Industry Session 5: Energy Harvesting

Challenges and solutions for implementing Energy Harvesting powered solutions

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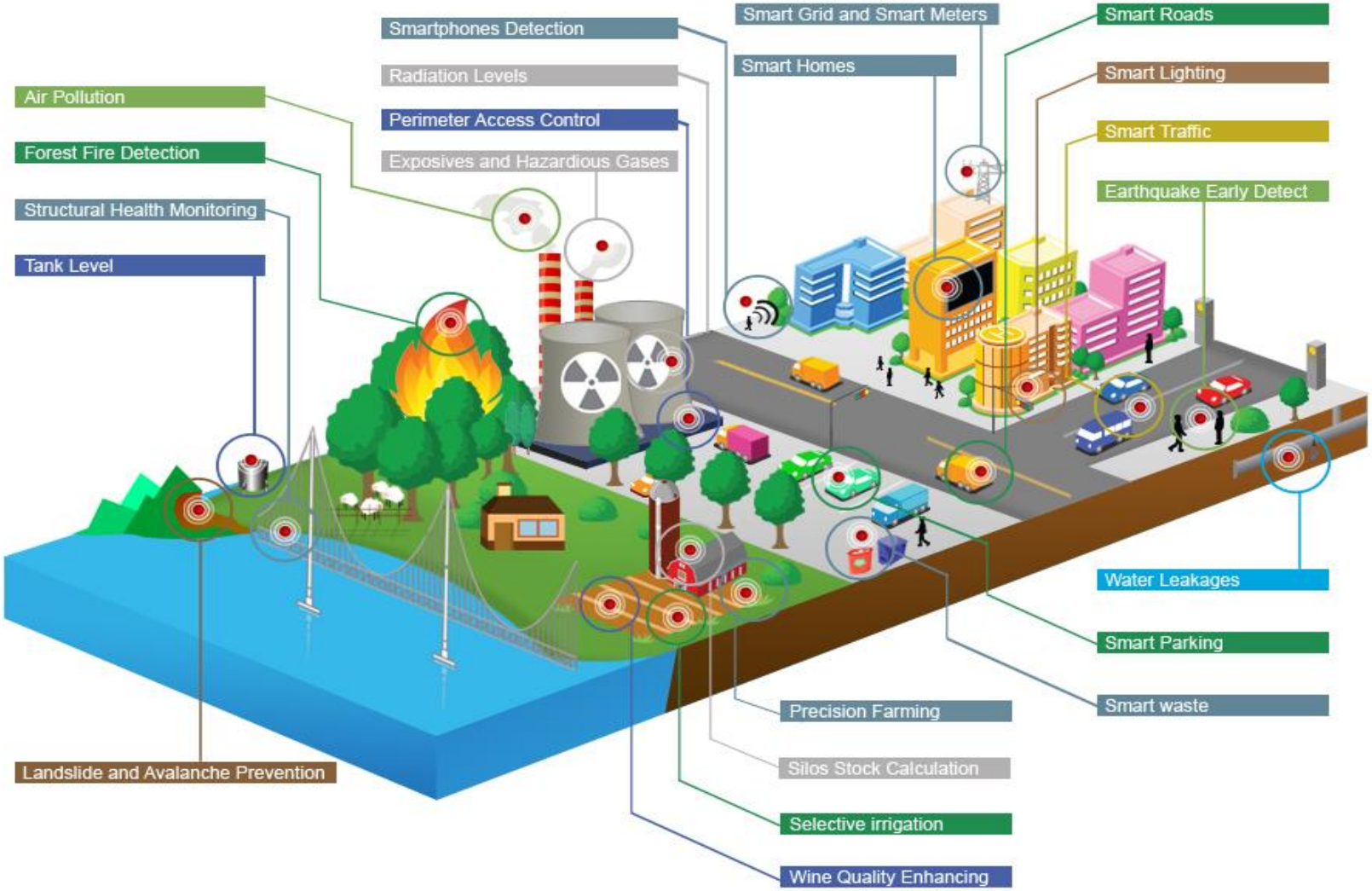
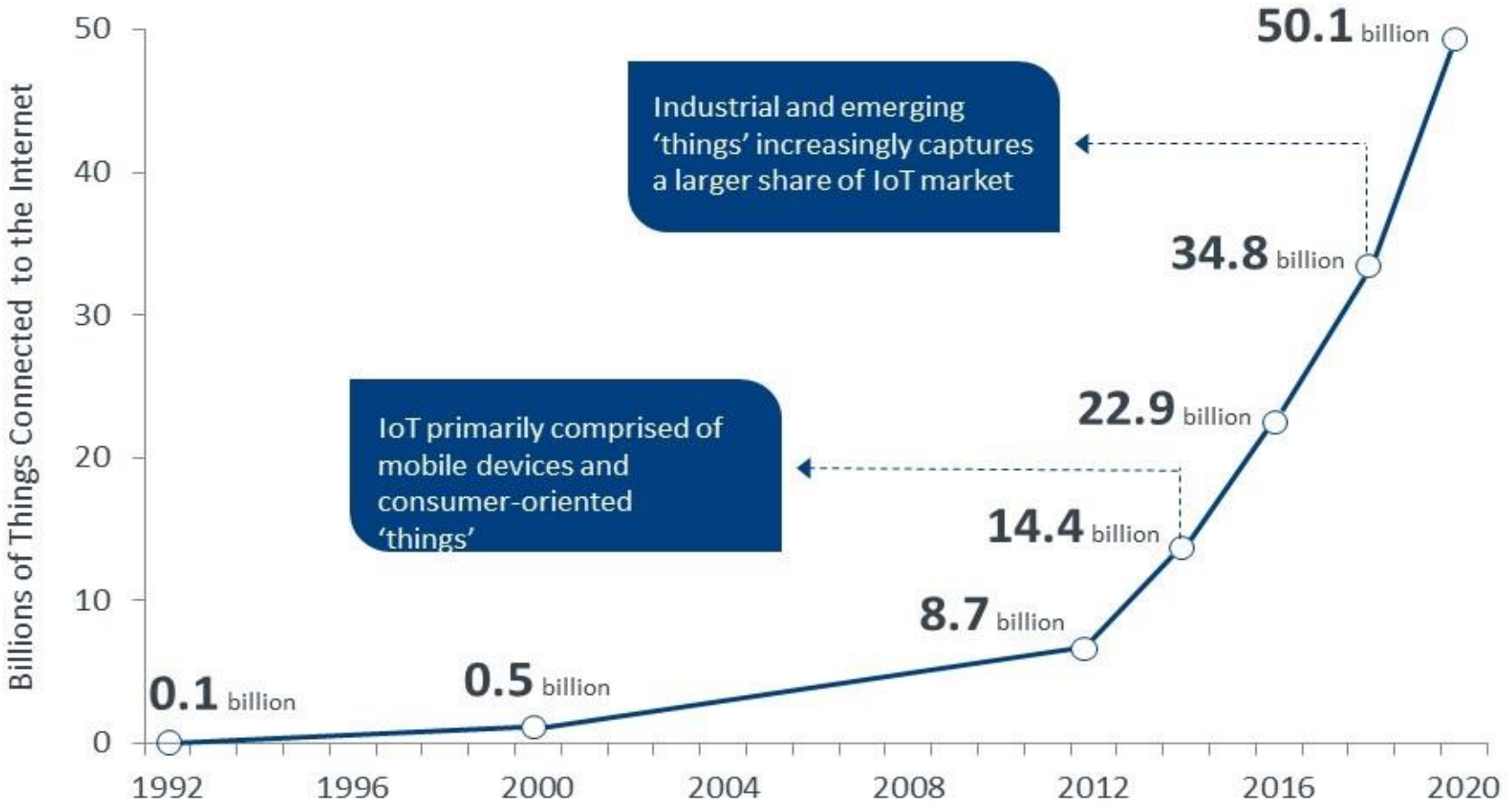
Letantos Smart World



