

## **SECTION 1 – ENERGY RATE STRUCTURES & PRICING**

1. In evaluating savings for electrical recommendations, the \_\_\_\_\_ cost of demand and energy should always be used.
  - a. weighted average
  - b. tiered
  - c. mean
  - d. marginal
  - e. None of these answers
  
2. With the prices at the following levels, which fuel is the least expensive based upon initial cost per GJ? Use LHV.
  - a. Natural gas at €0.25 per cubic metre
  - b. Diesel at €0.50 per litre
  - c. Propane at €0.32 per litre
  - d. Electricity at €0.035 per kWh

**The following electric information must be used for questions 3, 4 and 5:**

Commercial Time of Use (Time of Day) Rate (CTOU-14) Schedule:

Basic Customer Charge: \$ 500.00

Demand Charge:

Summer (June through September) Demand Charge: \$ 10.10 per kW

Non-Summer (October through May) Demand Charge: \$ 7.48 per kW

Energy Charge (Summer and Non-Summer):

On-Peak Energy \$0.05055 per kWh

Off-Peak Energy \$0.03775 per kWh

Utility Sales Tax: 5.0%

On-Peak Hours:

Summer: 10:00 am to 6:00 pm Monday through Friday

Non-Summer: 6:00 am to 10:00 am and 4:00 pm to 8:00 pm Monday through Friday

- 3. Given the following consumption information for this industrial plant, what would be the November electrical charges?**

Actual Demand = 2,100 kW

Total Energy Consumption: 982,800 kWh

(393,120 kWh On-Peak and 589,680 kWh Off-Peak)

- a. \$60,758
  - b. \$55,974
  - c. \$61,258
  - d. \$69,183
  - e. None of these answers
- 4. For the November billing what would be the plant's load factor, expressed as a percentage, assuming a 30 day billing period.**
- a. 45%
  - b. 50%
  - c. 55%
  - d. 60%
  - e. 65%
  - f. None of these answers

5. A lighting vendor is recommending adding controls to turn off a series of high pressure sodium fixtures in the warehouse during the third shift and weekends. An average cost (based upon November charges) of \$0.0623 per kWh was used in estimating savings. Assuming the calculation methodology in the proposal for estimating the energy (kWh) savings is reasonable, are the estimated annual monetary savings accurate?
- a. Yes
  - b. No
6. For a plant with an actual demand of 1,100 kW and measured kVar of 800, what would be the approximate power factor?
- a. 72%
  - b. 76%
  - c. 81%
  - d. 86%
  - e. 92%
7. For larger commercial/industrial customers, the development of more sophisticated metering is allowing electrical pricing alternatives that more accurately reflect a utility's cost of production. This is often referred to as Real-Time Pricing.
- a. True
  - b. False
8. What would be the approximate annual operating cost of a 35 kW Toshiba three-phase AC induction motor operating continuously (24/7) at 1,775 rpm (full load) with a nameplate rated efficiency of 93%? The electrical costs are as follows:
- Demand - \$12.00 per kW  
Energy - \$0.0635 per kWh  
Utility sales tax = 5%
- a. \$17,637

- b. \$20,530
  - c. \$23,250
  - d. \$27,671
  - e. \$26,350
  - f. None of these answers
- 9. A rewind 15 kW air handler motor is operated at 80% load and has a power factor of 85%. If the motor efficiency is 90%, what would be the annual operating cost of the motor given 6,200 hours of annual operation and an average cost of electricity of €0.075 per kWh?**
- a. €5,270
  - b. €5,989
  - c. €8,598
  - d. €6,200
  - e. €7,240
  - f. None of these answers
- 10. Which of the following is not approximately equivalent to 1 GJ? Use LHV.**
- a. 27 cubic metres of natural gas
  - b. 28 litres of diesel
  - c. 253 kWh of electricity
  - d. 44 litres of propane

## **SECTION 2 – ENERGY SURVEYING AND INSTRUMENTATION**

- 11. An initial step in an energy assessment should be to evaluate the level and quality of the energy consumption data available for all purchased energy sources.**
- a. True
  - b. False

