmatrix} x_{11} & x_{12} & x_{1k} & x_{1,k+1} & x_{1,k+2} & \cdots & x_{1,2k} \\ \vdots & \cdots & \cdots & \cdots & \cdots & \cdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nk} & x_{n,k+1} & x_{n,k+2} & x_{n,2k} \end{bmatrix} \quad (3)$$

Matrix size	:	n x $(2k+l)$
n	:	population size. i.e. 20
k	:	number of control variables for the DG installation
l	:	the sizing for injected Q at generator buses

4. Perform Cloning Process

In this process parents are cloned by a factor of *m* which producing from the initial parents. Normally *m* is 20 to make 200 individuals in the population [27]. The fitness of the cloned offspring will be determined at the end process. The cloned matrix is exhibited (3) as follow: -

$$x_{mnd} = \begin{bmatrix} \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1,d} & f_1 \\ x_{21} & x_{22} & \cdots & x_{2,d} & f_2 \\ \vdots & \vdots & & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{n,d} & f_n \end{bmatrix} 1 \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1,d} & f_1 \\ x_{21} & x_{22} & \cdots & x_{2,d} & f_2 \\ \vdots & \vdots & & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{n,d} & f_n \end{bmatrix} 2 \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1,d} & f_1 \\ x_{21} & x_{22} & \cdots & x_{2,d} & f_2 \\ \vdots & \vdots & & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{n,d} & f_n \end{bmatrix} m \end{bmatrix} \quad (4)$$

Matrix size: mn x $(d + 1)$

where; n is the population number = 100

d is the number of variables = 2, and

m is the cloning scalar = 10

5. Fitness Calculation

Two fitness calculation processes will be performed. The first phase utilizes the individuals in the parents' population, while the second one uses the individuals in the offsprings population. The fitness value can be minimized or maximized based on the objective function. The transmission loss in a power system was chosen as the fitness function in this study.

6. Mutation Process

To breed offspring, the acceleration mutation operator is used in mutation. It is derived by the operator in Genetic Algorithm (GA) Acceleration Techniques provided by

$$\vec{V}_{acc}^{G+1} = \vec{V}_{best}^{G} + \lambda(\vec{V}_{best}^{G} - \vec{V}^{G}) \quad (5)$$

Where

$\vec{V}_{best}^{G}$ = the best solution in current population G

$\vec{V}^{G}$ = a candidate solution to the current population

$\vec{V}_{acc}^{G+1}$ = the accelerated $\vec{V}^{G}$

λ = the acceleration factor, $\lambda \in [0,1]$

7. Combination

The parent and offspring matrices are then cascoded together. If the parent matrix and the offspring matrix are represented by equations (6) and (7), respectively, then the combined matrix, C, will be represented by equation (8).

$$A_1 = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1,d} & f_1 \\ x_{21} & x_{22} & \cdots & x_{2,d} & f_2 \\ \vdots & \vdots & & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{n,d} & f_n \end{bmatrix} \quad (6)$$

$$A_2 = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1,d} & f_1 \\ x_{21} & x_{22} & \cdots & x_{2,d} & f_2 \\ \vdots & \vdots & & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{n,d} & f_n \end{bmatrix} \quad (7)$$

$$\mathrm{C} = \begin{bmatrix} A_1 \\ A_2 \end{bmatrix} \quad (8)$$

8. Selection Process

   Individuals from matrix C will be subjected to a selection process. For the next iteration, the best candidates from matrix C will be chosen. Candidates with the fittest fitness value, i.e., the least amount of loss created, would be chosen for the next evolution. Fitness compliance, mutation, and selection will be repeated until the fitness value reaches its end point.

9. Convergence test

   The stopping criterion is based on the difference between the maximum and minimum fitness which is 0.0001. Once the condition is obtained, optimal DG locations and sizes will be recorded. Otherwise, the process will repeat from Step 3 to Step 7.

$$Loss_{max} - Loss_{min} \leq 0.0001 \quad (9)$$

IV. RESULTS AND DISCUSSION

In this study, three optimization techniques namely EP, AIS and ICAMEP were involved for comparative studies in terms of total loss minimization in the system. In this study, Bus 30, as one of the weak buses [26] in the IEEE 30-Bus RTS. was chosen as the load bus under load variation. This bus was subjected to load variations from 15 MVar to 30 MVar with 5 MVar increment. Four cases are considered for this study

Case 1:	Single-DG installation scheme
Case 2:	Composite compensation scheme (Single DG-ORPD)
Case 3:	3-DGs installation scheme
Case 4:	Composite compensation scheme (3DG-ORPD)

3.1 Case 1: Single-DG installation scheme

Table 1 tabulates the results for system losses after installing single DG, optimized by all the three techniques (ICAMEP, EP, AIS) when the Q_{d30} was gradually increased.