Projecting the 'Things' Behind the Internet of Things

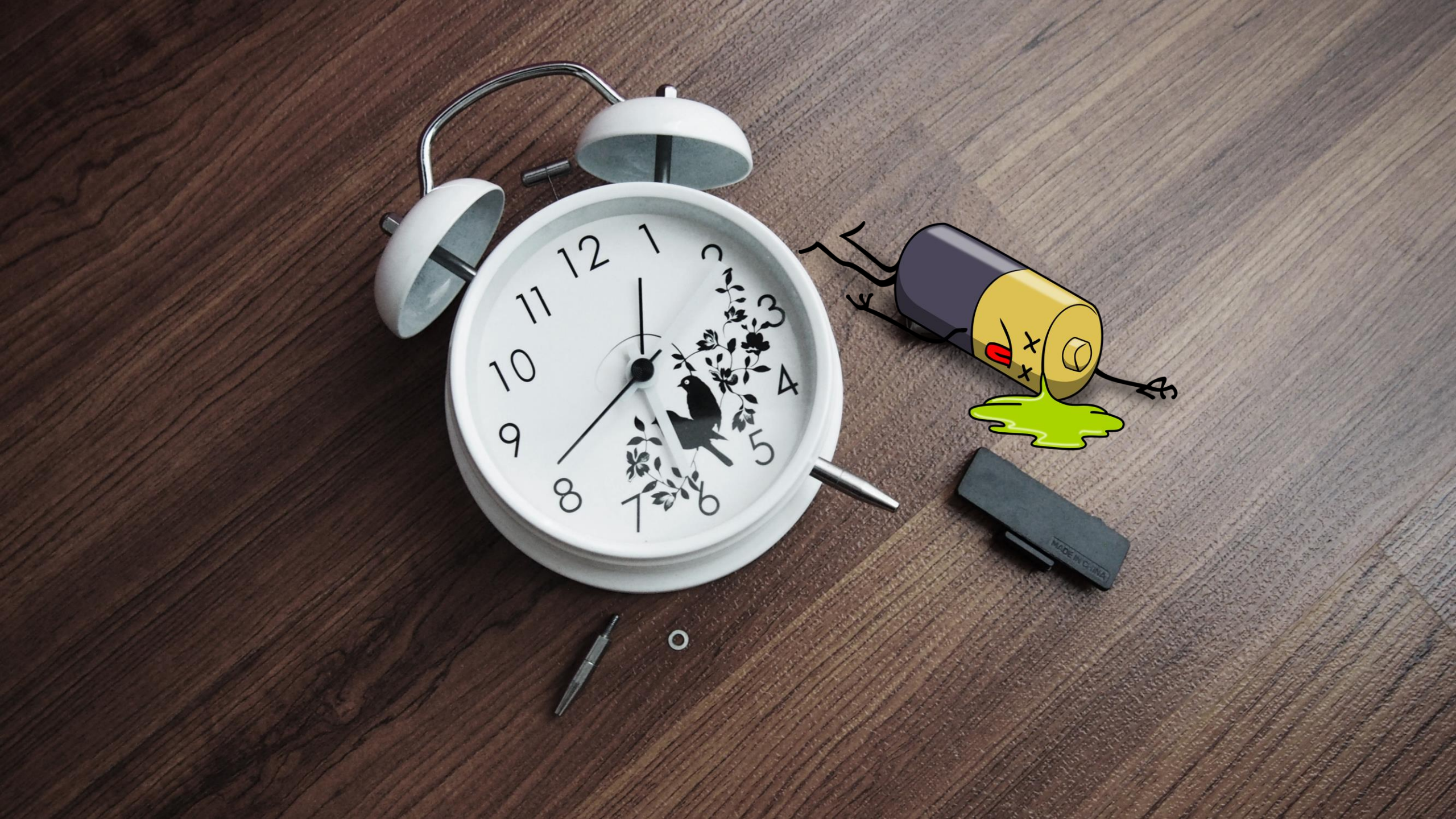
From 2014-2020, IoT grows at an annual compound rate of 23.1% CAGR