**12. The primary function of energy instrumentation is to:**

- a. Identify energy savings opportunities
- b. Save money
- c. Measure energy consumption
- d. Validate energy bills

**13. While generally used for thermal envelope analysis, infrared thermography such as cameras and temperature guns can be a valuable tool in evaluating electrically active equipment such as panels and switchgear.**

- a. True
- b. False

**14. The best way(s) to assure that compressed air leaks are minimized is to:**

- a. Educate personnel to the cost of compressed air
- b. Conduct periodic leak surveys with an ultrasonic leak detector
- c. Have maintenance personnel inspect compressed air lines weekly
- d. Valve off abandoned air lines
- e. All of these answers
- f. Periodic leak surveys with an ultrasonic leak detector and valve off abandoned air lines only

**15. Airflow (cfm) through a duct can be measured using which of the following?**

- a. Anemometer
- b. Velometer
- c. Sling psychrometer
- d. All of these answers
- e. Anemometer or velometer

**16. In determining the level of illumination in a space, a light level reading should be taken at a minimum of 100cm above the floor and in the center of the space.**

- a. True
- b. False

**17. The two (2) largest energy wasters in many industrial applications are:**

- a. Boiler inefficiency and excessive compressed air pressure settings
- b. Failed steam traps and compressed air system leaks
- c. Inappropriate HVAC thermostat set points and failed steam traps
- d. Poor air compressor performance and inadequate pipe insulation

**18. A large facility should be evaluated as a dynamic, not a static, user of energy.**

- a. True
- b. False

**19. Prior to conducting a site energy assessment, historical consumption of all purchased energy sources should be reviewed. At least \_\_\_\_\_ months of consumption should be evaluated for each energy source.**

- a. 12 months
- b. 18 months
- c. 24 months
- d. 6 months

**20. In performing a lighting survey, which of the following instrumentation could be used?**

- a. Foot-candle meter, velometer, ammeter
- b. Illuminance meter, luxmeter

- c. Thermometer, power factor meter, velometer
- d. Foot-candle meter, ammeter, hygrometer

### **SECTION 3 – ENERGY OVERVIEW**

**21. Which of the following countries is not among the world's largest importers of energy?**

- a. China
- b. Japan
- c. Brazil
- d. USA
- e. India

**22. Which of the following countries is believed to have the largest proven energy reserves?**

- a. Qatar
- b. Indonesia
- c. Saudi Arabia
- d. Russia
- e. USA

**23. Which of the following emerging world economies is (are) requiring significantly greater energy resources?**

- a. Chile
- b. Qatar
- c. China
- d. India
- e. Both China and India

**24. A standard equivalent barrel of crude oil contains \_\_\_\_\_ US gallons.**

- a. 34
- b. 42
- c. 45
- d. 55
- e. None of these answers

**25. Claimed advantages of biomass as an energy sources include that it is home grown and may be carbon neutral.**

- a. True
- b. False

**26. Several countries have banned the following items because of their low efficiency.**

- a. Compressed air operated tools
- b. Standard incandescent lamps
- c. Air conditioners less than 6,000 Btuh
- d. Electric motors with efficiencies less than 90%
- e. None of these answers

**27. Which of the following can impact the cost of natural gas to the end user?**

- a. Seasonality
- b. Demand
- c. News and rumors
- d. Speculation
- e. All of these answers



f. All of these answers except speculation

**28. The technology associated with extracting natural gas has improved significantly over the past two decades opening up deposits that were previously considered uneconomical to extract.**

- a. True
- b. False

#### **SECTION 4 – ENERGY ANALYSIS AND ECONOMICS**

**29. Financing mechanisms for energy initiatives can include:**

- a. Cash, also known as retained earnings
- b. Borrowing, also known as debt financing
- c. Performance contracting
- d. Leasing from an ESCO
- e. All of these answers

**30. The methodology used for evaluating the total cost of ownership of an asset or value of a project is:**

- a Rate of return
- b Simple payback
- c. Life cycle costing
- d. Internal rate of return

**31. Decreasing the speed (rpm) of a centrifugal fan will theoretically reduce the motor's power requirement:**

- a. In direct proportion
- b. In a cubic proportion
- c. In a squared proportion

