ENERGY SUBMETERING FOR CIRCUIT BREAKER PANELS and HARVESTING ENERGY FROM ENERGIZED CONDUCTORS

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21 April 2011

Proximity AC current sensor

Commercial Circuit Breaker

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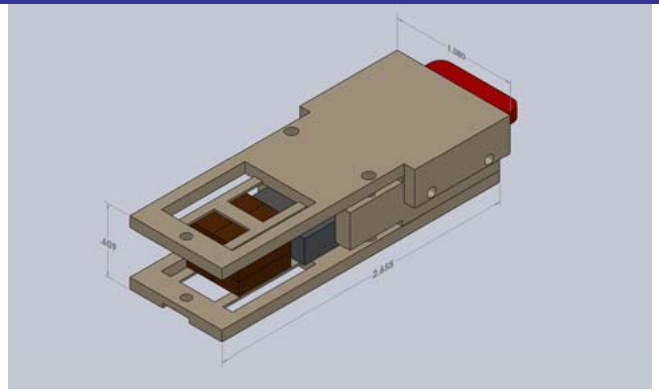


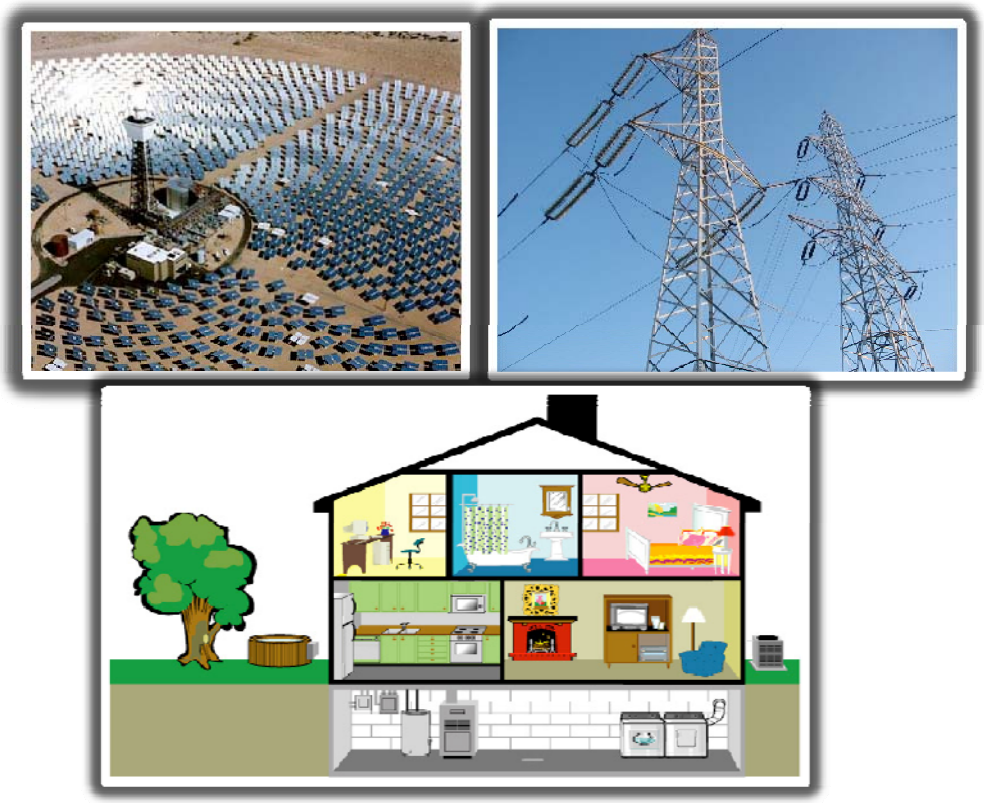
Proposed energy harvester with power conditioning and radio

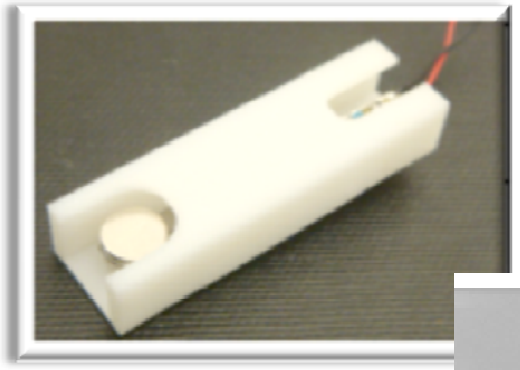
Why sub-metering our buildings?

