SKILL GUIDE · ENERGY & HEAT

# Stirling Engines: Turning Stored Heat Back Into Power

Everything else on this site about wood stoves, the Jean Pain mound, and the rocket mass heater is about generating and storing heat. A Stirling engine runs the other direction: it turns a heat source, live or stored, back into mechanical or electrical power. Here's how it actually works, what it really produces, and why it behaves differently on a cooling thermal battery than on a fire you're actively feeding.

## How it works, and its real advantage

A Stirling engine runs on external combustion: a sealed working gas is cyclically heated and cooled between a hot side and a cold side, and that temperature difference drives a piston. Because the heat source is external and never touches the working gas directly, a Stirling engine is genuinely fuel-agnostic, wood, propane, solar-thermal concentration, or waste heat from something else entirely all work, unlike a fuel generator locked to one specific fuel type.

## Real efficiency, stated honestly

Small Stirling engines are commonly cited at 5-15% real-world efficiency, well below their theoretical Carnot-limit ceiling. Documented small builds have come in as low as 1-6% at modest input power. A better research example recovered heat from a source as cool as 70°C and produced 30-40W at about 14% efficiency. Know the temperature threshold before planning around one: most small hobby and DIY Stirling engines need a hot-side temperature difference of at least 150-300°C to run at any meaningful output, well above what a lukewarm surface or gentle heat source provides. A specialized "low-temperature-difference" design can start moving on as little as 15°C, but those are a different, more specialized engine, not what a typical kit or garage build uses.

WARNING

**Precision machining is the real bottleneck**

Seal friction, dead volume, and internal gas leaks kill a Stirling engine's efficiency faster than anything else. A well-made kit or commercial unit will meaningfully outperform a garage-built one for exactly this reason; this is a harder DIY build to get right than a pedal generator.

## The realistic use case: combined heat and power

The practical application isn't a standalone power source, it's a bolt-on to heat you're already generating. If a wood stove is running 10 hours a day for actual heating anyway, adding a Stirling generator can realistically produce 50-100Wh of bonus electricity over that period: a genuine, worthwhile extra, not a primary power plan on its own.

*Where to find it:* ready-made commercial CHP-oriented Stirling units are genuinely rare, most manufacturers target natural gas or wood pellets rather than a standard wood stove. The RIGID RS1000 is one real example built for exactly this pairing, starting to generate once its hot chamber reaches roughly 180°C and producing up to 1kW electrical alongside usable hot water. Outside a purpose-built unit like that, this remains a genuinely harder DIY build than most others on this site, plan on a kit or a real machining background, not an afternoon project.

## A more available comparison: thermoelectric generators

A thermoelectric generator (TEG), the Seebeck-effect technology behind BioLite-style camp stoves, does a similar job with no moving parts at all: typically 3-10W, commercially available today, simpler and more durable than a Stirling engine, at a lower practical ceiling. A Stirling engine has a higher theoretical output and can scale further, at the cost of real mechanical complexity a TEG doesn't have. For a simple, buy-it-today option, a TEG stove is the more practical starting point; a Stirling setup is the higher-effort, higher-ceiling path.

## The thermal-battery caveat

A Stirling engine needs a sustained temperature difference to keep running, and a live, fed fire holds that difference steadily. A discharging thermal battery, a cooling Jean Pain mound, a cooling rocket-mass-heater bench, doesn't: output would decline as the stored heat runs down, the same way a candle dims as it burns rather than holding a constant brightness. Don't expect a Stirling engine paired with stored thermal mass to behave like a battery with steady voltage; it behaves like a fire dying down, because that's genuinely what's happening to the heat source underneath it.

## Sources


- Stirling engine mechanism and fuel-agnostic external combustion: Physics Forums
- Real-world small Stirling engine efficiency figures: Solar Powered Project; DIY Solar Power Forum

- Combined heat and power use case and realistic daily output: off-grid cabin/RV Stirling CHP documentation
- Thermoelectric generator (TEG) output and BioLite-style stove comparison: Wikipedia, BioLite; Resilience.org
- RIGID RS1000 commercial CHP Stirling unit and startup temperature: RIGID
- Minimum hot-side/cold-side temperature difference for small and low-temperature-difference Stirling engines: Real World Physics Problems