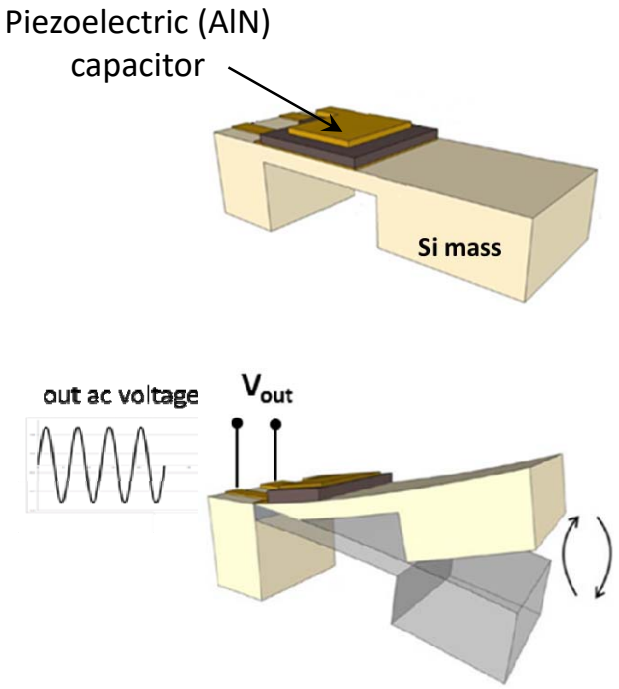
Piezoelectric MEMS Vibrational Energy Harvester

Motivation

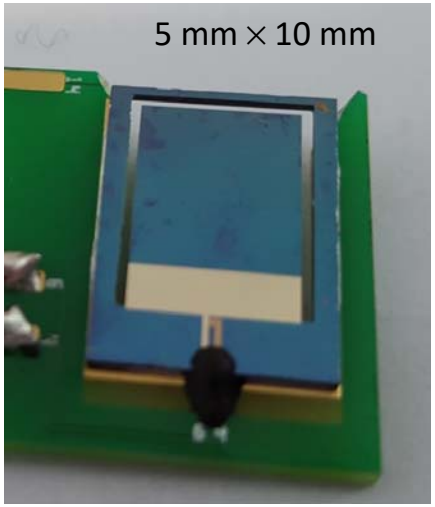
- ✓ Strong demand for energy harvesting technologies for IoT applications
- ✓ Piezoelectric vibrational EH is attractive technology due to MEMS capabilities

Demo content

- ✓ Tyndall's research overview
- ✓ Demonstration of typical devices
- ✓ Overview of technology challenges
- ✓ Demonstration of one potential application, i.e. harvesting of energy from the EM field surrounding the power cord (mains cable)



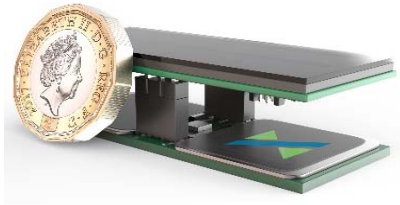
Tyndall MEMS harvester

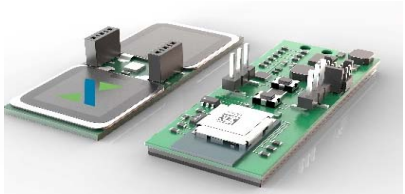


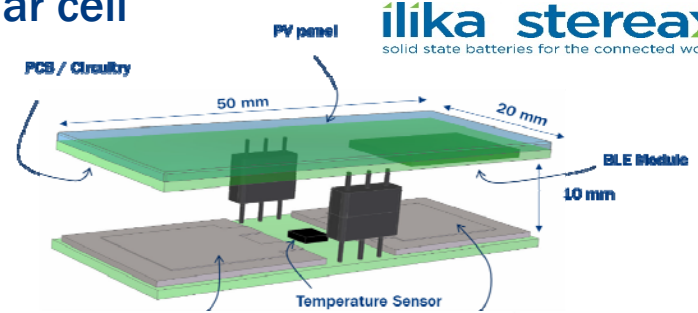
Oskar Z. Olszewski, Research Engineer, Tyndall National Institute, UCC

