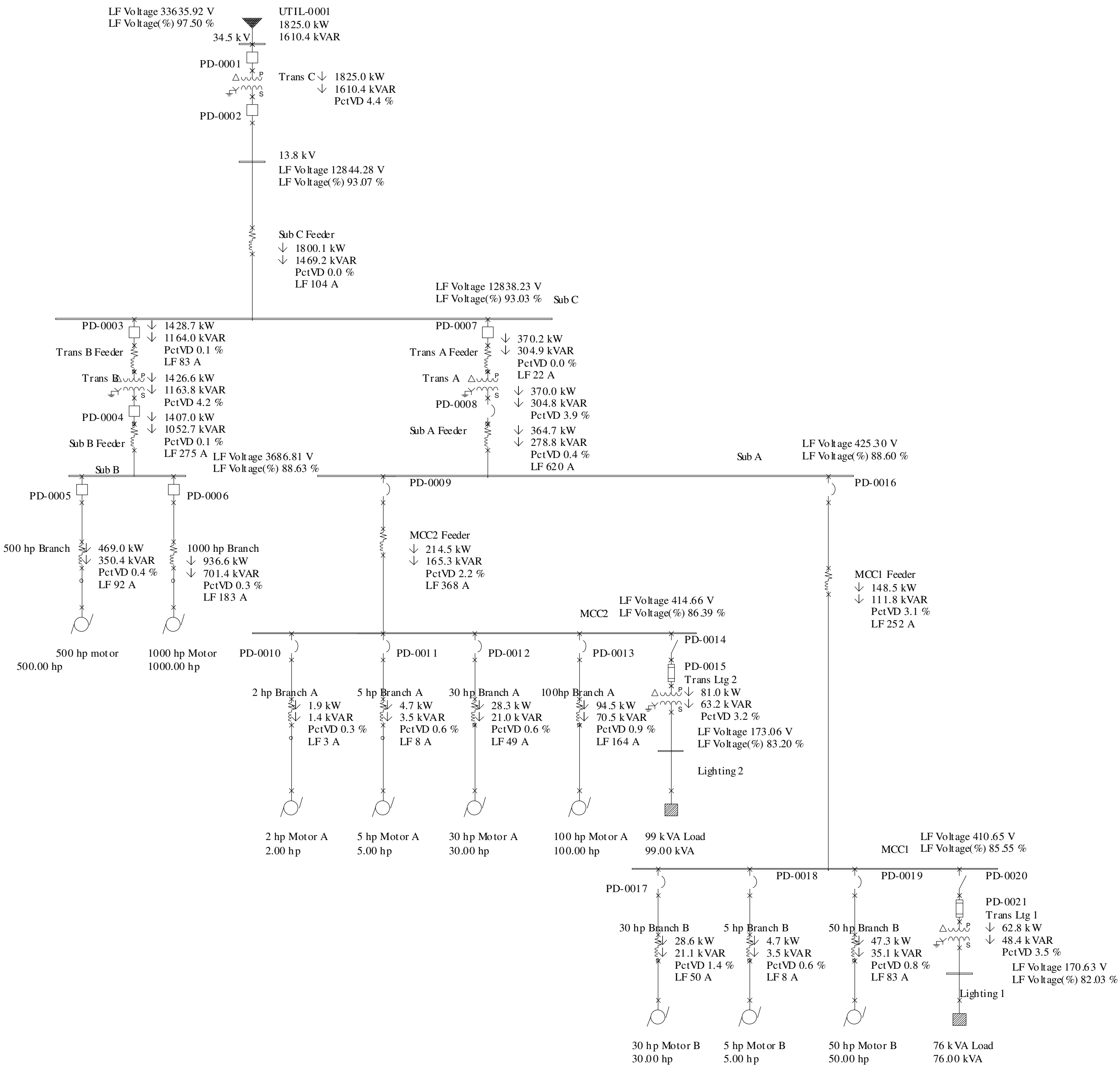
ECE471 INDUSTRIAL POWER SYSTEMS
Homework Set 5

1. Run the load-flow for the class example project. Use the Datablock format to display the bus voltages and list the total system losses.

