



# Fully oxide-based zero emission & portable energy supply

A clean way to power wireless IoT devices



FOXES is a project funded by the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 951774

## Powering wireless IoT devices

The Internet of Things (IoT) enables the communication and interaction between different devices and is the backbone infrastructure behind many future-shaping concepts such as Smart Cities and Work 4.0. To be embedded into vehicles or machines, or to be placed into remote locations away from the power-grid, IoT devices need to be fully wireless, lightweight, and energy-autonomous. Providing efficient solutions for powering wireless devices is the key for unlocking the true potential of IoT.



“ Within the project FOXES we pursue an integrated and environmentally-sustainable approach to the problem of powering wireless IoT devices. Our goal is to realize what we call FOXES Power Cube – an integrated  $2 \times 2 \text{ cm}^2$  system, which combines a high-efficiency solar cell with a multilayer capacitor and an energy management circuit. And we want to achieve this using only low-cost and environmentally friendly processes and materials, so that the Power Cube will have no negative environmental impact at its end of life.

Marco Deluca, Project Coordinator  
(Materials Center Leoben Forschung GmbH, AT)

## FOXES Goal

The goal of the EU-funded project FOXES is to develop FOXES Power Cube – a clean, compact, low-cost and scalable high-energy density solution for powering IoT devices such as wireless sensor nodes.

FOXES Power Cube combines :

- a high-efficiency solar cell
- a high-energy density multilayer thin-film capacitor
- an energy-management circuit

The device ensures autonomous operation of IoT devices, storing in the capacitor the solar-energy surplus generated by the solar cell, for being used when solar light is not available.

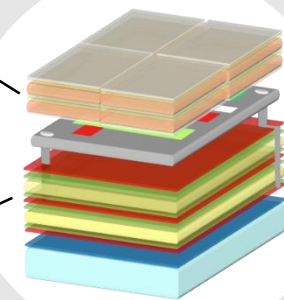
All components of FOXES Power Cube are monolithically integrated using low-cost and sustainable processes.

Targeted energy generation:  $> 250 \text{ mJ/day}$

### FOXES Power Cube

Fully lead-free perovskite solar cell with  $> 10\%$  efficiency.

Electronics based on graphene and metal-oxides for energy management circuit.



Lead-free perovskite multilayer thin film capacitor with high energy density ( $> 50 \text{ J/cm}^3$ ).

Substrate