We need more information !

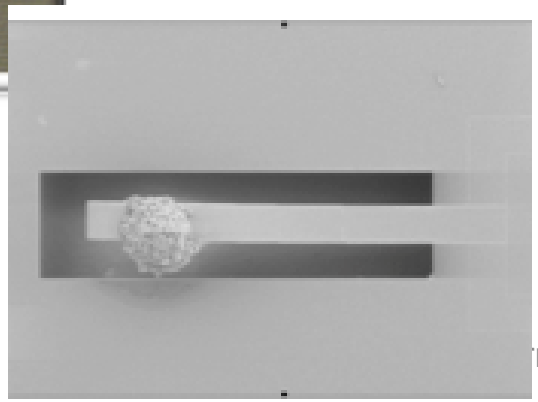
Demand response

Smart grid





Meso-scale proximity AC current sensor(2 x 0.5 in^2)

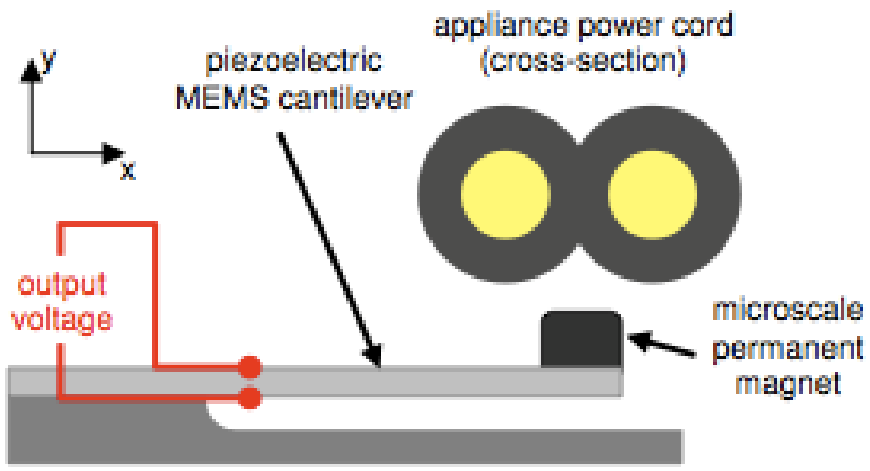


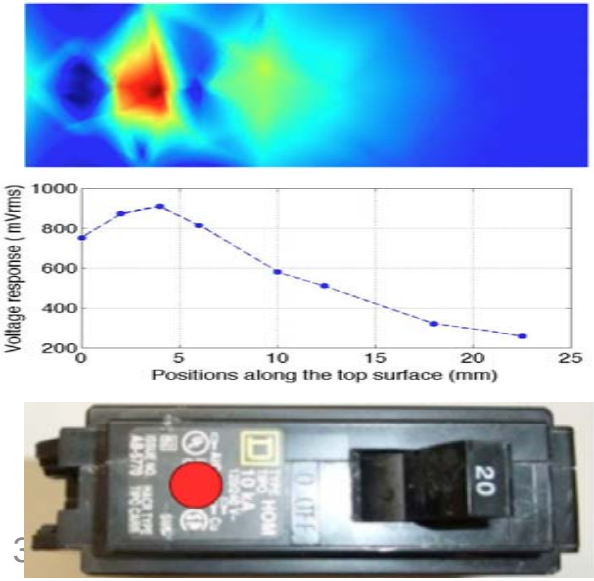
MEMS AC current sensor (800 micron long beam)

