Building Integrated Photovoltaic for Energy Efficiency

1.0 INTRODUCTION

Customarily, shunt capacitors are often installed in electrical distribution networks for reactive power compensation which in turn will reduce power losses, voltage profile improvement and feeder capacity releases. This spurs into an idea of energy efficiency and energy saving improvement for an unbalanced electrical system in a large-scale building acquired via the power losses minimization under the concept of Volt-VAR optimization utilizing the capacitors for reactive power compensation and voltage regulators for the voltage magnitude control. Particle Swarm Optimization (PSO) techniques have been used to determine the optimal location and sizing for voltage regulators and capacitors yielding to an improvement in terms of energy saving, power losses minimization and total cost investment for the installed equipment. Then, the idea to integrate the PV Solar panel with the Optimized building if proposed in the further study to further improve the energy efficiency. The results have shown that the proposed method of OPS-VRC based PSO provides a propitious amount of energy saving as well as power loss minimization with minimal investment cost whilst maintaining the power factor, voltage magnitude as well as total harmonic distortion without violating the limit specified by the utility.

2.0 OBJECTIVE

This section highlight the main objectives of the research.

a) To integrate PV solar system after the optimal placement and sizing of voltage regulators subsequent to capacitors (OPS-VRC) using Particle Swarm Optimization (PSO) for energy efficiency of an unbalanced electrical system for a large-scale building.

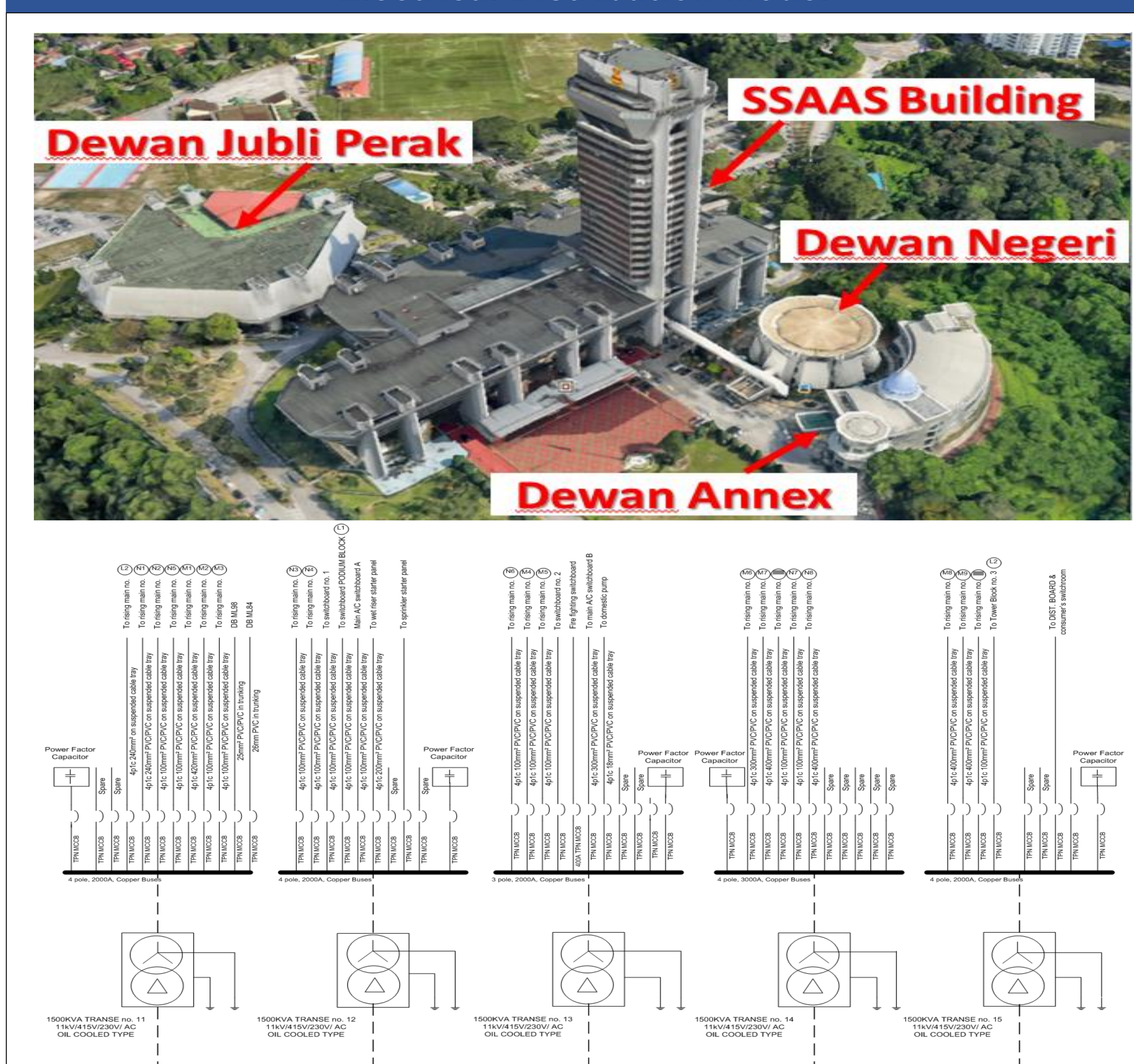
b) To compare and verify effectiveness in the performance of the integrated PV solar system with OPS-VRC based PSO in energy efficiency determination compared with the integrated PV solar system in the building system without OPS-VRC

