

Review

# The development of a micropower (micro-thermophotovoltaic) device

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## Abstract

A detailed review is carried out on current micropower technology. In particular, a prototype micropower device based on the concept of a thermophotovoltaic (TPV) system of generating electricity is reviewed in this report. This prototype micro-TPV power generator [W.M. Yang, S.K. Chou, C. Shu, H. Xue, Z.W. Li, *J. Phys. D: Appl. Phys.* 37 (2004) 1017–1020] is currently under research and development by the National University of Singapore (NUS). Focus is made on the possible improvements to the micro-TPV power device, in particular the efficiency of the micro-combustor, PV cells, and consequently the overall the efficiency.

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*Keywords:* Micropower device; Micro-combustion; Thermophotovoltaic; Micro-combustor

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## 1. Introduction

### 1.1. Motivation

The development of micropower devices is motivated by the increasing needs and demand for smaller scale and higher density power sources. Traditional batteries have failed to satisfy this need, due to relatively low projected energy densities, thus causing serious logistical mission constraints [1]. Mass and volume have also become important criteria in the growing trend towards the miniaturisation of both mechanical and electromechanical engineering devices. All kinds of micro-devices are being developed rapidly. This need for a tiny but powerful energy source is urgent. A micro-scale power system had been strongly regarded as a viable solution and an alternative power source. The micropower concept is still relatively new, as such, and not many micropower devices have been developed. By doing a detailed review of the currently available micropower devices, we can further understand how to make improvements to the present technology. In particular, the present efficiency of micropower generators that are being developed is still relatively low. Therefore improving the efficiency will greatly enhance the development of micropower devices.

### 1.2. Significance and need for micropower device

During the mid to late 1990s, Epstein and Senturia [2] first suggested the concept of a micro-heat engine and Power MEMS to describe micro-systems, which can generate power or pumped heat. Since then, all kinds of micro-devices have been developed rapidly around the world. The interest in producing miniaturised mechanical devices has opened up new opportunities for micropower generation, because of the need for power supply devices with high specific energy (small size, low weight and long duration). Micro-gas turbine engines [3], micro-rotary engines [4], micro-thermoelectric systems [5] and micro-fuel cells [6] are typical micropower systems being developed. However, the miniaturisation of these devices is very much limited by the currently available power supply system. Despite the rapid miniaturisation of numerous electromechanical and mechanical engineering devices, the size, weight and energy storage capabilities of electrochemical batteries cannot be compromised. They occupy a significant fraction of both mass and volume of the entire device, thus greatly affecting both the design and specifications (Fig. 1).

There has been strong interest in both military and civilian applications for an alternative power generation system.

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