Table 1: Transmission loss minimization for single-DG installation using DG scheme.

Technique	Q_{d30} (MVAR)	Power loss (MW)		DG Sizing (MW)	DG Location
		pre-opt	post-opt	S1	Loc1 (Bus No)
	15	18.67	17.87	4.65	26
EP	20	19.55	18.74	3.78	30
	25	20.93	20	3.78	30
	30	23.44	**22.55**	**2.69**	30
	15	18.67	17.87	4.65	26
AIS	20	19.55	18.74	3.78	30
	25	20.93	20	3.78	30
	30	23.44	**22.24**	**3.78**	30
	15	18.67	16.67	11.8	30
ICAMEP	20	19.55	17.77	9.04	30
	25	20.93	19.03	9	30
	30	23.44	**21.71**	**5.03**	30

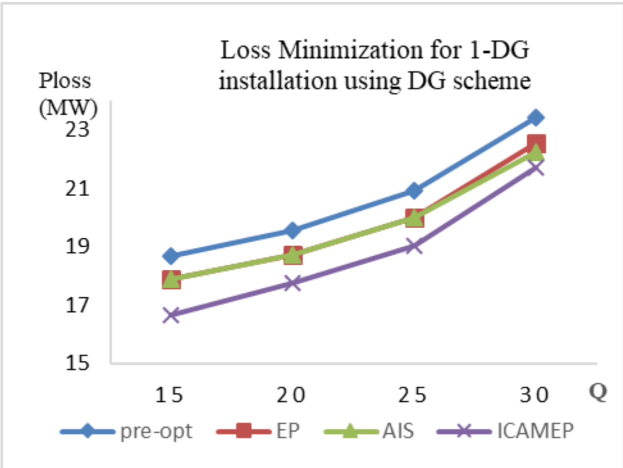

Figure 4: Comparison of Loss Minimization for 1-DG installation using DG scheme

The system loss without DG installation at each reactive load value is 18.67 MW, 19.55 MW, 20.93 MW, and 23.44 MW when Q_{d30} load varies from 15 to 30 MVar, respectively as tabulated in the table. At Q_{d30} = 30 MVar, EP, AIS and ICAMEP techniques managed to get 22.55 MW and 22.24 MW and 21.71 MW respectively as highlighted in the table. The sizes of DG to be installed are 2.69 MW, 3.78 MW and 5.03 MW. This led to 3.8% loss reduction using EP, 5.12% solved using AIS and 7.38% solved by ICAMEP. The low minimization of the three techniques can be clearly illustrated in Fig. 4 whereby ICAMEP shows the lowest loss profile if compared to other techniques.

3.2 Case 2: Composite compensation scheme (Single DG-ORPD)

In this case, composite compensation scheme is conducted to the system at the same reactive loading variation as those in Case 1. The combination between single DG installation with ORPD was conducted to the system as an initiative to reduce the total transmission loss in the system. The results for composite compensation (integrated of single DG and ORPD) scheme for single DG installation are tabulated in Table 2. Similar load increment has been applied from 15 MVAR to 30 MVAR involving all the three optimization techniques. In general, the implementation of the composite compensation scheme into the system has reduced the loss values. At Q_{d30} = 30 MVAR the power loss indicates reduction from 23.44 MW to 21.73 MW, solved using EP, 21.73 MW solved using AIS and 20.62 MW solved using ICAMEP. This implies the superiority of the proposed ICAMEP over EP and AIS in terms of achieving lower loss value. A similar phenomenon can be observed for other loading conditions. The required ORPD values for 5 generators at bus 2, 5, 8, 11 & 13 for all techniques are also shown in Table 2. For instance, ICAMEP identified 83.91 MVAR, 22.46 MW, 39.87 MVAR and 22.60 MVAR as the amount of reactive power to be dispatched at generators at Buses 2, 5, 8, 11 and 13 to achieve the loss reduction at Q_{d30} = 30 MVAR. The optimal DG sizing to be injected to the system are 3.88 MW, 3.88 MW and 7.11 MW is required to be installed at Buses 11, 11 and 30 respectively, when solved using EP, AIS and ICAMEP.

