

TRIBOELECTRIC-POWERED SYSTEM FOR PEDESTRIAN AND VEHICLE DETECTION WITH WIRELESS DATA TRANSMISSION

A. Delbani¹, A. Karami², D. Galayko³, N. Hodzic², S. Vaidyanathan², M. Kane¹ and P. Basset²

¹EASE/AME Lab, Univ Gustave Eiffel, Nantes, Pays de la Loire, France

²ESYCOM Lab, Univ Gustave Eiffel, CNRS, Marne-la-Vallée, France

³Sorbonne Université, CNRS, LIP6, Paris, France

Abstract

We report a 25x23 cm² triboelectric generator (TENG) to transform the mechanical interaction between the car and the road into an electrical energy source. Up to 200 μJ were obtained from scratch with a single human step, which is enough to supply a BLE module to send data from 4 different sensors. Alternatively, each actuation can generate a voltage up to 1 kV, which allows to generate an electromagnetic wave that can be received several meter away. Much larger power is expected from future experiments with a car.

1- Introduction

5G Roads will communicate data from sensors.

- **Problem:** power autonomy for these abandoned sensors.
- **Solution:** transform the car-road system into a source of energy via transducers.

Triboelectric transducers “TENGs” are a recent alternative to convert mechanical energy into electrical energy.

