

# Photovoltaic for miniature IoT devices

***Lightricity Ltd***

***Speaker: Dr Julien Campos***

***Position: Lead Technologist***

AMANDA PROJECT

2<sup>nd</sup> Webinar

7<sup>th</sup> December 2021

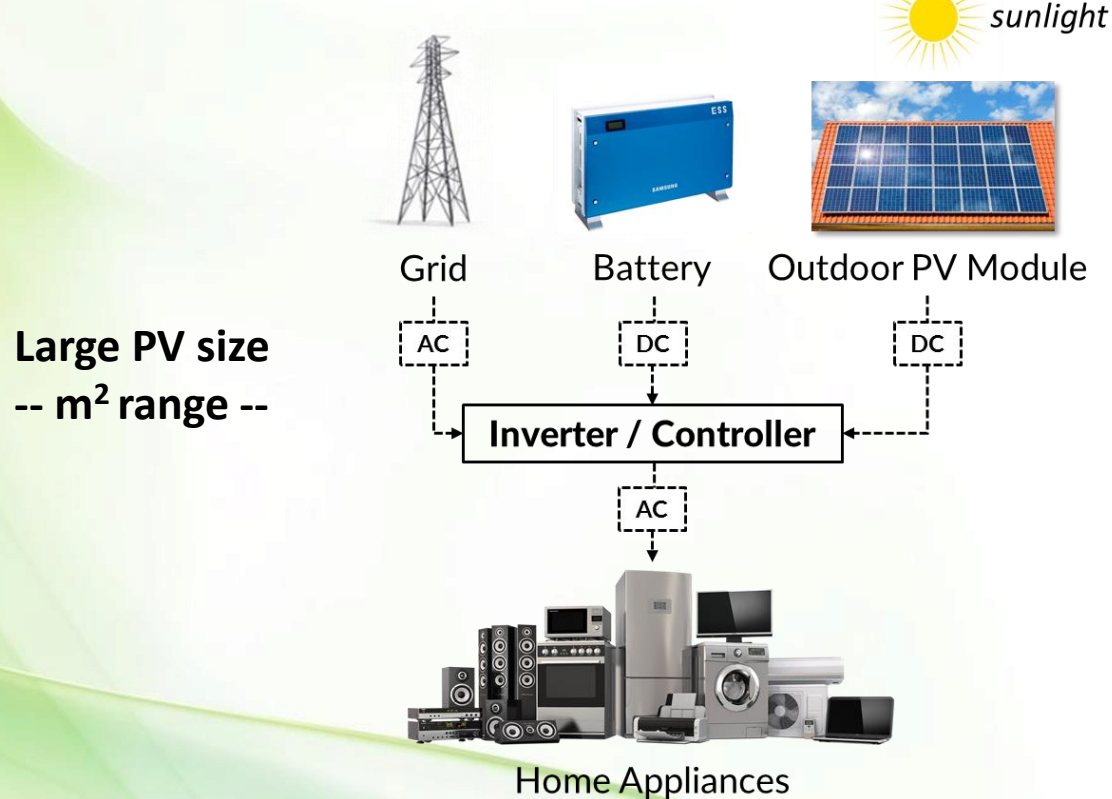
**lightricity**

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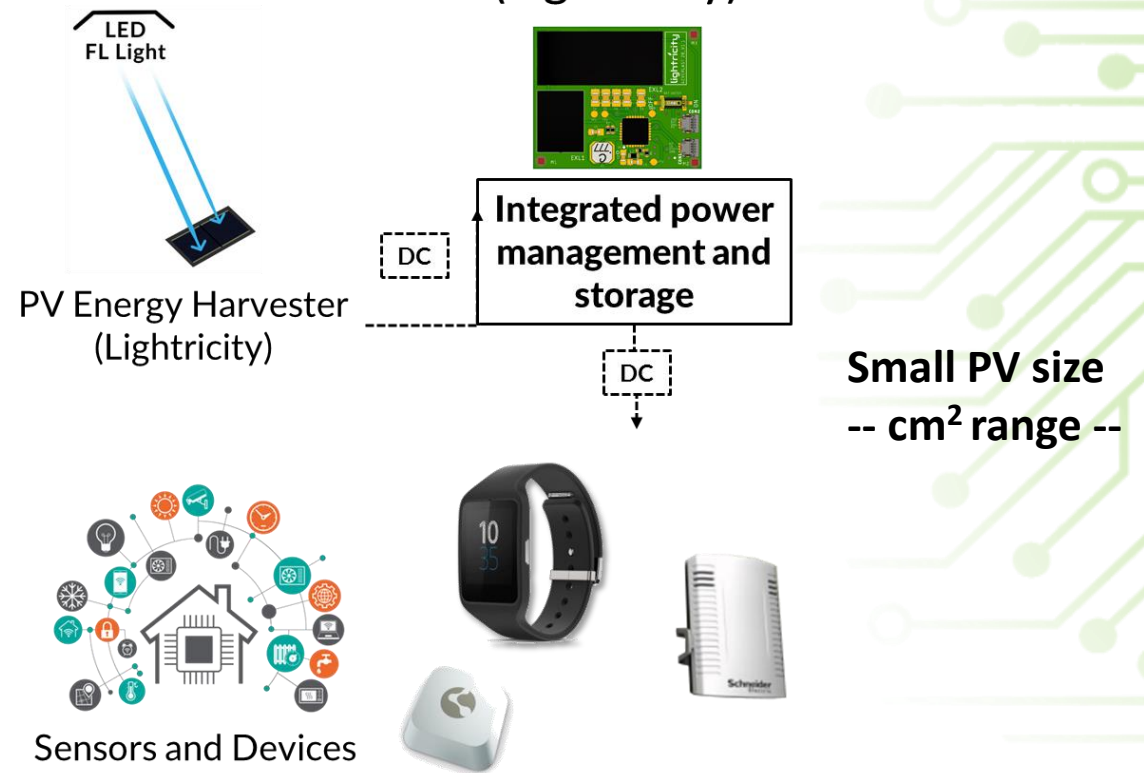
# Company introduction

- **Lightricity Ltd** is a spin-out from **SHARP** Laboratories of Europe Ltd, **SHARP**'s European R&D lab
- Established after 4 years of intensive R&D on **Energy Harvesting (EH)** and IoT devices, **Lightricity** aims to commercialize its unique **IP-protected** indoor Photovoltaic (PV) technology