- d. By a fixed percentage of the output power rating
- e. None of these answers

**32. If natural gas cost 0.14€ per cubic metre, electricity from Green Power (Wind Farm) is 0.09€ per kWh and heavy fuel oil is 0.65€ per litre, which would be the most expensive fuel for an equivalent application? Assume conversion efficiencies of 100% for electricity, 84% for oil, and 90% for natural gas. (Use 37 MJ per litre for natural gas and 40 MJ per litre for oil.)**

- a. Natural gas
- b. Heavy fuel oil
- c. Electricity
- d. They are nearly equivalent

**33. What would be the approximate peak demand for a 75 kW AC motor if it were 75% loaded, had a rated efficiency of 95%, and a power factor of 0.86?**

- a 72 kW
- b. 59 kW
- c. 67.0 kW
- d. 79.0 kW

**34. A proposed new system is expected to save \$50,000 annually and cost \$5,000 per year additional in labor and maintenance expenses. The system installed cost is \$250,000 and it has a projected life of 20 years. If the minimum corporate rate of return is 25%, which answer is closest to the NPV of the proposed system?**

- a. -\$ 4,570
- b. +\$15,090
- c. -\$11,670
- d. +\$72,690
- e. -\$72,070

**35. A building is heating with diesel fuel at a cost of 0.79€ per litre. The older model system has an efficiency of 80%. A local HVAC contractor wants to install a ground-source heat pump with an average seasonal COP of 3.5. If the cost of electricity averages 0.20€/kWh, will the annual heating cost of the heat pump be less, more, or the same, assuming 39 MJ/litre for diesel?**

- a. Less
- b. More
- c. Same

**36. An energy saving project is expected to save \$29,800 per year. If the installed cost is \$100,000 and it is anticipated to have a five (5) year life, what would be the internal rate of return (return on investment)?**

- a. 10%
- b. 15%
- c. 20%
- d. 12%
- e. 25%

**37. A vendor proposal to replace the AC induction motors in a plant uses an average existing motor efficiency of 84.5% in projecting savings for all the motors. The motors to be replaced range in size from 15 kW to 150 kW. Will this assumed efficiency provide an accurate estimate of the potential savings?**

- a. Yes
- b. No

**38. Consider a 50 kW motor operating a variable torque load. What would be the change in shaft power when the speed is reduced by 180 rpm?**

- a. 10.0 kW

- b. 13.5 kW
- c. 20.0 kW
- d. 36.5 kW
- e. None of these answers

**39. If air is flowing in a duct at 13,500 CMH and weighs 1.225kg/m<sup>3</sup>, how many kilograms of air flow through the duct daily?**

- a. 396,900 kg
- b. 442,305 kg
- c. 456,957 kg
- d. 496,125 kg

## **SECTION 5 – STRATEGIC ENERGY PLANNING**

**40. Factors for consideration when developing an energy plan include:**

- a. The types, quantities required, and availability of energy sources
- b. The specific end use applications and their contribution to overall energy costs.
- c. Proposed changes in company management
- d. All of these answers
- e. Types, quantities required and availability of energy sources PLUS specific end use applications and their contribution to overall energy costs

**41. An effective Strategic Energy Plan is not a complex voluminous document.**

- a. True
- b. False

**42. Major factors impacting an energy plan can include:**

- a. The price of each energy source employed (€/GJ)

- b. Visibility of support from senior management
- c. Availability of internal and external energy expertise
- d. All of these answers
- e. The price of each energy source and availability of internal and external energy expertise

**43. The following is not required in a Strategic Energy Plan?**

- a. Visible senior management support
- b. Assuring that senior management participates in Energy Committee meetings
- c. Securing and maintaining employee involvement
- d. Recognizing and rewarding employees
- e. Establishing accountability and a timeline to assure implementation of recommended strategies and measures

**44. It is important that an Energy Committee have cross-departmental representation.**

- a. True
- b. False

**45. Which of the following is not a primary function of a Strategic Energy Plan?**

- a. Assuring that the necessary energy resources are available
- b. Make the most cost-effective energy decisions possible
- c. Provide for orderly growth and transitions
- d. Establishing employee policies relating to energy efficiency
- e. Develop a strategy to address utility supply problems