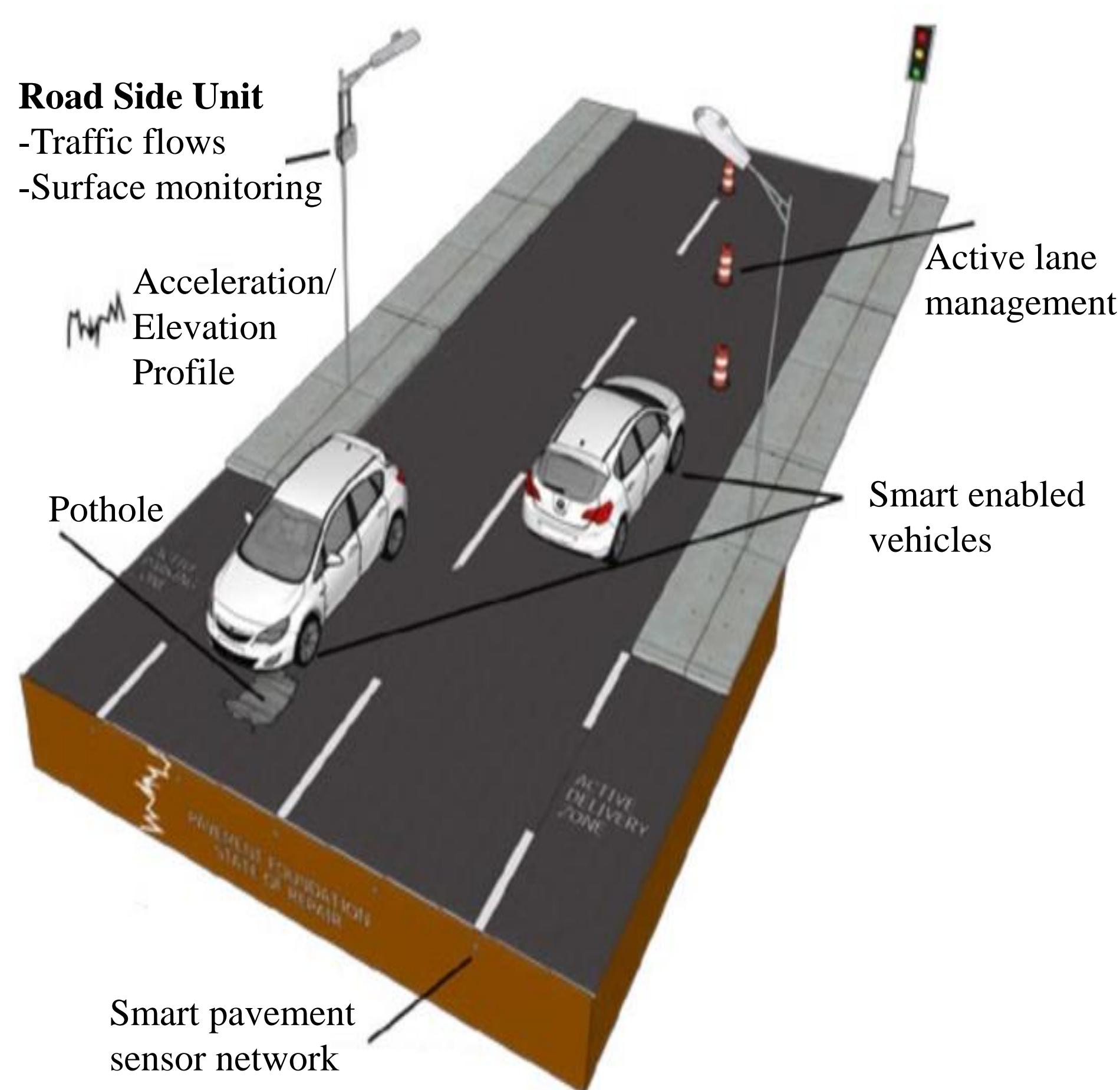
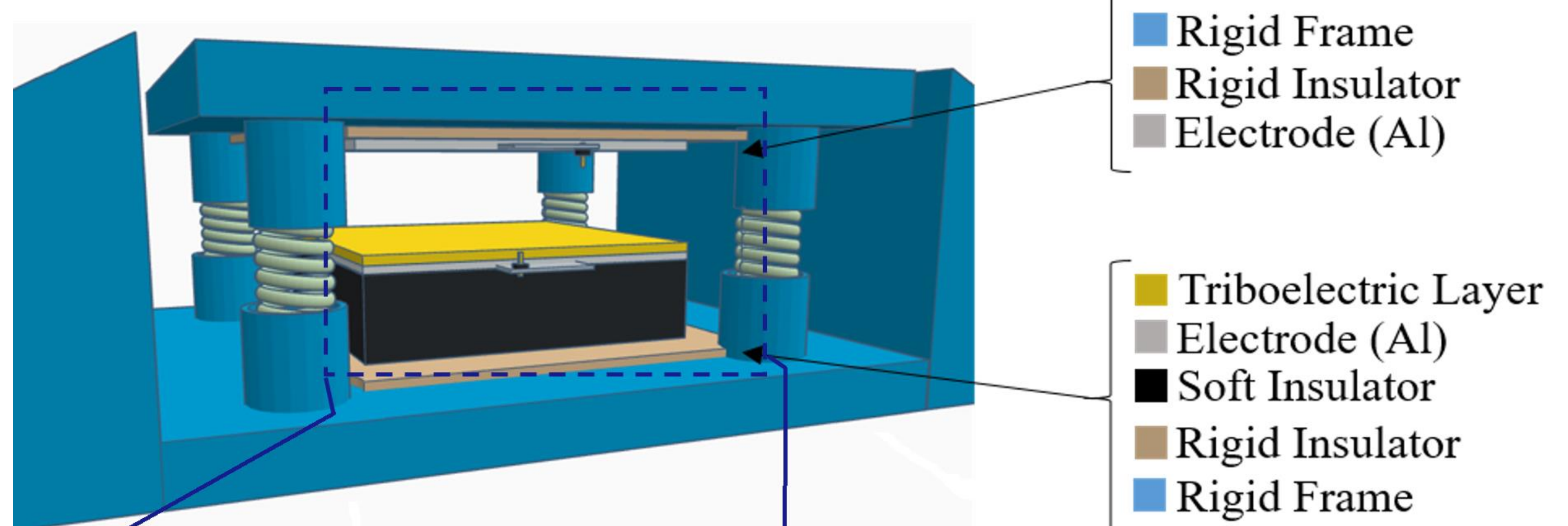


Fig 1: 5G roads, From « Contrat d'objectifs et de performance entre l'état et l'IFSTTAR 2017-2021 » p. 36

2- Experimental Setup Description



- Active area = 625 cm².
- 100 μm-thick PTFE as triboelectric material.

