

# Development of a Car/Road Triboelectric Generator for Autonomous Wireless Data Transmission

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## Abstract

We report a 25x23 cm<sup>2</sup> 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 sending data from 4 different sensors. Alternatively, each actuation can generate a very high voltage, 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- Experimental Setup Description

2 road bumps with a movable upper vertical plate have been fabricated so that a triboelectric transducer can be excited with a vertical deflection of a few mm to a few cm.

The transducer is made of an electrode on which is glued a PTFE sheet of 25x23 cm<sup>2</sup> wide / 100 μm thick, and a second contact electrode made of aluminum.

For the preliminary tests, the original springs were replaced with softer springs so that vertical deflection could be achieved with the force generated by a human step.

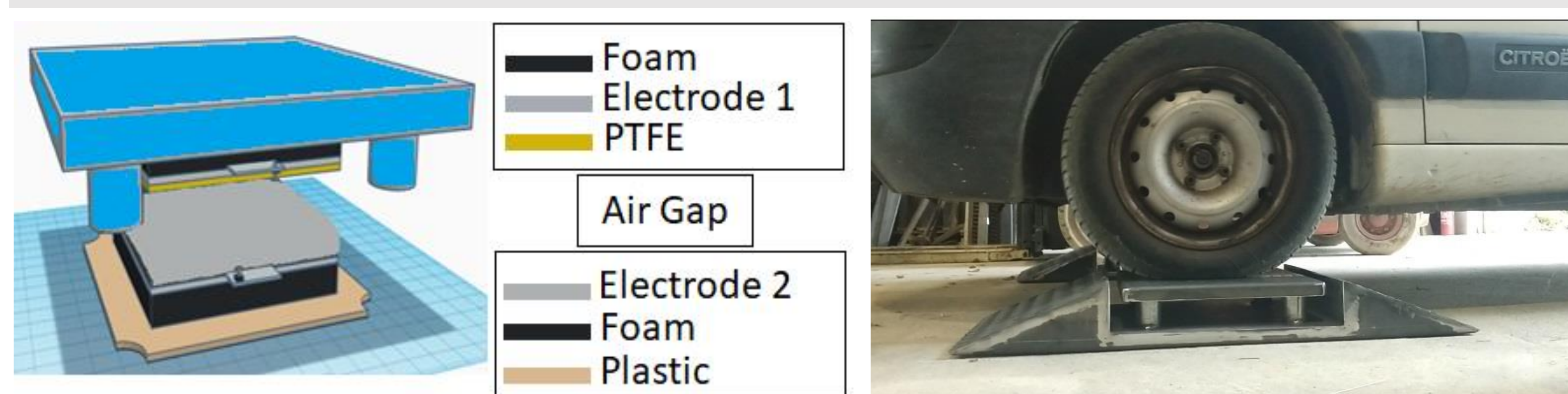


Fig 2: Car/Road Active layer and Prototype

## 4- Hertz Approach for Car Detection

Each actuation generates a sparkle across the plasma switch. The resulting electromagnetic (EM) wave has been detected several meters away thanks to a 5-cm in diameter receiver antenna made of three loops.