**46. It is important to establish a relationship with each of your energy providers.**

- a. True
- b. False

**47. Energy source options (alternative sources) are a consideration in a Strategic Energy Plan.**

- a. True
- b. False

**48. Due to the technical requirements of the position, it is essential that the Energy Manager be an engineer.**

- a. True
- b. False

**49. The initial energy reduction goal of a program (projected % annual savings) should be aggressive to emphasize the importance of controlling energy expenditures.**

- a. True
- b. False

## **SECTION 6 – MECHANICAL SYSTEMS – HVAC**

**50. Air has eight (8) basic properties that can be plotted on a Psychrometric Chart. Included in these are:**

- a. Dry bulb temperature, wet bulb temperature
- b. Enthalpy and entropy
- c. Specific humidity and relative humidity
- d. All of these answers

- e. Dry bulb temperature, wet bulb temperature, specific humidity and relative humidity

**51. At a specified pressure, if you know any two (2) properties of air, you can determine the other properties with a Psychrometric Chart.**

- a. True
- b. False

**52. What is the approximate relative humidity of air at 25°C dry bulb and 17°C wet bulb?**

- a. 40%
- b. 50%
- c. 45%
- d. 55%

**53. If 400 cfm of outdoor air at 35°C is mixed with 4,000 cfm of return air at 24°C, what would be the mixed air temperature of the air entering the cooling coil?**

- a. 24.5°C
- b. 25.0°C
- c. 25.5°C
- d. 26.2°C
- e. None of these answers

**54. The formula for calculating the transmission of heat through a material or structural component is:**

- a.  $Q = 1.08 \times \text{CMH} \times \Delta T$  (dry bulb)
- b.  $Q = U \times A \times \Delta T$  (dry bulb)
- c.  $Q = U \times A \times \text{HDD} \times \text{hours}$
- d.  $Q = \text{CMH} \times 0.68 \times \Delta T$  (wet bulb)

e.  $Q = (\text{thickness}) \times (\text{hours}) \times A \times U$

**55. The basic refrigeration circuit contains four (4) components. They are:**

- a. The evaporator, expansion device, hot gas line, and compressor
- b. The expansion device, fan, condenser, and motor
- c. The compressor, condenser, expansion device, and evaporator
- d. The compressor, heat exchanger, and condenser

**56. Which of the following air distribution systems is generally considered the most efficient?**

- a. Single zone
- b. Dual duct
- c. Multizone
- d. Terminal (electric) reheat
- e. Variable air volume

**57. An air conditioner has a coefficient of performance of 4.1. The compressor is rated at 50 kW. What is the refrigeration capacity of the air conditioner?**

- a. 12.2 kW
- b. 205 kW
- c. 2.05 kW
- d. 45.9 kW
- e. 47.95 kW

**58. Having a master plan for HVAC controls is important to assuring systems are properly specified, installed, and controlled.**

- a. True
- b. False



**59. The principles used in producing comfort cooling in window air conditioners are fundamentally the same as those utilized in multi-stage centrifugal chiller.**

- a. True
- b. False

**60. A centrifugal fan operates at 1,750 rpm and maintains a static pressure in the duct of 200 mbar. What is the approximate speed at which the supply fan needs to operate to maintain a new static pressure of 170 mbar?**

- a. 1,800 rpm
- b. 1,613 rpm
- c. 1,367 rpm
- d. 1,226 rpm

**61. A building having an exhaust system without a makeup air system may be prone to which of the following:**

- a. Over pressurization
- b. Excessive infiltration
- c. Excessive negative pressure in the building
- d. Excessive infiltration and excessive negative pressure in the building

**62. The term Thermal Energy Storage (TES) refers to**

- a. Chilled water storage only
- b. Ice storage only
- c. Eutectic salts storage only
- d. All of these answers

**63. For equivalent space cooling loads, the required storage tank capacity (volume) of ice storage systems is less than that of chilled-water systems due to the \_\_\_\_\_ properties of water.**

- a. Specific heat
- b. Latent heat
- c. Sensible heat
- d. None of these answers