## Conventional PV



## Indoor PV (Lightricity)

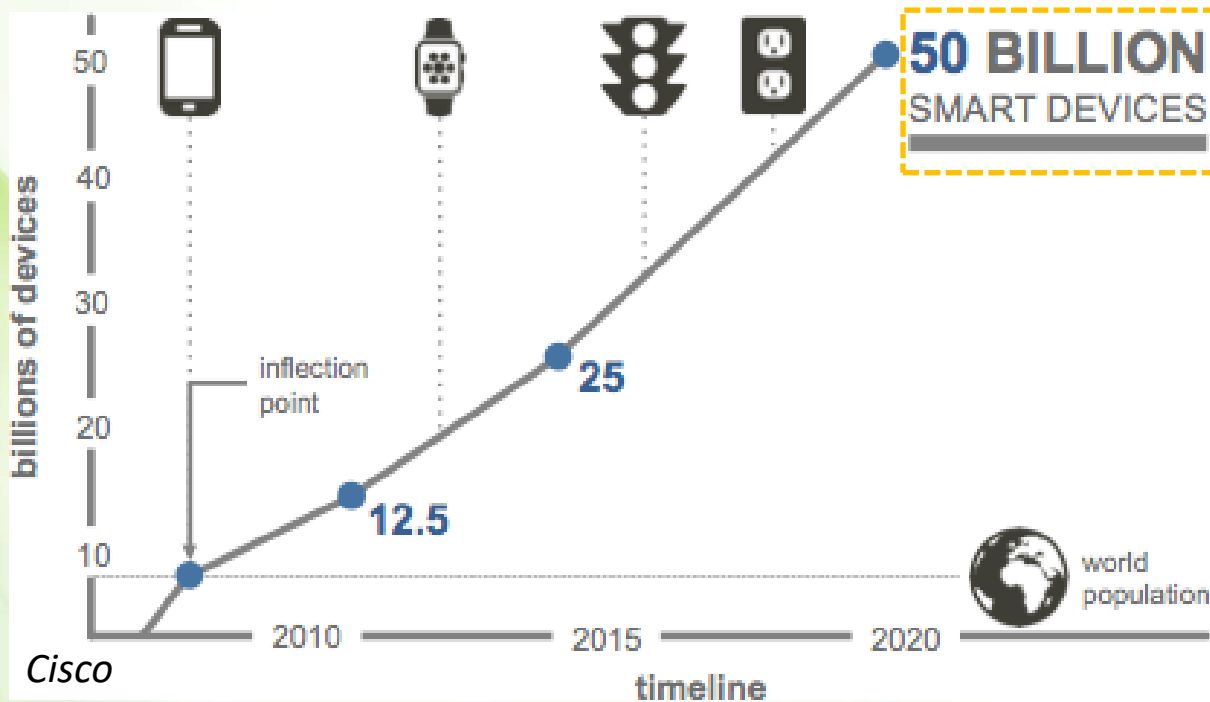


- **Lightricity** offers sustainable, environmentally friendly PV Energy Harvesting components and systems that eliminate the need for battery replacements of IoT devices and sensors inside buildings

# Problem and solution

**Problem:** Billions of wireless smart IoT devices currently requiring primary batteries or wires

- Big issue with **extra-maintenance**: >100 million battery replacements per day required in the near future
- Huge **cost** and **environmental impact** (waste) currently limiting the deployment of IoT devices in the field



Required Battery Replacements per Day						
Battery Lifetime (Years)	Number of Assets Monitored					
	10 B	20 B	50 B	100 B	1 T	
	1	27 M	55 M	137 M	274 M	2,740 M
	2	14 M	27 M	68 M	137 M	1,370 M
	3	9 M	18 M	46 M	91 M	913 M
	5	5 M	11 M	27 M	55 M	548 M
	10	3 M	5 M	14 M	27 M	274 M

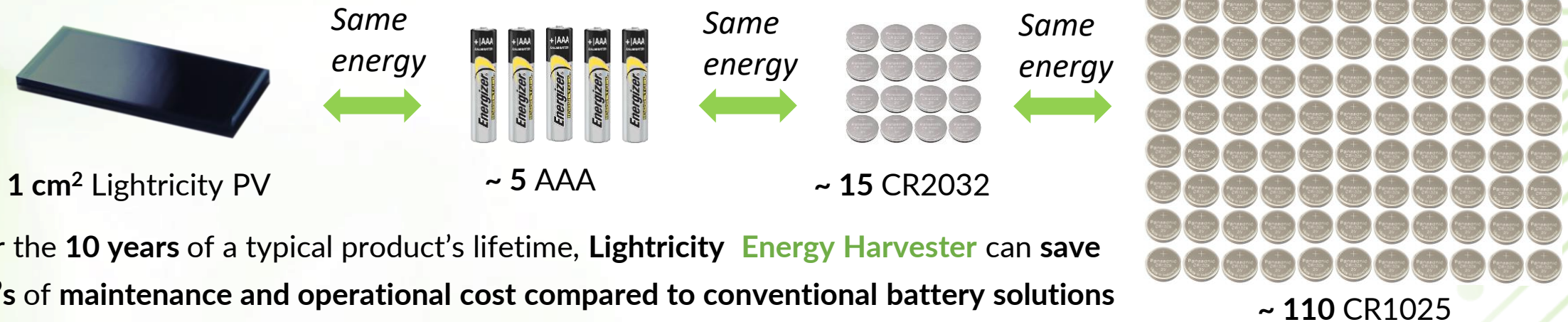
**Opportunity:** Overall demand increasing but currently no acceptable solution available in the market

**Solution:** Lightricity can provide a sustainable, affordable, scalable and efficient solution to power the current and future generation of ultra-low power, miniaturised IoT sensors and devices

