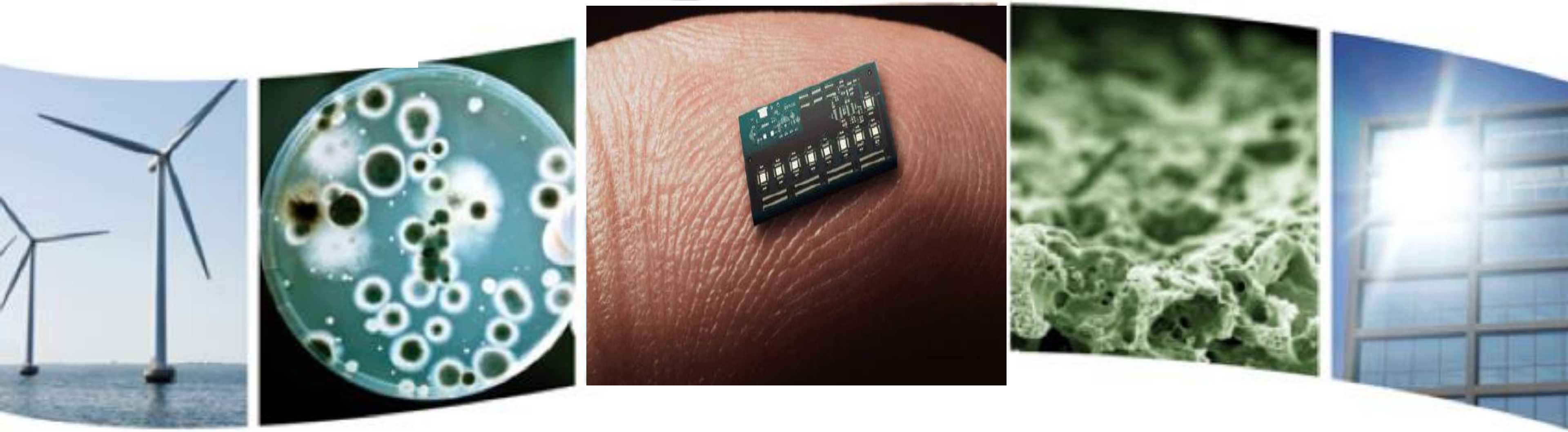

Sistemes autònoms i la seva energia per la industria 4.0

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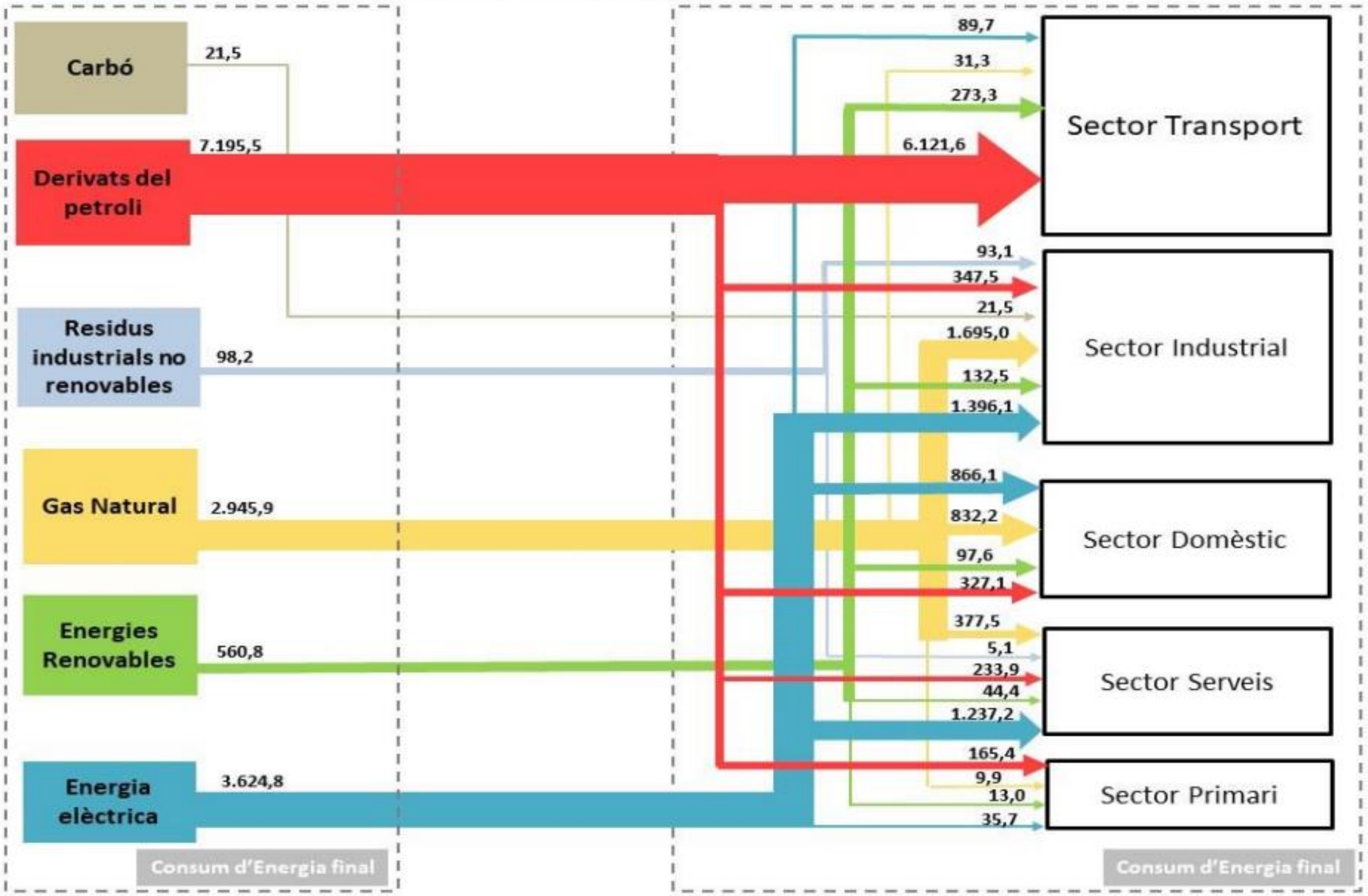
DIAGRAMA SANKEY DEL SISTEMA ENERGÈTIC DE CATALUNYA A L'ANY 2019



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Energia consumida pel sector industrial

Energia elèctrica:
1396,1 ktep (electricitat)
132,5 ktep (renovables)
Total: 1528,6 ktep =
17,8 TWh

Energia tèrmica:
1695,0 ktep (Gas)
21,4ktep (Carbó)
347,5ktep (der. Petroli)
93,1 ktep (Residus)
Total: 2157,0 ktep=
25,0 TWh

Consum d'energia a la industria

Eficiència

Neutralitat Climàtica (descarbonització)

Sostenibilitat

Gestió intel·ligent
Noves eines digitals per control i comunicacions.