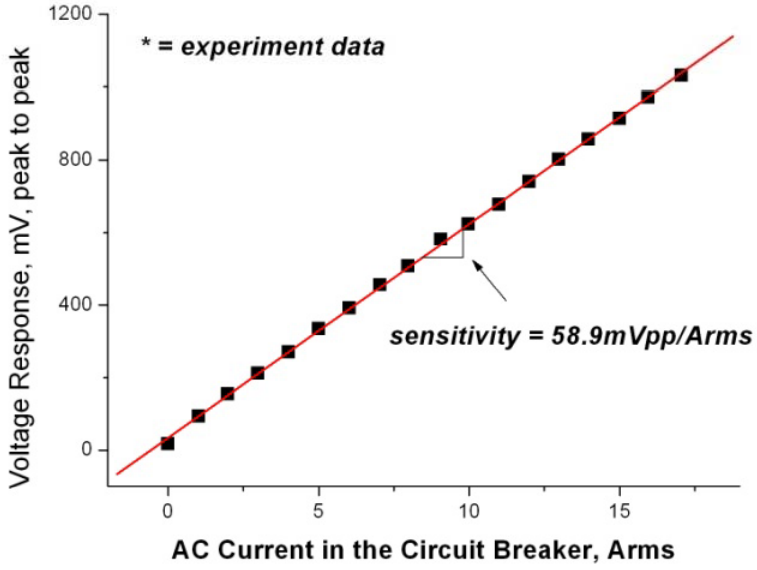
- **Inexpensive**
- **Easy to install**
- **Small**
- **Wirelessly enabled**

