

Environmental Engineering FE CBT Exam

Knowledge: Energy and Environment with 8 Example Problems

Contents

1 Exam Scope and Energy Pathways	3
1.1 Energy sources, forms, and end uses	3
1.2 Conventional and alternative sources	3
1.3 Energy-accounting mindset	3
2 Combustion and Carbon Formation	4
2.1 Key balanced reactions	4
2.2 Mass ratios from stoichiometry	4
2.3 Combustion products and environmental implications	4
3 Biomass and Waste-Derived Energy	5
3.1 Biomass conversion routes	5
3.2 Heating value	5
3.3 Energy rate from a waste stream	5
3.4 Moisture and fuel quality	5
4 Hydropower and Wind	6
4.1 Hydropower	6
4.2 Turbine selection concept	6
4.3 Wind energy	6
4.4 Environmental considerations	6
5 Solar and Nuclear Energy	7
5.1 Solar energy	7
5.2 Nuclear energy	7
5.3 Efficiency interpretation	7
5.4 Why rejected heat matters environmentally	7
6 Greenhouse Gases and Carbon Footprint	8
6.1 Major greenhouse gases	8
6.2 Emission-factor method	8
6.3 Carbon dioxide equivalent	8
6.4 Carbon-footprint logic	8
7 Kaya Equation and Energy Intensity	9
7.1 Sustainability impact	9
7.2 Kaya carbon-emission equation	9
7.3 Typical calculation pattern	9
8 Thermal Efficiency, Rejected Heat, and Water Needs	10
8.1 Heat-engine balance	10
8.2 Interpreting rejected heat	10
8.3 Cooling-water problems	10
8.4 Environmental connection	10
9 Comparing Energy Sources on an Environmental Basis	11
9.1 Direct versus indirect impacts	11
9.2 Common conceptual traps	11
10 FE Problem-Solving Checklist and Formula Sheet	12
10.1 Core equations	12
10.2 Combustion ratios worth recognizing	12
10.3 Five-step FE workflow	12

Contents (continued)

10.4 What to know versus what to look up	12
11 8 Example Problems	13
12 Reference and Alignment Notes	21

1 Exam Scope and Energy Pathways

The FE Environmental specification assigns **4–6 questions** to Energy and Environment. The two listed knowledge areas are: (1) energy-source concepts, including conventional and alternative sources; and (2) environmental impacts of energy sources and energy production, including greenhouse-gas production, carbon footprint, thermal impacts, and water needs.

1.1 Energy sources, forms, and end uses

The FE Reference Handbook presents energy as a chain of conversions. Primary sources include fossil fuels (gas, oil, coal), nuclear fuels, geothermal energy, biomass, sunlight, wind, hydropower, waves, tides, and ocean thermal energy. Energy can appear as chemical energy, nuclear energy, heat, mechanical work, electrochemical energy, and electricity. End uses include residential, industrial, and transportation demands.

A useful exam habit is to identify three things before calculating: **source** → **conversion process** → **useful output**. Then account for losses or environmental releases along the pathway.

1.2 Conventional and alternative sources

Category	Typical examples	Main FE-style considerations
Conventional	Coal, oil, natural gas, nuclear	Fuel consumption, combustion products, thermal efficiency, rejected heat, cooling requirements
Alternative / renewable	Biomass, hydro, wind, solar, geothermal	Resource availability, conversion route, intermittency or site dependence, environmental footprint
Waste-derived energy	Municipal or industrial wastes with fuel value	Heating value, moisture effect, mass fraction, energy recovery

1.3 Energy-accounting mindset

Always keep units explicit. Common energy units on the FE exam include joules, kilojoules, kilowatt-hours, Btu, and Btu/lb. Useful conversions in the FE Reference Handbook include

$$1 \text{ kWh} = 3.6 \times 10^6 \text{ J}, \quad 1 \text{ kW} = 3413 \text{ Btu/hr.}$$

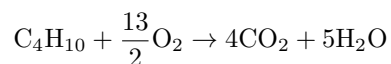
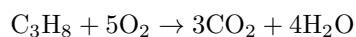
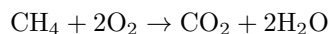
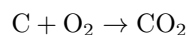
Power is energy per unit time. A power plant or renewable-energy device may therefore be analyzed with energy, power, efficiency, flow, and operating time in a single problem.

Exam tip: Do not confuse energy (kWh, J, Btu) with power (kW, W, Btu/hr).