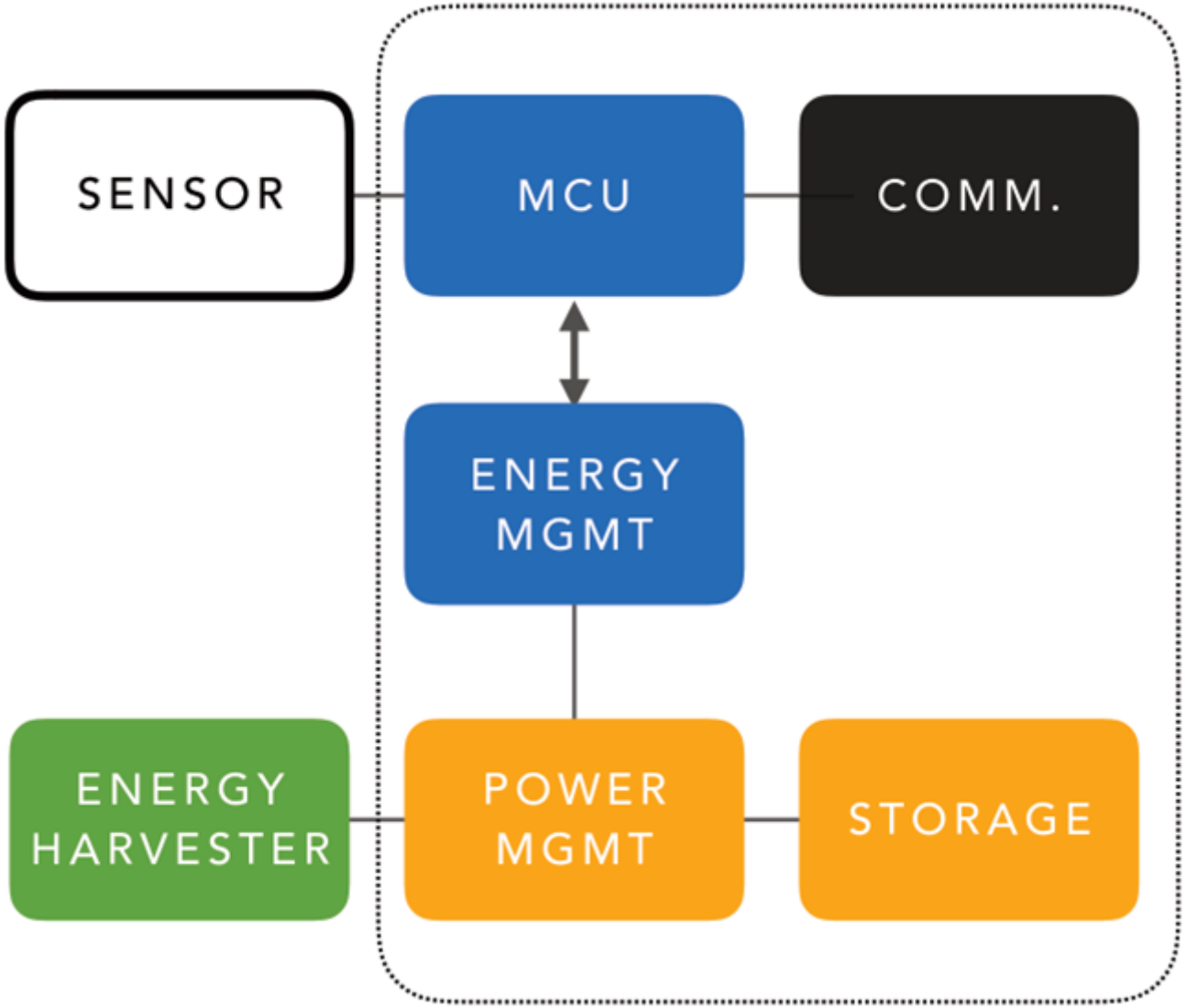
CompTIA

Sources: Group SJR | Cisco | CompTIA


3 000 000 000
yearly in US alone


MADE IN CHINA

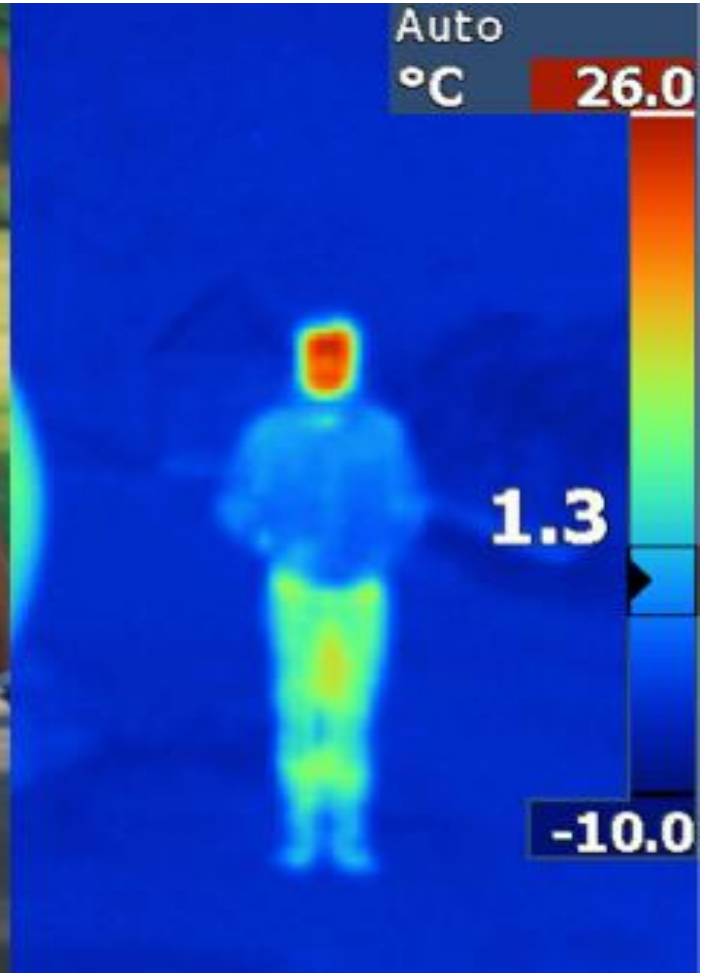
Wireless sensor node components



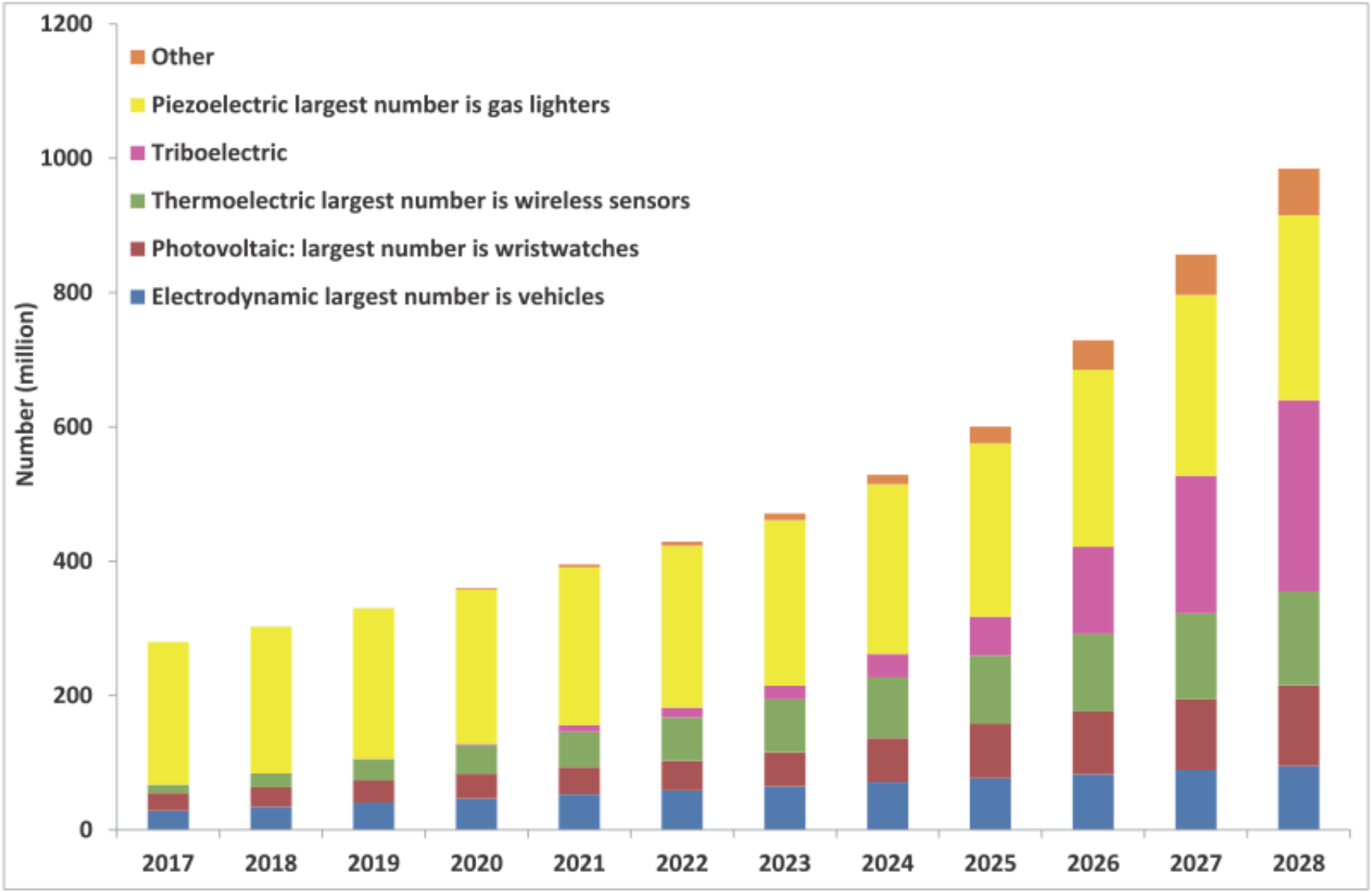
What are the challenges

- How much energy is there?
- Only EH or battery extension or only battery?
- How to interface the EH source?
- Selecting the intermittent storage
- Energy aware system or not?

