For a cost of energy of 0.02 $/kWh, determine the capital cost required for a wind turbine operating under the conditions given below.

- Rotor Radius: 30 m
- Wind Velocity: 7 m/s
- Air Density: 1.2 kg/m³
- Turbine Speed: 1.6 radians/s
- Interest Rate: 13%
- Turbine Lifetime: 30 years
- Annual Hours of Operation: 5724 hr/yr

**Solution:**

We begin by calculating our turbine power output. We have

\[ \dot{W}_{wt} = \eta_{wt} \frac{1}{2} \rho A \bar{v}^3 \]

To determine the efficiency we must calculate the tip speed ratio

\[ \text{TSR} = \frac{\omega R_{rotor}}{\bar{v}} = \frac{(1.6)(30)}{7} = 6.86 \]

Then the efficiency is given by

\[ \eta_{wt} = -0.020554(\text{TSR})^2 + 0.18327(\text{TSR}) + 0.023286 \]

\[ = -0.020554(6.4)^2 + 0.18327(6.4) + 0.023286 = 0.3135 \]

So that our power is

\[ \dot{W}_{wt} = (0.3545)(0.5)(1.2)\pi (30)^2 (7)^3 = 182.42 \text{ kW} \]

Solving for our capital cost we have

\[ P_{cap} = \frac{\text{COE} \times \dot{W}_{turb} \times (\text{annual hours of operation})}{(A/P, i, N)} \]

For our economic conversion factor we have

\[ (A/P, i, N) = \frac{i(1+i)^N}{(1+i)^N -1} = \frac{(0.13(1.13)^{30}}{(1.13)^{30} -1} = 0.1334 \]

Substituting and calculating

\[ P_{cap} = \frac{(0.02)(182.42)(5724)}{(0.1334)} = $156,549 \]