Descarbonizació
Neutralitat climàtica

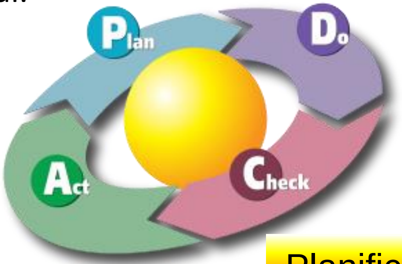
Electrificació

Font: MTERD

Tècniques d'estalvi d'energia a la indústria: (una perspectiva des la gestió elèctrica)

ISO 50001 és una normativa internacional desenvolupada per ISO (Organització Internacional per a l'Estandardització u Organització Internacional de Normalització) que té com a objectiu mantenir i millorar un sistema de gestió d'energia en una organització, el propòsit és el que permetrà una millora continua de l'eficiència energètica, la seguretat energètica, la utilització d'energia i el consum energètic amb un enfocament sistemàtic.
Aquest estàndard apunta a permetre que les organitzacions millorin contínuament l'eficiència, els costos relacionats amb l'energia, i l'emissió de gasos d'efecte hivernacle.
Aquest estàndard ha estat publicat per ISO el juny de 2011 I renovat en el 2018, i és aplicable per a qualsevol tipus d'organització, independentment del seu tamany, sector, o ubicació geogràfica.
El sistema ha estat modelat a partir de l'estàndard ISO 9001, de sistemes de gestió de qualitat, i de l'estàndard ISO 14001, de sistemes de gestió ambiental.

La millor eficiència la té aquella energia que no es gasta així com aquella energia que no es perd i/o dissipa.



Plan-Do-Check-Act

Planificar –Fer –Verificar-Actuar

If your company is looking for **Industrial Energy Efficiency Inspiration**, check out **13 ways businesses are doing it today**

INDUSTRIAL ENERGY ACCELERATOR

Energy efficiency allows industrial operations to achieve the same, and often better outcomes with less energy.

These measures are saving companies huge amounts of money and are helping to mitigate climate change by reducing carbon emissions.

1 Turning it off

Compressors, conveyors, machinery, computers and lights left on but not used can consume up to 70% of their full power.

2 Switching to LEDs

LED bulbs use about a quarter of the energy needed to produce the same light as halogens and can last five to ten times longer.

3 Controlling temperatures

A programmable thermostat can reduce consumption by up to 15 per cent.

4 Waste heat recovery

One way to significantly improve energy efficiency is reuse the waste heat that is already being generated in industrial processes. There are various technologies available today for effective heat recovery. Even a simple heat exchanger can often do the trick.

5 Sticking to the speed limit

Sometimes variable or adjustable speed drives, which are devices that can vary the speed of a normally fixed speed motor, can reduce energy consumption by as much as 60%.

6 Optimizing air compressors

Altogether, air compressors account for up to $3.2 billion in wasted energy costs annually in the United States, there are plenty of ways to improve the performance of compressed air systems, including leakage detection, lowering air pressure, adding improved controls and unobstructed ambient inlet air. .

7 Maintaining equipment

Regular cleaning and planned maintenance of electrical and mechanical equipment goes a long way towards optimising its performance and lifespan, which can translate to energy efficiency savings.

8 Scheduling machinery use

When possible schedule operation of certain machinery outside of peak hours. Peak hours can constitute up to 30% of a manufacturing facilities monthly utility bill.

9 Replacing outdated equipment

Improved or upgraded energy monitoring systems, equipment and motors can drastically improve efficiency. Right sizing motors to run at higher loads and efficiencies is important in gaining savings. Consider replacing failed motors with IE3 and IE4 efficiency class motors.

10 Getting everyone on board

Successful energy savings initiatives are collaborative, involve all employees and clearly communicate the real business costs and potential.

11 Applying for certification

ISO
ISO 50001

Implement an internationally accredited energy management system (EnMS) like ISO50001. Some organizations decide to adopt the standard solely for the benefits it provides. Others decide to get certified to improve corporate image and credibility among customers, clients and stakeholders

12 Conduct energy audits

It's impossible to improve your energy use if you aren't aware of the amount your company uses in each part of the production cycle. In most cases plant and energy managers are surprised by the results. These audits don't even have to be a plant wide audits, shorter internal audits of systems and processes can be equally effective.

13 Monitoring and improving

Energy efficiency doesn't stop once a company has updated its equipment and processes. It requires constant monitoring. There are always opportunities to keep improving.

UNIDO CARBON TRUST SUSTAINABLE ENERGY FOR ALL Funded by: gef

www.industrialenergyaccelerator.org

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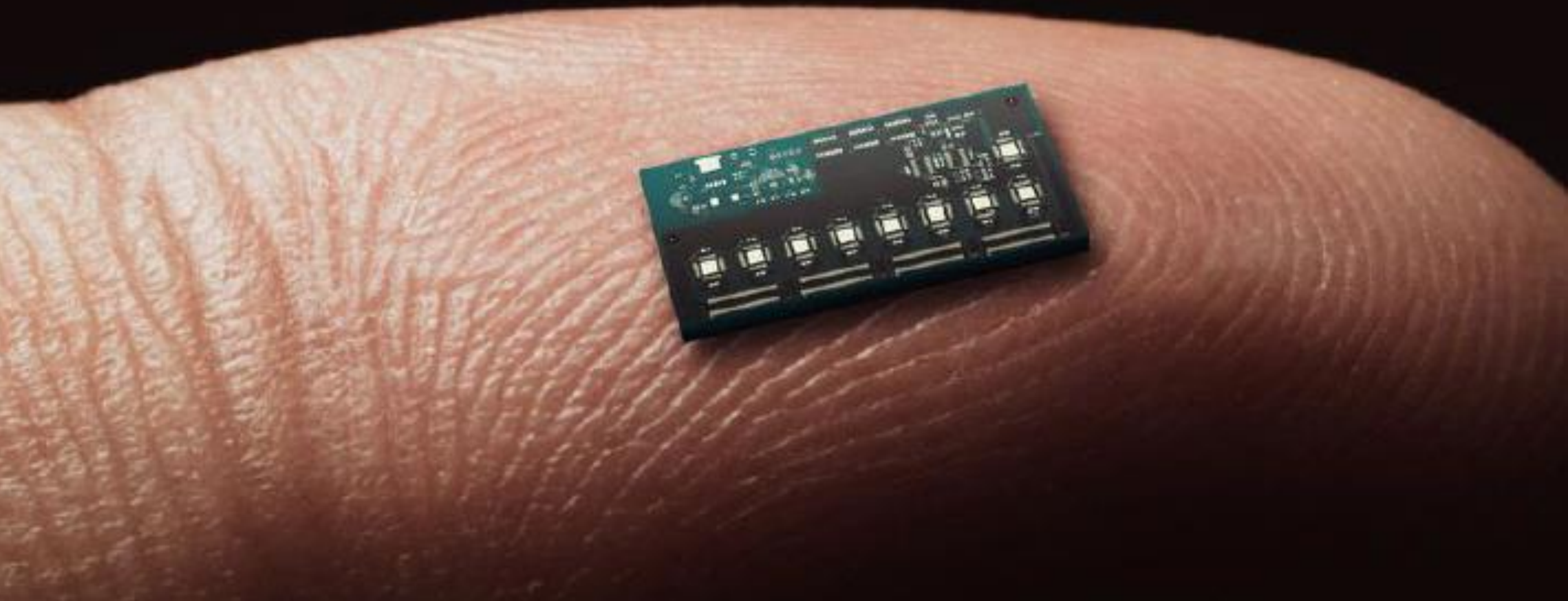
SELF-QUESTION: WHY NANO?

