Energy harvesting is the process of harnessing the ambient energy present around us in the form of vibrations, heat, or electromagnetic waves by converting this energy into electrical energy. Electromagnetic energy harvesting has substantially grown this last decade. This form of energy is particularly interesting because a lot of energy is lost due to the broadcasting inefficiency in wireless communication systems. Converting these microwave energies into a useful power supply is a great challenge, especially because of the low amplitudes of conventional WiFi signals at radio frequencies (RF).

In this work, microwave energy harvesters have been designed, based on subwavelength antennas, arranged on a two-dimensional artificial surface, commonly referred to as a metasurface. Metamaterials in general are artificial materials made of subwavelength electromagnetic resonators that can display non-natural physical properties such as e.g. a negative refractive index. Their size, their shape, their periodicity, and their orientation are parameters that have an influence on their control and manipulation of light.

Gabin Oumbe used metamaterial resonators to amplify the low amplitude of microwave signals and combined these resonators with embedded rectifier circuits. Doing so, he found a way to convert RF power into DC power. Nevertheless, a large enhancement of the electromagnetic field leads to higher radiative losses to the background, which is one of the main limitations for microwave energy harvesting.

He continued his investigation towards nonlinear metamaterial resonators where the radiative losses are separated from the harvesting and rectifying mechanism. This conceptually new approach shows better performance of the microwave energy harvesters, and higher microwave energy harvesting efficiency.

His research followed an iterative approach, using the powerful abstraction of electric equivalent models. The metasurfaces were subsequently simulated using numerical software based on a finite elements method. These analytical and numerical results were also assessed experimentally. One of the biggest challenges remains the integration of rectifier circuits within the metasurfaces.

In summary, the PhD work of Gabin Oumbe contributed to the exciting field of electromagnetic energy harvesting by investigating new physical approaches and techniques for efficient RF to DC energy conversion based on metasurfaces, that operate for realistic microwave input signals.