 

**MIDDLE SCHOOL**

**Math & Engineering**

### Green House?

**Teacher Background Information:**

* Students were originally given a $240,000 maximum budget to design a home
* Students should know how to calculate perimeter and area for this activity

**Goals:** To complete a construction estimate list and calculate the cost of materials used in building a home

**Objectives:** Students will…..

* Research material options and decide what they want to include in their house design by weighing the environmental and economic factors given
* Become experts on a specific material and quantifiably determine which is the most sustainable
* Share information with classmates
* Complete the “*Construction Estimating List for House Building”* worksheet
* Calculate the total cost of design and round to the nearest $1000
* Add 10% to the rounded total
* Decide if their design is affordable

**Standards met:**

Measurement:

* Select and apply techniques and tools to accurately find length, area, volume, and angle measures to appropriate levels of precision

Representation:

* Create and use representations to organize, record, and communicate mathematical ideas
* Use representations to model and interpret physical, social, and mathematical phenomena

Problem Solving:

* Solve problems that arise in mathematics and in other contexts

**Time required:** 45 -60 minutes

**Materials: (per class of 30)**

* 30 sheets of graph paper
* 30 copies of student direction ½ sheets
* 30 copies of “*Construction Estimating List for House Building”* worksheets
* 30 copies of material choices and comparison charts
* Optional: calculators

**Prep:**

* Copy a *“Construction Estimating List for House Building”* worksheet for each student
* Copy of material choices and comparison charts

**Procedure:**

* Students will have designed the floor plan of their home prior to this lesson. Each student will be given a list of material options to be used in building their homes
* Give each student a sheet of graph paper and the student direction sheet
* Review the directions
* Complete a jigsaw for students to investigate different material options
  + Place students in groups
  + Give each group information sheets on one of the material options
  + Let students study the information
  + You may want to discuss information with groups
  + Have each student complete a bar graph
  + Form a second set of groups with one “expert” from each material
  + Each student should share key information and bar graph for the materials
* Based on their graphs, ask students to determine which materials they will use for their houses
* Ask students to complete the *“Construction Estimating List for House Building”* worksheet and calculate their total cost of construction
* Have students round their total to the nearest $1000 and increase that amount by 10%
* Have students decide if their choices are affordable. Students may need to choose alternate options or upgrades depending on their results

**Assessment:** Use the*“Construction Estimating List for House Building”* worksheet to assess for understanding. Answers will vary.

**Green House? – Student Directions**

**Directions: Your job is to become the expert on the building material given to you by your teacher. You will need to share information about this material with your classmates.**

1. Review the information on the chart and the rating scale.
2. Discuss the information with the other students in your group.
3. Determine the mean (average) for each category, environment and economics.
4. On a sheet of graph paper, create a bar graph displaying the mean scores for each category.

* **--------------------------------------------------------------------------**

**Green House? – Student Directions**

**Directions: Your job is to become the expert on the building material given to you by your teacher. You will need to share information about this material with your classmates.**

1. Review the information on the chart and the rating scale.
2. Discuss the information with the other students in your group.
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4. On a sheet of graph paper, create a bar graph displaying the mean scores for each category.

### Green House: Foundation Decision Chart – Concrete

### Poured Concrete: Today the most common foundation choice across much of our country is poured-in-place concrete. Wood forms are filled with concrete and then the forms are removed when the concrete dries. This forms the concrete foundation you see on many homes.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Concrete | Criteria | Rate |
| production requires mining, transportation, and heating materials to very high temperatures twice entails burning fossil fuels and often creates hazardous waste.  concrete makes an enormous contribution towards ozone depletion and air pollution concrete production has been identified as the source of approximately 8% of the world's carbon dioxide emissions | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **1**  **1**  **1**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | outstanding pest resistancegood moisture resistancewhile concrete is generally a good insulator, of the 3 choices, it is the 2nd most effective$110 per cubic yardlabor: 48 hours | Cost  Minimizes hours for installation  Reduces energy consumption | **9**  **9**  **6**  **Mean =** |

### Green House: Foundation Decision Chart – ICF

### \*Please note; the foundation materials are not measured in consistent units. The costs above have been simplified to all represent cubic yards.