NANOTHINGS CAN BE RELIABLY INTEGRATED BY MNT

Specially thin films and nanowires



NANOTHINGS CAN MAKE THE DIFFERENCE: A BREAKTHROUGH?

(TRIVIAL AND NON-TRIVIAL EFFECTS)

INTERNET OF EVERYTHING
50 billion devices 2020
€4 trillion market
Human Progress
CHALLENGE: UBIQUITOUS SENSING
LOW COST MINIATURIZED SENSORS

Energy Harvesting, Low Power Consumption are the way forward for Internet of Everything (IoT)

Wearables energy harvesting has moved solidly out of lab and into the market and will be key to enabling the Internet of Everything's and the wearable technology boom.

Among many other sectors, smart cities, manufacturing 4.0, the health control and medicine of the future as well as safety systems are requiring of these developments for achieving energy autonomous sensor systems and an ubiquitous sensor technology

bottom-up approach for power management & communications

top-down approach for low energy sensor consumption & energy storage

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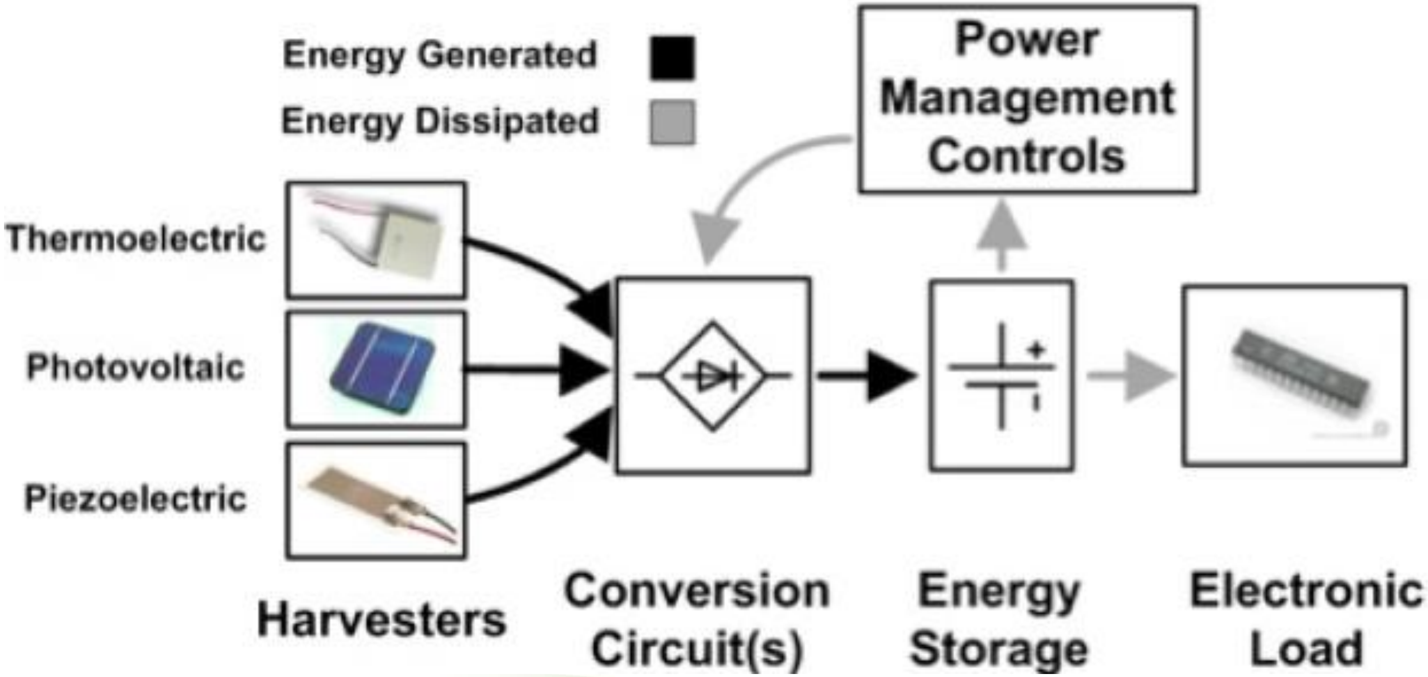
The Building Blocks of an Energy Harvesting System

The process of energy harvesting takes different forms based on the source, amount, and type of energy being converted to electrical energy.