# Value proposition

- **Lightricity** Energy Harvesting component is **6x more efficient per area than existing products**, aesthetically more attractive, has ultra-long lifetime (>20 years expected) and is easier to integrate (higher voltage output)
- Can be used as an efficient Energy Harvesting solution to power IoT devices otherwise requiring batteries

At **1000 lux** average illumination (bright indoor conditions), over 10 years:



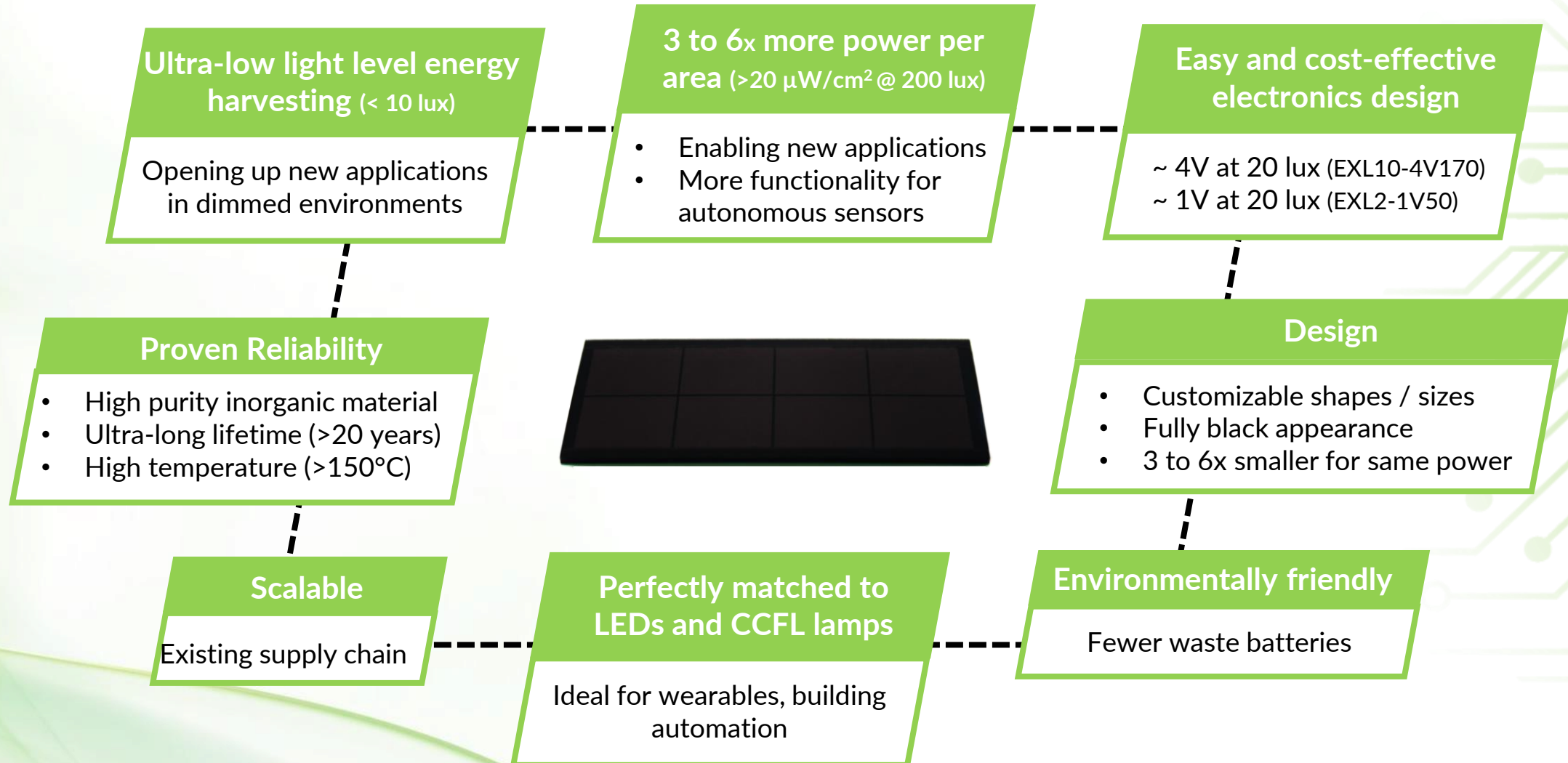
Over the **10 years** of a typical product's lifetime, **Lightricity Energy Harvester** can **save €100's** of maintenance and operational cost compared to conventional battery solutions