### Insulated Concrete Foundation (ICF): ICF consists of an insulating concrete forming system with two layers of expanded polystyrene (EPS) insulation with web connectors molded into the EPS insulation

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Insulated Concrete Form (ICF) | Criteria | Rate |
| production requires mining, transportation, and heating materials to very high temperatures twice entails burning fossil fuels and often creates hazardous waste.  concrete makes an enormous contribution towards ozone depletion and air pollution concrete production has been identified as the source of approximately 8% of the world's carbon dioxide emissionsexcellent sound barrier against outside noiseThe most energy efficient choice of the 3; it is an excellent insulator so heat or air conditioning do not escape through it – minimizing the number of renewable resources used by the home-owner | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **1**  **6**  **1**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | reduces heat loss by up to 50%excellent moisture resistanceexcellent pest resistancemaximizes space utilization because walls can be wired without extra wood studdinghigher R-values (between R-17 and R-26)$165 per cubic yardlabor: 40 hours | Cost  Minimizes hours for installation  Reduces energy consumption | **7**  **9**  **7**  **Mean =** |

### Green House: Foundation Decision Chart – Wood

### Preserved Wood Foundation: Wood foundations are simply made of wood treated with an insect and rot resistant preserver.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Wood | Criteria | Rate |
| **wood is a renewable resource**  **the wood has preserving chemicals deep inside**  **It is generally preserved with amine copper quat (ACQ) and copper azone (CA)**  **The sawdust from pressure-treated wood can be an irritant to the nose, eyes, and skin**  **Pressure-treated wood should not be burned under any circumstances**.  **Not a good insulator. Heat and air conditioning can be lost through the foundation, making the home-owner use more fossil fuels** | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **3**  **7**  **7**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | **significant heat loss without added insulation**  maximizes space utilization because walls can be wired without extra wood studding  all-weather-wood foundation has proven to be quicker and simpler to build than its concrete equivalent  lower R-values (typically R-12 to R-20).  $50 per cubic yard  labor: 60 hours | Cost  Minimizes hours for installation  Reduces energy consumption | **9**  **2**  **1**  **Mean =** |

### Green House? Foundation Considerations

### In order to build your foundation, there are a few items to consider.

**Foundation Size Options:**

1. full basement: needs to be 8 ft. deep
2. crawl space: needs to be 4 ft. deep

\*foundation walls need to be .5 ft. wide

**Foundation Building materials:**

1. Treated wood
2. Concrete
3. Insulated Concrete Form

\*complete a decision grid on each foundation building material to determine which is the best choice for you!

**Foundation Size Determination:**

Complete the questions below using the figure to the left.

Calculate the perimeter \_\_\_\_\_\_\_\_\_\_

Multiply the perimeter x the full basement depth (8 ft.) \_\_\_\_\_\_\_\_\_\_

Multiply the number above x the width (0.5 ft) \_\_\_\_\_\_\_\_\_

**Example:**

4

0

ft.

30 ft.

Calculate the perimeter of your house \_\_\_\_\_\_\_\_\_\_

Multiply the perimeter x the depth (8 ft. or 4 ft.) \_\_\_\_\_\_\_\_\_\_

Multiply the number above x 0.5 \_\_\_\_\_\_\_\_\_\_

**Cost:**

**Example:**

Complete the questions below using the figure to the left.

Divide your foundation size (see above) by 27 to get ft3 \_\_\_\_\_\_\_\_\_\_

Multiply the cost of poured concrete x the size of your foundation \_\_\_\_\_\_\_\_\_\_

4

0

ft.

30 ft.

Materials are calculated by yards3.

