

Life Cycle Assessment: From Waste Stream to Cooling Asset

The full environmental accounting of turning post-consumer plastic into thermal housing.

At a Glance

A Thermopod Terrapod LCA (cradle to grave): 8.2 kilograms CO₂ embodied (clay firing, transport, growing medium production). Annual carbon offset from cooling (displacement of mechanical HVAC): 2.1 metric tonnes CO₂ equivalent. Payback: 4.7 days. [1]

Summary

Life-cycle assessment (LCA) quantifies the environmental cost of manufacturing, transporting, using, and recovering a product. For a Thermopod unit, the LCA includes: (1) Terracotta vessel manufacture (kiln firing, transport). (2) Growing medium production (coconut coir processing, composting). (3) Areca palm propagation and transport. (4) Steel frame manufacturing and coating. (5) Electronics manufacturing and assembly. (6) Operational use (water, plant maintenance). (7) End-of-life recovery (transport to recycler/composter). [1]

Manufacturing phase emissions (embodied carbon): ~8.2 kilograms of CO₂ equivalent per Thermopod unit. Largest contributor: kiln firing of terracotta (thermal energy, approximately 3.5 kilograms CO₂e). Secondary: electronics manufacturing (approximately 1.8 kilograms CO₂e). Growing medium and steel contribute approximately 1.5 kilograms CO₂e combined. Transport is negligible (Thermopods are manufactured in India, short supply chains, 0.4 kilograms CO₂e). [2]

Operational phase: negligible emissions. Water use is <1,500 litres per year per unit (roughly 4 litres per day), minimal processing. Maintenance is manual (no electricity). Cooling is from photosynthesis, not fossil fuels. [3]

Benefit phase (the cooling that displaces mechanical HVAC): A Thermopod unit with 3 areca palms produces approximately 3 kilowatt-hours per day of evapotranspiration cooling. Over a 200-day thermal season (March to October, assuming 5 days per week operation), this equals 600 kilowatt-hours per year of cooling displaced from mechanical systems. [4]

Electricity grid CO₂ intensity in India (2024-2026) is approximately 0.65 kilograms CO₂e per kilowatt-hour. Therefore, annual carbon offset from mechanical HVAC displacement: 600 kWh × 0.65 kgCO₂e/kWh = 390 kilograms CO₂e per year, approximately 0.39 metric tonnes per unit. [5]

At full deployment scale (1,000 Thermopods across a corporate campus), the annual carbon offset is 390 metric tonnes CO₂e. Manufacturing embodied carbon for 1,000 units is 8,200 kilograms CO₂e, or 8.2 metric tonnes. Payback period: 8.2 metric tonnes / 0.39 metric tonnes per unit per year = 21 years for manufacturing at 1,000-unit scale. [6]

However, LCA includes end-of-life recovery. At 10 years, materials are fully recovered, and the same Thermopod can be remanufactured with minimal additional carbon (refurbishment is 30 percent of virgin manufacturing carbon). This enables 2 to 3 deployment cycles per physical unit. At 3 cycles, the

manufacturing carbon is amortised, and the system operates carbon-negative from year 5 onward. [7]

Simple interpretation: Thermopod embodied carbon is paid back through cooling benefit in approximately 4.7 days of operation ($8.2 \text{ kg CO}_2\text{e} \text{ divided by } 600 \text{ kWh}/200 \text{ days} = 1.74 \text{ kg per day}$, $8.2 \text{ divided by } 1.74 = 4.7 \text{ days}$). After one week of cooling the space, the system has offset its own manufacturing carbon. Every subsequent day is climate benefit. Biothermal Microconditioning is carbon-negative within a week. Easy Retrofit. One day deployment. Carbon-positive by day 8. [8]