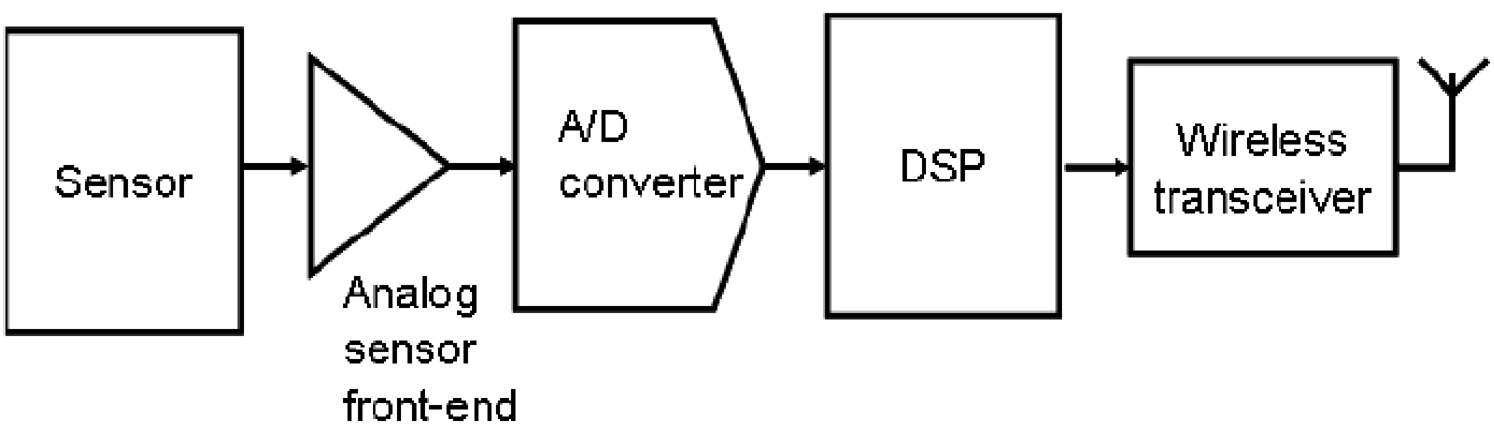
In its simplest form, the energy harvesting system requires a source of energy such as heat, light, or vibration, and the following three key components.



Transducer/harvester: This is the energy harvester that collects and converts the energy from the source into electrical energy. Typical transducers include photovoltaic for light, thermoelectric for heat, inductive for magnetic, RF for radio frequency, and piezoelectric for vibrations/kinetic energy.

Energy storage: Such as a battery or super capacitor.

Power management: This conditions the electrical energy into a suitable form for the application. Typical conditioners include regulators and complex control circuits that can manage the power, based on power needs and the available power.



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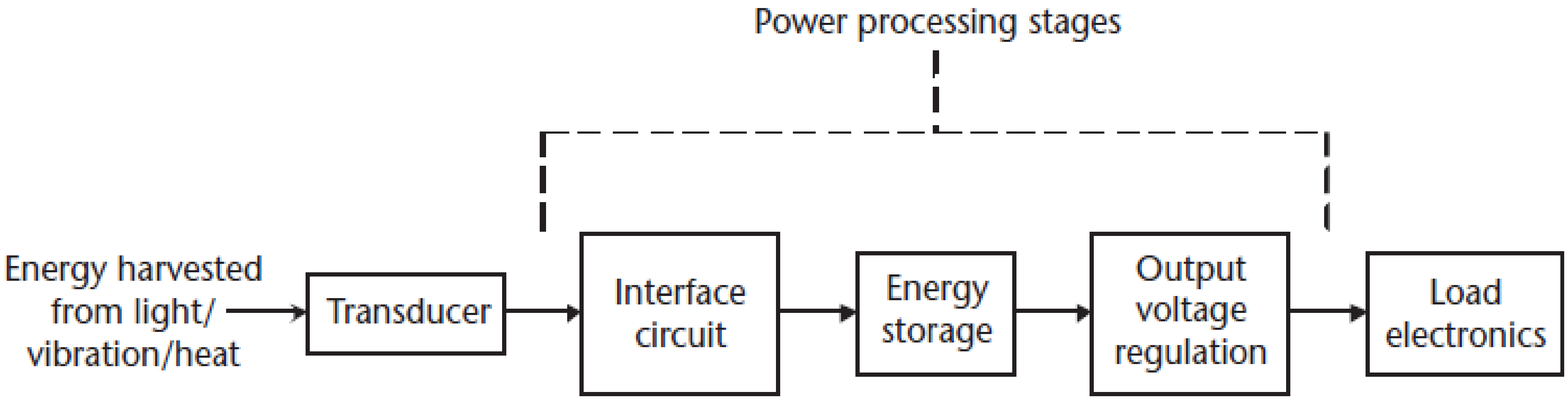
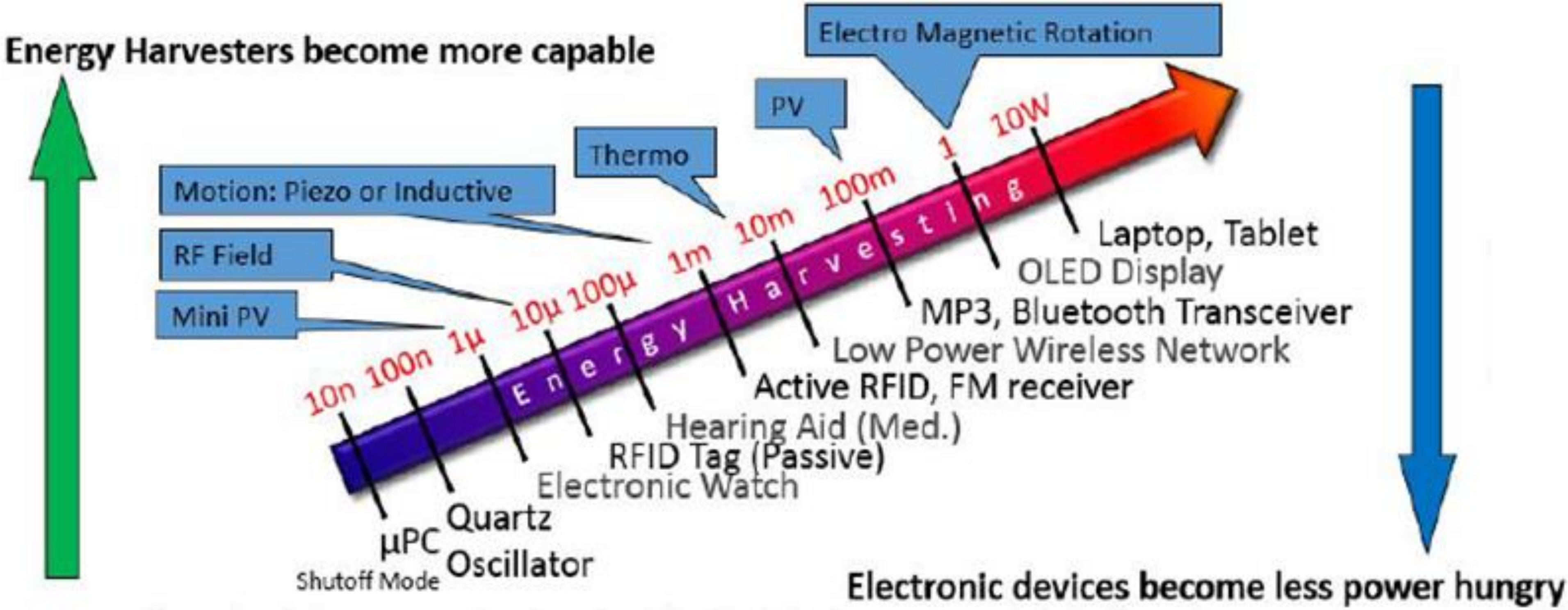
Light energy: From sunlight or artificial light.
Kinetic energy: From vibration, mechanical stress or strain fluid flow.
Thermal energy: Waste energy from heaters, friction, engines, furnaces, etc.
RF energy: From RF signals
Chemical energy: chemical gradients, salinity gradients,…



