

Technology Briefs

EVALUATION OF RECYCLED PLASTIC FEEDSTOCKS & MARKETING STRATEGIES FOR A SOLAR OVEN

Background

Persons Helping People (PHP) is non-profit corporation based in St. Paul, MN, whose mission is to help alleviate hunger in developing countries by helping people help themselves. Their primary product is a prototype solar cooker that is low-cost, easily assembled, lightweight, durable, and solar-efficient. Solar ovens have the potential to reduce the consumption of cooking fuels, such as wood, by 50%, and have the potential for impacting conservation efforts in developing countries.

The Clean Washington Center assisted with implementation and funding of a project to provide technical assistance to PHP in development of their manufacturing process to accommodate recycled plastics. The goal of this project was to evaluate feedstock conversion to recycled polyethylene terephthalate (PET) in the collar and casing components; evaluate use of recycled-content composite plastic lumber in the frame, and to determine appropriate domestic and international marketing strategies for the current solar cooker model.

The design of PHP's prototype solar oven, includes three potential components that could be manufactured from recycled plastic; the casing, the collar, and the oven's rigid lid frame. The prototype casing and collar pieces are currently manufactured from polypropylene and nylon resins. The lid frame is constructed from natural lumber. The estimated maximum temperature inside a solar oven is 300°F, so internal components must withstand exposures to this temperature for extended time periods.

Evaluation of Recycled Plastic Materials

The consulting work of John Fearncombe of Bottom Line Consulting, Inc. (BLC) demonstrated the feasibility of using recycled PET in both the casing and collar components. BLC evaluated the suitability of using post-consumer PET, including specification of the particular grade and

Key Words

- Materials:** Recycled PET and HDPE.
- Technologies:** Injection molding.
- Applications:** Use of recycled PET in components of a solar oven and the use of recycled polyethylene lumber in framing.
- Market Goals:** To determine appropriate domestic and international marketing strategies for recycled-content solar ovens.
- Abstract:** Evaluate performance and functional capabilities of recycled plastic in certain molded and non-molded components in a solar oven, where tolerance to high temperatures is required.

formulation required, based on the following performance standards: stiffness, impact resistance, shipping durability, heat

deflection temperature (HDT) under load, UV resistance, aesthetics, chemical/moisture resistance, durability and service life. Potential grades of post-consumer resins were identified that would produce solar oven components (casing, collar, glazing) meeting these performance standards, be cost-effective, and compatible with standard plastic manufacturing equipment.

The target for incorporation of recycled PET (RPET) in the casing was to enhance performance while using a recycled feedstock. The key performance properties for the **casing** were:

Stiffness of Flex Modulus:	>375,000 psi
Drop Impact Strength	100 foot-pounds
HDT at 66 psi	>130°F (pref. 170°F)



The target for incorporation of recycled PET in the collar was to enhance stiffness, UV resistance, dimensional stability, and heat resistance.

The key performance properties for the **collar** were:

Stiffness of Flex Modulus	>650,000 – 800,000 psi
HDT at 66psi	>300°F
Embrittlement	Nonsignificant over 10 years

Successful molding of post-consumer PET requires tailoring the resin chemistry and molding conditions to meet the performance properties at the lowest piece-per-part cost. Noting the performance specifications or requirements for the collar and the casing, production tests were conducted using varying formulations containing recycled PET.

The casing component requires significant resistance to damage from impact, and, therefore, a formulation using primarily recycled PET, with impact modifying additives, was developed to provide the needed strength. A new casing mold is currently being designed and tested because the prototype mold was not strong enough for the required pressures of recycled PET. The collar piece requires heat resistance, and therefore a formulation containing recycled PET and a glass filler was developed for the collar piece.

The feasibility, availability, and heat tolerance of composite plastic lumber, made from recycled wood fibers and recycled polyethylene was evaluated for the rigid frame components. The most common sources of recycled polyethylene are milk jugs, detergent bottles, grocery bags, and packaging films. Natural lumber is currently used in the prototype for this frame, but is relatively expensive, generates sawdust, has limited weatherability, and is subject to use as firewood in developing countries.

For the most part, plastic lumber is extremely durable and maintenance-free. However, the solar oven's performance requirement of a 300°F service temperature made it challenging to find a plastic lumber product that exhibits this heat tolerance. Based on BLC's analysis of performance of various types of composite plastic lumber and the design of the glazing frame, BLC recommended a glass-reinforced

plastic lumber made from high-density polyethylene. The service temperature limit for HDPE should be adequate for most applications.

Market Strategies and Recommendations

The CWC retained the services of SpiritWest Management (Seattle, WA), to evaluate PHP's current marketing strategy for this product, based on the anticipated use of recycled content components and PHP's long-term business goals.

PHP will continue to operate as a not-for-profit organization, with a major focus on making the "SOS Sport" available at a low cost. They are poised to mass-produce this item at a material cost of \$20. They will actively market the "SOS Sport" both domestically and internationally. The environmental feature of recycled-content components will be emphasized. Each unit utilizes sixty-five, 20-ounce recycled plastic soft drink bottles and a salvaged aluminum printing plate.

Spirit West Management, Inc., points to two primary markets for the solar ovens; developing countries and the domestic United States. However, current domestic trends for solar ovens appear to be weak, therefore, better results are likely to be obtained by targeting the international workplace. There is often initial resistance for using solar ovens in developing countries because it changes the way people cook their food. This initial resistance may be overcome with basic awareness training on issues such as air quality, inaccessibility and cost of fuel, and water pasteurization.

Domestically, PHP will focus market efforts on service and humanitarian organizations, environmental education centers, summer camps, mission and relief agencies, churches, personal use, and others purchasing solar cookers for fundraising projects or for overseas distribution.

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For More Information

For more information call CWC at (206) 443-7703, email info@cw.org, or visit the CWC Internet Website at www.cw.org.

CWC is a nonprofit organization providing recycling market development services to both businesses and governments, including tools and technologies to help manufacturers use recycled materials. This research was partially funded through a grant from the U.S. Environmental Protection Agency.

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