EH sources

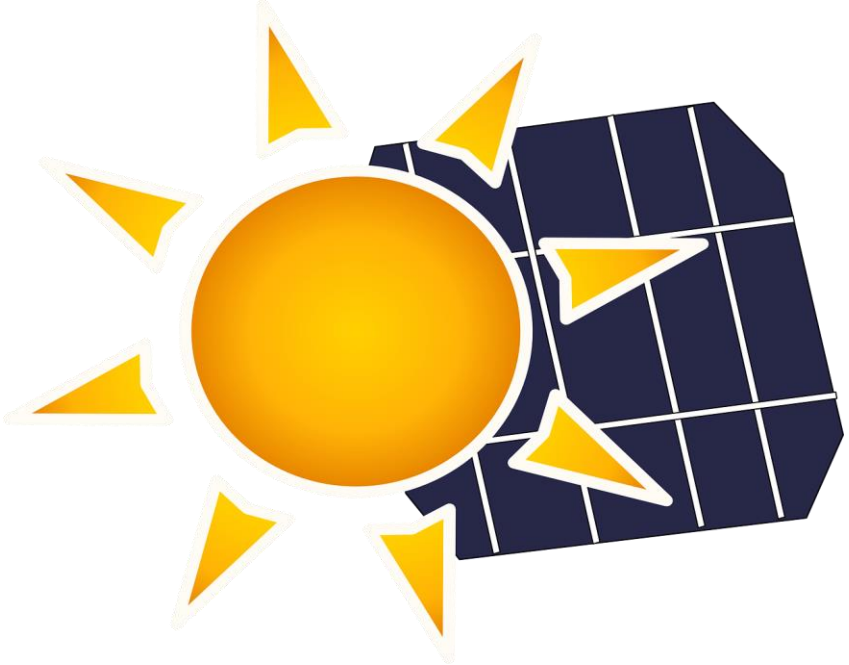


Energy Generation Side Effects



IDTechEx research reports:
Battery Elimination in Electronics and Electrical Engineering 2018-2028
Energy Harvesting: Off-Grid Microwatt to Megawatt 2017-2027

