Energy Manager Quiz with Answers

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This quiz can help you prepare for exams. "Step-by-step" answers are written down (at the end) in blue text.

FYI- You may need a calculator, as well reference tables to solve some of these problems.[1]

TIP: If you need additional help, you can watch FREE videos explaining concepts & equations.

Search on YouTube: "CEM Basics Series" (playlist)

Economics, Strategy and M&V Questions:

1. Which has the greatest NPV assuming a 25 year planning horizon and MARR = 12%?
   a. Install a $20,000 solar system that will last 25 years, and generate 38,000 kWh/year at $.10/kWh.
   b. Install a $25,000 Ground-Source Heat pump that will last 50 years and save $3,500/year. Ignore the value of RECs.

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[1] You can download FREE Tables (Economics, Steam, Power Factor Conversion, Psychrometric Chart, etc.) here: http://www.profitablegreensolutions.com/tools

Additional articles (and explanations) on these topics are here: https://www.profitablegreensolutions.com/energy-resources

2. If a waste heat exchanger saves $1,000,000 per year and will last 7 years, how much can you pay for the waste heat exchanger (total installation cost) if your company's MARR is a 30%?
    a. $ 3,300,000
    b. $ 2,802,100
    c. $ 356,900
    d. $ 8,172,200
    e. None of the above

3. An energy manager is evaluating the operating costs of two boilers. One is natural gas fired with an efficiency of 75%, another is electric with an efficiency of 97%. Natural gas costs $0.92/therm, electricity costs $0.095/kWh. Determine the cost per MMBtu for heating water for each system.
    a. Electric: $28.7/MMBtu; Gas:$12.27/MMBtu
    b. Electric: $28.7/MMBtu; Gas:$9.2/MMBtu
    c. Cannot be determined

4. In a "True Lease", you are "renting" the equipment, with no agreement to own the equipment at the end of the term.
    a. True
    b. False

TIP: If you need to review Financing or M&V Terminology, there is a free webinar here:
https://www.youtube.com/watch?v=1o4nDDHUjrA&feature=youtu.be

5. An ESCO identifies energy savings opportunities within the design for the new building (has not been built yet). Which of the following would be the most appropriate M&V Approach to account for the "avoided cost" (from the energy savings) within the new building?
    a. IPMVP Option B
    b. IPMVP Option C
    c. IPMVP Option D
    d. Answers A and B
    e. None of the Above

TIP: For a basic understanding of IPMVP, you can download a free document here: http://evo-world.org/en/

Audit & Billing Questions:

6. Kilowatts are a measure of the consumption of energy while kilowatt-hours are a measure of the consumption of power.
    a. True
    b. False

7. A flue gas analyzer is used to determine how many steam traps have failed in your steam system.
    a. True
    b. False

8. Which instrument is useful for identifying uninsulated steam lines:
    a. Tachymeter
    b. Psychrometer
    c. Infrared Camera
    d. Bourdon Gauge
    e. Both C and D

9. If you pay $10 per kW per month and have a 80% demand ratchet for 11 months, how much extra will you pay (for next 11 months) if you had a 700kW additional spike (above normal demand) during last month?
    a. $0
    b. $6,160 per year
    c. $61,600 per year
    d. $77,000 per year

10. An electrical system has 52.9 kVA and 50.5 kW. How many kVARs of capacitance are required to correct the power factor of the total load to 95%?
    a. 10.8 kVARs
    b. 0 kVARs
    c. 20 kVARs
    d. 35 kVARs
    e. 75 kVARs

This article may also be useful: http://www.profitablegreensolutions.com/single-post/2016/09/20/Power-Factor-Ratchets-and-Your-Electric-Bill

11. Consider the following inverted block rate structure for a monthly bill:

Customer charge:		$250/month
Demand charge:		$10/kW/month
Energy charge:	0 – 25,000 kWh	$0.08/kWh
	25,000 – 100,000 kWh	$0.09/kWh
	Over 100,000 kWh	$0.12/kWh

    Assume that a facility uses a total of 200 kW and 86,400 kWh for one month for all energy loads. How many dollars would they save per month from a lighting upgrade resulting in 25 kW lighting power reduction if the lighting system operates 300 hours per month and operates during the peak demand period?
    a. $600
    b. $675
    c. $850
    d. $925
    e. $1,150

12. When an electric AC induction motor is 15% loaded, the power factor is relatively high.
    a. True
    b. False

Lighting Questions:

13. Correlated Color Temperature refers to how well you can distinguish colors under a particular lighting system.
    a. True
    b. False

14. Use of occupancy sensors installed within a typical conference room that is illuminated by fluorescent lamps will typically:
    a. Reduce monthly lighting operating hours
    b. Increase lamp lives
    c. Reduce billed kW demand.
    d. a and b
    e. a, b, and c

Motors and HVAC Questions:

15. The largest percentage of electric motors installed in buildings and industry in the US are:
    a. AC induction
    b. DC
    c. AC synchronous
    d. Cogeneration
    e. Direct generation

16. In the absence of other data, choose the best estimate of electric motor efficiency (in percent) when motors are properly loaded:
    a. 33
    b. 50
    c. 72
    d. 90
    e. 100