4.0 RESULT

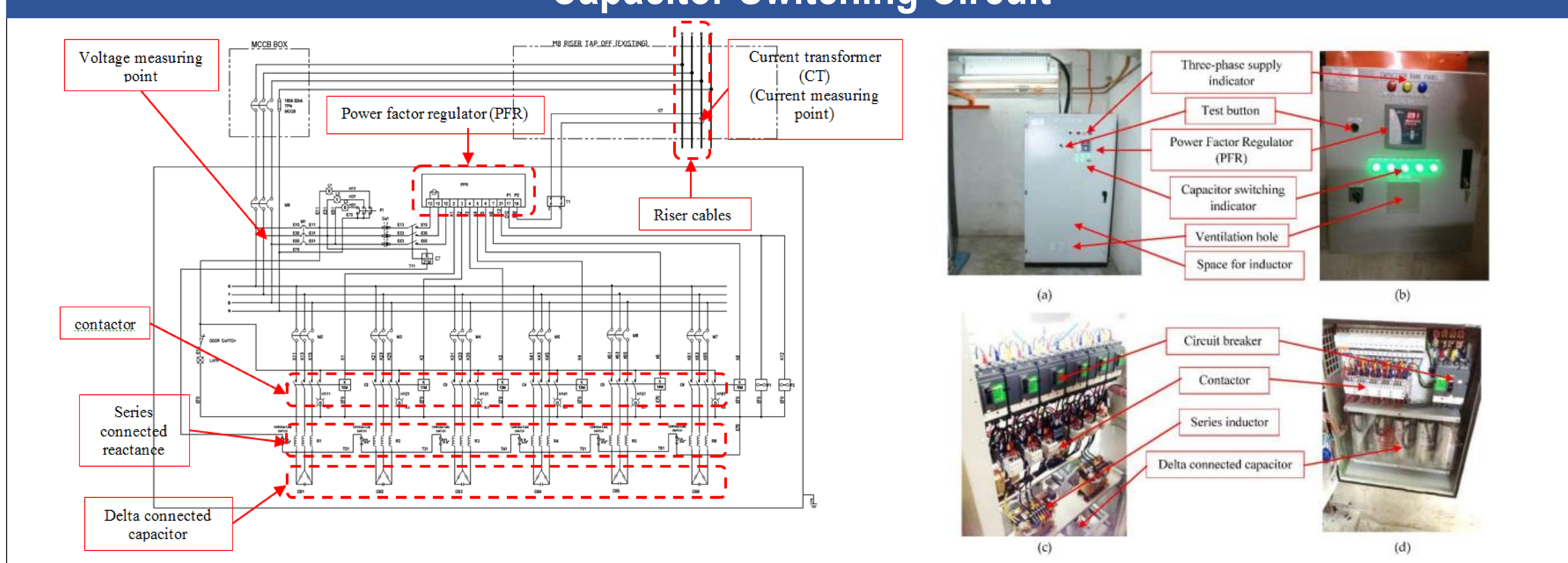
System parameters	Base case	OPS-VRC based PSO	Integrate PV Solar with Base case	Integrate PV Solar with OPS-VRC based PSO
Objective Function (RM/year)	-	440,190.99	221,725.20	681,206.88
Total cost of energy consumption (RM/year)	1,705,578.63	1,241,496.95	1,483,853.43	1,019,771.75
Total cost of energy losses (RM/year)	2,812.25	1,802.94	2,880.30	1,907.83
Total cost of voltage regulators (RM)	-	8,100.00	-	8,100.00
Total cost of capacitors (RM)	-	16,800.00	-	16,800.00
Total real power consumption (kW)	2950.01	2147.32	2,572.3	1761.62
Total real power supply by PV (kW)	-	-	377.71	385.7
Total reactive power consumption (kVAr)	1696.27	1214.33	1,696.4	1234.9
Total real power loss (kW)	4.86	3.12	4.94	3.31
Total reactive power loss (kVAr)	2.47	1.54	2.61	1.82
Total voltage regulators size (kVA)	-	54	-	54
Total capacitors size (kVAr)	-	280	-	280
Maximum voltages magnitude (V_{L-N})	253.44	254.30	255.27	254.21
Minimum voltages magnitude (V_{L-N})	250.12	252.05	241.16	250.08
Average power factor (p.f.)	0.84	0.87	0.84	0.86
Maximum THDv (%)	3%	2%	3%	2%
Percent Saving (%)	-	26%	13%	40%