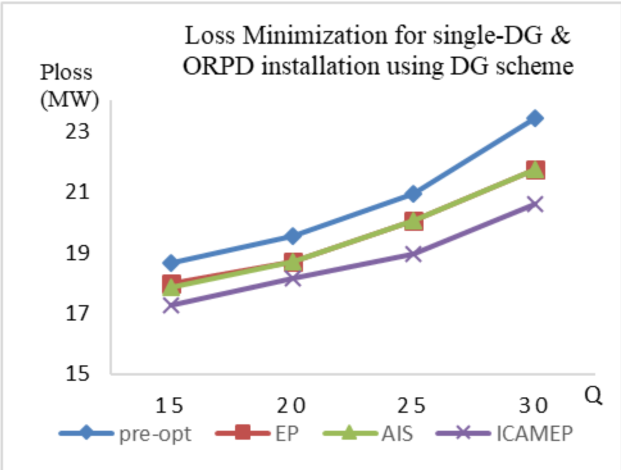

Figure 5: Comparison of Loss Minimization for Single-DG installation using composite compensation (DG & ORPD) scheme.

Table 2: Transmission loss minimization for single-DG installation using composite compensation (DG & ORPD) scheme.

Techs	Q_{d30} (MVAR)	Total loss (MW)		Sizing (MW)	Location	Optimal sizing Q_g (MVAR)				
		pre-opt	post-opt	*S1*	*Loc1*	Q_{g2}	Q_{g5}	Q_{g8}	Q_{g11}	Q_{g13}
	15	18.67	17.99	4.83	10	62	48.64	31.21	25.29	25.21
EP	20	19.55	18.71	4.41	25	42.33	39.48	26.37	39.06	34.27
	25	20.93	20.04	4.41	22	42.33	39.48	26.37	39.06	34.27
	30	23.44	**21.73**	**3.88**	11	29.7	31	38.62	86.52	50.25
	15	18.67	17.87	4.39	7	41.31	39.83	41.48	41.81	25.03
AIS	20	19.55	18.71	4.41	22	42.32	39.47	26.36	39.05	34.27
	25	20.93	20.04	4.41	22	42.32	39.48	26.35	39.05	34.27
	30	23.44	**21.73**	**3.88**	11	29.69	30.99	38.61	86.51	50.24

	15	18.67	17.26	7.41	30	24.03	25.75	28.24	74.07	19.22
ICAMEP	20	19.55	18.16	9.68	19	-0.99	35.93	32.95	70.68	11.53
	25	20.93	18.96	8.09	30	35.28	47.28	55.41	15.28	36.25
	30	23.44	**20.62**	**7.11**	30	83.91	22.46	39.87	59.87	22.6

Figure 5 depicts the results of the three optimization techniques used to address the loss profile reduction caused by reactive load variations at Bus 30. The result indicates that ICAMEP has the lowest profile loss as compared to EP and AIS, implying its superiority over EP and AIS. The loss reduction contributing to 7.30 % using both EP & AIS and 12.03 % solved by ICAMEP. The proposed ICAMEP appears to be superior to EP and AIS in terms of producing the lowest power loss in the system.

Table 3: Transmission loss minimization for 3-DGs installation

Techs	Q_{d30} (MVAR)	Total loss (MW)		Optimal Sizing (MW)			Optimal location		
		pre-opt	post-opt	S1	S2	S3	L1	L2	L3
EP	15	18.67	16.9	3.44	4.34	3.15	23	23	30
	20	19.55	17.71	3.44	4.34	3.15	23	23	30
	25	20.93	19.03	3.78	4.96	1.83	11	30	21
	30	23.44	**21**	3.78	4.96	1.83	11	30	21
AIS	15	18.67	16.52	3.78	4.95	4.95	11	30	21
	20	19.55	17.31	3.78	4.95	4.95	11	30	21
	25	20.93	18.52	3.78	4.95	4.95	11	30	21
	30	23.44	**20.58**	3.78	4.95	4.95	11	30	21
ICAMEP	15	18.67	15.46	8.86	8.86	1.95	30	5	19
	20	19.55	16.72	6.12	5.66	4.48	30	5	5
	25	20.93	17.9	2.15	8.15	5.87	30	30	19
	30	23.44	**19.42**	**5.96**	**8.08**	**4.09**	**5**	**30**	**30**

3.3 Case 3: 3-DGs installation scheme

To explore the impact of the increasing number of DG installations in this study, 3 units of DG are installed into the system. This will require 3 optimal locations. Similar load variation from 15 MVAr to 30 MVar are also subjected to Bus 30. The results are depicted in Table 3 when solved using EP, AIS, and the proposed ICAMEP.