Wirelessly enabled AC electric current sensors on circuit breaker panels

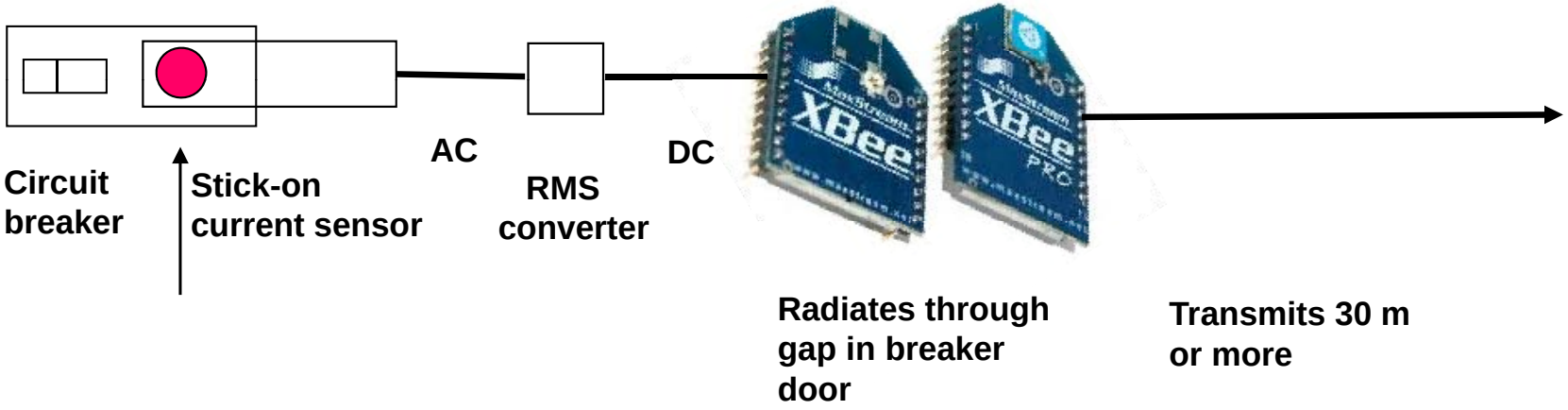
Working principle – Current sensor







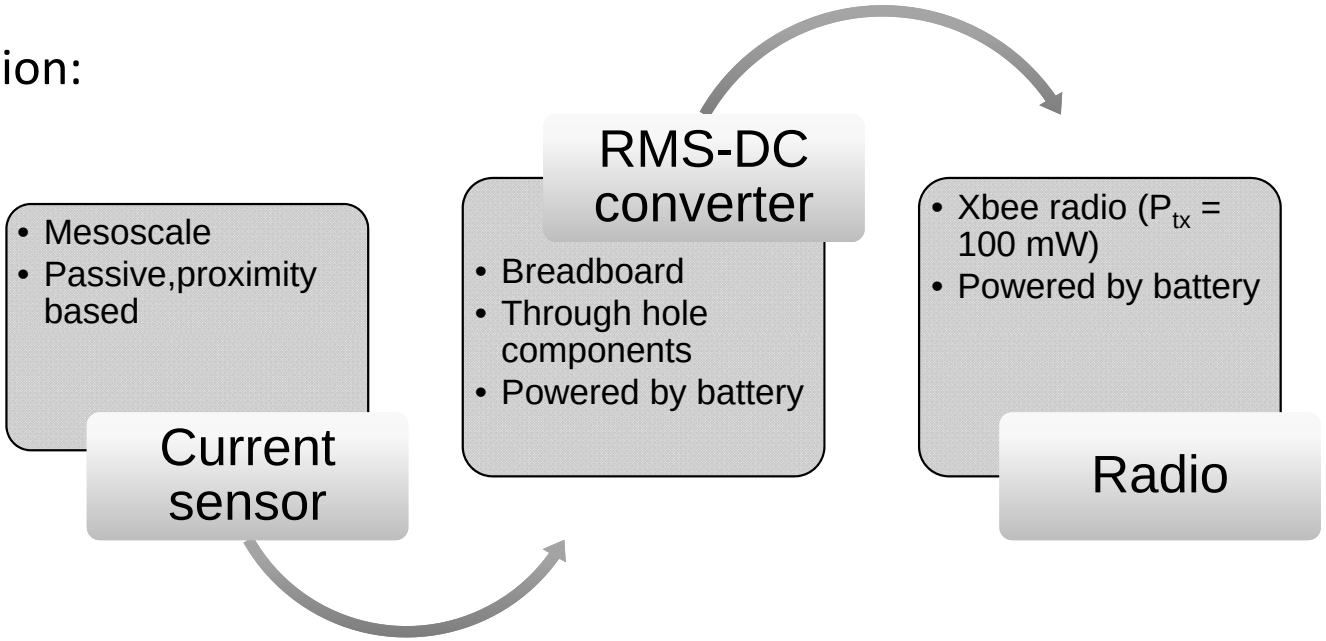
Demo !



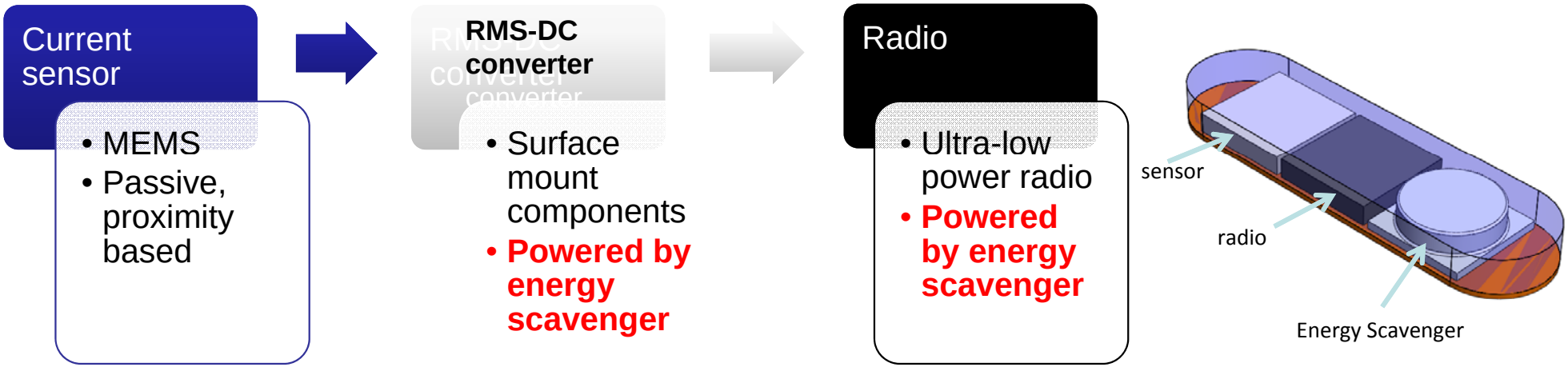
For our demo today the circuit breaker is in a building across the street so we take the AC sensor signal, convert it to an rms signal, digitize it, put it on the Internet, pick it up with a laptop, and project it here