**64. When properly sized and installed, Thermal Energy Storage systems will always save electrical energy, as well as reduce operating costs.**

- a. True
- b. False

**65. One of the main advantages of geothermal heat pumps is that when used for heating they can save 50% to 70% in heating over conventional air source heat pumps.**

- a. True
- b. False

**66. Which of the following geothermal heat pump systems is more commonly used in commercial applications?**

- a. Open-loop
- b. Horizontal closed-loop
- c. Vertical closed-loop
- d. Spiral closed-loop

**67. In addition to energy savings, another significant benefit(s) of geothermal heat systems is:**

- a. No exposure of outdoor equipment

- b. System design flexibility, including a smaller mechanical room
- c. No on-site combustion/emissions
- d. All of these answers
- e. a & c only

**68. What is the least efficient type of chiller for larger facilities?**

- a. Centrifugal
- b. Rotary screw
- c. Reciprocating
- d. Absorption
- e. Hermetic

**69. Which of the following chillers would be considered the most efficient?**

- a. Water-cooled centrifugal
- b. Air-cooled rotary screw
- c. Double effect Absorption
- d. Air-cooled reciprocating

**70. Inlet guide vanes are used to control capacity on a centrifugal chiller.**

- a. True
- b. False

**71. The typical refrigerant in an absorption chiller is**

- a. Lithium bromide
- b. Water
- c. R-134A
- d. Glycol

**72. On a cool day chiller energy can be reduced by:**

- a. Reducing refrigerant flow
- b. Increasing condenser cooling water flow
- c. Utilizing temperature reset
- d. Shutting off the chiller for 10 minutes each hour

**73. Energy saving measures for cooling towers can include:**

- a. Synchronous belts and sheaves
- b. Tip and hub seals
- c. Dew point monitoring & vibration sensors
- d. All of these answers
- e. Synchronous belts and sheaves and tip and hub seals

**74. Which of the following types of heat exchangers is likely to allow cross contamination between fluid flows?**

- a. Shell and tube
- b. Heat pipe
- c. Heat wheel
- d. Plate and frame
- e. Spiral

## **SECTION 7 – MECHANICAL SYSTEMS – COMPRESSED AIR SYSTEMS**

**75. The three (3) primary types of air compressors most often used today are:**

- a. Rotary screw, vane, and centrifugal
- b. Reciprocating, centrifugal, vane
- c. Rotary screw, centrifugal, and reciprocating

d. Reciprocating, rotary screw, vane

**76. Which of the following is considered an energy saving measure for compressed air systems?**

- a. Implementing a leak detection and repair program
- b. Reducing compressor discharge pressure to the lowest acceptable level
- c. Utilizing suction throttling control
- d. All of these answers
- e. Leak detection and repair and reducing compressor discharge pressure to the lowest acceptable level only

**77. Even though larger AC induction motors typically have efficiencies over 92%, the overall process of compressing air is less than 20% efficient.**

- a. True
- b. False

**78. Within normal operating ranges, for each 140 mbar the discharge pressure of an air compressor is reduced there will an energy saving of \_\_\_\_\_.**

- a. 1%
- b. 2%
- c. 3%
- d. 4%
- e. None of these answers

**79. Which of the following is not considered an energy savings measure for compressed air systems?**

- a. Automatic drain traps on receivers
- b. Reducing compressor discharge pressure
- c. Purchasing a compressor with a VFD

- d. Periodic leak surveys
- e. Replacing a refrigerated air dryer with twin tower desiccant air dryer

## **SECTION 8 – BOILERS AND STEAM SYSTEMS**

**80. The two (2) basic types of boilers are:**

- a. Fire tube and water tube
- b. Fire tube and combustion
- c. Fire tube and heat recovery steam generators
- d. Water tube and utility boiler

**81. Providing more O<sub>2</sub> to a boiler than necessary for complete combustion will not increase fuel costs.**

- a. True
- b. False

**82. After tuning a boiler the efficiency increased from 78.9% to 81.1%. Given an annual fuel cost of \$10,500,000 what would be the projected fuel savings?**