Energy Harvesting (EH)

- **Typical Energy Harvester Output Power**
  - RF: 0.1μW/cm²
  - Vibration: 1nW/cm²
  - Thermal: 10mW/cm²
  - Photovoltaic: 100mW/cm²

- **Typical Energy Harvester Voltages**
  - RF: 0.01mV
  - Vibration: 0.1 ~ 0.4 V
  - Thermal: 0.02 ~ 1.0 V
  - Photovoltaic: 0.5 ~ 0.7 V typ./cell



Source		Source Characteristics	Physical Efficiency	Harvested Power
Photovoltaic				
Office		0.1mW/ cm^2	10-24%	10 µW/cm^2
Outdoor		100mW/ cm^2		10mW/ cm^2
Vibration/Motion				
Human		0.5m@1Hz 1m/s^2@50Hz	max power is source dependent	4 µW/ cm^2
Industry		1m@5Hz 10m/s^2@1kHz		100 µW/ cm^2
Thermal Energy				
Human		20mW/ cm^2	0.10%	25 µW/ cm^2
Industry		100 mW/ cm^2	3%	1-10mW/ cm^2
RF (EM Energy)				
GSM	900MHz	0.3-0.03 µW/ cm^2	50%	0.1 µW/ cm^2
	1800MHz	0.1-0.01 µW/ cm^2		

Estimated power output values per harvesting principle at the state of the art

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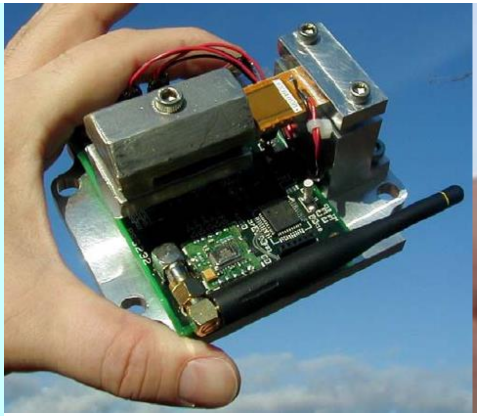
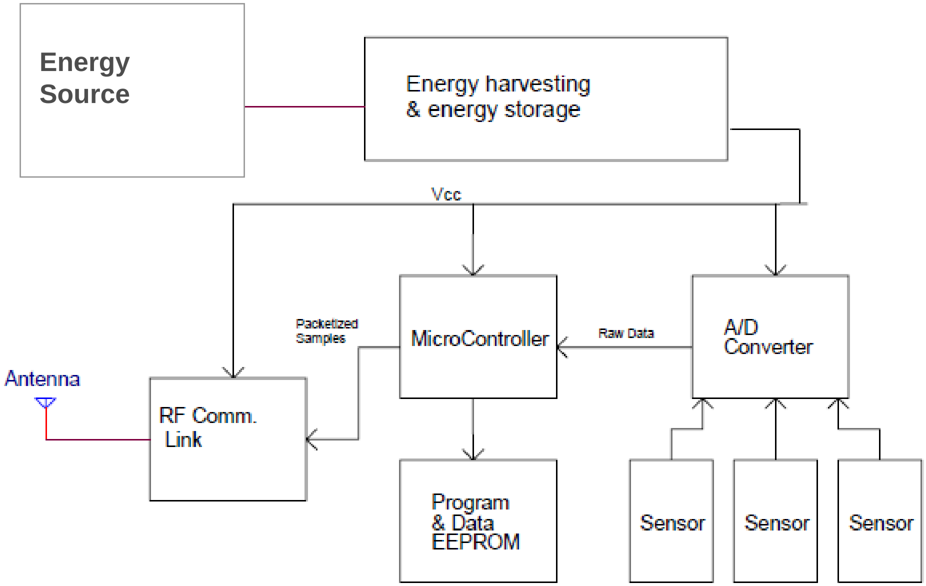
Portable and fully autonomous sensors

Energy Source Harvested Power
Vibration/Motion (frequency, amplitude)
Human 4 μW/cm2
Industry 100 μW/cm2
Temperature Difference (Th. gradients)
Human 25 μW/cm2
Industry 1–10 mW/cm2
Light (PV cell efficiency)
Indoor 10 μW/cm2
Outdoor 10 mW/cm2
RF (allowed bands)
GSM 0.1 μW/cm2
WiFi 0.001 μW/cm2





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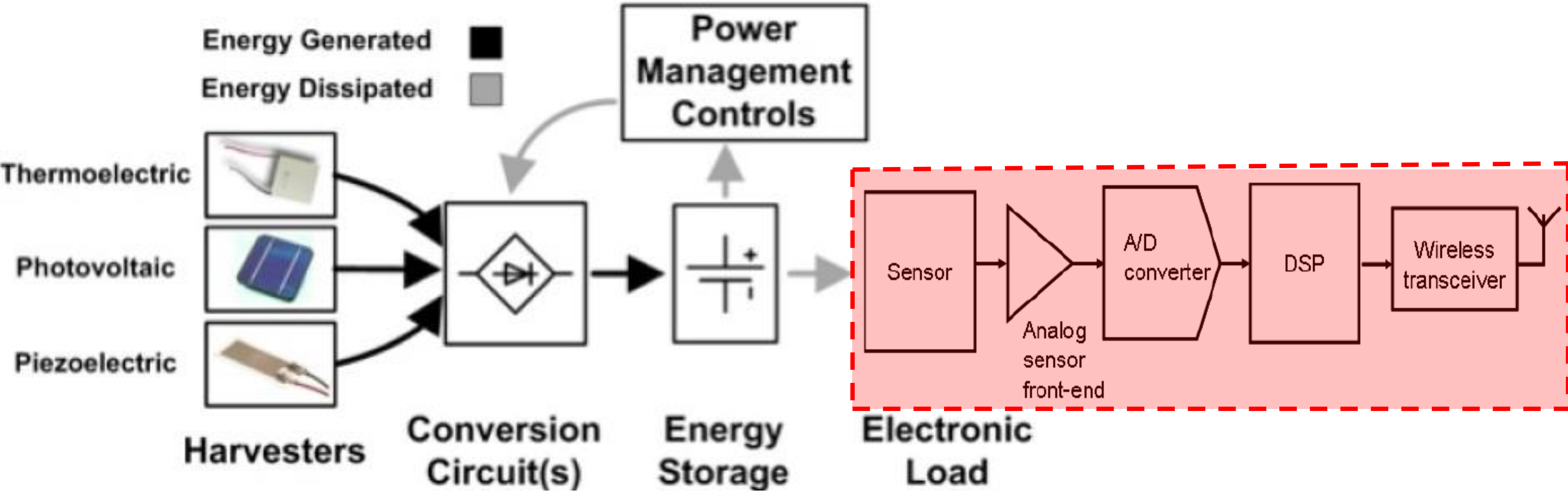