How much energy is there



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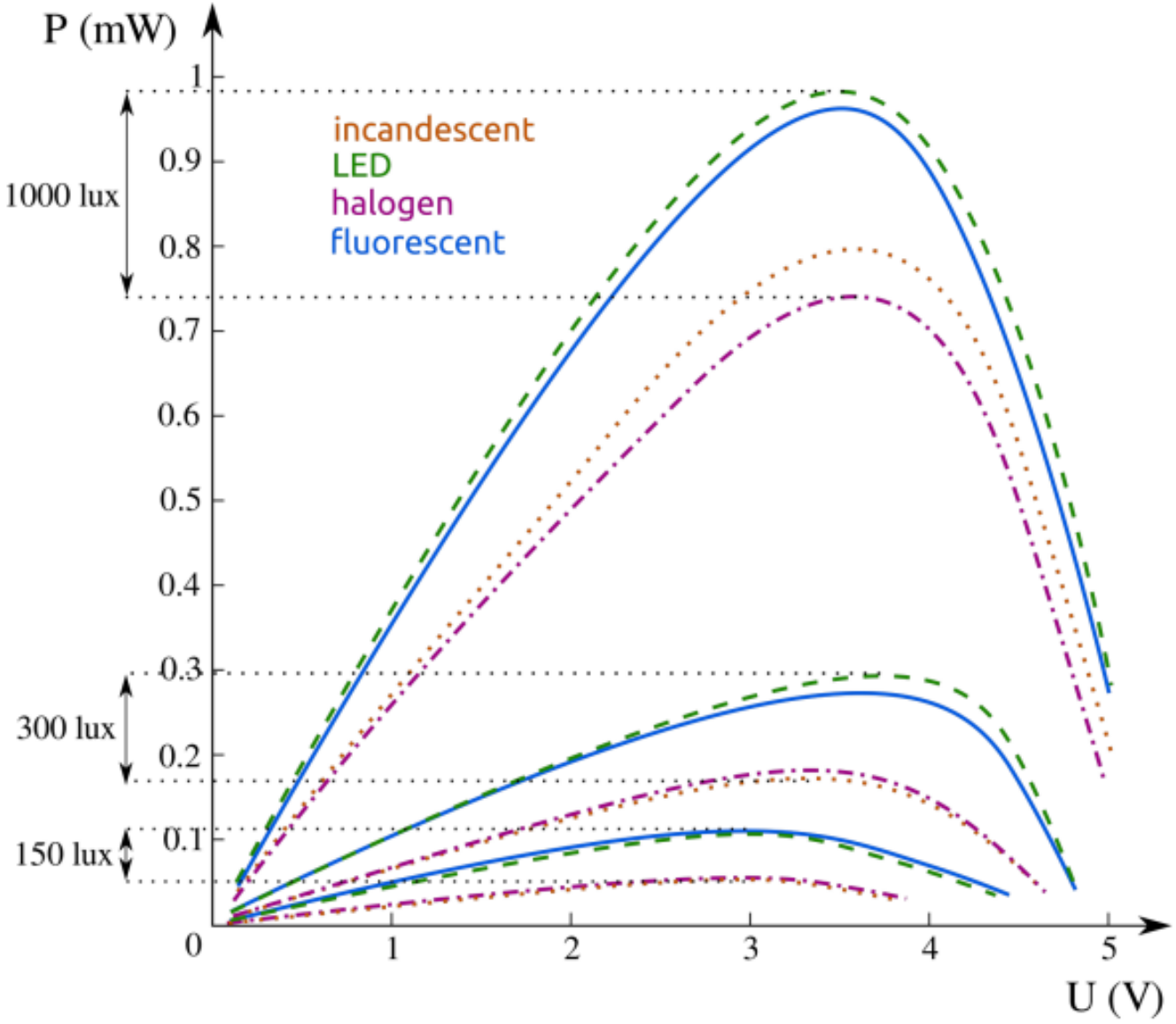
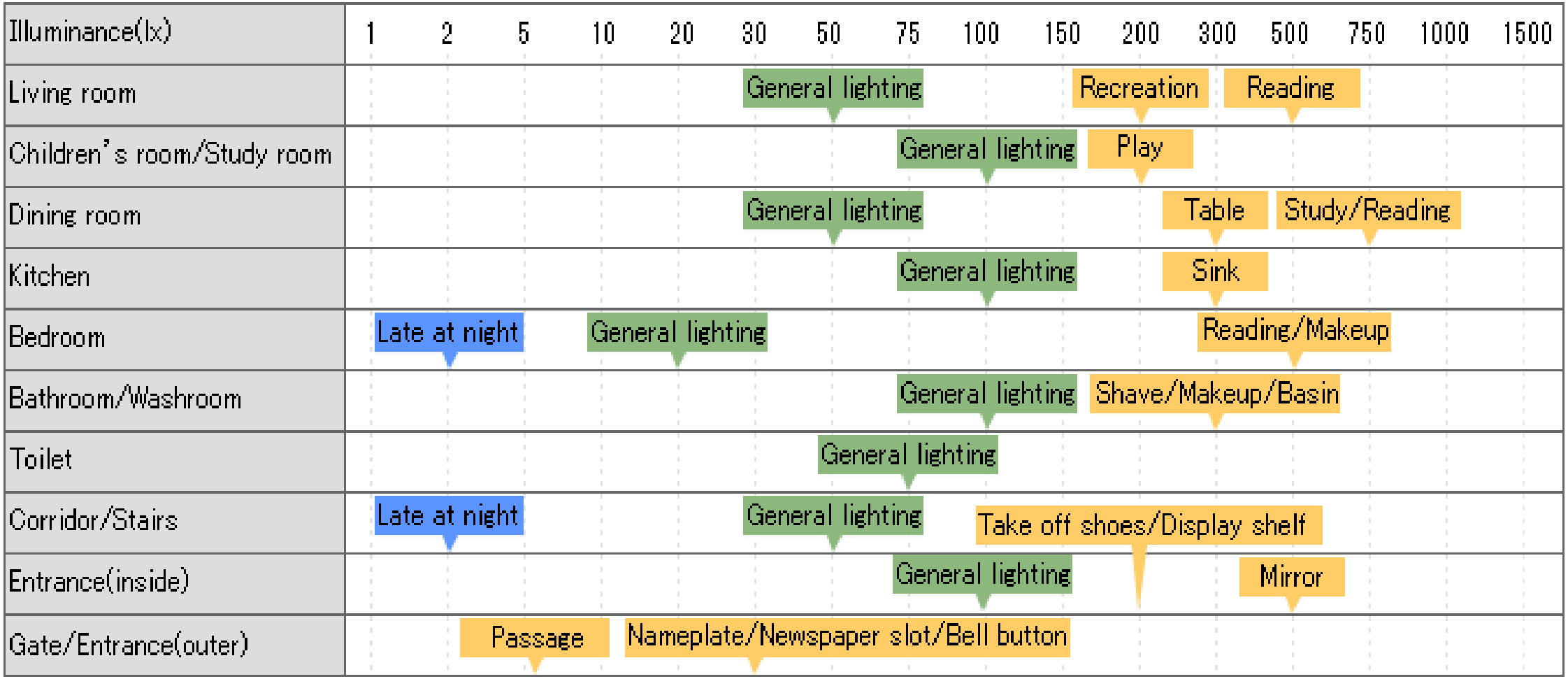
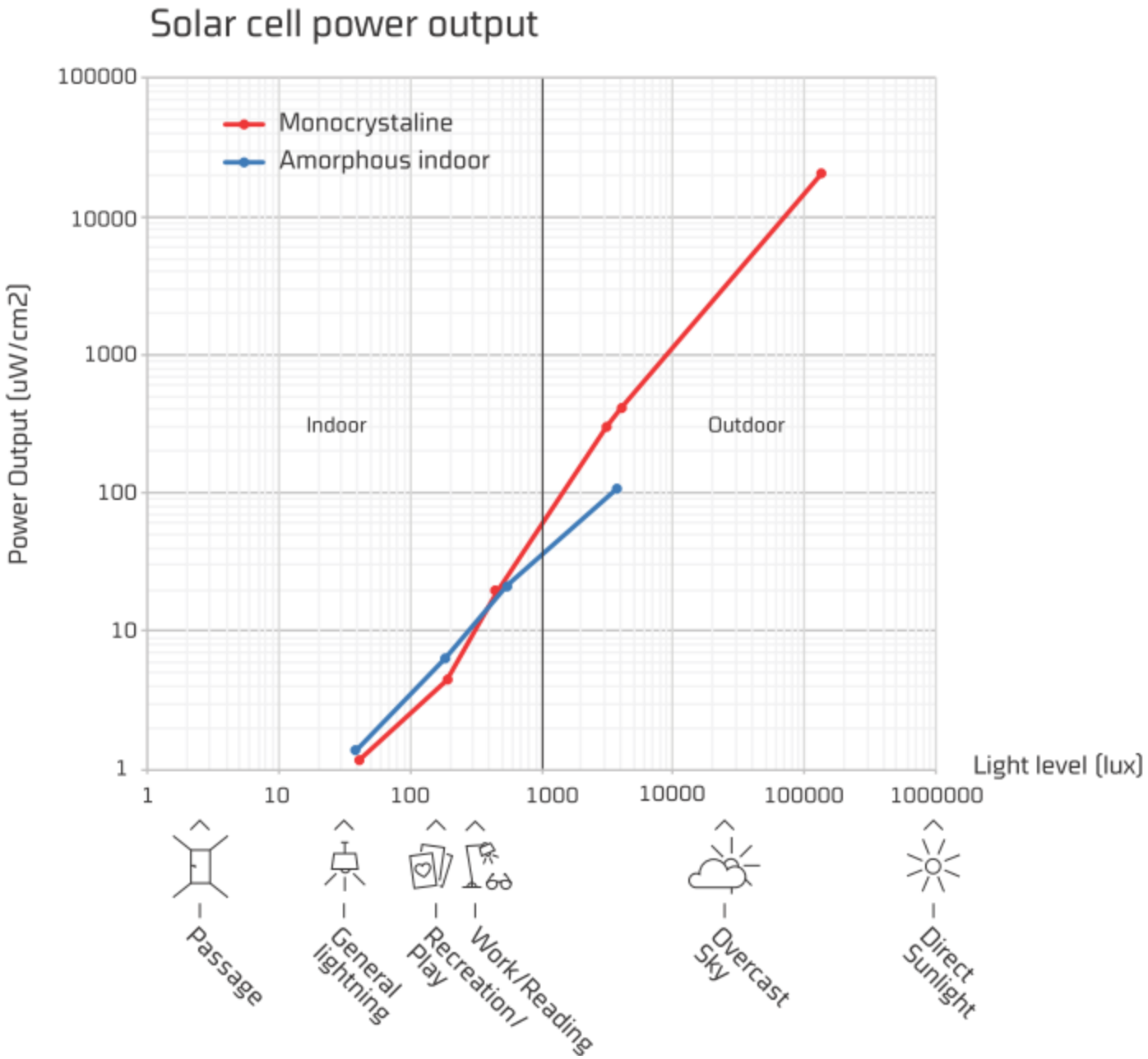
Panasonic AM-1815CA

