

## **Cool Energy, Inc. Intellectual Property Summary**

The intellectual property developed by Cool Energy, Inc. since its founding includes Stirling engine modeling software, Stirling heat pump modeling software, solar-Stirling system modeling software, and Stirling engine waste heat recovery modeling software. Other intellectual property developed by Cool Energy includes inventions for which Cool Energy has sought patent protection. The tables on the next two pages list all issued patents and patent applications currently in process by Cool Energy.

<b>Serial No. Patent No.</b>	<b>Filing Date</b>	<b>Title</b>
11/467,819 7,810,330 Issued 11/1/2010	08/28/06	Power Generation Using Thermal Gradients Maintained by Phase Transitions
11/467,854 7,617,680 Issued : 11/17/2009	08/28/06	Power Generation Using Low-Temperature Liquids
11/734,854 7,877,999 Issued: 2/1/2011	04/13/07	Power Generation and Space Conditioning Using a Thermodynamic Engine Driven Through Environmental Heating and Cooling
8,539,771 Issued: 9/24/2013	04/13/07	Power Generation and Space Conditioning Using a Thermodynamic Engine Driven Through Environmental Heating and Cooling
11/734,883 7,805,934 Issued : 10/5/10	04/13/07	Displacer Motion Control Within Air Engines
11/944,147 7,694,514 Issued: 4/13/10	11/21/07	Direct Contact Thermal Exchange Heat Engine or Heat Pump

Serial No. Patent No.	Filing Date	Title
12/536,728 8,224,495 Issued July 17, 2012	08/05/09	Control of Power Generation System Having Thermal Energy and Thermodynamic Engine Components
12/790,583 9,310,135 Issued April 12, 2016	5/28/10	Configurable Heat Exchanger
61/444,653 9,206,900 Issued December 8, 2015	2/18/11	Assembly for Sealing a Sliding Interface  Provisional filed 2/18/2011
62/159,545	Provisional 5/11/2015 Utility: 5/10/2016	Stirling Engine and Linear-to- Rotary Mechanism Methods, Systems, and Devices

In addition to the above patents and patents pending, Cool Energy has developed trade secrets in the following areas:

1. Fabrication method of non-metallic regenerators
2. Design and fabrication of hybrid heat exchangers comprised of a pressure-sealing body and rolled heat-transfer fins. The body and fins have been configured with both similar and dissimilar materials.
3. Design and fabrication method for very high surface area heat exchangers using off-the-shelf components in a custom housing.
4. Multiple different mechanical crosshead designs to prevent sideloading on the piston assemblies in the cylinders.
5. Techniques for controlling valves between the thermal cycles and the crankcase space for startup and shutdown of Stirling engines.
6. Stirling-engine-driven Stirling cooler configurations.
7. Stirling engine concepts for power generation with cold liquids (e.g., LNG)
8. Methods for Stirling engine operation at -100°C and below cold side temperatures.
9. Best-in-the-world thermodynamic modeling tool for low to medium temperature Stirling engines.
10. Best-in-the-world dynamic mechanism modeling tools for designing kinematic Stirling mechanism for lifetime and balance for medium temperature engines.

Any of these trade secrets or currently developing invention ideas may be submitted in future patent applications.

**Trademarks Issued and Applied For:**

Cool Energy	Live	Serial Number 77,631,139	Reg Number 3,938,363
SolarFlow	Live	Serial Number 77,631,112	Reg Number 3,941,172
SolarHeart	Live	Serial Number 77,631,126	Reg Number 4,045,779
Powering a Clean Tomorrow	Live	Serial Number 85,423,664	Reg Number 4,139,029
ThermoHeart	Live	Serial Number 86,369,130	Reg Number 4,847,270