3.0 METHODOLOGY

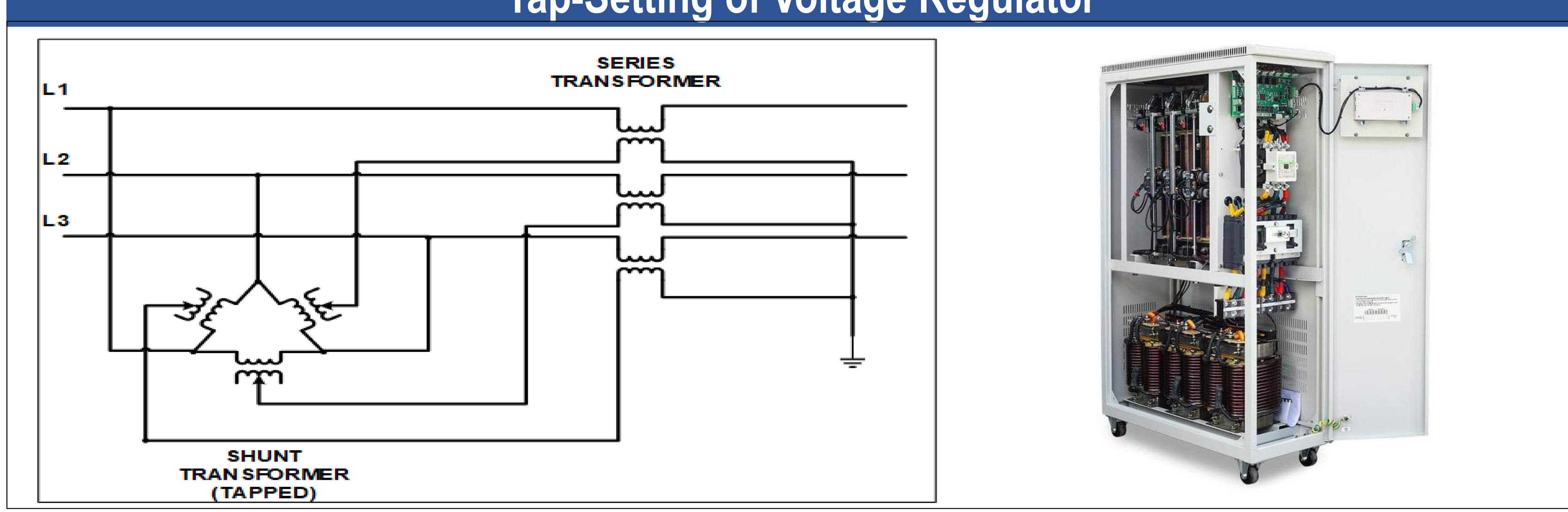
Electrical Distribution Model



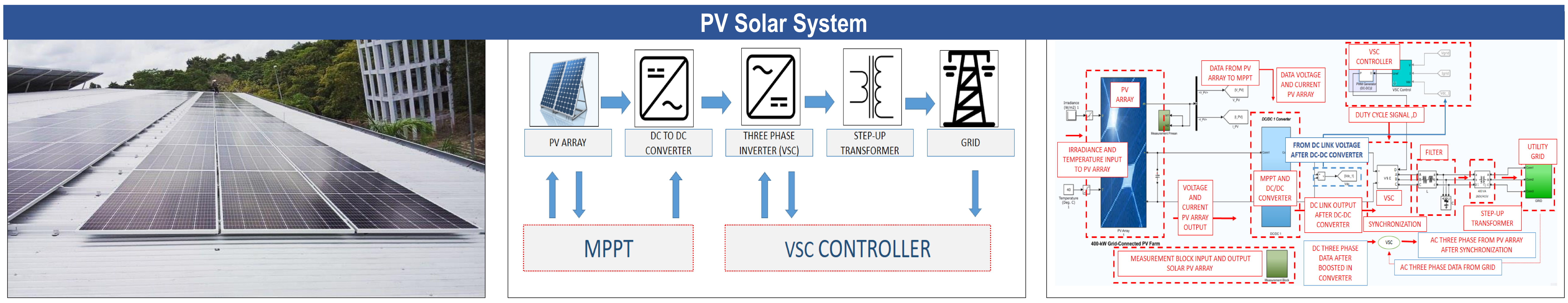
Capacitor Switching Circuit



Tap-Setting of Voltage Regulator



PV Solar System



5.0 ACKNOWLEDGEMENTS

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