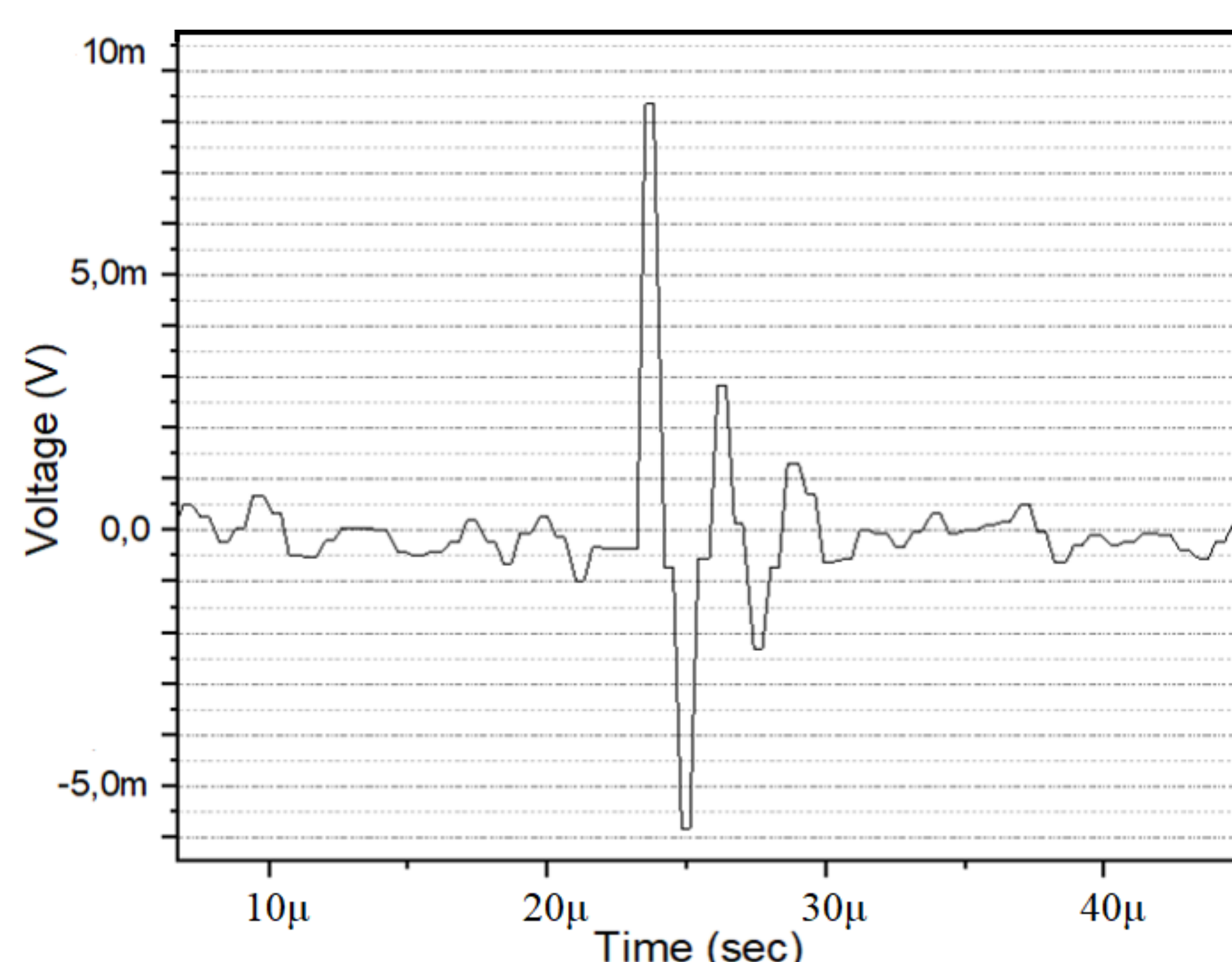


Fig 6: Received signal at 3 meters due to the EM waves generated by the plasma switch

The amplitude of the received signal gives an indication of the force applied on the transducer. This approach is very promising since almost no electronic is needed to transmit the information.

## 2- Transducer's Principle

- Pre-charge of the TENG by contact electrification between two materials,
- Variation of the TENG's capacitor due to external mechanical forces,
- Energy conversion by electrostatic induction.