2 Combustion and Carbon Formation

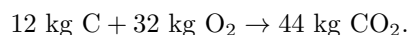
Combustion questions test stoichiometry, oxygen demand, carbon dioxide formation, and the link between fuel use and greenhouse-gas emissions. The FE Reference Handbook lists balanced combustion reactions for common fuels.

2.1 Key balanced reactions



2.2 Mass ratios from stoichiometry

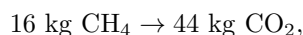
For complete combustion of carbon,



Thus the carbon-to-carbon-dioxide mass ratio is

$$\frac{m_{\text{CO}_2}}{m_{\text{C}}} = \frac{44}{12} = 3.667$$

For methane,



so

$$\frac{m_{\text{CO}_2}}{m_{\text{CH}_4}} = \frac{44}{16} = 2.75.$$

2.3 Combustion products and environmental implications

The specification explicitly includes greenhouse-gas production. Carbon dioxide is produced by complete combustion of carbon-containing fuels. The FE Handbook also identifies sulfur oxidation reactions, which connect sulfur in fuel to sulfur oxides, and incomplete combustion can produce carbon monoxide. On the exam, carefully distinguish *stoichiometric oxygen requirement* from *actual air supplied*; excess air changes flue-gas composition but does not change the theoretical carbon-to- CO_2 conversion when combustion is complete.

When only fuel composition and complete combustion are given, start with a balanced reaction. Convert moles using molecular weights, then scale to the stated fuel mass or flow.

Exam tip: Check mass balance on both sides of the reaction before using a stoichiometric ratio.

3 Biomass and Waste-Derived Energy

The FE Reference Handbook shows several biomass conversion pathways. Biomass is not a single technology; the route depends on feedstock and desired product.

3.1 Biomass conversion routes

Feedstock / input	Conversion route	Product / use
Woody material	Direct combustion; size reduction/pelleting	Heat; solid fuel
Cellulosic material	Pyrolysis, liquefaction, gasification	Solid, liquid, or gaseous fuels
Starch/sugary material	Fermentation	Liquid fuel
Wet organic wastes	Anaerobic digestion	Gaseous fuel
Oily plant material	Extraction	Liquid fuel

3.2 Heating value

Heating value is energy released per unit mass of fuel. If several waste components are mixed, a mass-weighted average is used:

$$HV_{mix} = \sum_i w_i HV_i$$

where w_i is the mass fraction and $\sum_i w_i = 1$.

The FE Handbook tabulates typical heating values for municipal solid waste components. Representative values include paper at about 7200 Btu/lb, plastics at about 14,000 Btu/lb, food waste at about 2000 Btu/lb, wood at about 8000 Btu/lb, and mixed municipal solid waste at about 4500 Btu/lb.

3.3 Energy rate from a waste stream

For a waste mass flow rate $\dot{m}$ and heating value HV ,

$$\dot{Q}_{fuel} = \dot{m} HV$$

If only a fraction η becomes useful energy,

$$\dot{W}_{useful} = \eta \dot{m} HV.$$

3.4 Moisture and fuel quality

The Handbook's "as-fired" heating values emphasize that moisture and inert material reduce useful energy per unit as-received mass. High-moisture wastes can therefore have lower effective fuel value than dry paper, plastic, or wood.

Exam tip: For mixture problems, convert percentages to fractions before multiplying by component heating values.

4 Hydropower and Wind

4.1 Hydropower

The FE Reference Handbook gives the following hydropower approximation:

$$P = 10QH$$

where P is power in kW, Q is flow in m^3/s , and H is effective head in m.

This equation is a convenient FE form of gravitational power available from water. It shows that hydropower output scales linearly with both flow and head. Doubling Q doubles power; doubling H also doubles power.

4.2 Turbine selection concept

The Handbook includes operating regions for hydraulic turbines. In broad terms, different turbine types are suited to different combinations of head and power. The FE exam may ask for a conceptual selection from a chart rather than a derivation.

4.3 Wind energy

The FE Handbook states that the energy contained in wind is kinetic energy:

$$KE = \frac{1}{2}mv^2$$

where m is mass and v is wind speed. This relation alone shows the strong importance of wind speed: for the same air mass, doubling v increases kinetic energy by a factor of four.

The Handbook also compares wind-farm noise with familiar sources; it lists wind-farm sound at 350 m as approximately 35–45 dB(A), overlapping rural nighttime background levels.