The reactive power load on bus 30, Q_{d30} was gradually increased from 15 MVAR to 30 MVAR. Similar phenomenon can be observed where loss values have been minimized with the deployment of 3DGs installation utilizing all three optimization techniques. For example, at Q_{d30} = 30 MVAR, the power loss was decreased from 23.44 MW to 21.0 MW using EP, while it is 20.58 MW using AIS and 19.42 MW using the proposed ICAMEP as shown in Table 3. The result shows that ICAMEP appears to have achieved the lowest power loss over EP and AIS. ICAMEP outperformed EP and AIS in achieving the lowest loss value. This will require 5.96 MW, 8.08 MW and 4.09 MW DG sizing to be installed at Buses 5, 30 and 30. It means that 2 units of DGs are required to be installed at Bus 30.

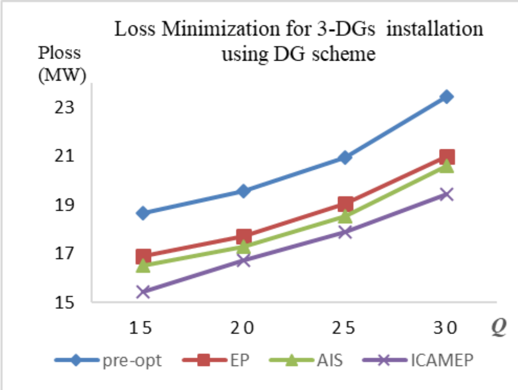

Figure 6: Comparison of Loss Minimization for 3-DGs installation scheme

Figure 6 depicts the results of the three DGs installation optimized by EP, AIS and ICAMEP with respect to Q_{d30} variation. EP exhibits 10.41% in loss reduction, while AIS obtains 12.20% and ICAMEP managed to get 17.15%. Again, this shows that ICAMEP has the lowest profile as compared to EP and AIS and identified as the most superior over EP and AIS.

3.4 Case 4: Composite compensation scheme (3DG-ORPD)

Table 4 tabulates the result for the compensation effort by the integration of 3 units of DG and ORPD in composite compensation scheme within the same reactive load variation. The implementation of composite compensation scheme involving 3 DGs and ORPD managed to reduce the total transmission loss, using all the optimization techniques. For instance, at the same reactive power loading of Q_{d30} = 30 MVAR the power loss indicates reduction from 23.44 MW to 20.69 MW solved using EP, 20.69 MW solved using AIS and 19.77 MW solved using ICAMEP. Again, the required ORPD values for 5 generators at Buses 2, 5, 8, 11 & 13 for all techniques are presented in Table 4. On the other hand, when Q_{d30} = 30 MVAR, the optimal sizing of 3-DGs are 8.24 MW, 5.59 MW and 5.11 MW is required to be installed at bus 7, 5 and 5 respectively. This indicates that 2 units of DGs are required to be installed at Bus 5.

The optimal position and sizing solved using EP are Buses 15, 18, and 26, with 3.39 MW, 3.40 MW, and 4.7 MW, respectively. Meanwhile, for AIS, the sizing of 3DGs are 3.39 MW, 3.40 MW, and 4.67 MW. The same tables contain the results for various reactive power loading at Bus 30.

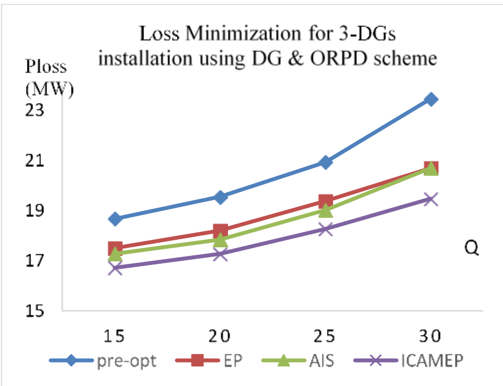

Figure 7: Comparison of Loss Minimization using composite compensation scheme involving 3-DGs & ORPD

Figure 7 depicts the results of the three optimization techniques used to address the loss profile caused by the reactive load variations at Bus 30, i.e. i_{d30}. ICAMEP indicates the lowest profile loss as compared to EP and AIS, implying its superiority. The loss reductions are 11.73% using both EP & AIS and 15.66% solved by ICAMEP. Again, the proposed ICAMEP exhibits superior performance over EP and AIS in terms of achieving the lowest power loss in the system.

V. CONCLUSION

This paper has presented an intelligent composite compensation scheme under load variation for solving loss control in power system. By utilizing the IEEE 30-Bus RTS system, a new ICAMEP optimization technique has been tested and confirmed its superiority. The proposed technique has successfully exhibited power loss in power system and determined the values for DG sizing and location. This demonstrates that the implementation of ICAMEP technique in 5-DGs installation using DG scheme is more effective and significantly outperforms DG+ORPD scheme in the loss minimization.

VI. ACKNOWLEDGMENTS

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