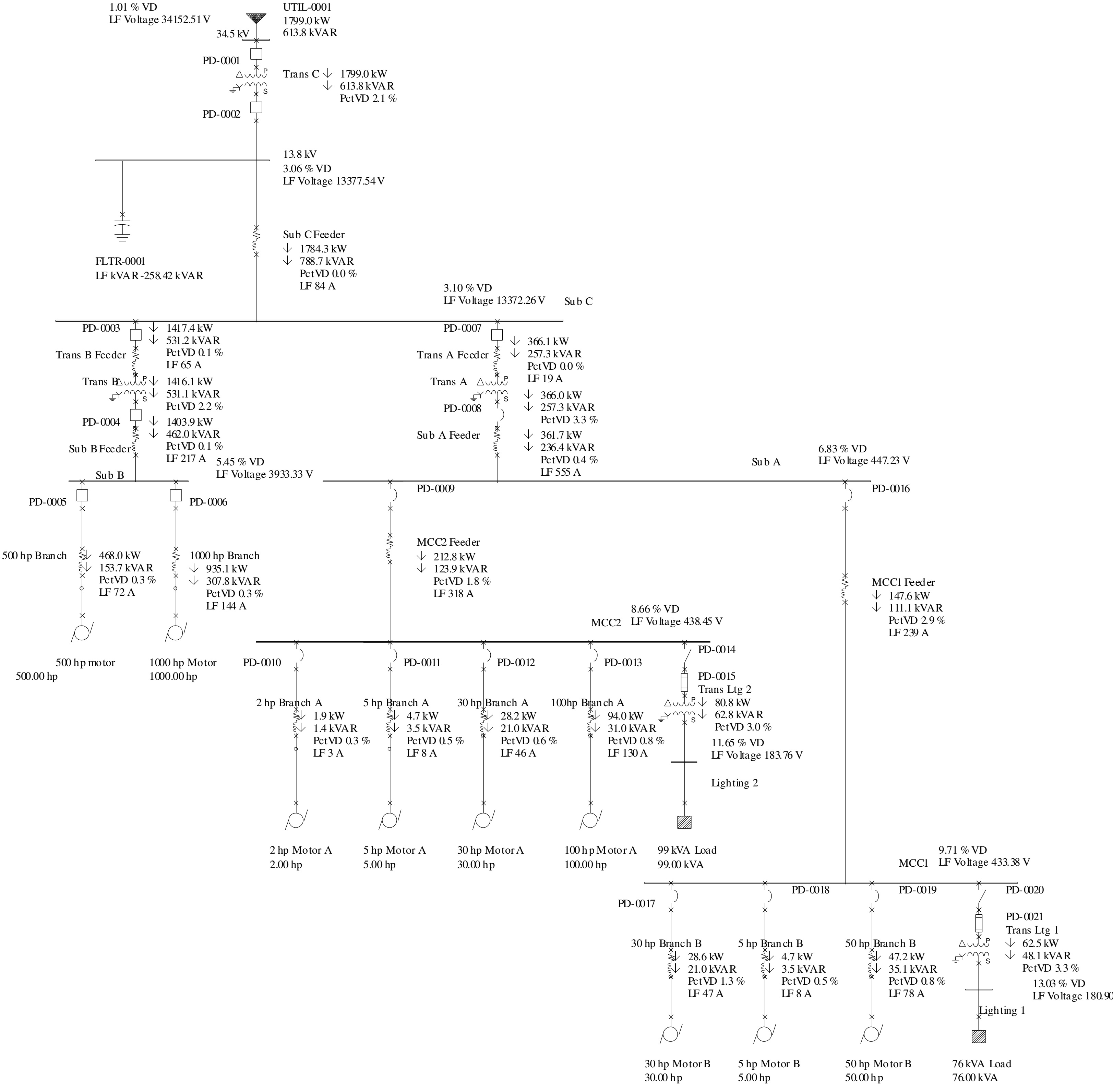


***** T O T A L   S Y S T E M   L O S S E S *****

79. KW   301. KVAR

2. Adjust the power factor to 0.95 lag at each large motor and then place a capacitor bank at the 13.8 kV bus that will bring the overall pf up to 0.95 lag. Then adjust the transformer taps so that the bus voltages will be close to nominal. Again, display the bus voltages and list the total system losses.