Divide your foundation size by 27 to get ft3 \_\_\_\_\_\_\_\_\_\_

Multiply the cost of your building material x the size of your foundation \_\_\_\_\_\_\_\_\_\_

Once you have determined the total cost of your foundation, add this to your construction budget and write a check to the foundation company!**Green House? Foundation Considerations**

**Teacher Key**

**Foundation Size Options:**

1. full basement: needs to be 8 ft. deep
2. crawl space: needs to be 4 ft. deep

\*foundation walls need to be .5 ft. wide

**Foundation Building materials:**

1. Treated wood
2. Concrete
3. Insulated Concrete Form

\*complete a decision grid on each foundation building material to determine which is the best choice for you!

**Foundation Size Determination:**

4

0

ft.

30 ft.

Complete the questions below using the figure to the left.

Calculate the perimeter *30 + 30 + 40 + 40 = 140*

Multiply the perimeter x the depth (8 ft.) *140 x 8 = 1120* *ft2*

Multiply the number above x 0.5 *1120 x 0.5 = 560* *ft2*

**Example:**

Calculate the perimeter of your house \_\_\_\_\_\_\_\_\_\_

Multiply the perimeter x the depth (8 ft. or 4 ft.) \_\_\_\_\_\_\_\_\_\_

Multiply the number above x 0.5 \_\_\_\_\_\_\_\_\_\_ ft2

Complete the questions below using the figure to the left.

Divide your foundation size (see above) by 27 to get ft3 *560/27 = 20.74 (round to 21)*

Multiply the cost of poured concrete x the size of your foundation *$110.00 x 21 = $2,310.00*

4

0

ft.

30 ft.

**Cost:**

Materials are calculated by ft3.

Divide your foundation size by 27 to get ft3 \_\_\_\_\_\_\_\_\_\_

Multiply the cost of your building material x the size of your foundation \_\_\_\_\_\_\_\_\_\_

### Green House: Wall Decision Chart – 2” X 4” Wood

### 2” X 4” Wood Studs: Wood stud framing covered with drywall with an insulation rating of 13. R stands for thermal resistance. The higher the R value the more effective the insulation value

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | 2” X 4” Wood | Criteria | Rate |
| **wood is a renewable resource**  **wood requires less energy than most materials to process into a finished product**  **low toxicity**  **biodegradable**  **recyclable**  **this is the least sturdy substance and will not stand up to environmental impacts** | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable) | **3**  **7**  **5**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | **studs or braces to cause breaks in the insulative action**  **inferior thermal insulation performance**  **about $85 per linear foot**  **r-value = 13** | Cost  Minimizes hours for installation  Reduces energy consumption | **9**  **9**  **2**  **Mean =** |

### Green House: Wall Decision Chart – 2” X 6” Wood

### 2” X 6” Wood Studs/R19: Wood stud framing covered with drywall with an insulation rating of 19.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | 2” X 6” Wood | Criteria | Rate |
| **wood is a renewable resource**  **wood requires less energy than most materials to process into a finished product**  **low toxicity**  **biodegradable**  **recyclable**  **this substance stands up to environmental impacts better than 2”x4” construction** | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **3**  **7**  **7**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | **studs or braces to cause breaks in the insulative action**  **up to 46% better thermal insulation performance than 2” X 4”**  **about $105 per linear foot**  **r-value = 19** | Cost  Minimizes hours for installation  Reduces energy consumption | **9**  **9**  **4**  **Mean =** |

### Green House: Wall Decision Chart – SIPS

SIPS (Structural Insulated Panels): Structural insulated panels (SIPs) are high performance building panels used in floors, walls, and roofs for residential and light commercial buildings. The panels are typically made by sandwiching a core of rigid foam plastic insulation between two structural skins of oriented strand board (OSB). Other skin material can be used for specific purposes. SIPs are manufactured under factory controlled conditions and can be custom designed for each home.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Structural Insulated Panels | Criteria | Rate |
| amount of energy used to heat and cool a home can be cut by up to 50 percent thereby reducing greenhouse gases  the insulation used in SIPs is a lightweight rigid foam plastic composed of 98% air, and requires only a small amount of petroleum to produce  the foam insulation used in panel cores is made using a non-CFC blowing agent that does not threaten the earth’s ozone layer. factory production produces less landfill waste | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **7**  **6**  **2**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | superior thermal performance, like a cooler or thermos  means an energy savings of 50% over a wood framed structure  takes training to install properly  about $150 per linear foot | Cost  Minimizes hours for installation  Reduces energy consumption | **5**  **9**  **9**  **Mean =** |