4.4 Environmental considerations

Hydropower and wind avoid direct fuel combustion during operation, but the exam specification asks for environmental impacts as well as energy-source concepts. Relevant source-based issues include water-resource dependence for hydropower and noise considerations for wind. When a question provides site-specific data, use the given values rather than relying on generic assumptions.

Hydropower FE shortcut: if Q and H are given in the Handbook units, use $P = 10QH$ directly before adding any stated efficiency factor.

5 Solar and Nuclear Energy

5.1 Solar energy

The FE Handbook shows how solar generation varies over a day and how seasonal conditions affect output. Solar output is tied to solar availability, so generation tends to rise during daylight hours and fall at night. The Handbook also includes a chart for flat-plate collector tilt angle as a function of latitude, with different curves for maximum winter, summer, and year-round insolation.

5.2 Nuclear energy

The FE Handbook tabulates representative characteristics of several reactor types. Examples include pressurized-water, boiling-water, gas-cooled, liquid-metal, fast-breeder, and fluid-fueled reactors. The table emphasizes **thermal efficiency, power density, pressure, heat flux, fuel enrichment, and coolant**.

Representative thermal efficiencies in the table are approximately 36% for pressurized-water reactors, 22–30% for boiling-water reactors, about 30% for gas-cooled systems, and about 33% for liquid-metal systems.

5.3 Efficiency interpretation

For any heat engine,

$$\eta = \frac{W}{Q_H} = \frac{Q_H - Q_L}{Q_H}$$

where Q_H is heat supplied, W is useful work, and Q_L is rejected heat. Rearranging,

$$Q_L = Q_H(1 - \eta).$$

Thus a plant with 35% thermal efficiency rejects about 65% of the supplied thermal energy as lower-grade heat unless that heat is recovered for another use.

5.4 Why rejected heat matters environmentally

The FE specification explicitly lists thermal impacts and water needs. Thermal plants that reject large quantities of heat may require cooling systems. In exam problems, rejected heat can be calculated from efficiency, and any required cooling-water flow should be determined from data supplied in the problem.

Exam tip: Thermal efficiency is a fraction, not a percent, inside equations. Use 0.35, not 35, for 35%.

6 Greenhouse Gases and Carbon Footprint

The FE Environmental specification explicitly includes greenhouse-gas production and carbon footprint. The PE Environmental Reference Handbook supplements this topic with greenhouse-gas inventory concepts.

6.1 Major greenhouse gases

The source material identifies carbon dioxide, methane, nitrous oxide, and fluorinated gases as important long-lived greenhouse gases. Their sources differ: fossil-fuel combustion is a major carbon-dioxide source, methane is associated with oil and gas systems and anaerobic decay, and nitrous oxide is associated with agricultural, industrial, and combustion activities.

6.2 Emission-factor method

A basic inventory relationship is

$$\text{GHG emissions} = \text{activity data} \times \text{emission factor}$$

Activity data might be fuel burned, electricity consumed, distance traveled, or material processed, depending on the problem statement.

6.3 Carbon dioxide equivalent

Different greenhouse gases can be converted to a common CO_2 -equivalent basis using global warming potential (GWP):

$$m_{CO_2e} = m_i GWP_i$$

For multiple gases,

$$m_{CO_2e,tot} = \sum_i m_i GWP_i.$$

Carbon dioxide has a GWP of 1 by definition for the selected time horizon. The source material gives higher GWP values for methane, nitrous oxide, and several fluorinated gases.

6.4 Carbon-footprint logic

A carbon footprint is the sum of greenhouse-gas emissions attributable to an activity or system boundary. FE questions are most likely to provide emission factors and activity data directly. Use consistent units, multiply, and sum on a common CO_2e basis.

Do not add kilograms of methane directly to kilograms of carbon dioxide when the question asks for CO_2e . Convert each gas using the stated GWP first.

7 Kaya Equation and Energy Intensity

The FE Reference Handbook includes a sustainability form that separates population, economic activity, energy intensity, and carbon intensity.

7.1 Sustainability impact

$$SI = P \left(\frac{GDP}{P} \right) \left(\frac{E}{GDP} \right).$$

The terms are population, per-capita gross domestic product, and energy use per unit GDP.

7.2 Kaya carbon-emission equation

$$E_{carbon} = P \left(\frac{GDP}{P} \right) \left(\frac{E}{GDP} \right) \left(\frac{CO_2}{E} \right)$$

The four factors can be interpreted as:

1. P : population;
2. GDP/P : economic activity per person;
3. E/GDP : energy intensity of the economy;
4. CO_2/E : carbon intensity of energy.