The status quo and future plans

Present version:



Future version:

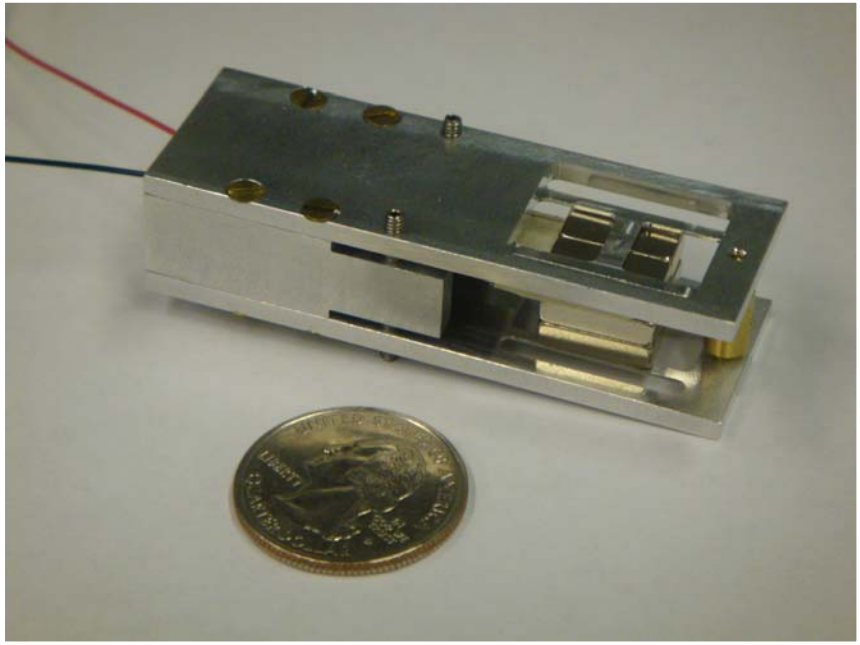


Challenges and potential problems

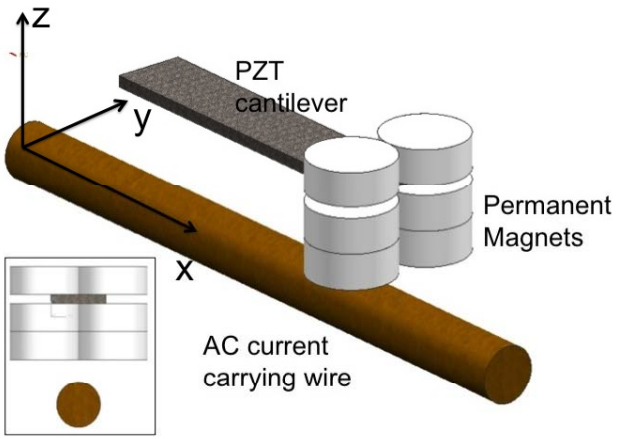
1. Our current sensor is subjected to noise from ambient vibrations.
   - Band pass filter which attenuates the signals other than 60Hz
2. Interferences from neighboring breakers.
   - Need further investigations.