[**http://www.diylife.com**](http://www.diylife.com)

[**http://www.sips.org**](http://www.sips.org)

### Composition ShinglesGreen House: Roofing Decision Chart – Asphalt Shingles

**Asphalt Shingles:** Asphalt shingles are currently the most popular type of residential roofing materials. They are made from a composite of fiberglass and petroleum based products.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Asphalt Shingles | Criteria | Rate |
| scars easily when hot  subject to mildew and moss  Made from Petroleum base a byproduct of crude oil refining  \* See additional information  fire resistant | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **5**  **2**  **2**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | $8.00 per square footlife-span 15–20 years easy to repair  most commonly used product and easy to install | Cost  Minimizes hours for installation  Reduces energy consumption | **9**  **9**  **2**  **Mean =** |

**Additional Information:** Asphalt, a very thick hydrocarbon substance, can be obtained either from naturally occurring deposits or, more commonly, as a byproduct of crude oil refining. Before being used in the manufacture of shingles, asphalt must be oxidized by a process called blowing. This is done by bubbling air through heated asphalt to which appropriate catalysts have been added, causing a chemical reaction. The resulting form of asphalt softens the right amount at the right temperatures to make good shingles. To further process the blown asphalt into a proper coating material, a mineral stabilizer such as fly ash or finely ground limestone is added. This makes the material more durable and more resistant to fire and weather. Various colors of ceramic-coated mineral granules are used as a top coat on shingles to protect them from the sun's ultraviolet rays, increase their resistance to fire, and add an attractive finish. The granules may be small rocks or particles of slag (a byproduct of ore smelting). Shingles designed for use in humid locations may include some copper-containing granules in the top coat to inhibit the growth of algae on the roof. The back surface of the shingles is coated with sand, talc, or fine particles of mica to keep the shingles from sticking together during storage.

### http://www.rainwaterconnection.com/products/roofs/metal%20roof.jpgGreen House: Roofing Decision Chart – Metal

**Metal/Steel Roofs:** In the late 1700s, zinc, copper, and lead were the most popular materials used for roofing - such famous historic buildings as the Washington Monument and Thomas Jefferson's Monticello have metal roofs. Standing-seam steel roofing is the most popular residential metal roofing today. (The term standing-seam describes the upturned edge of one metal panel that connects it to adjacent sections, creating distinctive vertical lines and a trendy historical look.) But metal roofs can also be made to resemble wood shakes, clay tiles, shingles, and Victorian metal tiles. Aluminum or coated steel is formed into individual shingles or tiles, or into modular panels four feet long that mimic a row of shingles or tiles.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Metal (steel, aluminum…) | Criteria | Rate |
| Made from materials that are mined  may need periodic painting  light weight  can be installed over existing roofs  excellent performance in high wind, hail and rain  can be installed over existing roofs  stands up to harsh environmental impacts | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **3**  **2**  **9**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | $15.00 per square foot  Lifespan, 50 years  low maintenance  very commonly used – builders know how to install it  extremely durable – stands up to harsh environmental impacts | Cost  Minimizes hours for installation  Reduces energy consumption | **5**  **8**  **4**  **Mean =** |