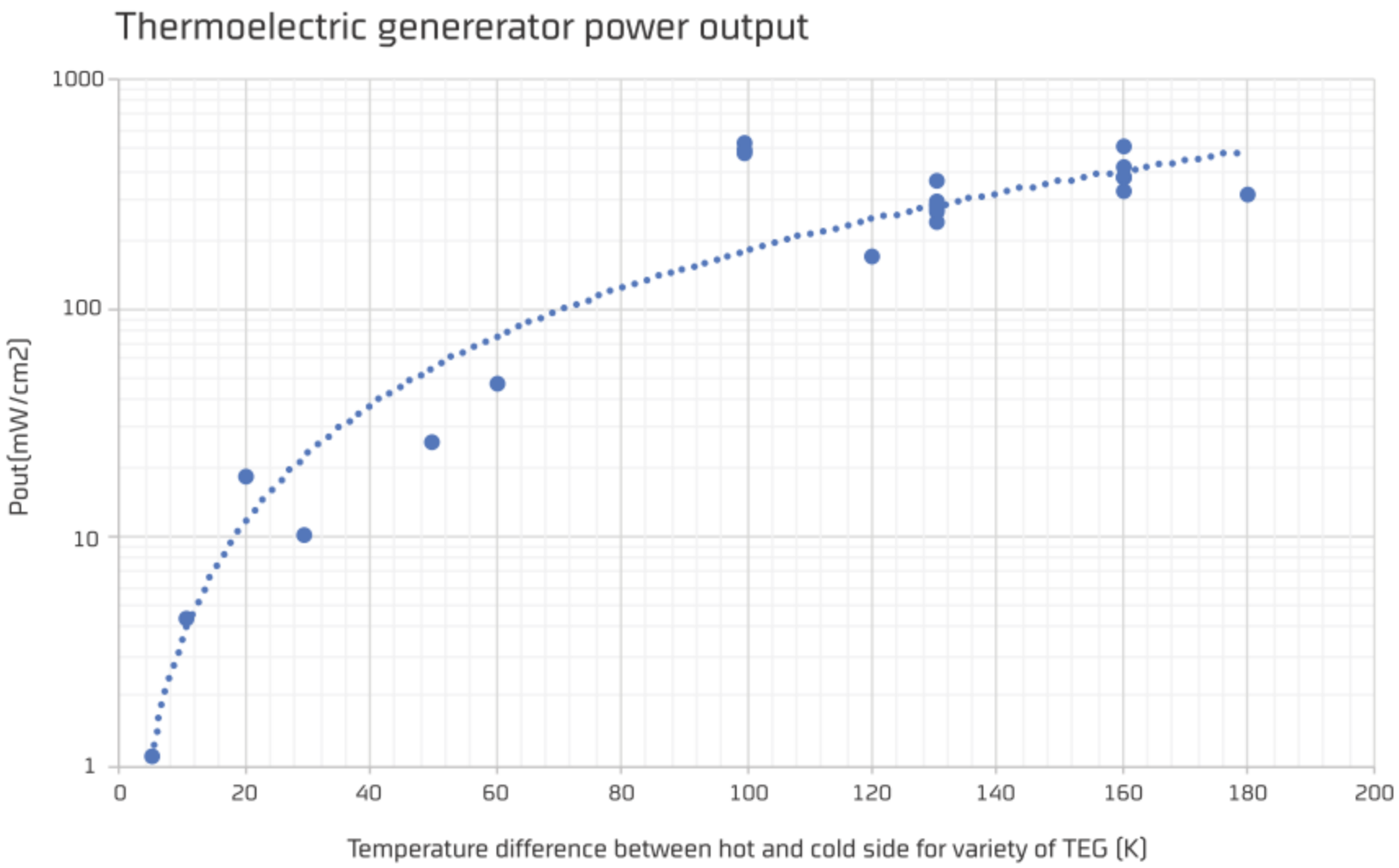


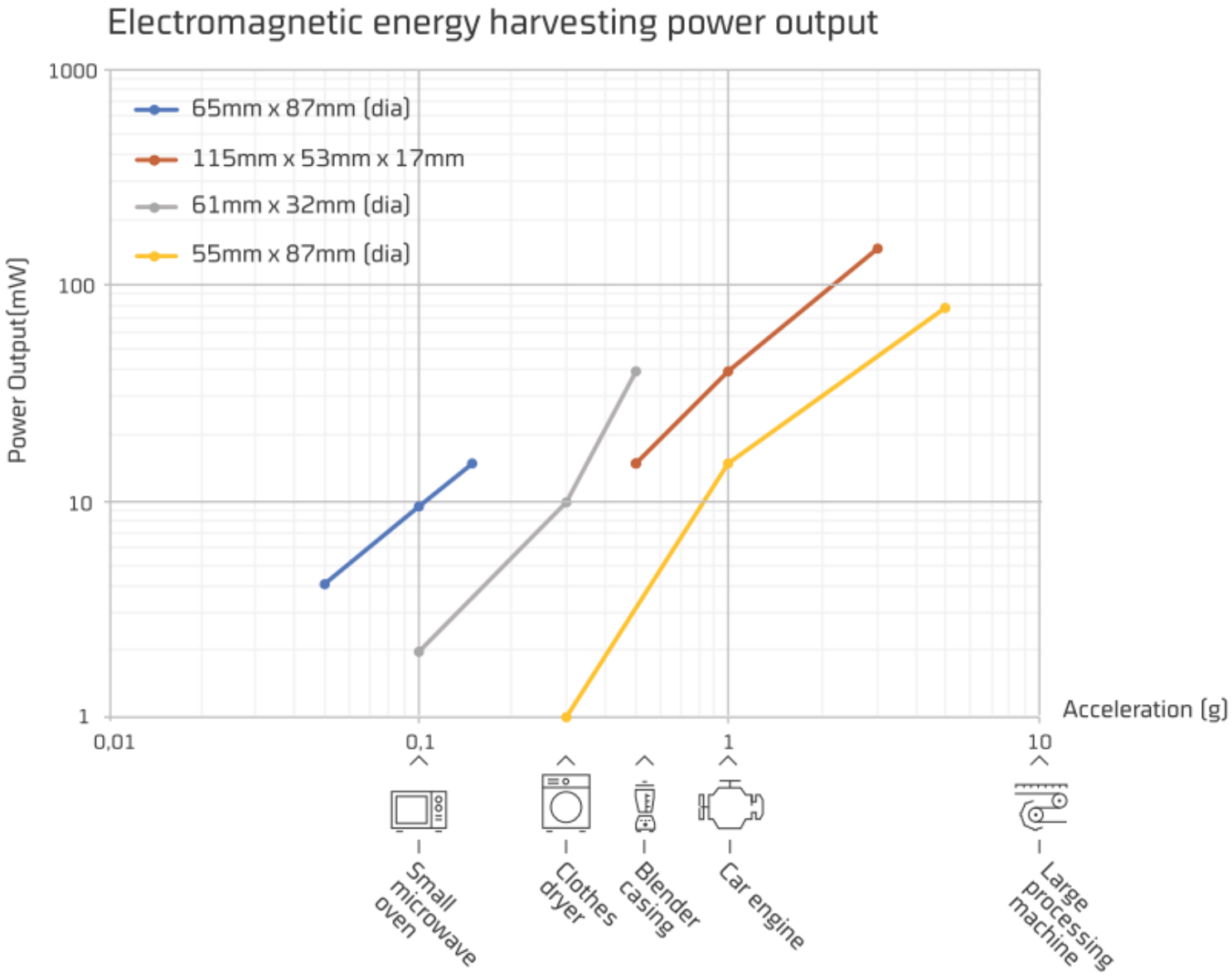


The standard for brightness is the average illuminance of the floor surface as recommended in JIS Z9110-2010

https://panasonic.net/ecosolutions/lighting/technology/knowledge/03/



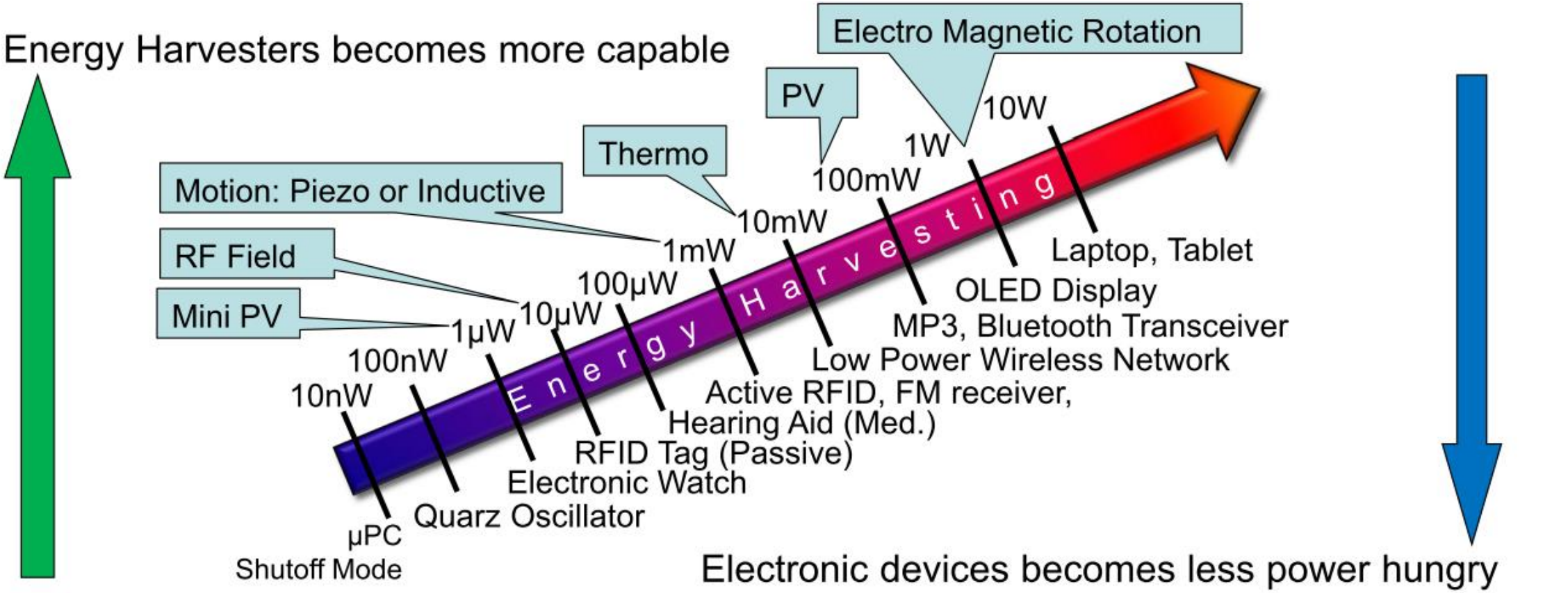




Power requirements

- Application average power consumption
- Application surge current consumption
- Application operating voltage – primarily sensor and actuator driving