Perpetual beacon for Industry 4.0 powered by solar cell and solid state battery

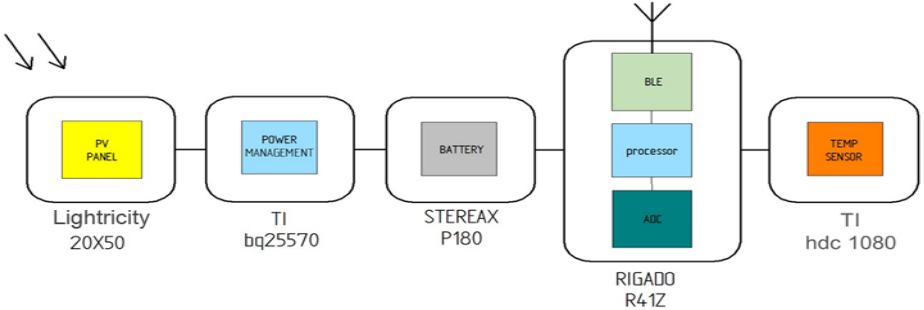
Operates to 150 °C







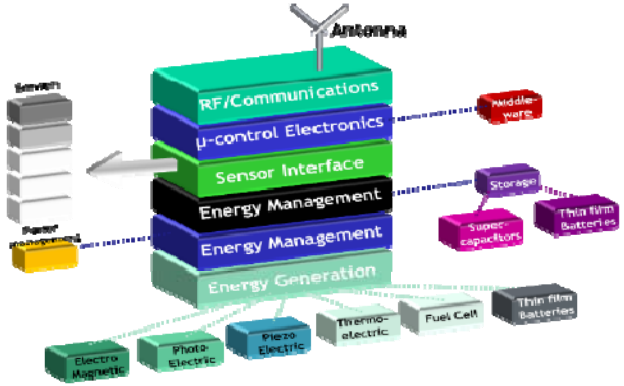
- a single transmission uses 28.5 µAs at full power (+4dBm)
- = 7.92 nAh per transmission
- = 12626 transmissions per 100 µAh charge
- = 35 hours of operation at 1 transmission every 10 seconds
- at 3.5 V = 100 µJ per transmission



Watch the video www.ilika.com

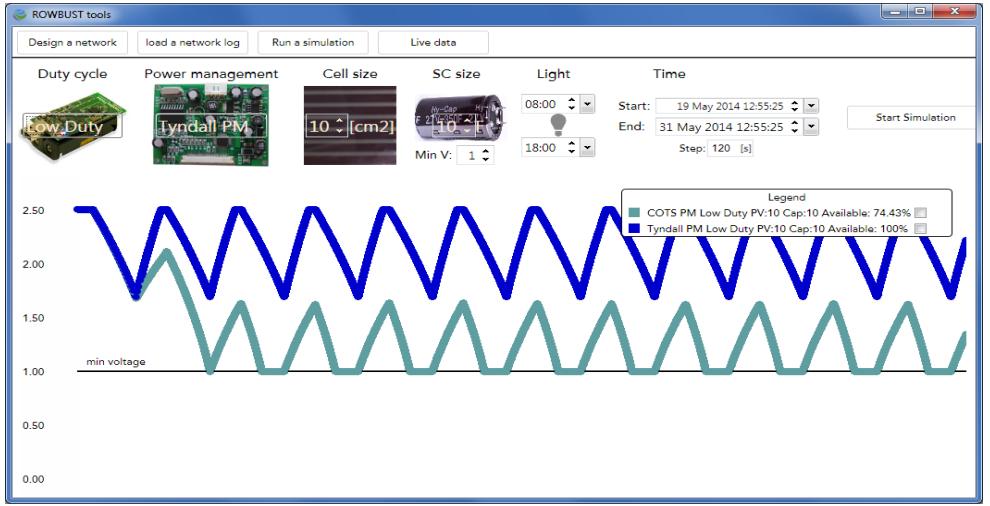
Asset Tracking for Industry 4.0

- Tracking assets to maintain workflow efficiencies and recover lost material has a significant cost saving in manufacturing facilities.
  - Tracking high value material can save in the order of €100K in some cases.
- Candidate technologies face challenges to be Energy Harvesting ready.
  - BLE is a low power, but the challenge is getting good enough accuracy
  - UWB is very accurate but the challenge is to reduce power consumption
- Focusing on Energy Harvested BLE asset tracking. Technologies under investigation include, Indoor solar, Vibrational, Thermoelectric, Inductive charging, etc.



