RENEWABLE ENERGY SOURCES IN WIRELESS SENSOR NETWORKS

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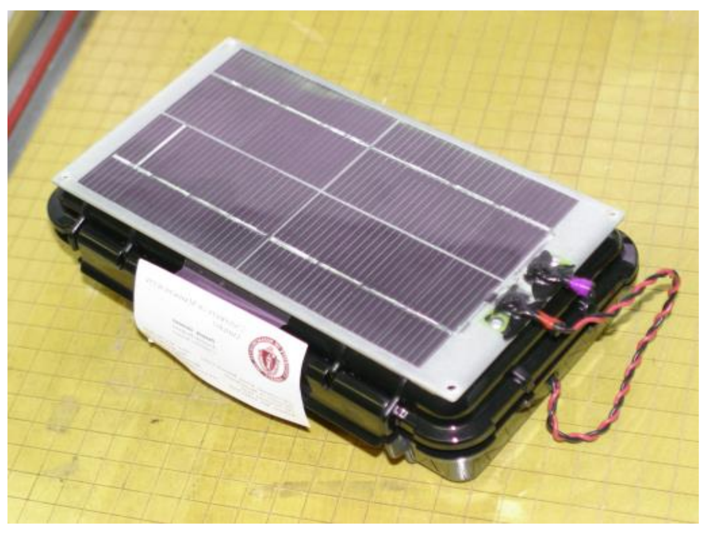
a review of energy harvesting and scavenging techniques used or designed specifically for use in contemporary wireless sensor networks

Electromagnetic waves harvesting

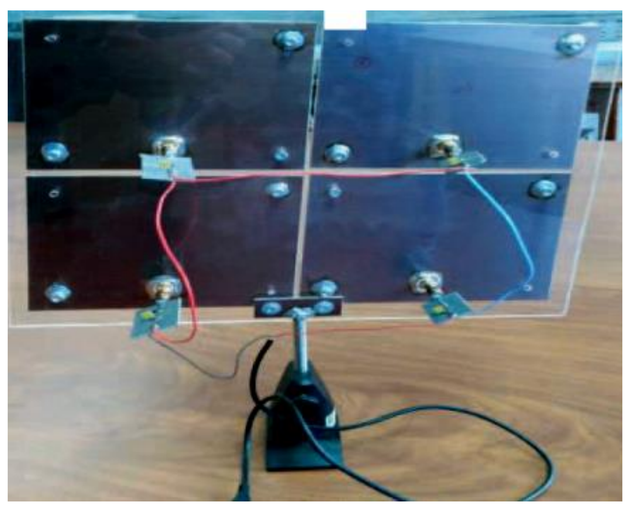
- solar cells

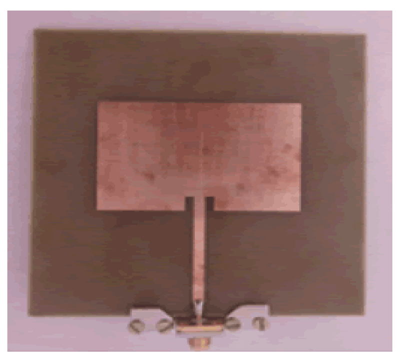
most commonly used method today; outdoor panels provide approx. 10 mW/cm^2; existing WSN nodes favor monocrystaline Si panels 5×5-10×10 cm^2



- rectennas

may be employed feasibly in radio and microwave part of the spectrum, but not widely used in WSN; backscattering radio sen-sor networks seem a pro-missing research area, but have too low range and data transfer speed at present