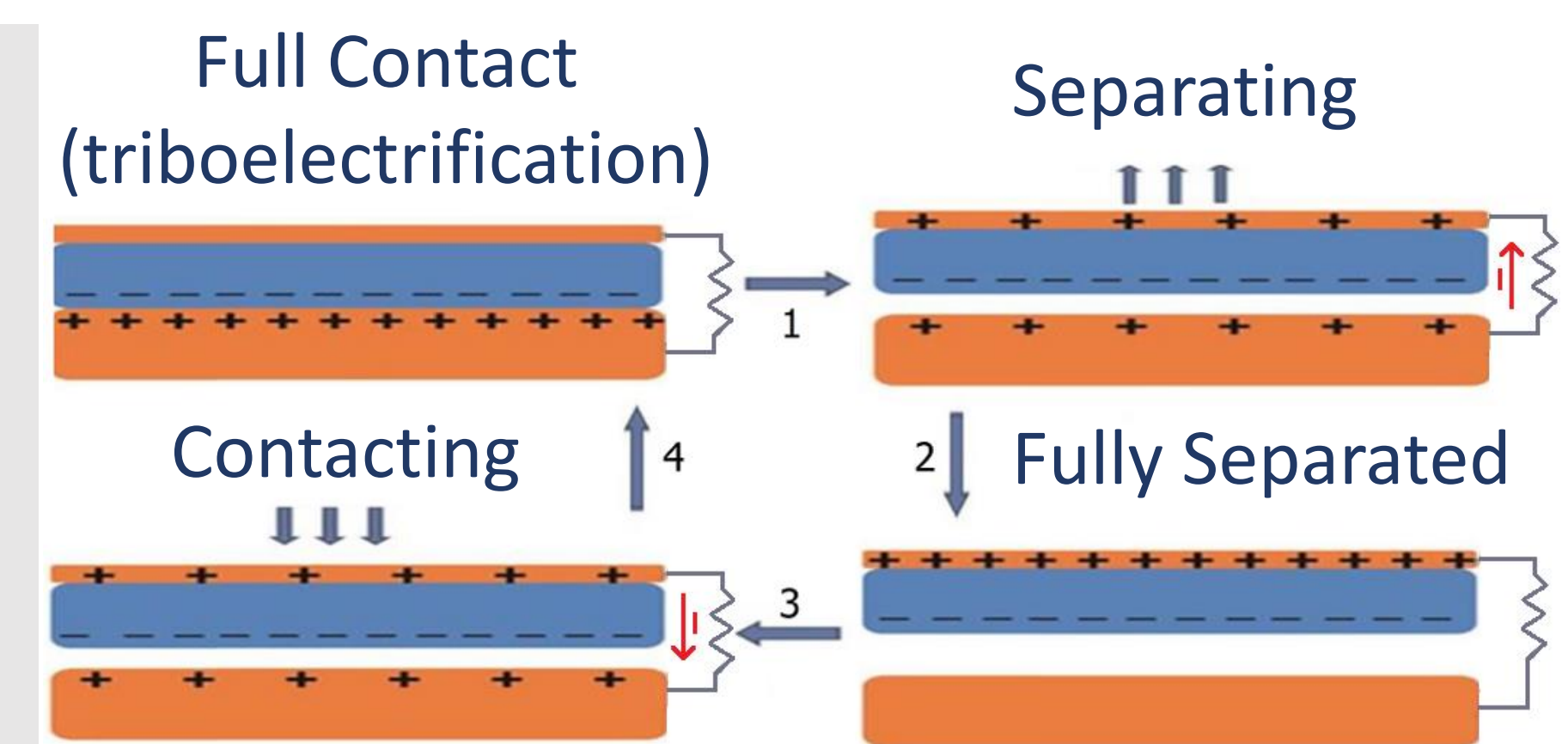


Fig 1: Energy Conversion and charge transfer

## 3- Data transmission with a BLE module

First, a half-wave rectifier is used to generate very-high voltage across  $C_{rect}$  from a single human step (fig. 3).