17. If a motor has a Variable Speed Drive (VSD) installed that slows down a 200 HP motor by 20%, what are HP savings?
    a. 102 HP
    b. 160 HP
    c. 97.6 HP
    d. 40 HP
    e. None of the above

18. If the outside temperature is a uniform 75°F throughout the year, the number of cooling degree days in a calendar year is approximately:
    a. 8,760 CDD
    b. 1,825 CDD
    c. 3,650 CDD
    d. 0 CDD

19. A 250 ton chiller has COP of 4.2. If the chiller is running at full capacity, what is the load (in kW) of the chiller?
    a. Cannot be determined
    b. 841 kW
    c. 1050 kW
    d. 209 kW

20. Air at 69 F dry bulb and 50% relative humidity flows at 6750 cubic feet per minute and is heated to 90 F dry bulb. How many BTU/hr is required in this process? Assume no duct losses.
    a. 73,857 Btu/year
    b. 637,875 Btu/year
    c. 153 kBtu/year
    d. Cannot be determined

Steam, Industrial and Thermal Storage Questions:

21. What is the value for Enthalpy when Saturated Steam is at 400 degrees Fahrenheit?
    a. 1201 Btu/lb
    b. 825 Btu/lb
    c. 375 Btu/lb
    d. 767 Btu/lb

22. If colder air flows into a compressor, generally- the efficiency of the compressor is:
    a. Reduced
    b. Improved
    c. Neither because the efficiency is not related to intake air.

23. It is not possible for heat recovery systems (heat exchangers) to reduce temperatures below the dew point temperature of the hot gas.
    a. True
    b. False

24. Thermal Energy Storage using ice as the storage medium is accomplished primarily through latent heat storage.
    a. True
    b. False

25. Consider a process that requires 10,000 MMBtu/year and this energy is supplied by an old, oil-fired boiler (uses residual fuel oil #6) that is only 50% efficient. You retrofit to a natural gas fired boiler that is 80% efficient, what are the energy savings?
    a. 20,000 MMBtu/year
    b. 12,500 MMBtu/year
    c. 7,500 MMBtu/year
    d. None of the Above

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Answers:

1. Answer = A. To compare the economics, it is normal to think that we could use Annual Value because the projects have different lives. However, the problem states that the planning horizon is only 25 years, so in that case, we should use NPV. The savings from the solar system would be $3,800/year.

   The PV of the Annual Savings from the Solar System:
   = $3,800/year (P/AIN Factor)
   = $3,800/year (7.8431)
   = $29,803

   NPV of Solar System:
   = $29,803 - $20,000
   = $ 9,803.

   PV of the Annual Savings from the Ground Source HP:
   = $3,500/year (P/AIN Factor)
   = $3,500/year (7.8431)
   = $27,451

   NPV of Ground Source Heat Pump:
   = $27,451 - $25,000
   = $ 2,451

   Therefore, the Solar System would have the highest NPV.

2. Answer = B. In this problem, we are given A and must find P. Logically, for this project to have a positive NPV, we know the P (from the positive cash flows) must be at least equal to the Cost. Thus, lets find the P and then that is the maximum we can pay for the installed cost.

The PV of the Annual Savings of $1,000,000 per year:
= $1,000,000/year (P/AIN Factor)
= $1,000,000/year (2.8021)
= $ 2,802,100

Thus, we can pay $2,802,100 for the Waste Heat Exchanger and still have a positive NPV.

3. Answer = A. To compare fairly, we must get the fuel prices in the same $/unit. We choose $/MMBTU, and we know that 1kWh=3,412 BTU and then incorporate the efficiency information.

$\$/MMBTU_{electric}$:

If we use 1 kWh, that would be 3,412 BTUs. Then the $/MMBTU in fuel cost would be:
= ($0.095/3,412 BTU)*(1,000,000BTU/1 MMBTU)*(1/.97)
=$28.7/MMBTU

$\$/MMBTU_{gas}$:

We know that 1 Therm equals 100,000 BTUs. Then the $/MMBTU in fuel cost would be:
= ($0.92/Therm)*(1 Therm/100,000BTU)*(1,000,000BTU/1 MMBTU)(1/.75)
= $12.27/MMBTU

The Gas option has the lower cost per unit of fuel.

4. Answer = True. A True (or “Operating”) Lease is basically “renting” and you (the Lessee) do not own the equipment at the end of the lease.

5. Answer = C. IPMVP Option D is useful in this case, because there is no energy performance data on the new part of the building. Option D allows for a simulation to be done so we can estimate the baseline and “avoided costs” from doing energy improvements.

6. Answer = B: False. Power is expressed as kW and Energy is expressed as kWh. Power is a “rate of flow”.

7. Answer = B: False. A Flue Gas Analyzer will tell you the efficiency of combustion, but will not tell you the volume of steam or really any information about what is happening downstream within the steam system.

8. Answer = C. An Infrared Camera will help you identify uninsulated surfaces (if they are hot). A Tachymeter measures RPM. A Psychrometer measures humidity. A Bourdon Gauge is used to measure static pressure (usually in a tank).