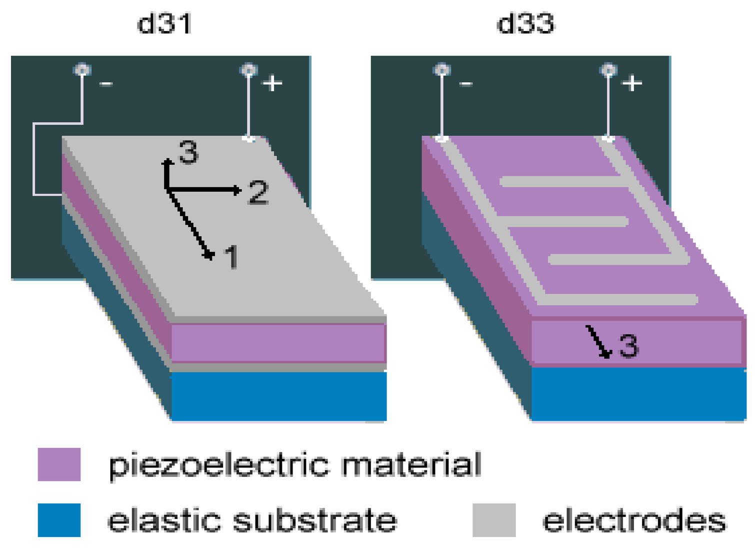




Mechanical energy harvesting

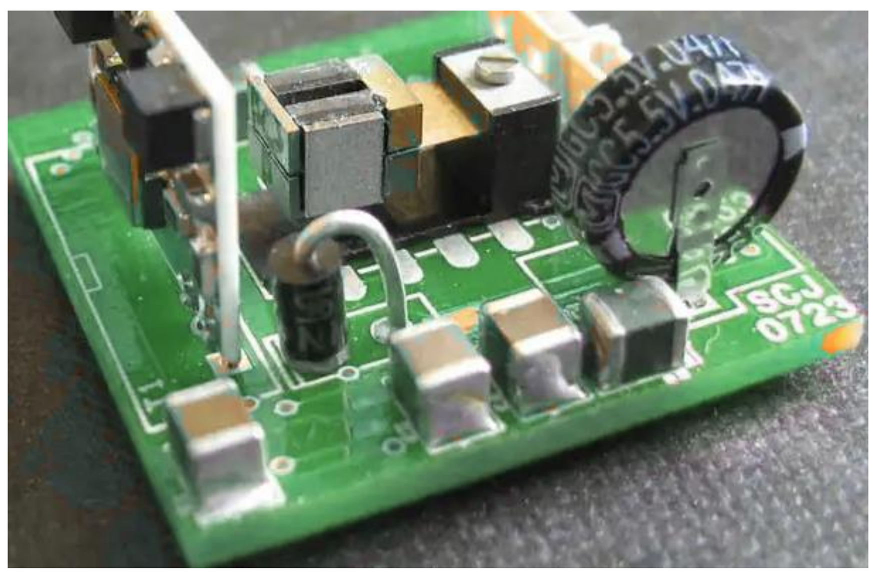
- piezoelectric harvesters

popular due to high efficiency and minimization potential; materials used include PZT, PMN-PT. PZN-PT, ZnO and AlN; default design adopted by most researchers is cantilever



- EM induction μgenerators

lower efficiency, moving parts prone to malfunction, harder miniaturization, but still popu-lar in WSN research; two basic kinds are oscillatory (trans-lational) and rotational



- electrostatic energy harvesters

work on the principle of changing the electrostatic energy inside a capacitor by altering its geometry (and thus voltage or charge); electret-free harvesters use sync. circuits and work in cycles, similar to thermodynamic ones; electret harvesters feature per-manently polarized materials

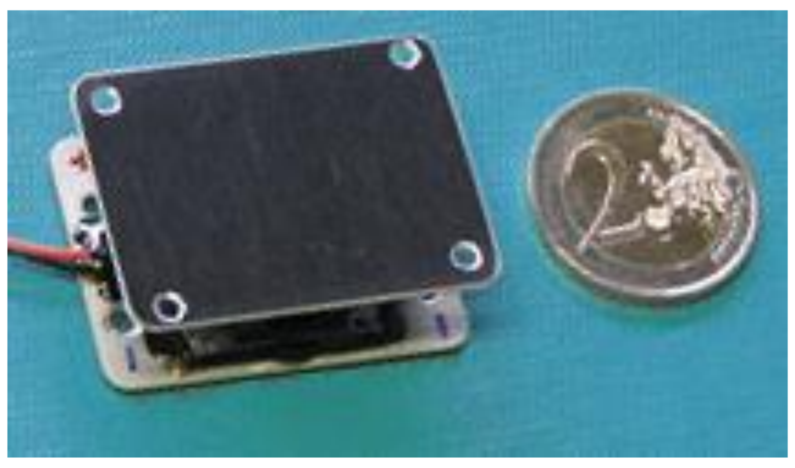
- triboelectric energy harvesters

emerging technology, often com-bined with other MEH types to create hybrid harvesters; work on the principle of electrification by friction; dielectric polymers are gaining popularity as the material

Thermal energy harvesting

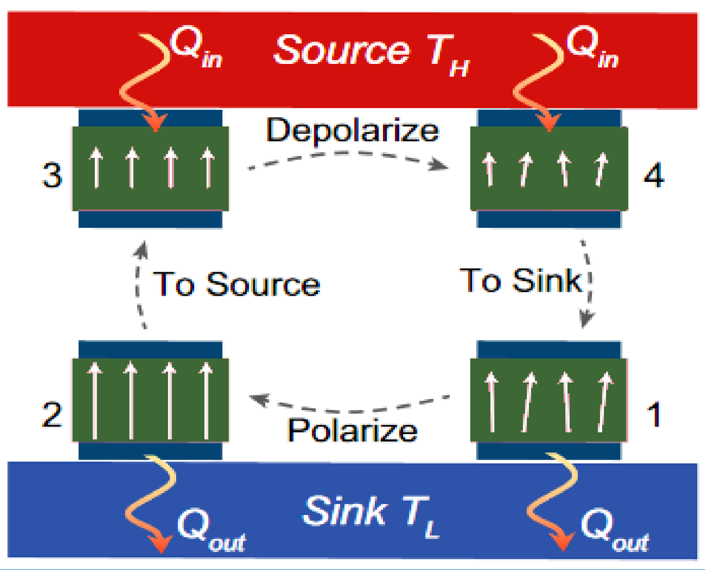
- thermoelectric μgenerators

Seebeck effect based (require spatial temperature gradient); simple to install and maintain, no moving parts, environment friendly, but require bulky heat sinks; large number of thermo-couples is connected serially into thermopiles, which are then connected in parallel



- pyroelectric harvesters

pyroelectric effect based (requ-ire temporal temperature gra-dient); better efficiency than TEG and do not require bulky sinks; suitable for use with heat pumps like refrigerators and air conditioners; perovskite type ferroelectric ceramics are the most promissing material



- thermomagnetic harvesters

ferromagnetic materials being heated over their Curie tem-perature lose magnetic proper-ties, and the change in magnetic flux may be used to induce current; the first generator of this type was constructed by N. Tesla in 1889; lately, gadolinium and its alloys came into focus with Curie temperatures close to 20°C; although not many dedi-cated harvesters of this type have been deployed in WSN yet, with miniaturization under way, the reports are expected soon

10. Međunarodna konferencija o obnovljivim izvorima električne energije, Beograd, 17. i 18. oktobar 2022.
10. International Conference on Renewable Electrical Power Sources, Belgrade, 17. and 18. October 2022.