RoWBUsT

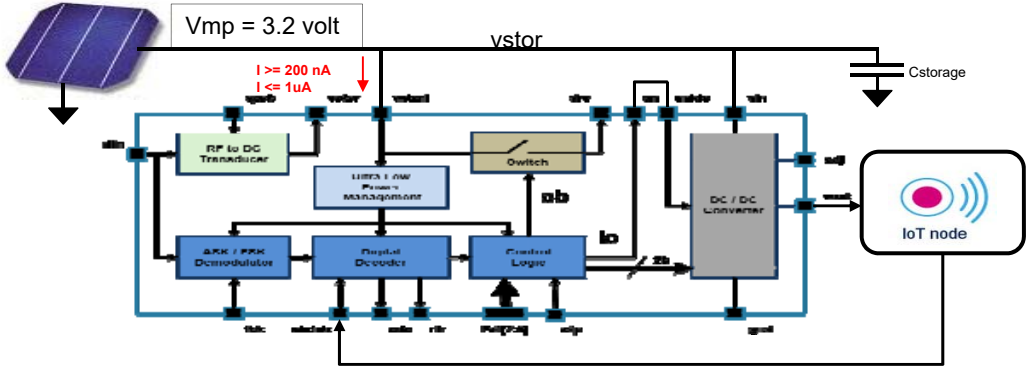
- An IERC funded project with a goal to develop an energy harvesting, wireless sensor deployment, assisting simulation tool.
  - The user selects from a range of components (power management boards, solar panels, super capacitor, etc.) and runs a simulation.
- This example compares a Tyndall PM board with a COTS PM board.
  - The graph shows the energy availability of the super capacitor as it charges and discharges.



- Adjusting size and type of the components helps the user find the optimum setup for their device to power it indefinitely or simply extend the battery life.

Powering Battery-Free Systems with PV cell

- A battery free wireless lux sensor with Bluetooth communication
- Sensor datas are displayed on a Smartphone through an app



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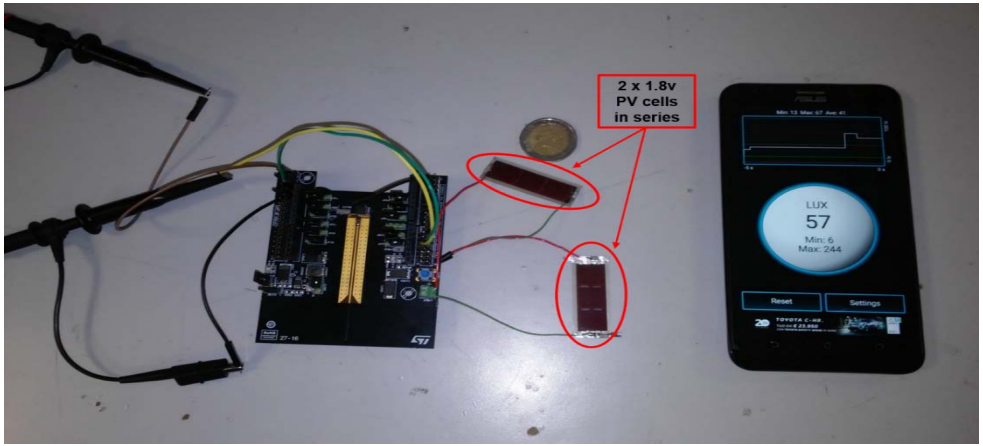
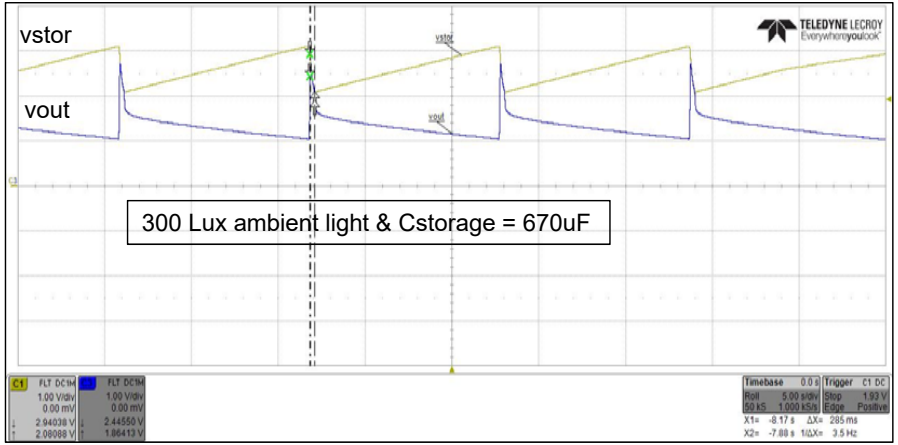