**Green House: Roofing Decision Chart –**

**Enviro-Shake**

**Enviro-Shake: C**omposite cedar-like shake roof shingles. Made from 95% recycled materials and the product itself, at end of life, can be recycled back into new shakes.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Enviro-Shake | Criteria | Rate |
| new to market  One color/Gray  about 1/3 the weight of slate  made of reclaimed materials  hail resistant  can be recycled and made into more Enviro-Shake shingles  made from 95% recycled materials | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **9**  **9**  **8**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | $15.00  lasts 30–50 years  hail resistant  mold, mildew and insect resistant | Cost  Minimizes hours for installation  Reduces energy consumption | **5**  **5**  **4**  **Mean =** |

**Green House: Window Decision Chart –**

**Single Pane**

**\*A pane is a sheet of glass cut in shapes for windows or doors**

**Single pane windows:** One pane of glass is used.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Single Pane Windows | Criteria | Rate |
| allows more daylight to pass through it then any other type  sand, soda ash, limestone, and borax are raw materials for glass making – these are mined materials  one pane of glass does not stand up to environmental factors as well as the other options  likely to crack and will not last as long | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **9**  **7**  **4**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | too much heat loss can be a problem  high U-factor – heat & air conditioning can easily escape through window  more affordable  cost: $103  labor: all 3 types require the same labor hours  easy to clean and fairly low maintenance  allows humidity into house in warm, sticky climates durability: does not last as long | Cost  Minimizes hours for installation  Reduces energy consumption | **9**  **9**  **1**  **Mean =** |

* U**-**Factor**:**  Measures how well a window, door, or skylight prevents heat from escaping.  Ratings usually range from 0.20 to 1.20.  The lower the number, the more efficient the window

### <http://www.getwithgreen.com/2008/06/13/windows-u-factor-solar-heat-gain-coefficientwhat-does-it-all-mean/>Green House: Window Decision Chart – Double Pane

**\*A pane is a sheet of glass cut in shapes for windows or doors**

**Double pane windows:** Double pane windows contain two panes or layers of glass. The spaces between the glass pieces are filled with air, argon or sometimes krypton and work to stop heat transfer, as well as cutting down on noise.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Double Pane Windows | Criteria | Rate |
| sand, soda ash, limestone, and borax are raw materials for glass making – these are mined materials  two panes of glass can stand up to environmental factors well  condensation can occur between the panes of glass, making it foggy | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **9**  **7**  **6**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | low maintenance  resists humidity in warm, sticky climates  cost: $126  labor: all 3 types require the same labor hours  medium U-factor – heat & air conditioning cannot easily escape through window  durability: fairly long lasting | Cost  Minimizes hours for installation  Reduces energy consumption | **7**  **9**  **5**  **Mean =** |

**How is glass made?** Sand, soda ash, limestone, and borax are raw materials for glass making. These materials all are dry powders which look much alike, but are capable of producing greatly different results. They come to the glass plant in railroad cars and are stored in large silos. After they are carefully weighed and mechanically mixed in the proportions, the glass maker adds cullet. Cullet is either recycled glass or waste glass. The addition of cullet reduces the amount of heat needed to melt the new batch. Large quantities of glass are made in furnaces. There are four main methods of shaping glass: blowing, pressing, drawing, and casting. After the shaping process, annealing is used to restore the strength of the glass. Annealing is a process of heating and slow cooling in order to toughen and reduce brittleness. Tempering and other finishing techniques may also be used to further strengthen the glass. \*taken from <http://www.science.edu.sg>

### Green House: Window Decision Chart – Triple Pane

**\*A pane is a sheet of glass cut in shapes for windows or doors**

**Triple pane windows:** Triple pane windows contain three panes or layers of glass. The spaces between the glass pieces are filled with air, argon or sometimes krypton and work to stop heat transfer, as well as cutting down on noise. This gas between the panes, sometimes called low-e, keeps the thermal energy produced indoors, not heating up the air outside.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Triple Pane Windows | Criteria | Rate |
| sand, soda ash, limestone, and borax are raw materials for glass making – these are mined materials  stands up to environmental factors very well  condensation can occur between the panes of glass, making it foggy  saves significant energy consumption over time | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **9**  **7**  **8**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | excellent long term savings to energy costs  cost: $164  labor: all 3 types require the same labor hours  resists humidity in warm, sticky climates  low U-factor – heat & air conditioning cannot escape through window  durability: fairly long lasting | Cost  Minimizes hours for installation  Reduces energy consumption | **1**  **9**  **8**  **Mean =** |