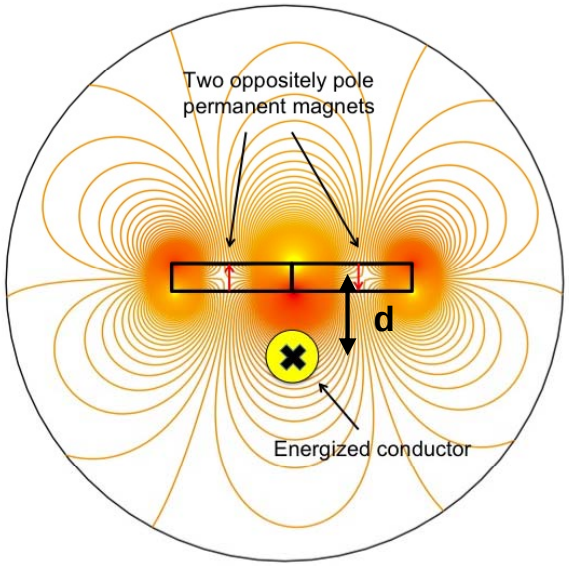
Questions?

HARVESTING ENERGY FROM ENERGIZED CONDUCTORS



Quick preview

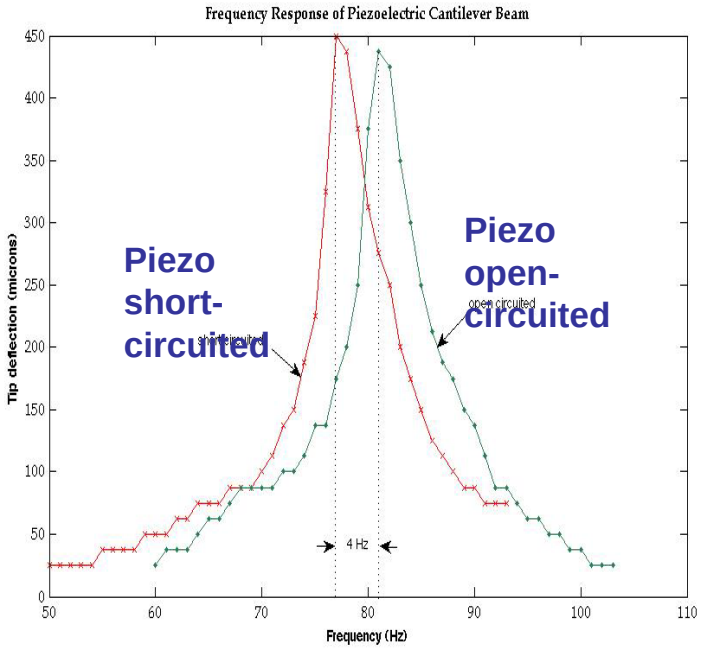




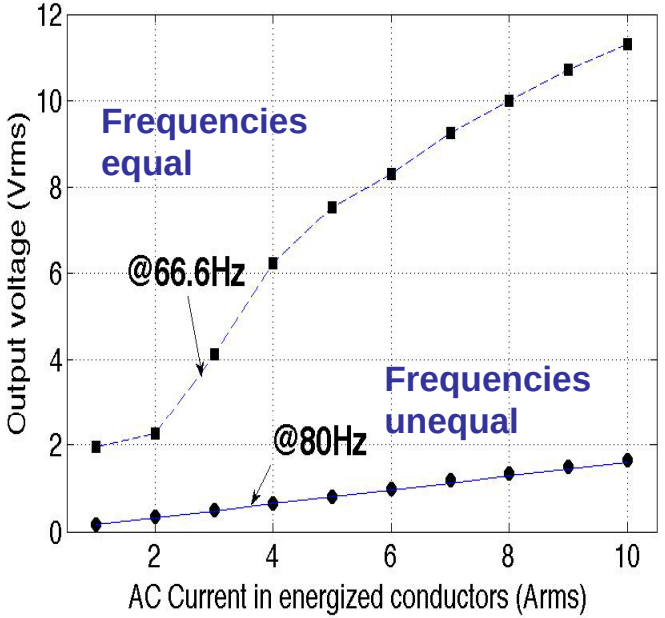
1. This design uses two oppositely poled magnets
2. Maximum power achieved: few milliwatts @ 50 A_{rms}
3. Output power is proportional to I^2 and $1/d^4$

The resonance frequency of an energy harvester can be passively tuned by changing the resistive load across the device.