## Key environmental benefits:

- Eliminate the considerable economic and environmental (~€1.2k per tonne) costs of battery disposal due to the proliferation of IoT devices (Statista: 75.4bn devices by 2025) + sensor disposal costs. Encourage re-use and recycling model, achieving a hazardous waste reduction near 100% (no use of heavy metals)

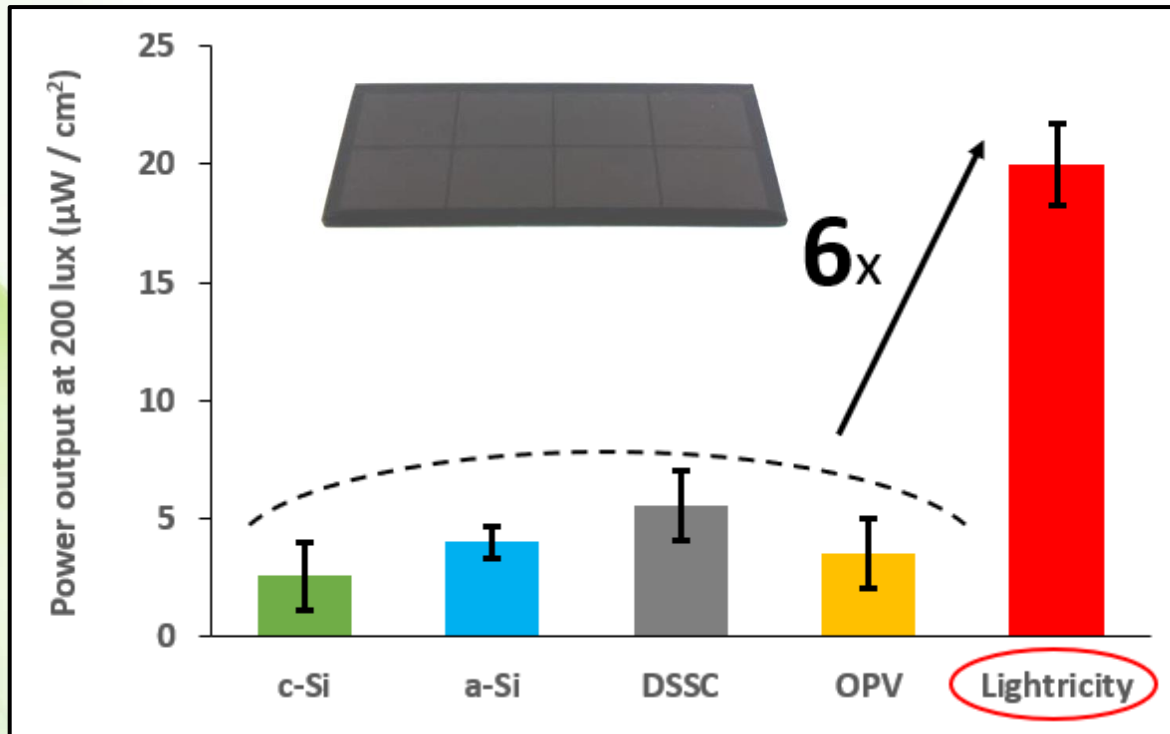


# Technology features: ExCellLight



# Lightricity vs. existing Energy Harvesting technologies

**World's best indoor Photovoltaic solution** based on a high purity / ultra-long lifetime (>20 years) inorganic material

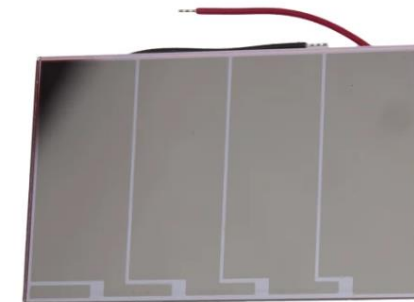


Test performed under Fluorescent and white LED spectra at 200 lux. 30-35% PV cell efficiency achieved indoors!