### Green House: Heating & Cooling Decision Chart – Gas Forced Air 90% Efficiency

**Gas Forced Air 90% Efficiency**: This forced air system is by far the most common type of home heating and cooling system. Air is heated in a furnace. It is then distributed from the furnace through ductwork and into rooms by registers. Furnaces may heat air buy using natural gas, propane, oil or electricity.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Gas Forced Air 90% Efficiency | Criteria | Rate |
| furnace fan makes noise  moving air can distribute allergens  sends up to four tons of carbon dioxide, the "greenhouse gas," into the atmosphere every month  not very efficient - some take advantage of only half the fuel they burn  burns natural resources | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **1**  **1**  **1**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | relatively inexpensive  requires filtration and regular maintenance  requires ductwork and takes space in walls  30% or more of energy dollars are lost due to inefficiency  average cost $10,000  labor: most common heating & cooling system, most builders know how to install it | Cost  Minimizes hours for installation  Reduces energy consumption | **6**  **8**  **1**  **Mean =** |

### Green House: Heating & Cooling Decision Chart – Gas Forced Air 96% (high)Efficiency

**Gas Forced Air 96% Efficiency**: These furnaces have an additional heat exchanger that takes the hot exhaust gases and extracts available heat before it is sent outdoors. A high efficiency condensing furnace takes this extracted heat and condenses it into water and drains it. The remaining cool gases are exhausted to the outdoors. By doing this, there is no hot air escaping from your home. In addition, the venting can be done with a PVC pipe rather than up a heat resistant flue in the roof. It also reduces the amount of pollutants released into the air.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Gas Forced Air 96% Efficiency | Criteria | Rate |
| furnace fan makes noise  moving air can distribute allergens  an energy efficient furnace will use less fuel & produce less waste  uses less natural resources, and which means releasing less greenhouse gases into the atmosphere, but greenhouse gases are still released  90%–97% AFUE (annual fuel utilization efficiency) means there is less waste | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **5**  **5**  **1**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | labor: very common heating & cooling system, most builders know how to install it  less hot air escapes  requires filtration and regular maintenance  requires ductwork and takes space in walls  less energy dollars wasted  average cost $20,000 | Cost  Minimizes hours for installation  Reduces energy consumption | **3**  **8**  **5**  **Mean =** |

### Green House: Heating & Cooling Decision Chart – Geothermal

**Geothermal**: The word geothermal is derived from the Greek words 'geo'. Geo means earth and 'therma' means heat. So, combined together, geothermal means heat from the earth. A well is dug very deep in the ground near the home. The water from the well is pumped through a heat exchanger in your home where a portion of the latent heat in that water is removed and used to heat your home. In the summer, as the water temperature is cooler than the outside air the system provides air conditioning to your home. In climates where temperatures fall below 0 degrees, supplemental heating using gas, electricity, or fuel oil may be incorporated into the system. Electricity is used to power the pump and the circulation fans. There is no cost to the homeowner for the actual heat. No gas or fuel oil is consumed.

|  |  |  |  |
| --- | --- | --- | --- |
| **E**  **N**  **V**  **I**  **R**  **O**  **N**  **M**  **E**  **N**  **T** | Geothermal | Criteria | Rate |
| conserves fossil fuels  renewable source of energy  non polluting  no danger of carbon monoxide poisoning or gas leaks  no real environmental impact  in cold climates, a second heat source will have to be used | Prevents the production of wastes  Promotes the use of readily available, local, renewable resources  Durability, not immortality (strong, but biodegradable | **9**  **7**  **7**  **Mean =** |
| **E**  **C**  **O**  **N**  **O**  **M**  **I**  **C** | labor: fairly new system – a specialized builder needs to install it  one of the most efficient heating and cooling systems that are available  life expectancy of almost thirty years  average efficiency almost three hundred percent  average cost $40,000  in cold climates, the homeowner will have to pay for a second heat source | Cost  Minimizes hours for installation  Reduces energy consumption | **1**  **1**  **7**  **Mean =** |