Supercapacitor enables a small solar cell to power a wireless sensor

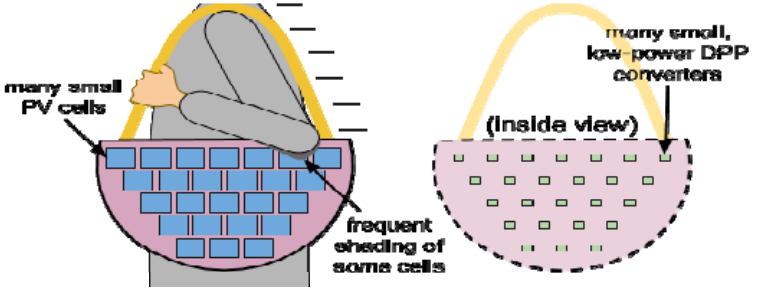
- Wireless sensors are becoming ubiquitous, but wiring power to them is expensive and batteries require replacement and disposal.
- The environment has abundant energy, but often it can only be harvested at very low power, as low as sub mW.
- Much higher peak power from ~50mW for Bluetooth to 1W+ for cellular is required to capture and transmit data, usually at very low duty cycle so average power is < power from the energy harvester.

- Supercapacitors, which deliver high power, can be charged at very low current, have “unlimited’ cycle life, and store sufficient energy for data capture and transmission are ideal power buffers to solve this problem.
- This demo shows a small solar cell charging a supercapacitor at ~1mW supporting a Bluetooth sensor drawing 50mW peak power.

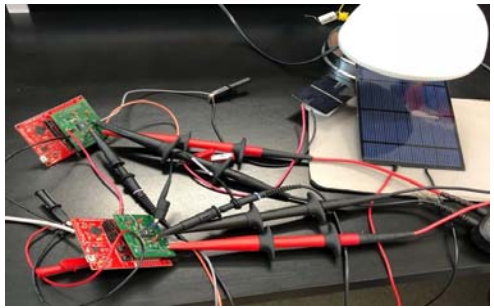
Enabling Photovoltaic-Powered Wearables

Katherine A. Kim, F. Selin Bagci, Yu-Chen Liu, and Franklin Bien

Goal: Effectively implement wearable PV applications with unavoidable uneven lighting



Solution: Independent differential power processing converters



Early Prototype

Features

- Naturally utilizes the PV voltage characteristics
- Independent MPPT control of each PV cell
- Cells can have different sizes and characteristics
- Self-powered with passive protections

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Inaugural International Energy Harvesting Workshop

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Power Electronics
Research Centre

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A High Efficiency Switched Supercapacitor Energy Management Circuit for Energy Harvesting Powered Wireless Sensor

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- The aim of this work is to create a high efficiency autonomous energy management circuit for low-power, low-voltage energy harvesting powered wireless sensor
- Key circuit characteristics:
  - Maximum power point tracking controlled operation
  - Pulsed delivery of energy to load, similar to wireless sensor operation
  - Efficiency of over 90% for typical sensor active power levels
- Benefits of circuit usage:
  - Increased efficiency when compared to existing energy management solutions (in terms of both DC-DC conversion and system efficiency)
  - Removes the dependency on battery storage elements, which have limited lifetime and relatively low charge/discharge efficiency
  - Enables wireless sensors to become smart sensors