Main **competing technology** currently **amorphous Silicon** with:

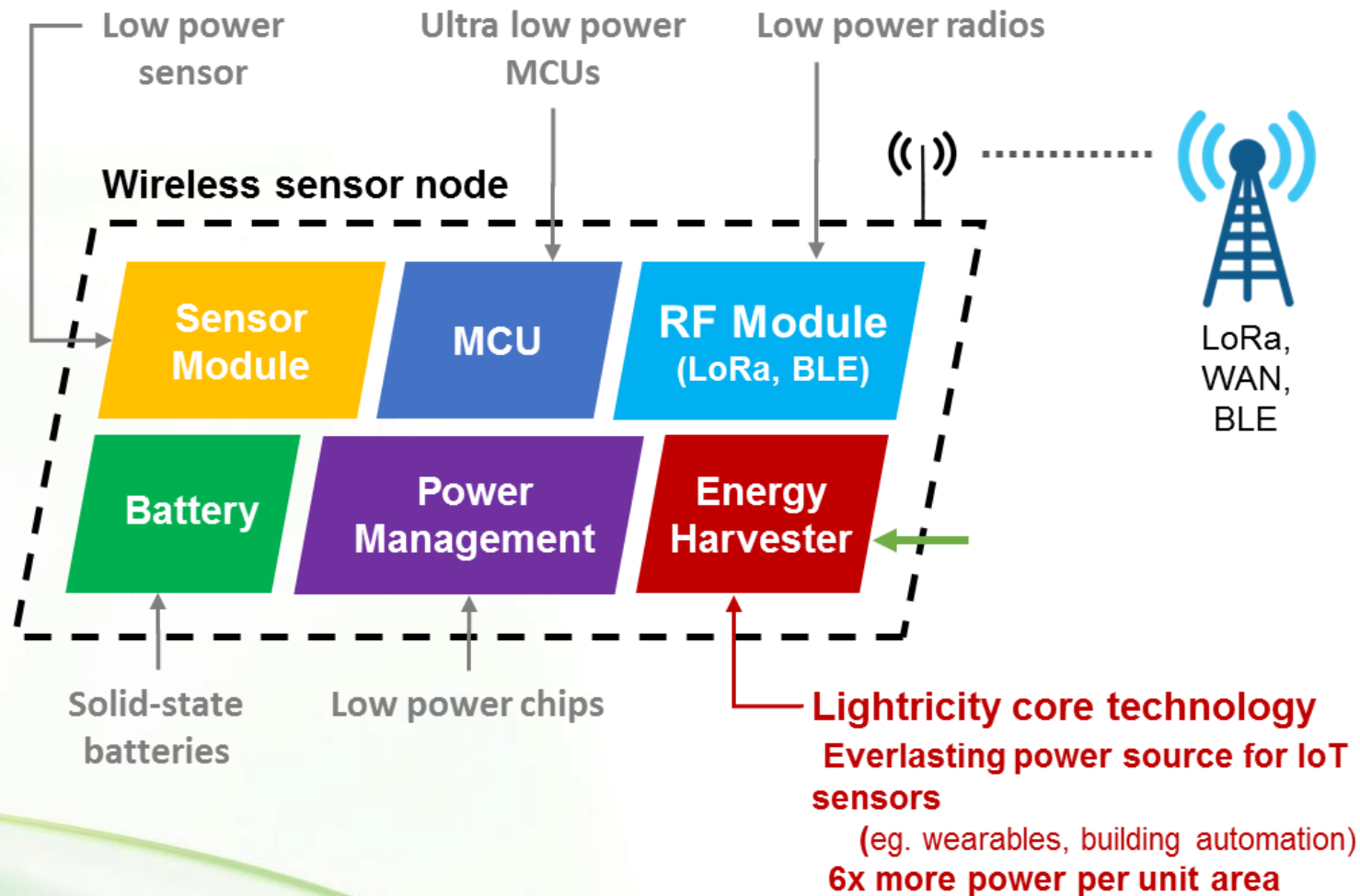
- Low performance (especially under low light level)
- Poor aesthetics (brownish and non-uniform color)
- Cumbersome: relatively large sizes, wires for electrical connections