- a. \$264,595
- b. \$321,655
- c. \$291,335
- d. \$284,834
- e. \$301,615
- f. None of these answers

**83. Stack combustion analysis will measure which of the following?**

- a. Flue gas temperature, carbon dioxide, carbon monoxide, and type of fuel
- b. Flue gas temperature, oxygen, carbon monoxide, carbon dioxide

- c. Flue gas temperature, sulfur, sulfur-oxide, oxygen
- d. Flue gas temperature, sulfur, oxygen, steam temperature

**84. The purpose of blowdown is:**

- a. To cool the boiler water
- b. Reduce contaminants that accumulate within the boiler water
- c. To release unclean steam
- d. To clean the boiler tubes

**85. If the average daily stack temperature were to slowly increase 100°F over a three (3) month period, you might suspect which of the following?**

- a. A broken or split tube
- b. Fouling of the tubes
- c. Changes in the weather
- d. Changes in the air/fuel ratio

**86. The most important function of a steam trap is to:**

- a. To sense and and remove condensate with minimal loss of steam
- b. To sense and release pockets of air
- c. To act as pressure interface between the high pressure steam system and the lower pressure condensate system
- d. None of these answers

## **SECTION 9 – ELECTRICAL SYSTEMS**

**87. A motor operates at best efficiency at:**

- a. 100 to 120% of full load
- b. 20 to 80% of full load

- c. 70% of full load
- d. 60 to 100% of full load

**88. In smaller sizes (lower KW rating) IE3 premium efficiency motors can be as much as 3% more efficient than IE2 standard motors.**

- a. True
- b. False

**89. When a high use motor fails, rewinding is the most cost effective option.**

- a. True
- b. False
- c. Cannot be determined

**90. Efficacy is defined as:**

- a. Lumens/square metre
- b. Candela/square metre
- c. Lux/watt
- d. Lumens/watt

**91. A task lighting source is mounted 3 metres above the working plane and provides 540 lux of illumination. If the light source is lowered by 0.6 metres, what would be the approximate new lighting level?**

- a. 780 lux
- b. 900 lux
- c. 700 lux
- d. 840 lux
- e. None of these answers



**92. Of the type lamps noted below, which has the highest currently available efficacy?**

- a. LED
- b. Pulse-start metal halide
- c. High pressure sodium
- d. Low pressure sodium

**93. Which of the following lighting sources has the greatest potential for increased efficacy and applications?**

- a. Fluorescent
- b. Halogen
- c. LED
- d. Ceramic metal halide
- e. Low pressure sodium

**94. A building with 1,200 four-lamp four-foot electromagnetically-ballasted fluorescent fixtures with 34 watt lamps is to be renovated with an equivalent number of similar fixtures with T-8 lamps and electronic ballasts. Given the following information what would be the annual savings.**

Existing fixture input wattage = 144

New fixture input wattage = 114

Annual operating hours = 3,000

Marginal cost of electricity:

kW = \$11.00

kWh = \$0.0563/kWh

State utility sales tax = 5%

- a. \$ 6,800
- b. \$10,832
- c. \$11,374
- d. \$ 6,476

- e. None of these answers

## **SECTION 10 – BUILDING MANAGEMENT SYSTEMS AND CONTROLS**

**95. Potential benefits of a DDC control system include flexibility, accuracy, system performance feedback, integration, and energy savings.**

- a. True
- b. False

**96. PID control is not the preferred control strategy to minimize/eliminate “overshooting” a setpoint.**

- a. True
- b. False

**97. Where possible, internal personnel should be trained to program BAS systems in lieu of continually contracting for those services with the supplying vendor.**

- a. True
- b. False

**98. The following is not a type of controller function (Control Response).**

- a. Two-position
- b. Floating
- c. Proportional
- d. Differential
- e. Proportional plus integral
- f. Proportional plus integral plus derivative

**99. In a DDC control loop, the function of a sensor is to measure a controlling variable or other control input in an accurate and repeatable manner.**

- a. True
- b. False

**100. The function of a controller is to compare an input with a set of instructions (such as throttling range, setpoint, etc.,) to produce the appropriate output signal.**

- c. True
- d. False