Harvesting types: Energy Balances

bottom-up approach for power management & communications

top-down approach for low energy sensor consumption & energy storage

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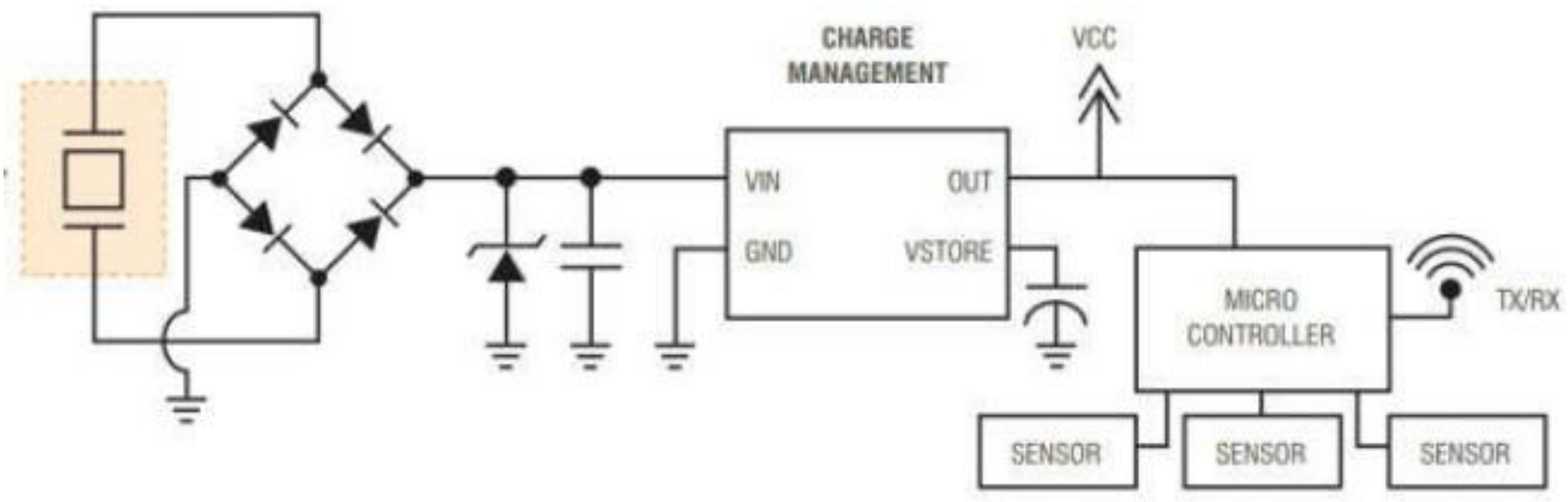
Harvesting Kinetic Energy

Piezoelectric transducers produce electricity when subjected to kinetic energy from vibrations, movements, and sounds such as those from heat waves or motor bearing noise from aircraft wings and other sources. The transducer converts the kinetic energy from vibrations into an AC output voltage which is then rectified, regulated, and stored in a thin film battery or a super capacitor.



Potential sources of kinetic energy include motion generated by humans, acoustic noise, and low-frequency vibrations. Some practical examples are:

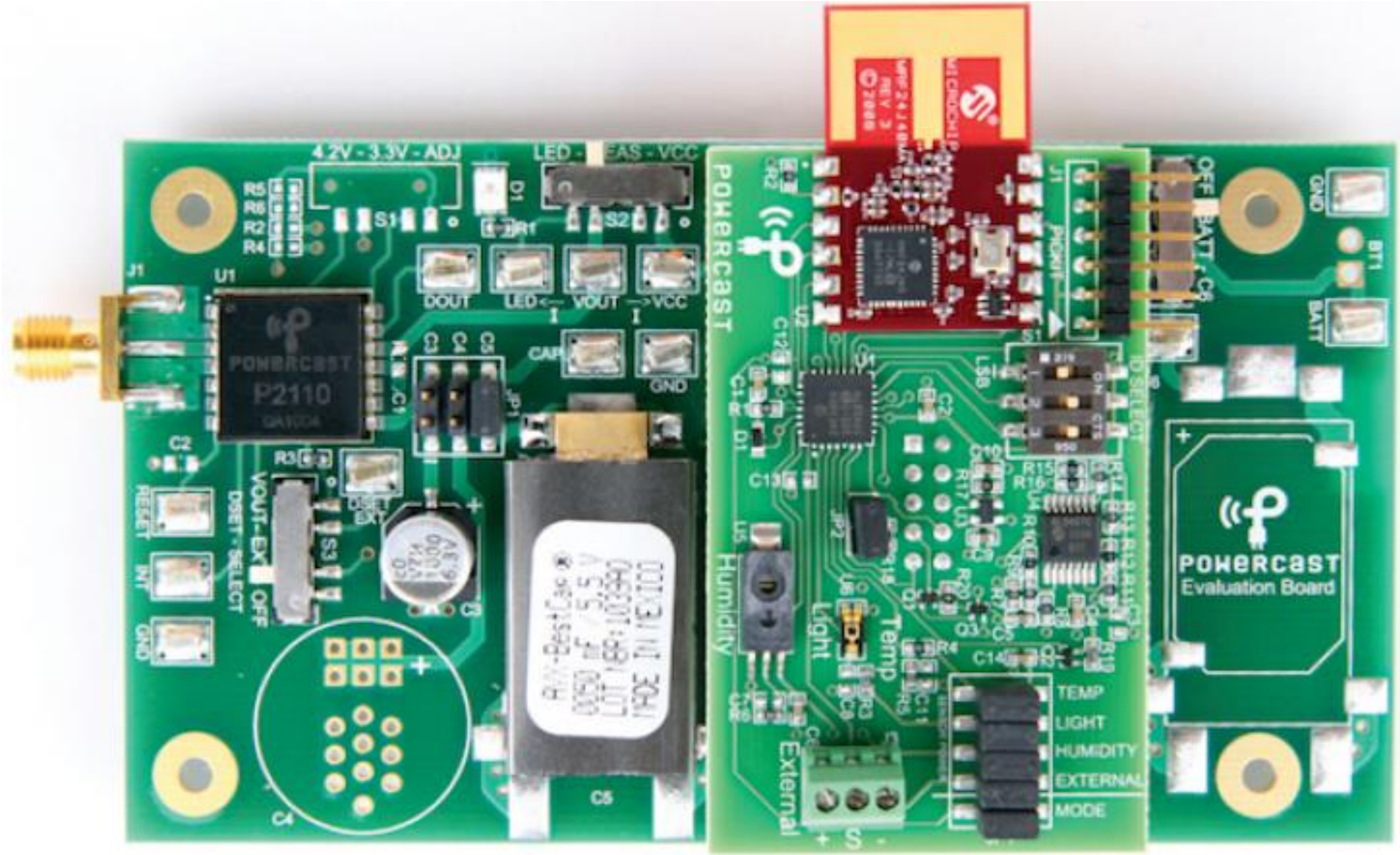
A batteryless remote control unit: Power is harvested from the force that one uses in pressing the button. The harvested energy is enough to power the low-power circuit and transmit the infrared or wireless radio signal.