Power requirements

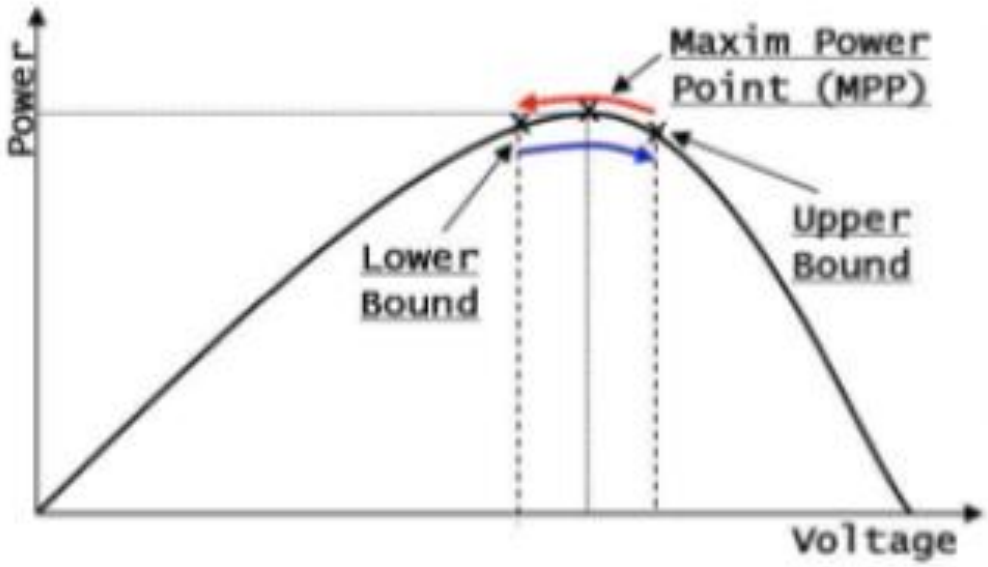


Energy Harvester Output

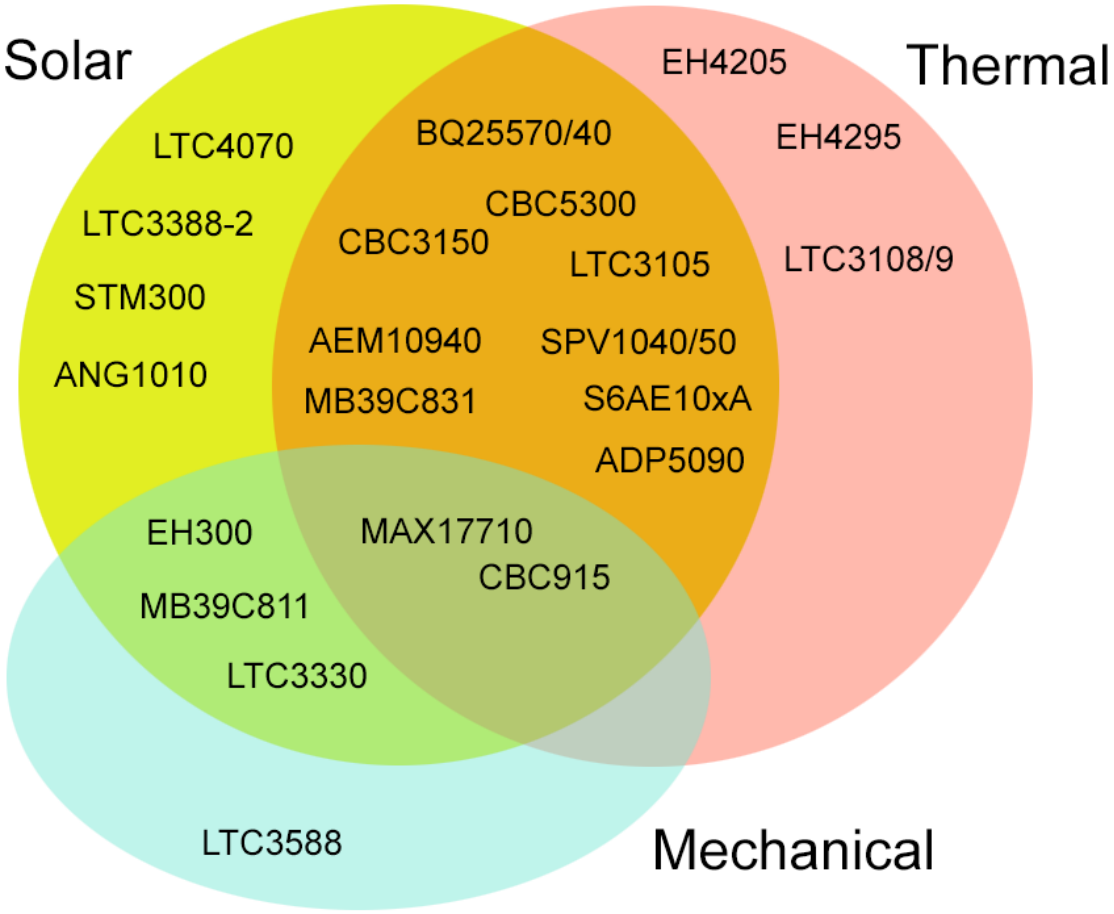
- Typical EH source outputs
- Ambient RF – 0.01V; low impedance
- Thermal – 0.01 - 1.0V+; low impedance
- Electromagnetic – 0.3 – 5V+; low to medium impedance
- Piezoelectric – 10sV; high impedance
- Photovoltaic – 0.5V/cell; medium impedance

Optimal Energy Extraction From a Harvester

- Maximizing power output
- Pros:
  - more power available
- Cons:
  - more complex system
  - costs energy to run