This decomposition helps identify how total emissions can change even when one factor improves. For example, lower energy intensity can be offset by growth in population or per-capita GDP. Likewise, switching to lower-carbon energy reduces the CO_2/E factor.

7.3 Typical calculation pattern

If the four terms are given in compatible units, multiply directly. Units should cancel to produce a mass of carbon dioxide per unit time.

For example, if

$$P [\text{person}] \times \frac{GDP}{P} \left[\frac{\$}{\text{person yr}} \right] \times \frac{E}{GDP} \left[\frac{\text{Btu}}{\$} \right] \times \frac{CO_2}{E} \left[\frac{\text{kg CO}_2}{\text{Btu}} \right],$$

then the result is kg CO₂/yr.

Exam tip: The Kaya equation is mainly a structured unit-cancellation problem. Write units under each factor before multiplying.

8 Thermal Efficiency, Rejected Heat, and Water Needs

Energy production can create environmental effects even when the useful product is electricity. One major pathway is waste heat.

8.1 Heat-engine balance

For a cyclic heat engine,

$$Q_H = W + Q_L,$$

and

$$\eta = \frac{W}{Q_H}.$$

Therefore,

$$Q_L = Q_H - W = Q_H(1 - \eta) = W \left(\frac{1 - \eta}{\eta} \right)$$

This form is especially useful when electric output W and thermal efficiency η are given.

8.2 Interpreting rejected heat

A 500 MW plant operating at 40% efficiency requires

$$Q_H = \frac{500}{0.40} = 1250 \text{ MW}_{\text{th}}$$

and rejects

$$Q_L = 1250 - 500 = 750 \text{ MW}_{\text{th}}.$$

This rejected heat must be transferred to the environment or recovered for another use.

8.3 Cooling-water problems

The FE specification lists water needs as an environmental impact. If a problem gives water heat capacity and allowable temperature rise, the required mass flow can be found from the sensible-heat relation

$$\dot{Q} = \dot{m}c_p\Delta T.$$

Thus,

$$\dot{m} = \frac{\dot{Q}}{c_p\Delta T}.$$

Use only the values supplied in the problem or reference materials. A smaller allowable ΔT requires a larger cooling-water flow for the same rejected heat.

8.4 Environmental connection

High heat rejection can translate into thermal discharge concerns or large cooling-water requirements. The exam may combine thermodynamic efficiency with an environmental constraint such as a maximum temperature rise.

A useful chain is: electrical output $\rightarrow$ thermal input $\rightarrow$ rejected heat $\rightarrow$ cooling-water requirement.

9 Comparing Energy Sources on an Environmental Basis

FE questions may be numerical or conceptual. A sound comparison uses the specific metric requested rather than declaring one source universally “best.”

Source	Conversion concept	Environmental topics emphasized by the source material
Fossil fuels	Chemical energy → heat → work/electricity	Combustion products, CO_2 , carbon intensity, rejected heat
Nuclear	Nuclear energy → heat → work/electricity	Thermal efficiency, coolant, rejected heat, reactor characteristics
Hydropower	Gravitational/mechanical energy → electricity	Flow and head dependence, water-resource use
Wind	Kinetic energy → mechanical/electrical energy	Wind-speed dependence, noise
Solar	Solar radiation → electricity or heat	Daily/seasonal availability, collector orientation
Biomass	Chemical energy from biological feedstock	Conversion pathway, combustion or biochemical processing
Waste-to-energy	Chemical energy in waste → heat/work	Heating value, composition, moisture, recovered energy

9.1 Direct versus indirect impacts

The FE topic description is broad enough to include direct emissions and resource needs. Problems may therefore ask for fuel-based emissions, cooling-water needs, or carbon-equivalent emissions. The supplied data determine the boundary of the calculation.

9.2 Common conceptual traps

- High efficiency does not mean zero environmental impact.
- Renewable does not mean that every environmental metric is zero.
- A low direct combustion footprint is not the same as zero life-cycle impact unless the problem defines the boundary that way.
- Water use and thermal discharge are different quantities; a plant may withdraw water, consume water, and return heated water in different amounts.

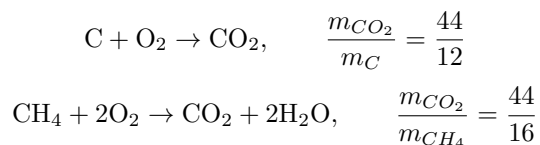
Exam tip: Answer the metric actually asked: energy, emissions, CO_2e , thermal load, water flow, or efficiency.