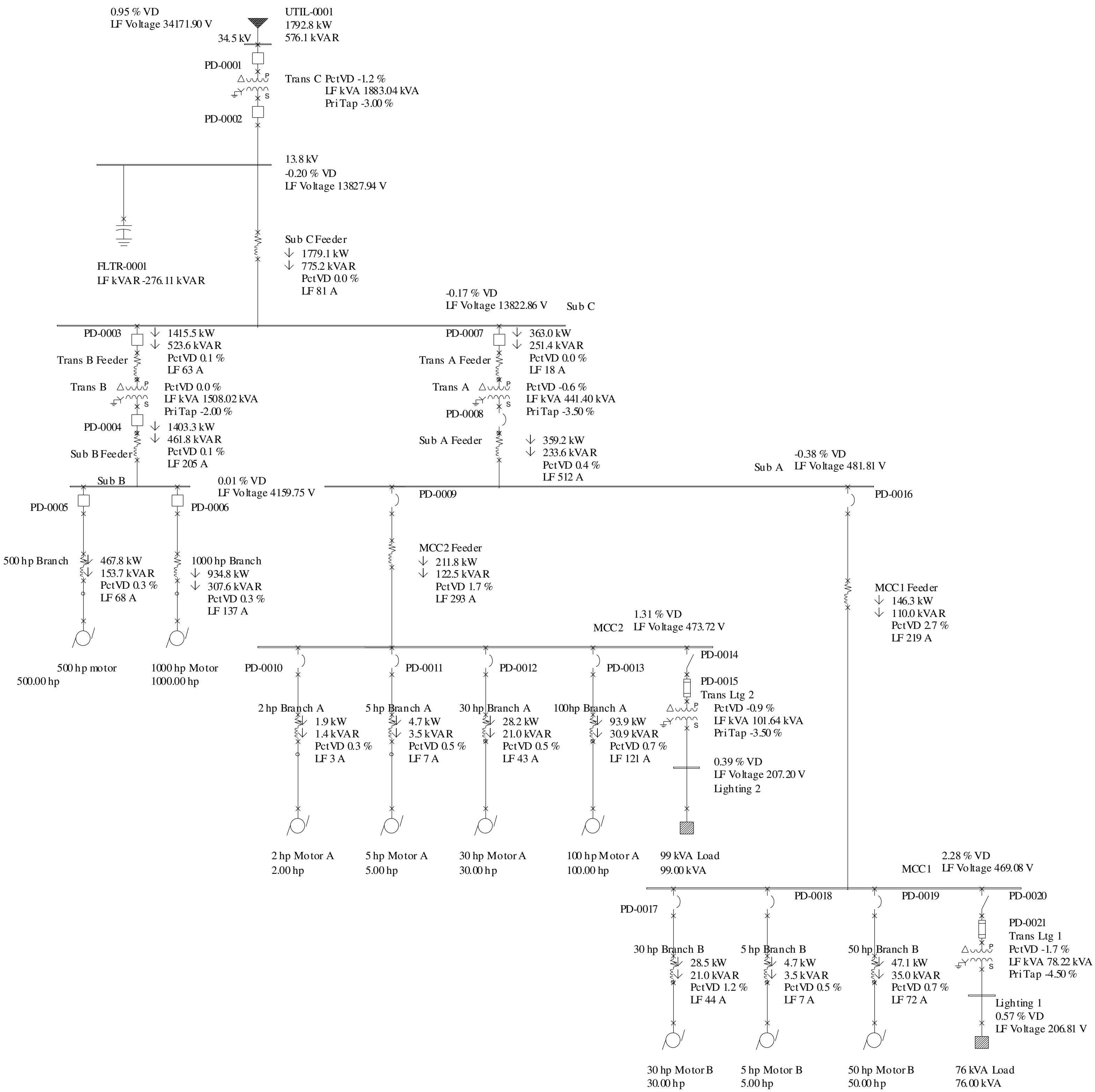
(a) For power factor correction only:



***** T O T A L   S Y S T E M   L O S S E S *****

53. KW   192. KVAR

2 (b). For power factor correction and tap adjustment:



***** T O T A L   S Y S T E M   L O S S E S *****

48. KW   172. KVAR

3. Calculate the total kVAR required in part 2. If the capacitors cost \$50/kVAR and energy costs 10¢/kWh, how long will it take for the capacitors to pay for themselves?

For 1000 hp motor, P_{out} = 746 kW and at 80% efficiency, P_{in} = 932.5 kW
At 0.8 lag pf Q_{in} = 699.4 kVAR and at 0.95 lag pf Q_{in} = 306.5 kVAR, so Q_c = 392.9 kVAR

For a total of 1600 hp the motors require $Q_{motors} = \frac{1600}{1000} \text{ x } 392.9 = 628.6 \text{ kVAR}$

Add this to the Q_{bank} = 275 kVAR and Q_{total} = 903.6 kVAR, which will cost: $\$_Q$ = \$45,180

From part 1 the real power loss is: 79 kW
From 2 (b) the real power loss is: 48 kW
The difference is: 31 kW and this saves \$3.1/hr

Time taken to recover capacitor costs = $\frac{45180}{3.1} = 14574 \text{ hours} = 1.66 \text{ years}$

The above analysis neglects interest, so the real figure will be slightly less than 2 years.