Dedicated EH Power Management



Example systems

Cold Start Issues

- Charging Large Capacitors
- Overloading the Source

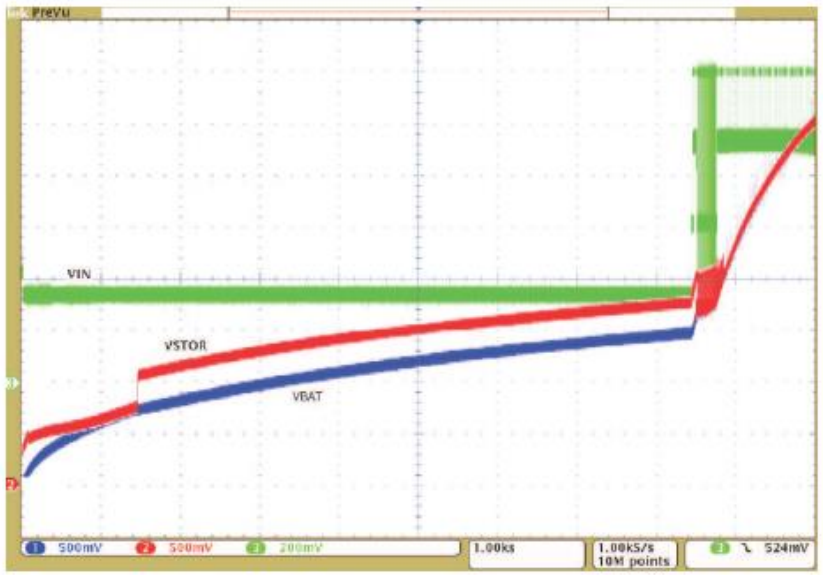


Figure 38. Charging a Super Cap on VBAT

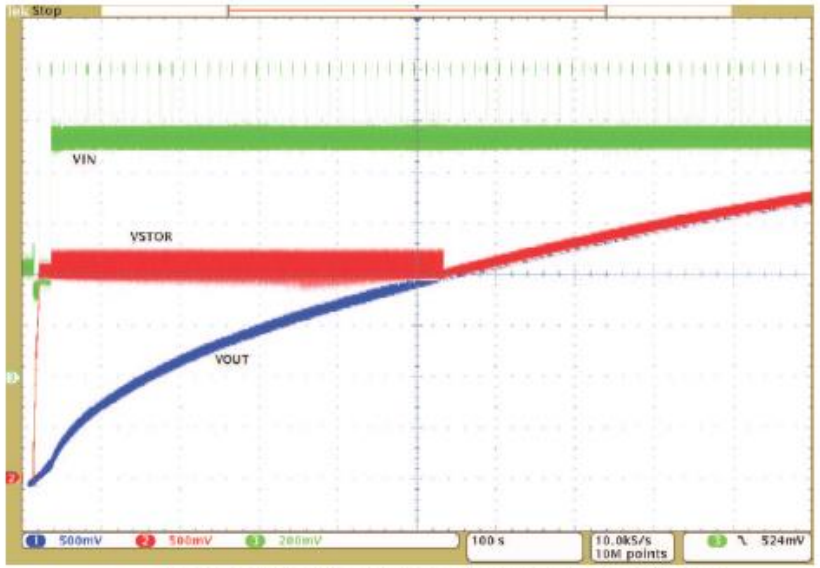


Figure 39. Charging a Super Cap on VOUT

Example from BQ25570 Datasheet

Intermittent Energy Storage

EH output typically cannot directly drive the application

- What is the average power consumption required?
- What are the voltages required?
- What is the peak current consumption?
- What is the expected lifetime of the system?
- Is safety an issue?
- Is size an issue?

Intermittent storage selection

Question	Requirement	Recommendation
Is the peak current consumption high	Yes	Supercapacitor
	No	Battery/Supercapacitor
Is the leakage current a problem	Yes	Battery
	No	Supercapacitor
Is the size an issue	Yes	Battery
	No	Supercapacitor
Lifetime (Cycle count)	Long >10y (100 000+)	Supercapacitor
	Short <10-15 (~1 000 – 10 000)	Battery/Supercapacitor
Harsh environments/ Safety	Yes	Supercapacitor
	No	Battery
Energy Utilization	Higher efficiency	Battery
	Lower efficiency	Supercapacitor

Energy Awareness

- Is the EH supposed to change the battery?
- Optimize the power by allowing the application to know the power state
  - Postpone processing when there is energy
  - Remove always on components
  - Sacrifice responsiveness and precision for low power
    - MCU based power management done with 55nA budget < top of the line CTOS opamps

Example systems

Solar has been around for a while

Main benefit:

- No battery changing
- Very long lifetime

Some are good ideas but don’t survive in market

Require >100 lux in order to work -> Large cells -> Aesthetics problem

Heat Powered Valve

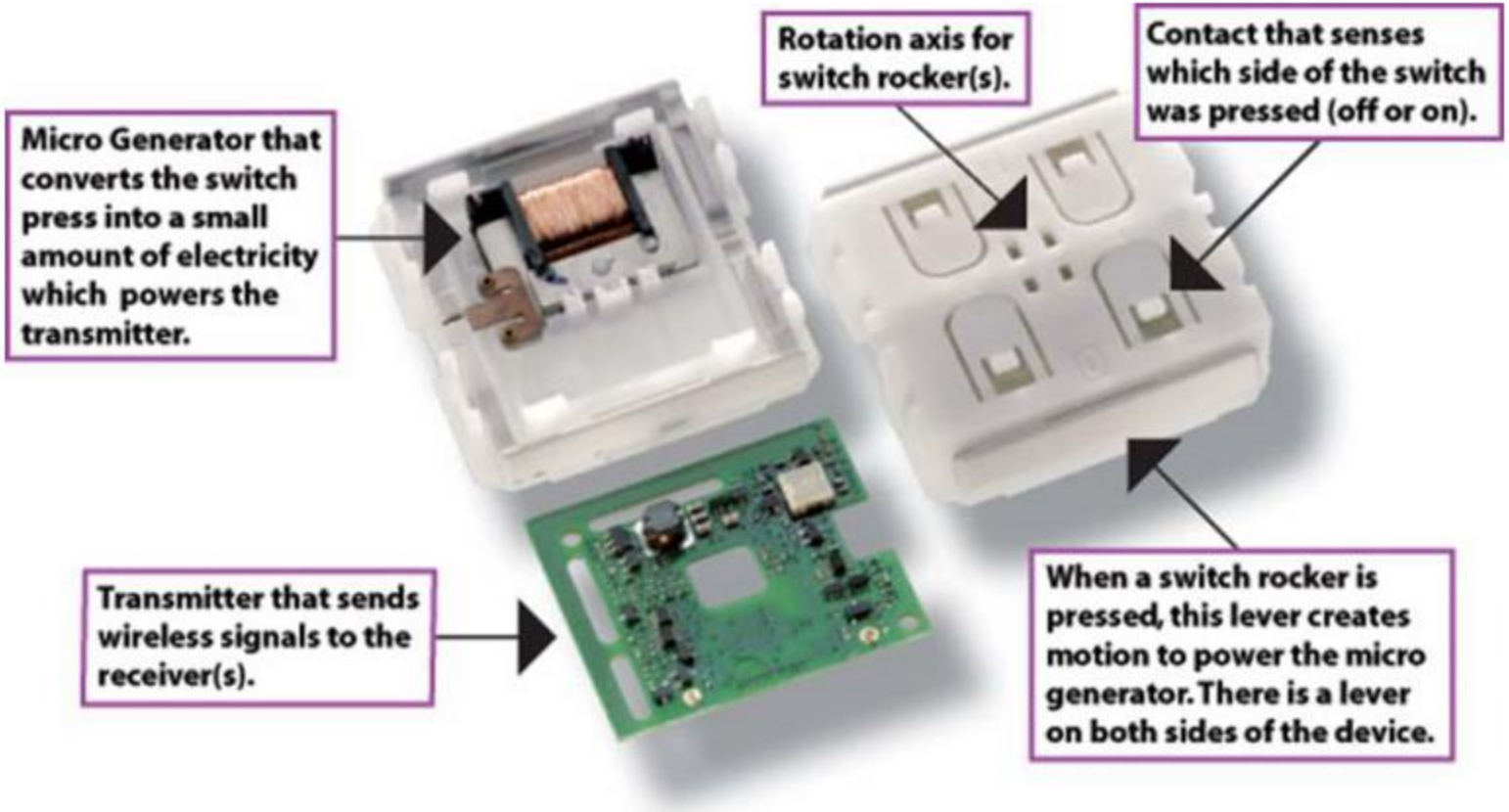
Main Benefit:
- No battery change
- Long operational time.
- A battery cannot store sufficient power for long lifetime

Source: Micropelt

Power Bus Bar Monitoring

Main Benefits:
- No battery replacement
- Elevated temperature
- Long lifetime

Self Actuated Switch



Main Benefits:
- No Battery Replacement
- Very long lifetime

Conclusions

- EH has been around for a while but not in focus
- Electronics power consumption has been reduced to the point where we can start substituting the batteries with EH
- EH is more expensive initially but can provide convenience and reduces full cost of ownership

Q & A

Thank you!