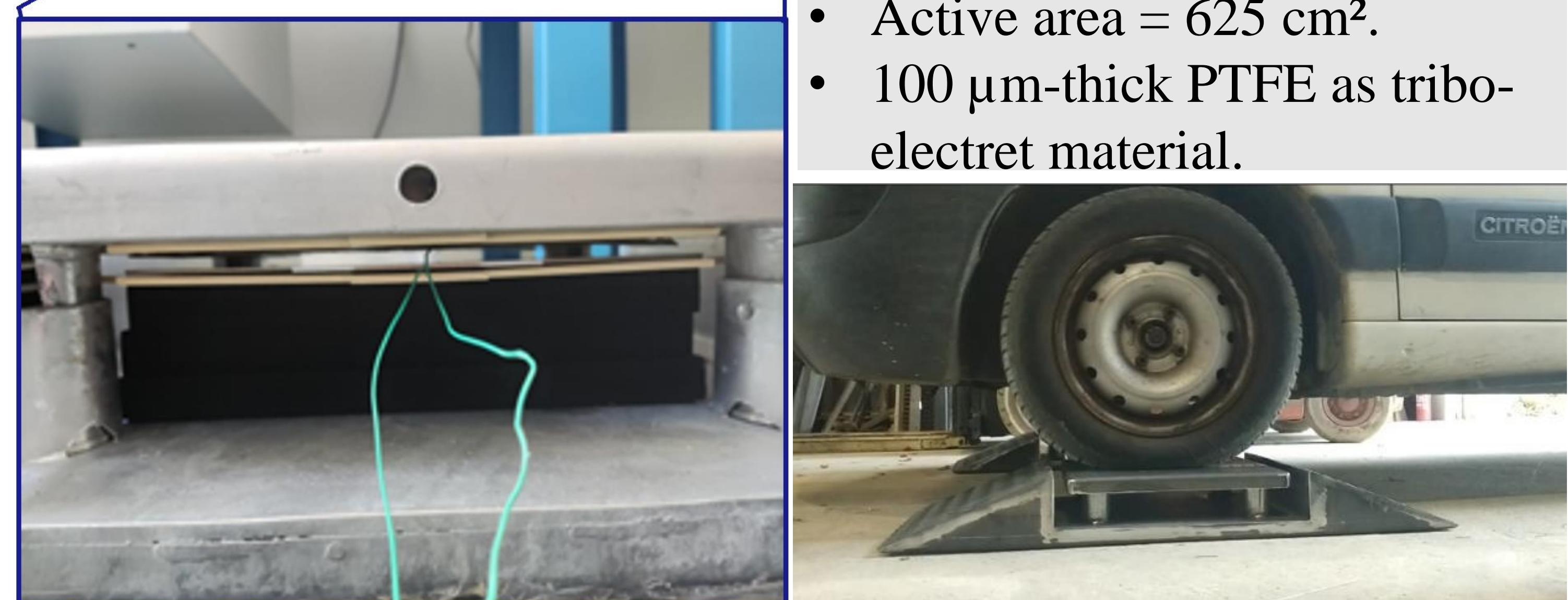


Fig 2: Car/Road Active layer and Prototype

3- Transducer's Principle

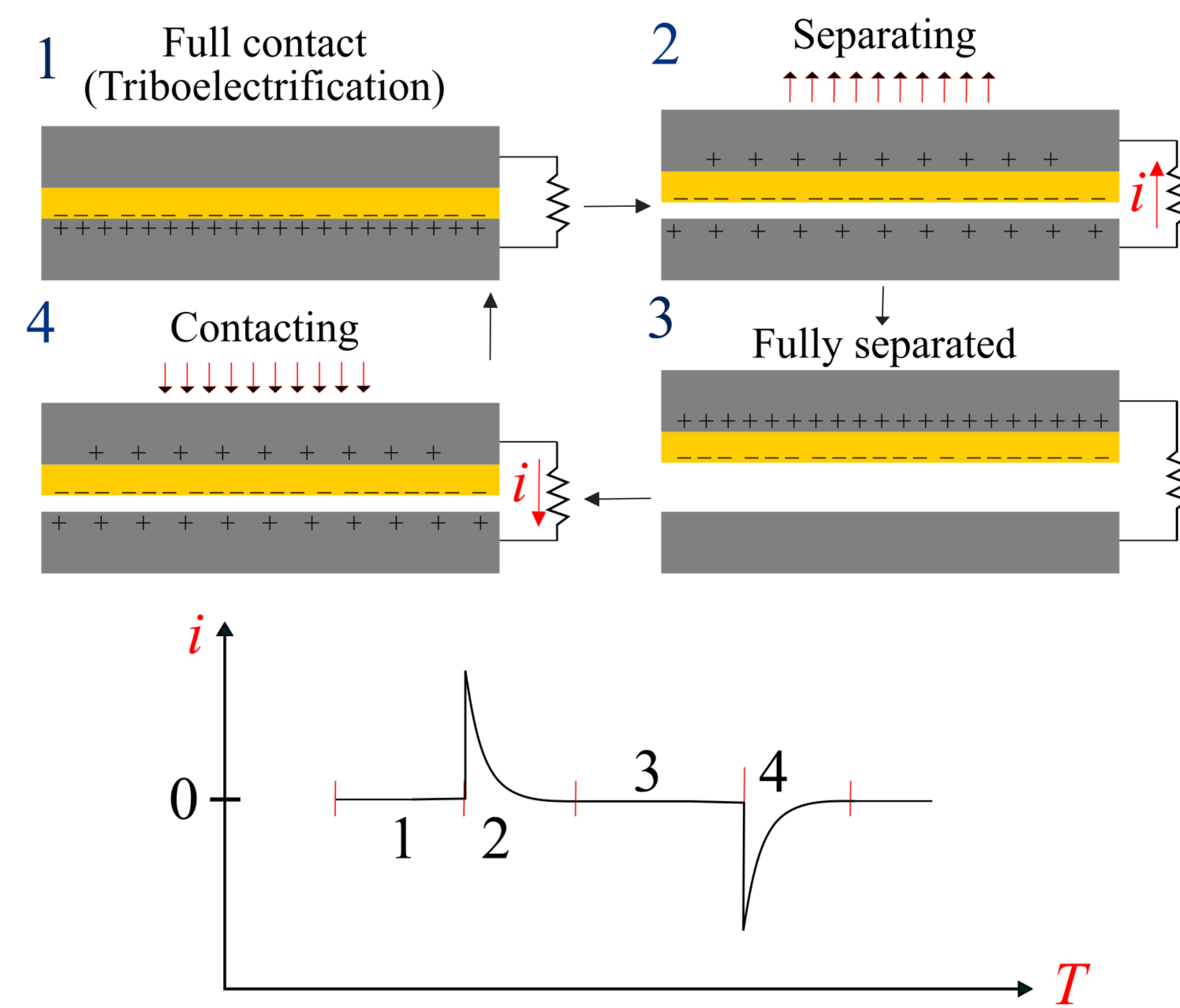


Fig 3: Energy Conversion and charge transfer

External mechanical forces results in a variation of a capacitor:

- Pre-charge by **contact electrification** between two materials.
- Energy conversion by **electrostatic induction** and charge displacement between the capacitor's electrodes.