Pressure sensors for car tires: Piezoelectric energy harvesting sensors are put inside the car tire where they monitor pressure and transmit the information to the dashboard for the driver to see.

Piezoelectric floor tiles: Kinetic energy from people walking on the floor is converted to electrical power that can be used for essential services such as display systems, emergency lighting, powering ticket gates, and more.

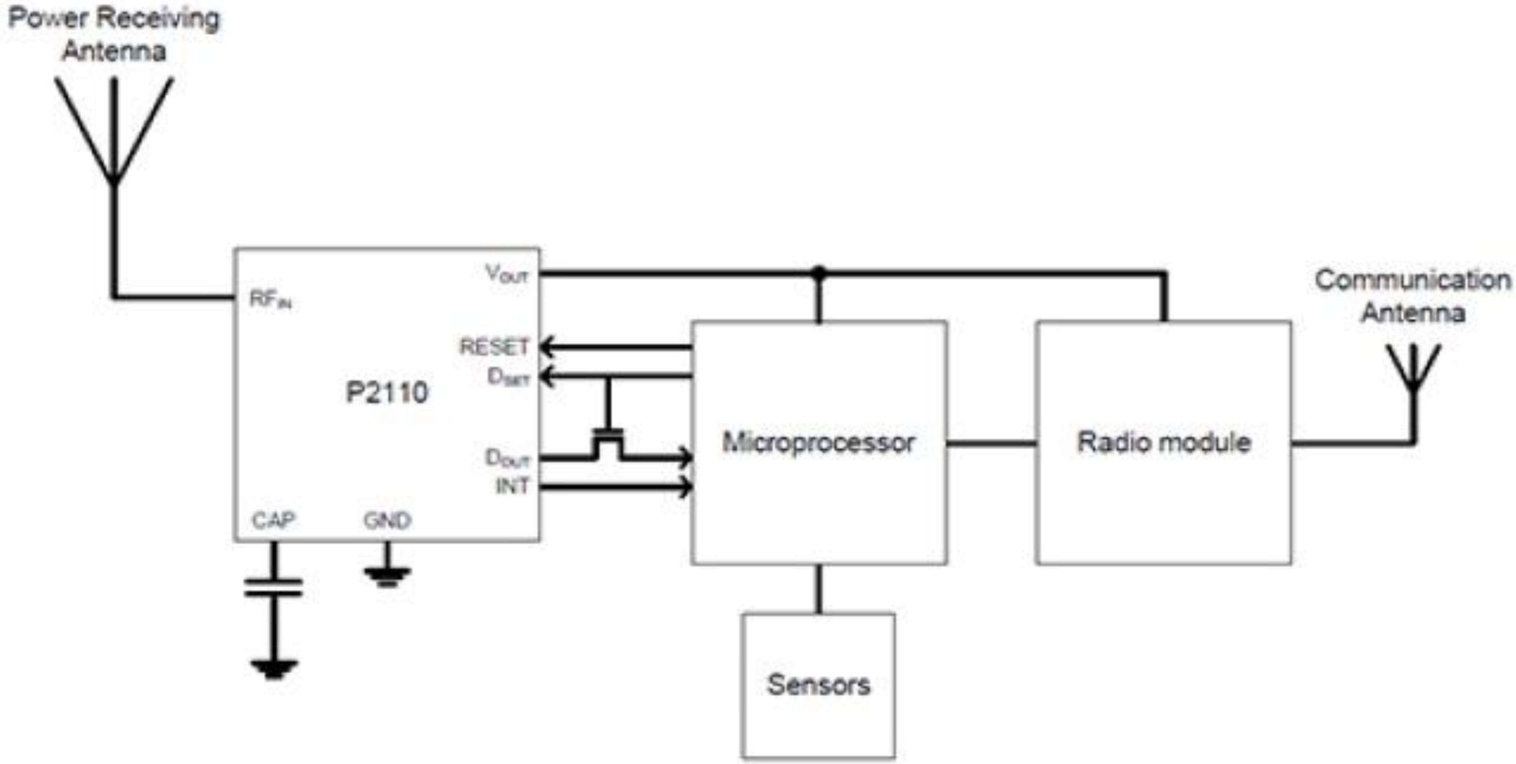
Harvesting RF Energy (waves)

In this arrangement, an RF power receiving antenna collects the RF energy signal and feeds it to an RF transducer such as the Powercast's P2110 RF Powerharvester.



A P2110 Power harvester receiver evaluation board.
Image courtesy of Nuts and Volts
(http://www.nutsvolts.com/uploads/magazine_downloads/pdf/rf_energy_harvester.pdf)

The Powerharvester converts the low-frequency RF signal to a DC voltage of 5.25V, capable of delivering up to 50mA current.
It is possible to make a completely battery-free wireless sensor node by combining sensors, the P2110, a radio module, and a low-power MCU.
Typical applications for these types of sensors include building automation, smart grid, defense, industrial monitoring, and more.



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Powercast P2110 RF energy harvesting for a batteryless wireless sensor. Image courtesy of Powercast (http://www.powercastco.com/test566alpha/wpcontent/uploads/2009/03/p2110-datasheet-rev-b.pdf)

Harvesting Solar Energy (photons)

Small solar cells are used in industrial and consumer applications such as satellites, portable power supplies, street lights, toys, calculators, and more. These utilize a small photovoltaic cell which converts light to electrical energy. For indoor applications, light is usually not very strong and typical intensity is about 10 μW/cm^2.

The power from an indoor energy harvesting system thus depends on the size of the solar module as well as the intensity or spectral composition of the light.

