Scalable Antarctic Thermoelectric Generator for Harvesting Ocean Thermal Energy In-Situ for Free Floating or Ice-Tethered Antarctic Observation Buoys

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A Scalable Antarctic Thermoelectric Generator (SATEG) capable of increasing the duration of Antarctic observation missions by an order of magnitude has been demonstrated at laboratory scale. The scientific principle behind the SATEG is thermoelectric energy conversion. This process converts a low magnitude heat flux directly into electricity. The main challenge with thermal harvesting in Antarctica is that temperature differences are small and dispersed over a large area. The core power generation unit of the SATEG is a module comprised of water- and air-side finned heat exchangers linked through two thermosyphons to a generator body containing commercial thermoelectric modules. This double-sided design allows SATEG to charge external observation units above or below the ice during polar winters. One or more SATEG module connected to a battery through a power conditioning unit comprises the energy system. The unique SATEG design enables concentration of Antarctic thermal energy through multiple phase change cycles operated under natural circulation to ensure there are no moving parts or consumables. A single module that weighs approximately 40 kg, when deployed through an 8 inch bore hole in an ice floe produces 75-150 kWh of electricity per year, depending on location. An ice buoy that consumes a nominal 7W requires 300 kWh of battery storage to support a 5-year mission, but only requires 25 kWh of storage when coupled with a single SATEG module. Therefore, the purpose of deploying a scaled SATEG network is to extend the useful lives of Antarctic probes while simultaneously increasing the magnitude of scientific data able to be collected during polar nights.