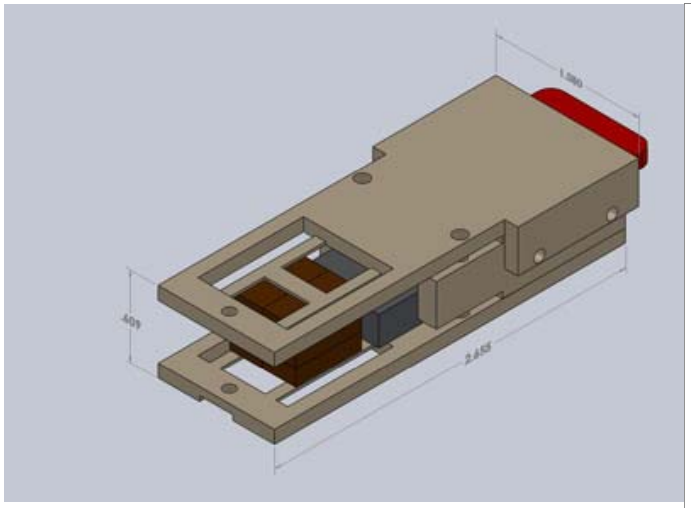
1. Allow the energy harvester to switch to its "sleep mode" when the supplied power exceeds the power required

