# Energy Analysis

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In order to quantify the energy savings due to replacing wood cooking with solar cooking, we undertook a study of the embodied energy of our solar oven, as well as the amount of energy offset by its use. We had accurate data for the materials used in the oven and their associated energy costs; however, precise treatments of offset energy and embodied energy due to transportation will require acquiring data on site. As a first approximation, transportation-based energy costs were neglected, and the following assumptions were made regarding the offset energy:

1. Solar cooking can replace one wood-cooked meal per day
2. One wood-cooked meal consumes 2 kg of wood at an energy density of 6 MJ/kg.

Thus, daily wood-fueled energy offset can be calculated:

Daily energy offset = 2 kg/day * 6 MJ/kg = 12 MJ/day.

The embodied energy of the oven was calculated by calculating the volume of each component material and multiplying by the volumetric embodied energy density, as seen the following table:

| MATERIAL | VOLUME | EMBODIED ENERGY DENSITY | EMBODIED ENERGY |
|---|---|---|---|
| | ($m^3$) | ($MJ/m^3$) | (MJ) |
| Steel | 0.000264833 | 251200 | 66.52613333 |
| Pine | 0.04129 | 1380 | 56.9802 |
| Glass | 0.004279 | 37550 | 160.67645 |
| Aluminum | 0.0003817 | 21870 | 8.347779 |
| Plywood | 0.006041 | 5720 | 34.55452 |
| Fiber board | 0.00623 | 4400 | 27.412 |
| Paint | 0.001136 | 117500 | 133.48 |
| | | | |
| **Total** | | | **487.9770823** |

Data for embodied energy of the materials came from a website called "Measures of Sustainability". Contributions due to hardware and adhesives were neglected. From the daily energy offset and the total embodied energy of the oven, we calculate the simple energy payoff time:

Payoff time = 488.0 MJ / (12 MJ/day) = 40.67 days.

If we assume an oven's lifetime to be two years, the total offset energy is:

Total offset energy = 12 MJ/day * 730 days – 488.0 MJ = 8,272 MJ.

It should be noted that the Nicaraguan ovens use recycled aluminum sheets for the interior reflectors, which significantly decreases the embodied energy of the oven. New aluminum, as opposed to the recycled variety, has an embodied energy density of 515,700 MJ/m3. If new aluminum were used in the ovens, the total embodied energy would increase from 488.0 MJ to 676.5 MJ, a 38.6% increase. The use of recycled aluminum is thus an extremely effective means of cutting down on embodied energy.

This first approximation suggests that our solar oven design is an effective tool for energy conservation. It is, however, only a first approximation. If further work is done, it should be focused on replacing the assumptions in this treatment with solid data gathered in Nicaragua. The required elements for further inquire are: transportation costs of oven materials, transportation cost of cooking wood, meals per day offset by solar cooking, wood consumed per meal, and the energy density of the wood. Additionally, the figures for embodied energy of our materials could be cross-checked to ensure accuracy.