10 FE Problem-Solving Checklist and Formula Sheet

10.1 Core equations

$$\begin{aligned}
 P_{hydro} &= 10QH \\
 KE_{wind} &= \frac{1}{2}mv^2 \\
 \eta &= \frac{W}{Q_H} = \frac{Q_H - Q_L}{Q_H} \\
 Q_L &= W \left(\frac{1 - \eta}{\eta} \right) \\
 \dot{Q}_{fuel} &= \dot{m} HV \\
 HV_{mix} &= \sum_i w_i HV_i \\
 GHG &= \text{activity} \times \text{emission factor} \\
 m_{CO_2e} &= \sum_i m_i GWP_i \\
 E_{carbon} &= P \left(\frac{GDP}{P} \right) \left(\frac{E}{GDP} \right) \left(\frac{CO_2}{E} \right)
 \end{aligned}$$

10.2 Combustion ratios worth recognizing



10.3 Five-step FE workflow

1. Identify the energy source and requested environmental metric.
2. Write the governing equation before inserting numbers.
3. Convert percentages to fractions and make units consistent.
4. Solve with 3–4 significant digits unless choices suggest otherwise.
5. Perform a physical check: efficiency between 0 and 1, positive flow/head, mass fractions sum to 1, and emissions have mass units.

The fastest reliable approach is dimensional: if the units do not reduce to the requested answer units, the setup is wrong even if the arithmetic is correct.

10.4 What to know versus what to look up

Know the physical meaning of efficiency, heating value, emissions factor, carbon intensity, flow/head, and CO_2e . Use the FE Reference Handbook for unit conversions, source-specific tables, hydropower relation, combustion reactions, reactor characteristics, waste heating values, and sustainability equations.

11 8 Example Problems

Example Problem 1: Hydropower Output

A hydropower facility passes $18 \text{ m}^3/\text{s}$ through a turbine with an effective head of 42 m. Using the FE Reference Handbook hydropower relation, estimate the power delivered by the water.

Solution

Use

$$P = 10QH.$$

Substitute:

$$P = 10(18)(42) = 7560 \text{ kW}.$$

Therefore,

$$P = 7.56 \text{ MW}$$

Check

Power scales linearly with both Q and H . A flow of tens of cubic meters per second and a head of tens of meters reasonably produces power on the order of several megawatts.

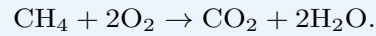
Exam tip: The FE Handbook form already produces kW for Q in m^3/s and H in m.

Example Problem 2: Carbon Dioxide from Methane Combustion

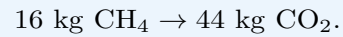
A process completely combusts 320 kg of methane. Estimate the mass of CO_2 produced.

Solution

Balanced reaction:



One mole of methane produces one mole of carbon dioxide. Using molecular weights,



Thus,

$$m_{CO_2} = 320 \left(\frac{44}{16} \right) = 880 \text{ kg}.$$

$m_{CO_2} = 880 \text{ kg}$

Check

The CO_2 mass exceeds the fuel mass because oxygen from air is incorporated into the product.

Example Problem 3: Weighted Heating Value of a Waste Mixture

A waste stream is 40% paper, 35% food waste, and 25% plastic by mass. Use typical FE Handbook heating values of 7200, 2000, and 14,000 Btu/lb, respectively. Find the mixture heating value.

Solution

$$HV_{mix} = \sum w_i HV_i$$
$$HV_{mix} = 0.40(7200) + 0.35(2000) + 0.25(14000).$$
$$HV_{mix} = 2880 + 700 + 3500 = 7080 \text{ Btu/lb.}$$

$$HV_{mix} = 7.08 \times 10^3 \text{ Btu/lb}$$

Check

The result lies between the minimum component value (2000) and maximum component value (14,000 Btu/lb), as a weighted average should.

Example Problem 4: Useful Energy from Waste Fuel

A facility burns 24,000 lb/day of a waste fuel with a heating value of 6500 Btu/lb. If 28% of the fuel energy becomes useful electrical energy, determine the useful energy per day in kWh. Use 1 kWh = 3413 Btu.