Lighting Conditions	
Environment	Typical lux Value
Dim corridor	50-100
Restroom	100-300
Homes	200-400
Office - Open	300-500
Kitchen	300-750
Hypermarket / Factories	1000
Outside under tree shading	3000-10000
Bright sunlight	>100000



Amorphous Silicon indoor PV panel (conventional)

# Integration with IoT sensors




# Industrial asset tracking and monitoring: SBRI UK

- **Lightricity** is leading a SBRI-funded project (>£1m) that includes Sony and the NHS hospitals
- This project aims to demonstrate PV-powered networks of beacons/trackers that enable the location and monitoring of valuable assets in hospitals, logistics and retail
- This includes wireless temperature monitoring in ultra-cold conditions (fridges and freezers)
- Devices should withstand harsh cleaning conditions (sterilisation, cleaning agents) and environmental conditions (dirt, etc)









# Product prototype line-up

	ExCellLight EXL10-4V170	ExCellLight EXL2-1V50	ExCellLight Custom EXLC-X	4EverLast 1.0 EVL10-4V150
<b>View</b>				
<b>Integration</b>	Stand-alone	Stand-alone	Stand-alone	Added electronics
<b>Shape</b>	Rectangular	Rectangular	Custom	Rectangular
<b>Size</b>	5.0 x 2.0 x 0.15 cm <sup>3</sup>	2.4 x 1.0 x 0.15 cm <sup>3</sup>	Custom	6.0 x 2.0 x 1.0 cm <sup>3</sup>
<b>PV active area</b>	7.8 cm <sup>2</sup>	2.15 cm <sup>2</sup>	Custom (mm <sup>2</sup> – cm <sup>2</sup> )	7.8 cm <sup>2</sup>
<b>Voltage output (MPP @ 200 lux)</b>	4V	1V	Custom (1V, 2V, 3V, 4V, 5V)	4V
<b>Power output (MPP @ 200 lux)</b>	170 μW	47.6 μW	Custom	150 μW (500 mW peak)

# Product prototype line-up (new)

	ExCellLight EXL1-1V20	ExCellLight EXL0.25-3V5	ExCellLight EXL0.10-3V2	4EverLast 2.0 EVL1/2-1V20/40
<b>View</b>				
<b>Integration</b>	Stand-alone	Stand-alone	Stand-alone	Added electronics
<b>Shape</b>	Rectangular	Square	Square	Rectangular
<b>Size</b>	11.65 x 8.85 x 0.65 mm <sup>3</sup>	5.0 x 5.0 x 0.65 mm <sup>3</sup>	3.5 x 3.5 x 0.65 mm <sup>3</sup>	27 x 32 x 3.0 mm <sup>3</sup>
<b>PV active area</b>	98 mm <sup>2</sup>	22 mm <sup>2</sup>	9.9 mm <sup>2</sup>	10-34 mm <sup>2</sup>
<b>Voltage output (MPP @ 200 lux)</b>	1V	3V	3V	1.8V, 3V or configurable
<b>Power output (MPP @ 200 lux)</b>	21.7 μW	4.9 μW	2.2 μW	Up to 50 μW (100 mW peak)

# Summary of features and benefits

- ◆ **Eco-friendly** “fit and forget” products (avoid primary Lithium batteries)
- ◆ **Highest PV performance** and reliability on the market, over a wide illumination range (10-100 000 lux)
- ◆ Enable **new functionalities** or **reduce PV footprint**, next generation of self-powered IoT devices
- ◆ Superior **aesthetics** that can boost brand visibility
- ◆ Unique **customization** available (shape, size, thickness, output configuration) to fit in any IoT product
- ◆ **Ultra-small** form factor possible for seamless integration
- ◆ **Robust**, even in harsh environments (elevated temperature up to 150 °C)
- ◆ Easily **scalable** (supply-chain already in place for mass production)

# THANK YOU!

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