

- 33.18** During a chiller plant upgrade, an oversized fixed speed pump, producing 200gpm and 80ft of total dynamic head with a 70% pump efficiency and 80% motor efficiency, is replaced with a duplex parallel pump set with variable frequency drives. The two replacement pumps provide 60GPM each at 45ft TDH which is sufficient to meet operational demands. The new pump efficiency is 75% and the new motor efficiency is 93%. The system operates continuously 24 hours per day 365 days per year. The average cost of electricity is $\$0.12/\text{kWh}$. What are the annual savings?
- A. $\$3100$
 B. $\$4100$
 C. $\$4900$
 D. $\$5500$

Make a table to organize the given information for the two scenarios.

	Existing	New
Qty of Pumps	1	2
Flow Rate	200gpm	$2 \times 60\text{gpm}$
TDH	80ft	45ft
Pump Efficiency	70%	75%
Motor Efficiency	80%	93%
Run Hours	$7/24/365$	$7/24/365$
Electricity Rate	$\$0.12/\text{kWh} \cdot \text{hr}$	$\$0.12/\text{kWh} \cdot \text{hr}$

Calculate the **whp** for both scenarios.

$$\text{whp} = \frac{Q\Delta h}{3960}$$

$$\text{whp}_1 = \frac{(200)(80)}{3960} = 4.04\text{hp}$$

$$\text{whp}_2 = \frac{(2)(60)(45)}{3960} = 1.36\text{hp}$$

Apply the pump and motor efficiencies to determine the electrical power demand, and convert units to KW .

$$P = \frac{WHP}{\eta_p \eta_m}$$

$$P_1 = \frac{(4.04\text{hp})}{(0.7)(0.8)} \left(0.7457 \frac{\text{KW}}{\text{hp}} \right) = 5.38\text{KW}$$

$$P_2 = \frac{(1.36hp)}{(0.75)(0.93)} \left(0.7457 \frac{KW}{hp} \right) = 1.46KW$$

Calculate the reduction in electrical demand:

$$Demand\ Reduction = 5.38KW - 1.46KW = 3.92KW$$

Apply the annual run hours and electricity rate to determine the annual cost savings:

$$Cost\ Savings = (3.92KW) \left(24 \frac{hrs}{day} \right) \left(365 \frac{days}{yr} \right) \left(\frac{\$0.12}{kW \cdot hr} \right) = \$4120$$

Answer B