9. Answer = C. Ratchet penalties are effective measures to encourage energy consumers to reduce kW spikes, because if you have a ratchet penalty, you will pay the ratchet percent for the next 11 months (even if you don’t use any demand during that period). In this case, if you set a new peak 700kW above your normal operating load (old peak), you will pay:
   = (700 kW)(0.8)(11 months)($10/month*kW)
   = $61,600 in extra charges (over the next 11 months)

10. Answer = B. There are a few ways to solve power factor correction problems. We know that PF = kW/kVA. First, lets solve for initial PF:

If the load is 50.5kW, then the PF would be:
= (50.5 kW)(52.9 kVA)
= 95.46 %

Surprise… the PF is already above 95%, therefore Zero capacitors are required. *However if the initial PF was 72%, then we would look up the PF correction tables (internet) and multiply the appropriate table factor by the Real Power (kW). For this extra example, to go from 72% to 95% Power Factor, then the table factor is 0.635.*

If the load is 50.50kW, then the capacitor size would be:
= (50.5 kW)(0.635 kVAR/kW)
= 32 kVAR

Another way to solve is to use the relationships that PF=kW/kVA and the Pythagorean Theorem to find the initial and final kVAR… The difference in kVAR would be the size of the capacitor to correct the PF to the new level.

11. Answer = D. This problem provides a lot of extra information (much like the "real world"). The dollar savings has two components: Demand and kWh Savings:

Demand Savings:
= (25 kW)($10/kW per month)
= $250 per month

kWh Savings (Note the savings would be in the 2nd Tier, so the price would be $.09/kWh):
= (25 kW)(300 hours)($0.09/kWh)
= $675 per month

Total Savings:
$250 + $675
=$925 per month

12. Answer = B: False. For this motor type, if the load is less than 20%, the power factor and resulting efficiency decline substantially.

13. Answer = B: False. CCT indicates the “color” of the light, not the ability to distinguish colors.

14. Answer = D. Because occupancy sensors will reduce kWh, but cannot be guaranteed to reduce demand (the lights may come on during a peak period). If the lights are “on” less hours per day, they should last longer (assuming the lights are not turned “off” and “on” rapidly).

15. Answer = A. Alternating Current Induction Motors are the most popular motor type for buildings.

16. Answer = D. 90% is a typical efficiency for a motor that is properly loaded.

17. Answer = C. Use the “Fan Laws” HP2=HP1 (RPM2/RPM1)3. Therefore, if the new speed (RPM2) is 80% of the old speed (RPM1), the new power load (HP2) will be:

$HP_2=HP_1 (.8)^3$

$HP_2=200HP (0.512)$

$HP_2=102.4$ HP

Thus, the Savings are $HP_1-HP_2 = 97.6HP$

As the Fan Laws are similar to a “theoretical maximum”, in practice- you may not completely achieve this level of savings, but you can come very close, which is still amazing.

18. Answer = C. 65 Degrees F is the “target” outside temperature. If the average temperature is 75, then we are 10 degrees “off target”. For 365 days, the Cooling Degree Days would be:

(10)(365)

=3,650 CDD per year

19. Answer = D. The Coefficient of Performance is the $Power_{moved}/Power_{input}$. With a 250 ton chiller, this machine is capable of moving 250 tons of cooling, therefore the $Power_{input}$ would be:

$4.2=P_m/P_i$

$4.2=250\ tons/P_i$

$P_i = 59.52$ tons

But "tons" must be converted into kW to answer the question. A "ton" is a rate of energy flow equal to 12,000 BTUs per hour and we also know that 1 kW = 3412 BTUs/hour. Thus the amount of kW can be found by:

*=(59.52 tons)(12,000 BTU/hr*ton)(kW/3412BTU/hr)*

=209 kW

20. Answer = C. Use the equation for "sensible heat transfer" (actually a "short cut" equation endorsed by ASHRAE):

$q = 1.08(CFM)\Delta T$ [q units are in Btu/hour]

q= 1.08 (Btu*min /ft^3*hour* ^oF)(6,750 ft^3/min)(21 ^oF)

q= 153,090 Btu/hour

21. Answer = A. Use the Saturated Steam tables to find Enthalpy in the gaseous state (h_g), which is: 1201 Btu/lb.

22. Answer = B: False. Colder air is more dense and dry, which reduces the work required by the compressor, thereby increasing the efficiency.

23. Answer = B: False. When the flue gases temperatures are reduced below the dew point, they will condense… (lets hope that you have a condensing boiler).

24. Answer = A: True. The "phase change" energy allows more Btu to be stored (or liberated) in energy storage applications.

25. Answer = C. To determine the savings, we need to compare the fuel consumed before and after the retrofit.

Before the retrofit, if the boiler is only 50% efficient, then the fuel supplied to the boiler will be more than the 10,000 MMBtu needed for the process. Thus, the fuel input will be 10,000/.5 = 20,000 MMBtu per year.

After the retrofit, the new boiler is 80% efficient and the fuel input will be 10,000/.8
= 12,500 MMBtu per year.

The Savings would be:
= 20,000 MMBtu – 12,500 MMBtu
= 7,500 MMBtu per year.