4- BLE Communication

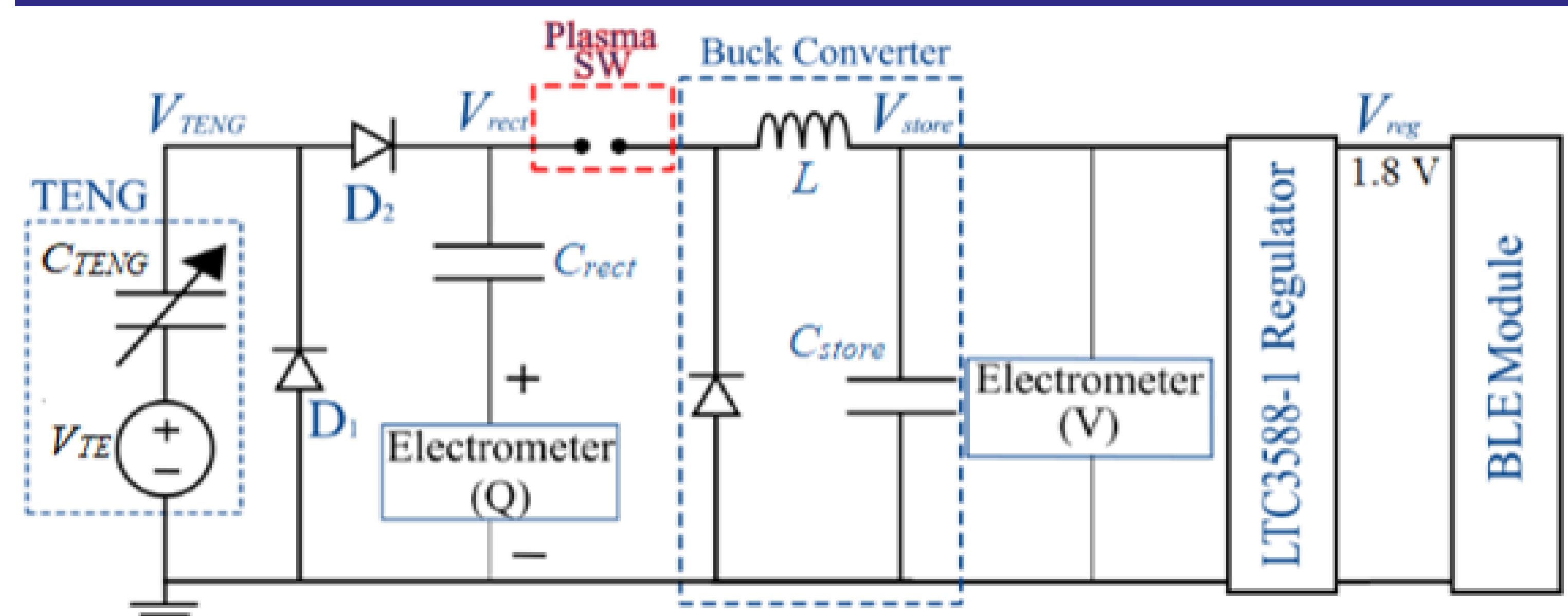


Fig 4: Circuit of the full system

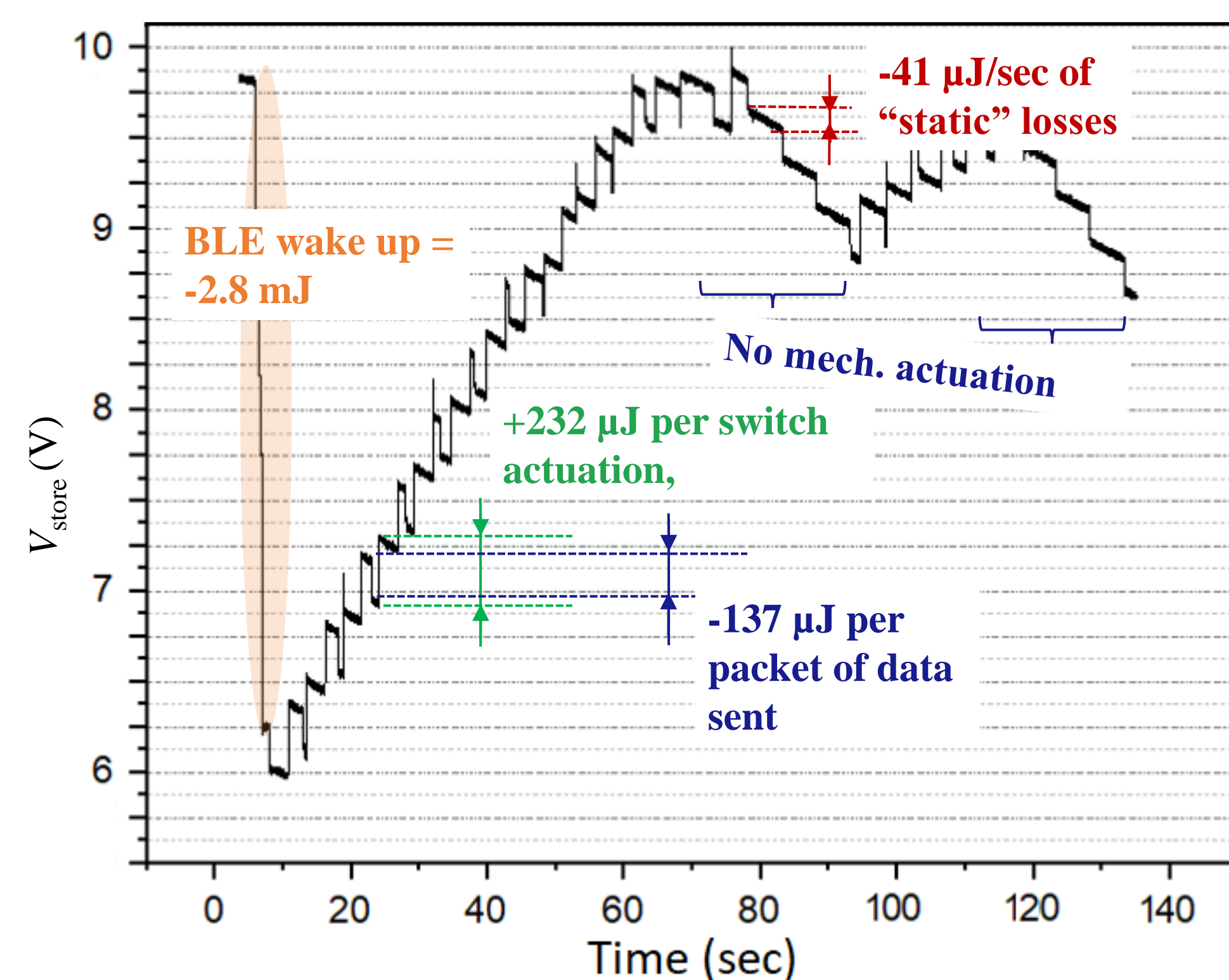


Fig 5: Voltage across C_{store} during mechanical excitation and BLE operation

- 1st voltage-drop: wake-up of the BLE module (RIOT-001).
- +232 μJ per plasma switch actuation.
- -137 μJ per BLE transmission.
- With data from 4 sensors (temperature, humidity, air pressure, and illuminance)
- -41 μJ/sec of « static » losses

5- Alternative transmission scheme: Hertz Experiment

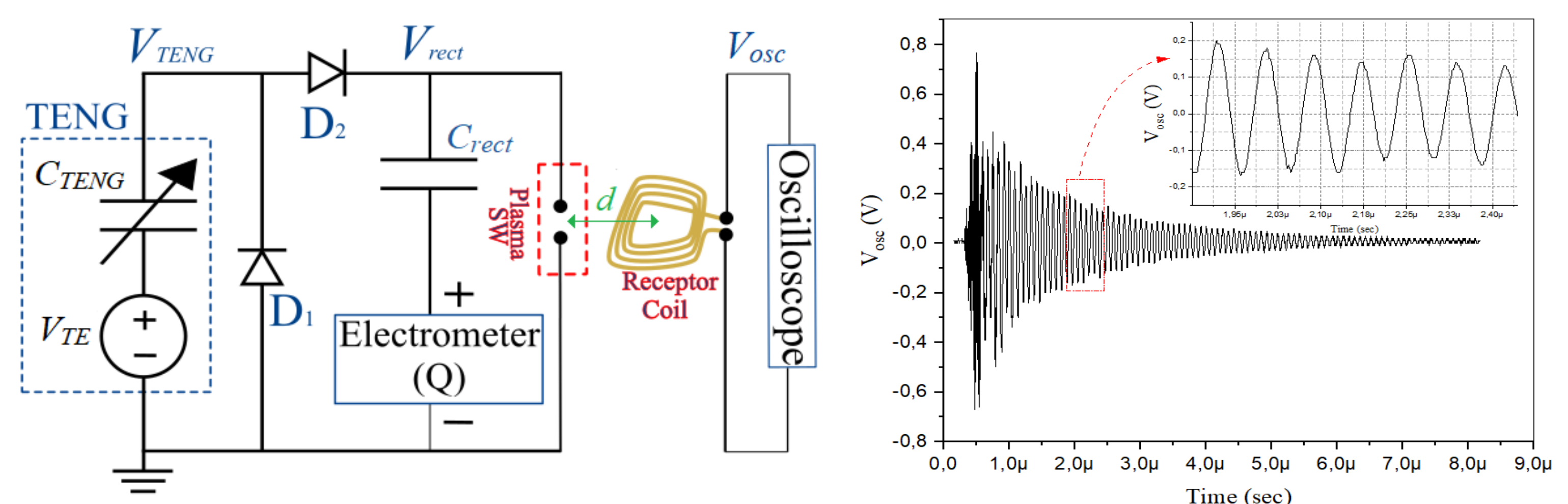


Fig 6: Received signal at 2 meters due to the EM waves generated by the plasma switch

Conclusion

- A low-cost triboelectric generator has been embedded in a road bump → +200 μJ are obtained from scratch with a single human step.
- A 2-stage PMS with a plasma switch has been implemented → +232 μJ are transferred (3 steps) to a low voltage storage capacitor → efficiency ~30% → Sufficient to send data with the BLE module.
- The plasma switch actuation generates an EM wave → Could be used for low-power data transmission.