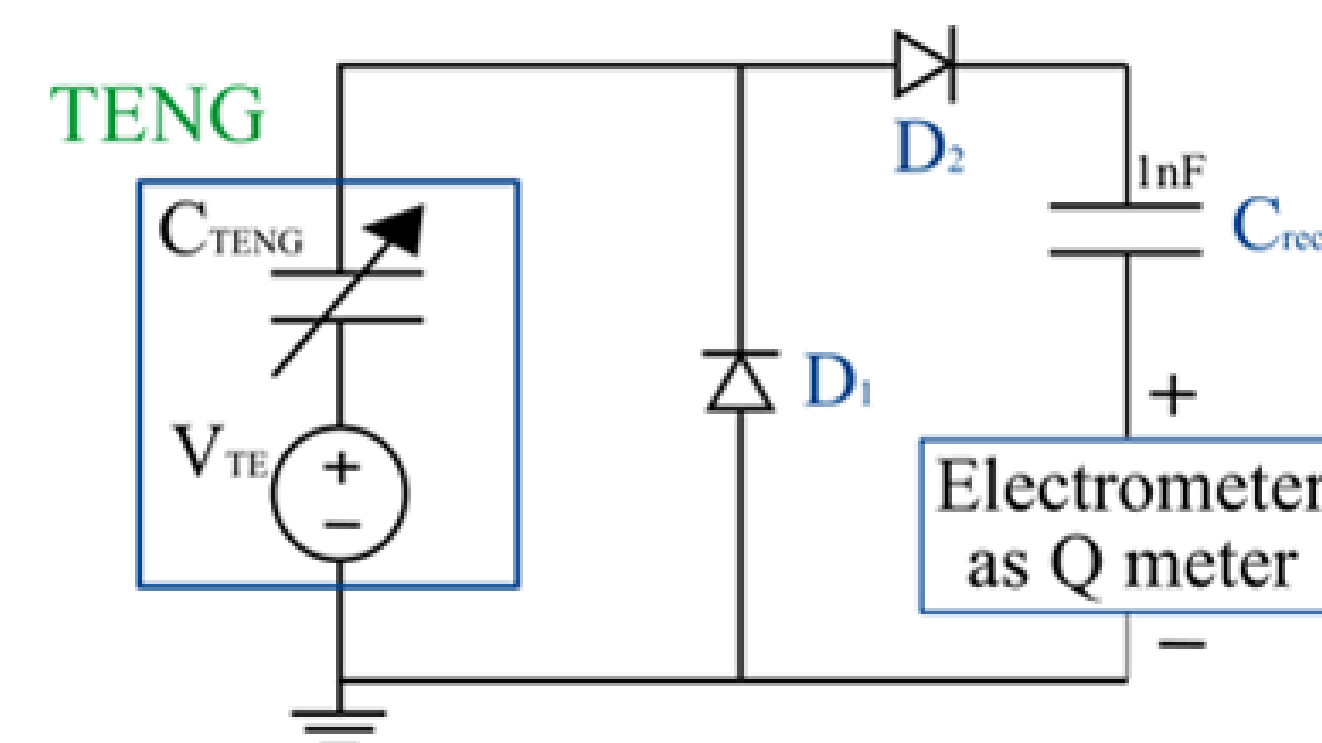


Fig 3: Circuit for energy measurement across  $C_{rect}$

Pressure	$V_{rect}$	Energy ( $C_{rect}$ )
13kN/m <sup>2</sup>	370 V	69 μJ
19kN/m <sup>2</sup>	520 V	199 μJ

