



智能資產與維護管理研究實驗室  
Smart Engineering Asset Management Laboratory (SEAM)

## A Novel Design of a Frequency Converter for Harvesting Wasted and Destructive Vibration from Operating Machines

MEEM Research Group for Renewable Energy  
Department of Manufacturing Engineering and Engineering Management  
City University of Hong Kong

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## Aim

To design and develop  
**Novel Energy Harvesters**  
for absorbing **destructive vibration** and **heat**  
generated by running machines and then  
converting them to **useful electricity** that can be  
consumed by wireless sensory systems

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## Background - 1

- With the ever growing advanced technologies available for wireless technology and low power electronics, sensors can be placed in almost any place without wire and power supply cord.
- Wireless sensors require their own power supply by mean of conventional batteries. Once the batteries have been run out, the battery must be replaced.
- The task of replacing batteries is tedious and could be damage if the sensor is installed in hazard environment. These issues can be potentially alleviated through the use of energy harvesters.

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## Background - 2

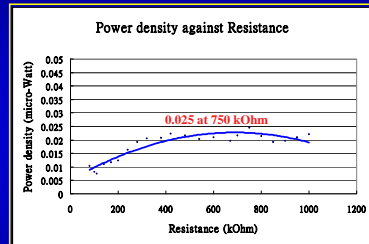
To maximize electricity output, the energy harvester is designed to have

- a matching load resistor,
- an optimized inductor, and
- an adjustor to match its resonant frequency with the dominant vibration frequency of the machine.

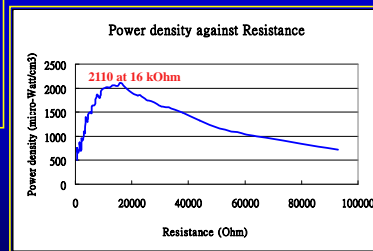
Our experimental results show that an energy harvester equipped with these three items can generate 83 times more power than a harvester without the above three items.

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## Power Output of Piezoelectric materials



Significantly larger power density generated



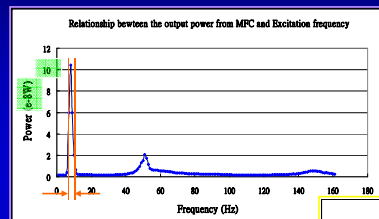
## Resonant Frequencies of Piezoelectric material

### Reason of research

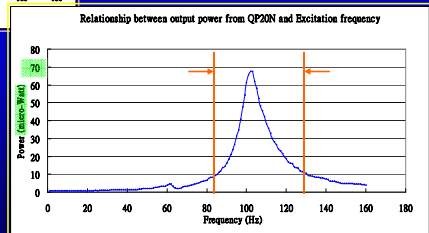
When the piezoelectric material is deformed, it generates electricity. The larger the deformation, the larger the output electricity.

The deformation of a structure is significantly increased at the first mode of resonance frequency. Hence, the piezoelectric material can generate larger output power this frequency.

## Resonance frequencies of the piezoelectric material



1. A larger power output
2. A wider frequency range



## Summary

- Transmission of RF signals without using conventional battery but through the harvested energies from vibration and heat were verified.
- With an appropriate load resistor, the maximum output power of the smart materials can be obtained.
- If the piezoelectric material is allowed to be vibrated at its own resonance frequencies, the harvested energy can be significantly increased. Hence, more electrical power can be supplied to the designated wireless device.
- Energy harvester prototype is promising because the power consumption can be further reduced by off-the-shelf low-power electronics and the latest technology.