Solution

Fuel energy per day:

$$Q_{in} = 24,000(6500) = 1.56 \times 10^8 \text{ Btu/day.}$$

Useful energy:

$$E_{use} = 0.28(1.56 \times 10^8) = 4.368 \times 10^7 \text{ Btu/day.}$$

Convert to kWh:

$$E_{use} = \frac{4.368 \times 10^7}{3413} = 1.280 \times 10^4 \text{ kWh/day.}$$

$$E_{use} \approx 12,800 \text{ kWh/day}$$

Example Problem 5: CO₂-Equivalent Emissions

An operation emits 1200 kg of CO₂ and 18 kg of methane. For this problem, use a methane GWP of 21. Determine total emissions in kg CO₂e.

Solution

Carbon dioxide contribution:

$$1200(1) = 1200 \text{ kg CO}_2\text{e.}$$

Methane contribution:

$$18(21) = 378 \text{ kg CO}_2\text{e.}$$

Total:

$$1200 + 378 = 1578 \text{ kg CO}_2\text{e.}$$

$$1.578 \times 10^3 \text{ kg CO}_2\text{e}$$

Check

The methane mass is small, but its contribution is magnified by its GWP.

Example Problem 6: Rejected Heat from a Thermal Power Plant

A power plant produces 420 MW of electric power at a thermal efficiency of 35%. Determine the thermal input and rejected heat rate.

Solution

$$\eta = \frac{W}{Q_H}$$

so

$$Q_H = \frac{420}{0.35} = 1200 \text{ MW}_{\text{th}}.$$

Then

$$Q_L = Q_H - W = 1200 - 420 = 780 \text{ MW}_{\text{th}}.$$

$$Q_H = 1200 \text{ MW}_{\text{th}}, \quad Q_L = 780 \text{ MW}_{\text{th}}$$

Interpretation

About 65% of the thermal input leaves as rejected heat, consistent with $1 - \eta = 0.65$.

Example Problem 7: Cooling-Water Flow for Rejected Heat

A plant must remove 250 MW of rejected heat using cooling water. The allowed water temperature rise is 10°C. Use $c_p = 4.18 \text{ kJ}/(\text{kg } ^\circ\text{C})$. Estimate the required water mass flow rate.

Solution

Use

$$\dot{Q} = \dot{m}c_p\Delta T.$$

Convert the heat rate:

$$250 \text{ MW} = 250,000 \text{ kJ/s.}$$

Then

$$\dot{m} = \frac{250,000}{4.18(10)} = 5981 \text{ kg/s.}$$

$$\dot{m} \approx 5.98 \times 10^3 \text{ kg/s}$$

Check

A lower permissible temperature rise would require a larger flow rate for the same rejected heat.

Example Problem 8: Kaya Equation

A region has population $P = 2.0 \times 10^6$ people, per-capita GDP of \$45,000/(person yr), energy intensity of 6000 Btu/\$, and carbon intensity of 5.0×10^{-8} kg CO₂/Btu. Estimate annual CO₂ emissions.

Solution

Use

$$E_{carbon} = P \left(\frac{GDP}{P} \right) \left(\frac{E}{GDP} \right) \left(\frac{CO_2}{E} \right).$$

Substitute:

$$E_{carbon} = (2.0 \times 10^6)(45,000)(6000)(5.0 \times 10^{-8}).$$

$$E_{carbon} = 2.70 \times 10^7 \text{ kg CO}_2/\text{yr}.$$

Convert to metric tons:

$$\frac{2.70 \times 10^7}{1000} = 2.70 \times 10^4 \text{ metric tons/yr}.$$

$$E_{carbon} = 2.70 \times 10^7 \text{ kg/yr} = 27,000 \text{ metric tons/yr}$$

Check

Units cancel as

$$\text{person} \times \frac{\$}{\text{person yr}} \times \frac{\text{Btu}}{\$} \times \frac{\text{kg}}{\text{Btu}} = \text{kg/yr}.$$

12 Reference and Alignment Notes

This study guide is organized around the FE Environmental CBT specification for **Energy and Environment**: energy-source concepts (conventional and alternative) and environmental impacts of energy sources and production, including greenhouse-gas production, carbon footprint, thermal impacts, and water needs.

Primary technical references used for alignment:

- NCEES, *FE Reference Handbook*, Version 10.6 (Environmental Engineering energy section; thermodynamics; unit conversions).
- NCEES, *FE Environmental CBT Exam Specifications*, Energy and Environment topic outline.
- NCEES, *PE Environmental Reference Handbook*, Version 2.0 (greenhouse-gas, CO_2e , and sustainability concepts used to reinforce the FE topic scope).

The worked problems are original practice problems constructed from the equations, tables, and concepts covered by the cited NCEES reference material. They are intended for study and are not NCEES exam questions.