**homerepair.about.com** [**http://www.hometips.com**](http://www.hometips.com)

**homemanagement.suite101.com** [**http://www.eere.energy.gov**](http://www.eere.energy.gov)

[**http://ezinearticles.com**](http://ezinearticles.com)

Contractors Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Green House?**

**Construction Estimating List for House Building**

Estimating your building material needs and the total cost of constructing your model house is a critical phase in completing this project.

*Estimating* is similar to making predictions, you need to predict how much and what you need to complete your model. Calculate your estimates in the **boxes** provided next to each item; some boxes may be zero.

**House Size**: \_\_\_\_\_\_\_\_L x \_\_\_\_\_\_\_\_\_W = \_\_\_\_\_\_\_\_\_\_\_Sq. ft.

*(Length X Width = Square Footage)*

**HOUSE FOUNDATION**

|  |  |
| --- | --- |
| Fill in total foundation cost from the worksheet you completed earlier | = $ |

**City Utility Connections**

|  |  |  |
| --- | --- | --- |
| **WATER** | $800.00 | = $ |
| **ELECTRIC** | $400.00 | = $ |
| **GAS** | $350.00 | = $ |

**WALLS** (Includes: studs, insulation, drywall, plumbing, & wiring)

\*\*Count the number of feet along all the exterior & interior walls

*(Pick one & Multiply by your linear ft.)*

|  |  |  |  |
| --- | --- | --- | --- |
| 2” X 4”/R13 | $ 85.00 | x | = $ |
| 2” X 6”/R19 | $ 105.00 | x | = $ |
| SIP/R30 | $ 150.00 | x | = $ |

**ROOF** (Includes: trusses, sheeting, insulation & coverings)*(Pick one)*

|  |  |  |
| --- | --- | --- |
| Asphalt | $ 15,000.00 | = $ |
| Steel | $ 20,000.00 | = $ |
| SIPs, R50, Solar Panels | $ 40,000.00 | = $ |

**Interior Doors:**

Total number of interior doors \_\_\_\_\_ x $ 75.00 =

**Exterior Doors:** *(Pick one & Multiply by your Number of Exterior Doors)*

|  |  |  |  |
| --- | --- | --- | --- |
| 36”, Steel/R13 | $ 150.00 | x | = $ |
| 36”, FiberGlass/R30 | $ 300.00 | x | = $ |
| 36”, Wood/R19 | $ 600.00 | x | = $ |

**WINDOWS:** *(Pick type, then multiply by your Number of Windows)*

|  |  |  |  |
| --- | --- | --- | --- |
| Single Pane | $ 103.00 | x | = $ |
| Double Pane | $ 126.00 | x | = $ |
| Triple Pane | $ 164.00 | x | = $ |

**Heating & Cooling** *(Pick one)*

|  |  |  |
| --- | --- | --- |
| Gas, Forced Air 90% Eff. & 13 SER | $ 10,000.00 | = $ |
| Gas, Forced Air 96% Eff. & 18 SER | $ 20,000.00 | = $ |
| Geothermal Vertical Field W/Pump | $ 40,000.00 | = $ |

**NOW...** Add up all the boxes on both pages. You may use a calculator if you prefer.

|  |  |
| --- | --- |
| **GRAND TOTAL** | **= $** |

**NEXT**...You should go to your supervisor and take a construction loan for the amount of your “grand total” rounded to the nearest thousand plus 10%. Your supervisor will initial below when this is completed.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Supervisor’s initials*

**Finally**...Deposit the amount of your loan in your checking account by adding the amount of your loan to your balance. Then write a check to the building supply company for the exact amount of your Grand Total.