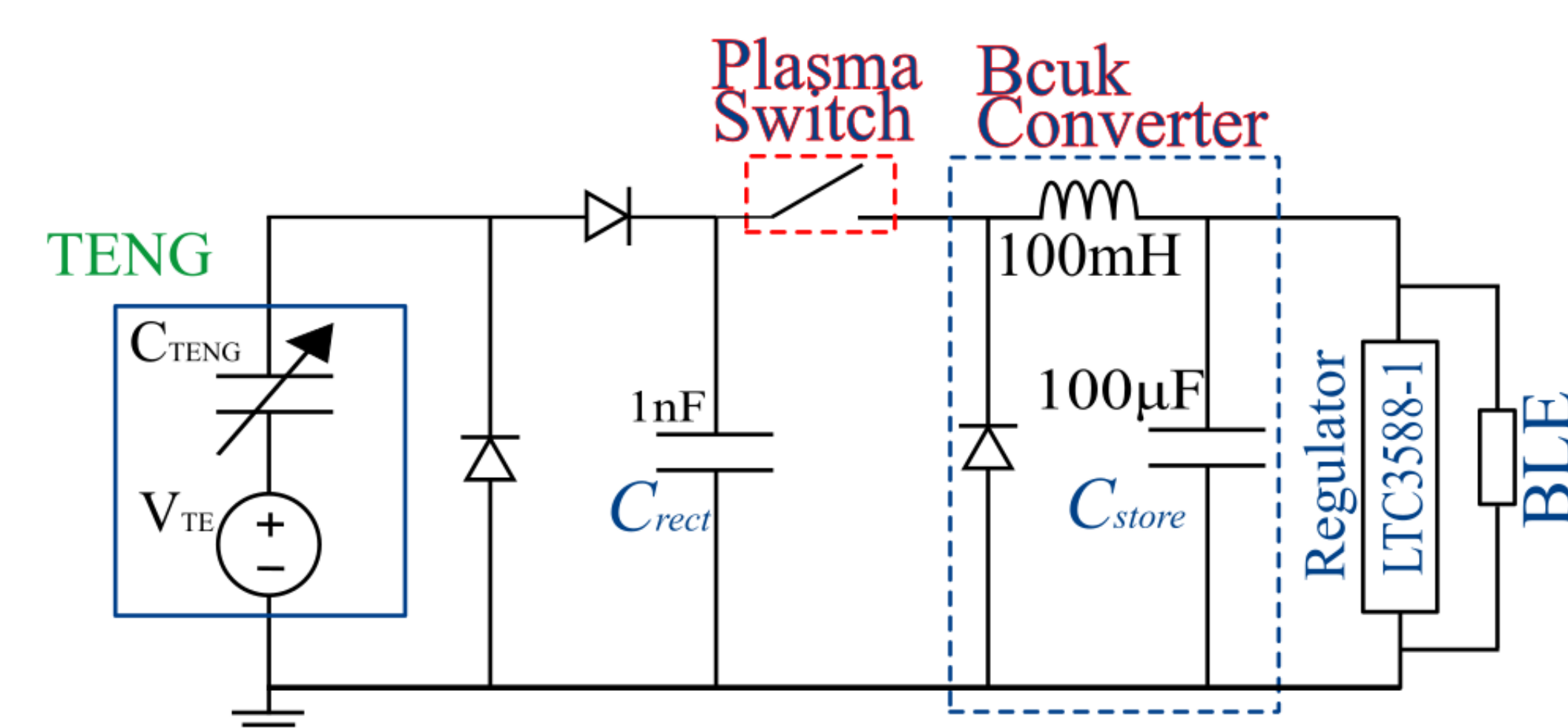


Fig 4: Circuit of the full system

To efficiently transfer the energy to  $C_{store}$ , a 2-stage power management system is used. (fig. 4)