Due to the intermittent nature of light, power from solar cells is usually used to charge a battery or supercapacitor to ensure a stable supply to the application.

Harvesting Thermal Energy (phonons)

Thermoelectric energy harvesters rely on the Seebeck effect in which voltage is produced by the temperature difference at the junction of two dissimilar conductors or semiconductors. The energy harvesting system consists of a thermoelectric generator (TEG) made up of an array of thermocouples that are connected in series to a common source of heat.

Typical sources include water heaters, an engine, the back of a solar panel, the space between a power component such as a transistor and its heat sink, etc. The amount of energy depends on the temperature difference, as well as the physical size of the TEG.

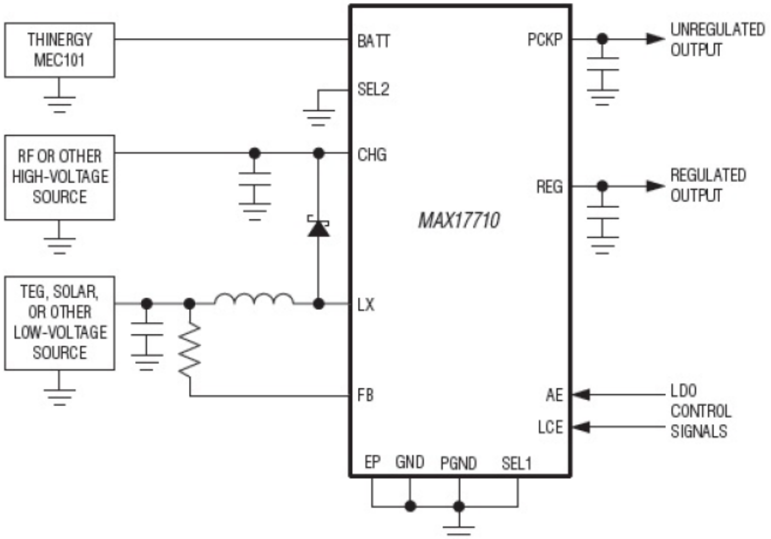
The TEGs are useful in recycling energy that would otherwise have been lost as heat. Typical applications include powering wireless sensor nodes in industrial heating systems and other high-temperature environments.

(http://thermoelectrics.caltech.edu/thermoelectrics/history.html)

Harvesting Energy from Multiple Sources

Manufacturers such as Maxim, Texas Instruments, and Ambient Micro have developed some integrated circuits with the ability to simultaneously capture different types of energy from multiple sources. Combining multiple sources has the benefit of maximizing the peak energy as well as providing energy even when some sources are unavailable.

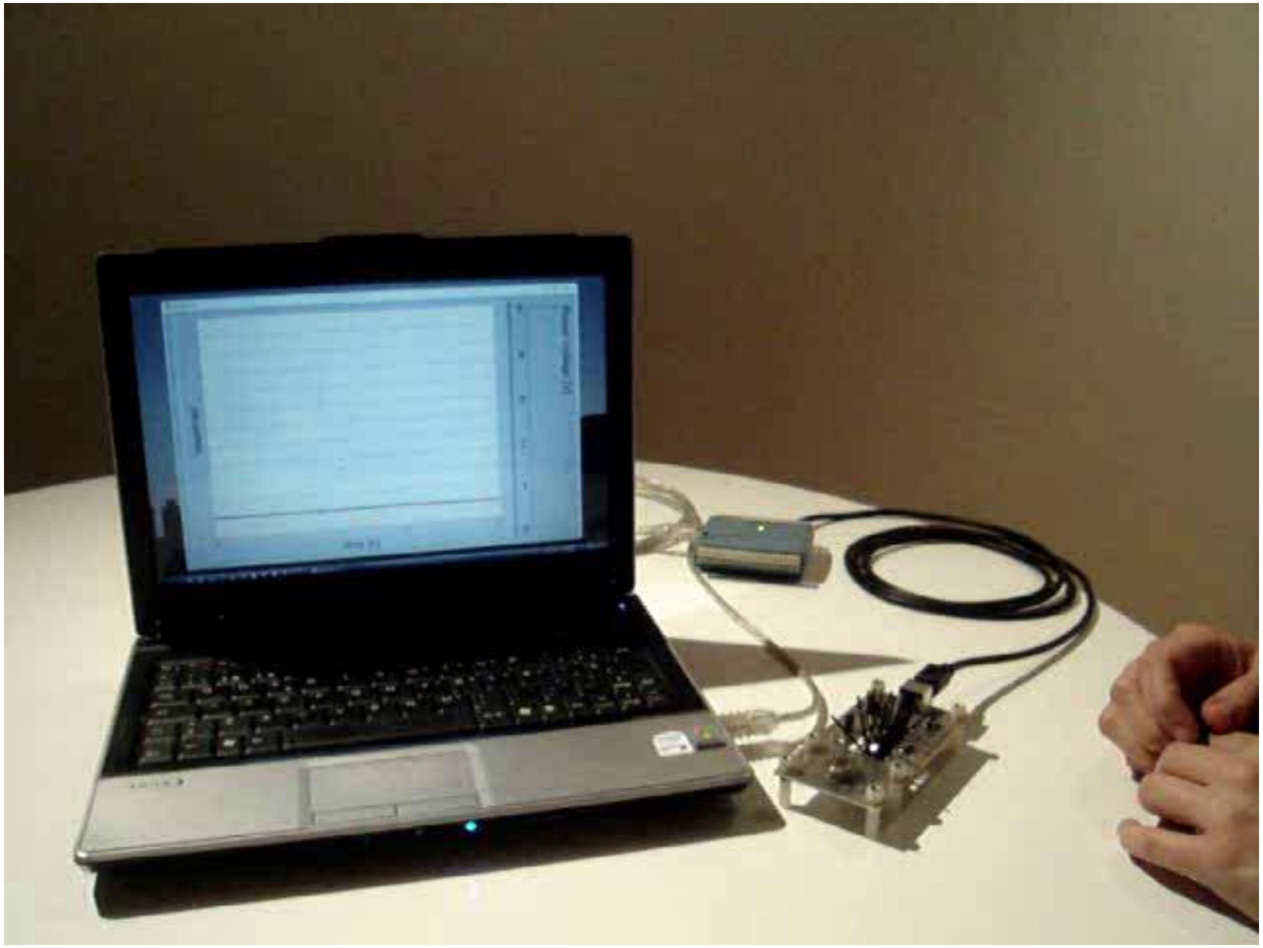
An example of a circuit that harvests energy from multiple sources is as shown below:



Maxim Integrated MAX17710 multiple source circuit . Image courtesy of Maxim Integrated

https://www.maximintegrated.com/en/images/qv/7183.gif.

Fully autonomous system



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