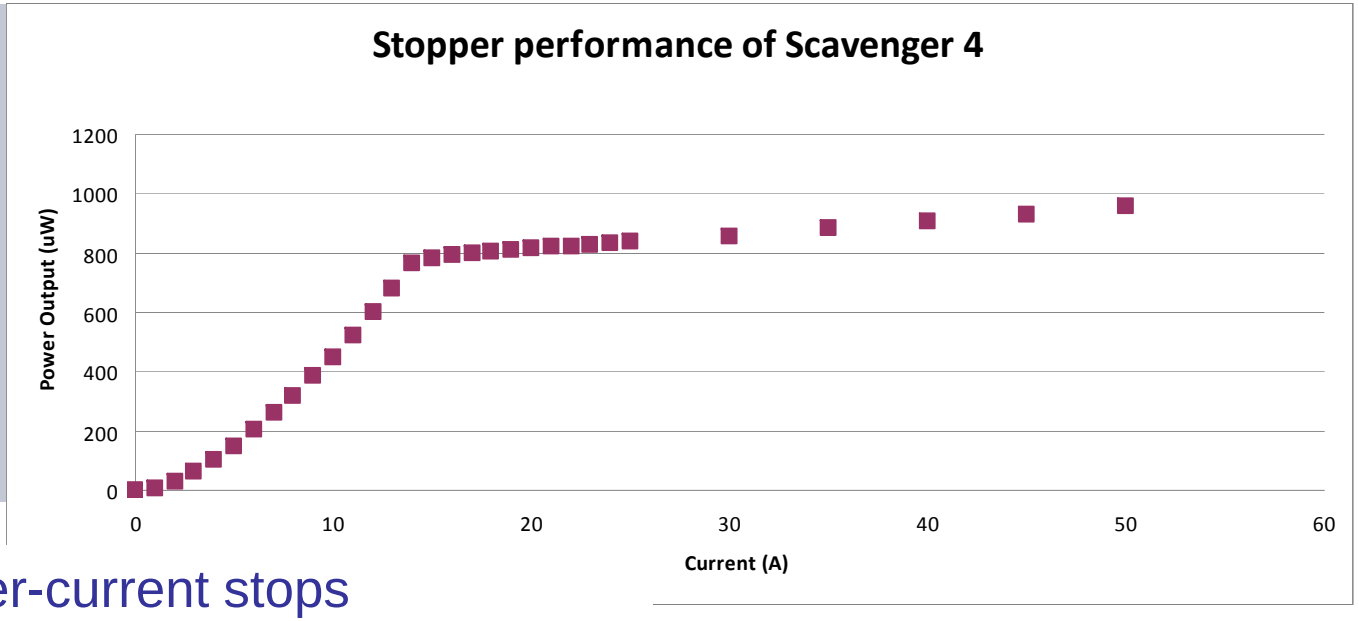


2. Turn the energy harvester into a linear electric current sensor by making the mechanical resonant frequency different from the drive frequency

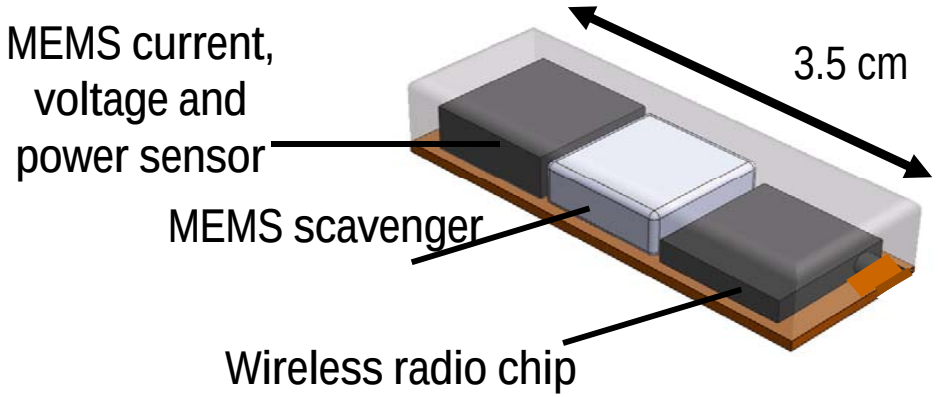


Energy Harvesters

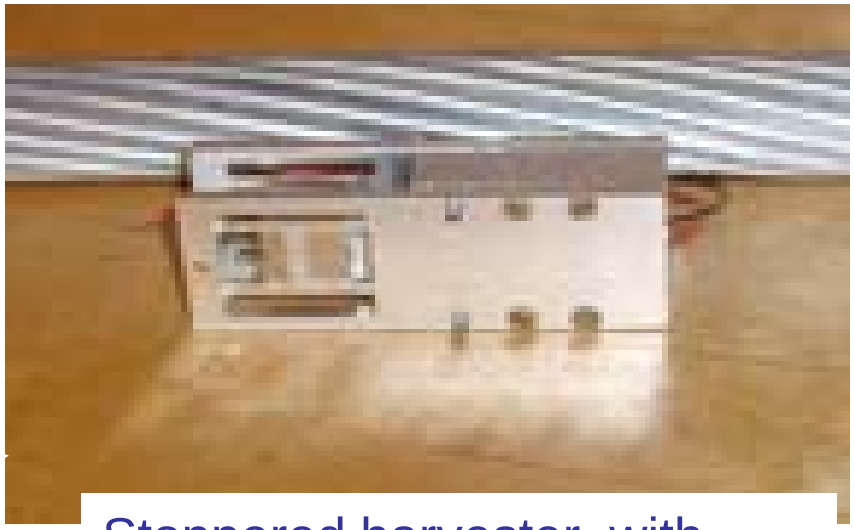




Energy harvester with over-current stops



Hermetically sealed (MEMS-on-Glass) sensor module



Stoppered harvester with overhead powerline conductor

Conclusions

1. We can make wireless passive proximity AC current sensors, for which one application is “stick-on” monitoring of residential or commercial loads from existing circuit breakers.
2. We can made related devices that harvest energy from energized conductors, to power self-sufficient wireless sensors.