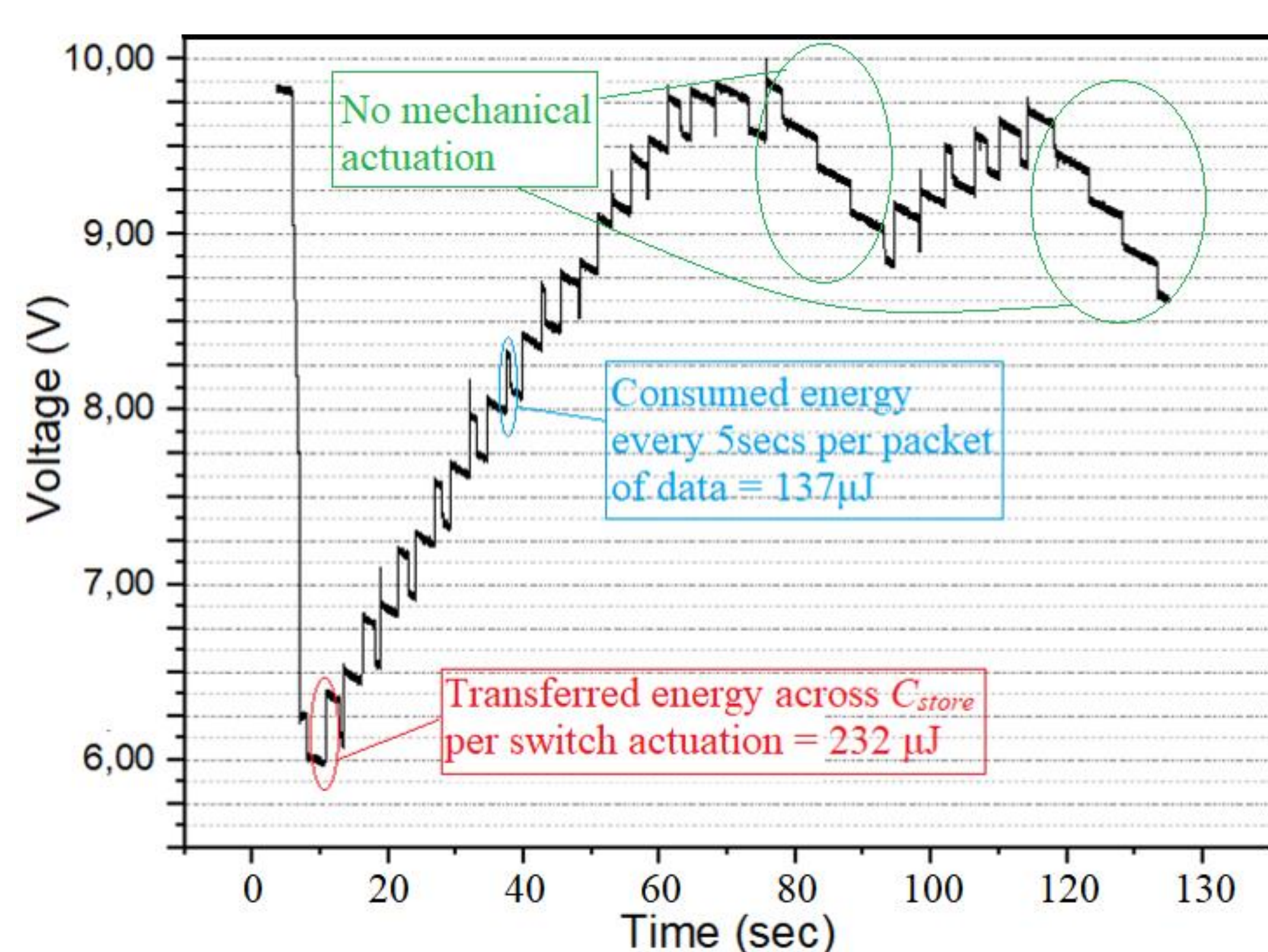


Fig 5: Voltage across  $C_{store}$  during mechanical excitation and BLE operation

At each plasma switch actuation at 1.25 kV, 232 μJ are transferred to  $C_{store}$ . It allows the transfer of the temp, humidity, illuminance, and pressure data through BLE.

Considering that a car is much heavier and would cause 4 actuations (one per wheel), the harvested energy in a in real situation is expected to be at least one order of magnitude higher.

## Conclusion

- We have demonstrated electrical power generation and data transmission with a BLE module using a triboelectric power generator embedded in a road bump. 232 μJ were generated by a single human step, which is enough to send a packet of data with a BLE module. Much higher power is expected with a car.
- With the use of plasma switch, a low-power management system has been obtained. The switch allows the transmission of data without additional wireless electronic module.
- Current work focuses on the extension the transmission distance and the use of a foam transducer that could be embedded in the road.