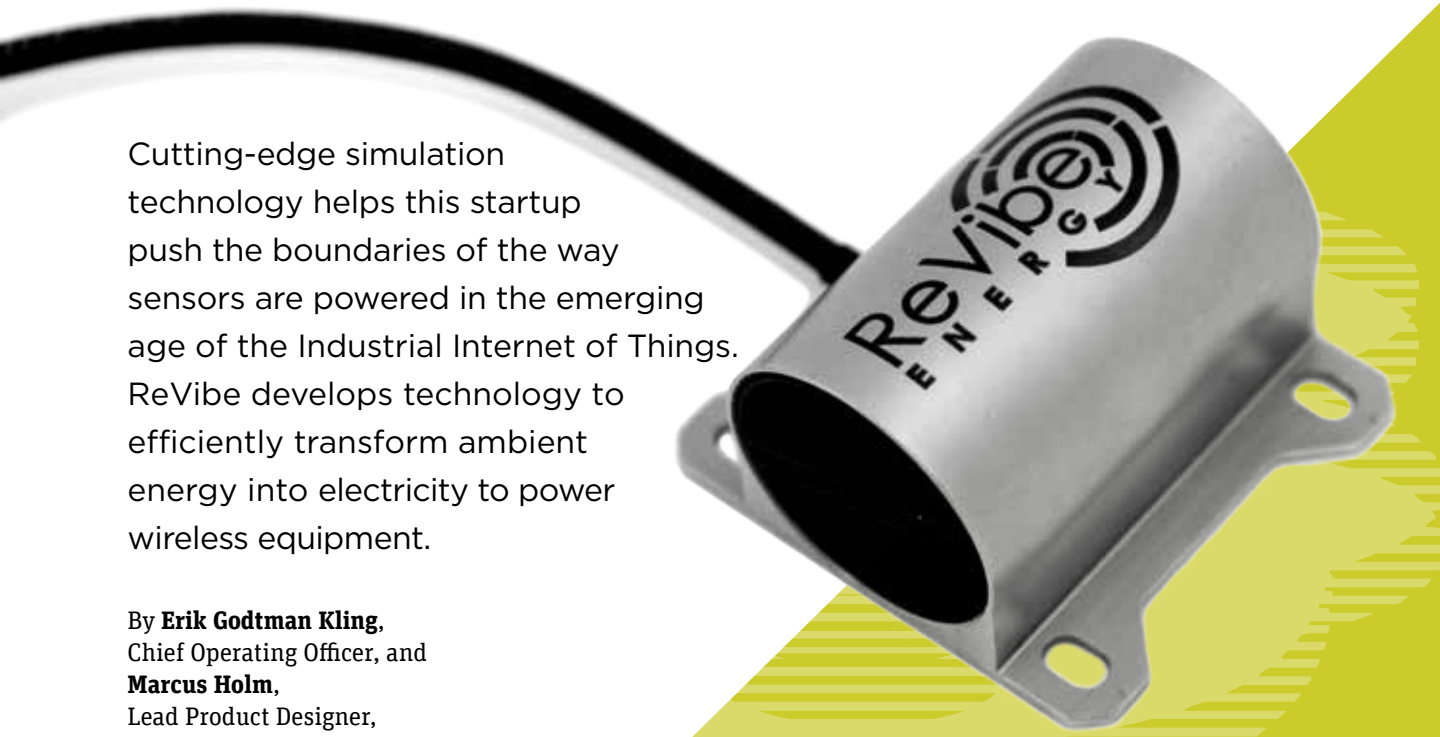
VIBRATION POWER GENERATION



Cutting-edge simulation technology helps this startup push the boundaries of the way sensors are powered in the emerging age of the Industrial Internet of Things. ReVibe develops technology to efficiently transform ambient energy into electricity to power wireless equipment.

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IBM, Cisco, Ericsson and Gartner are just a few of the many industry leaders predicting that the Internet of Things (IoT) will continue its rapid expansion as the number of connected devices maintains an exponential growth path. The biggest emerging issue with these connected devices is how they will be powered.

ReVibe Energy is a technology startup looking to revolutionize the way the IoT is powered. The company is developing a technology to efficiently transform ambient vibrations, present in all industrial environments, into electricity to power wireless equipment. ReVibe uses ANSYS software to perform upfront simulation to create the custom products that customers require.

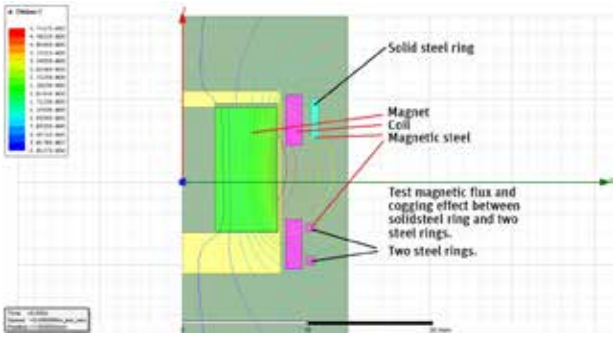
As interest in the Industrial IoT (IIoT, also known as Industry 4.0) continues to grow, customers are becoming increasingly aware of the benefits of wireless sensor networks (WSNs) for improved process monitoring. These sensors enable completely new business models within a wide range of industries.

ReVibe energy harvesters generate electricity from ambient vibration.

AN INDUSTRY IN TRANSITION

The increasing process monitoring in the IIoT is coupled with the growing desire for cheaper, smaller and more efficient sensors, and their associated communication protocols. Tens of sensors in today's WSNs will quickly expand to tens of thousands.

Energy supply is one of the most pressing challenges for the IIoT. Millions (and expected soon to be billions) of connected devices require power sources to keep them running. Currently, WSNs are either hardwired or battery powered, making the sensor networks expensive to install and maintain. Battery power provides complete autonomy, but battery life continues to be an obstacle. There is a constant trade-off between the lifetime and the functionality of the sensor, which often tips in favor of "dumb" sensors with longer operational lifespans.



Placing metal parts on the other side of the coil (cogging) affects the magnetic field. This example shows two small rings and a larger ring.

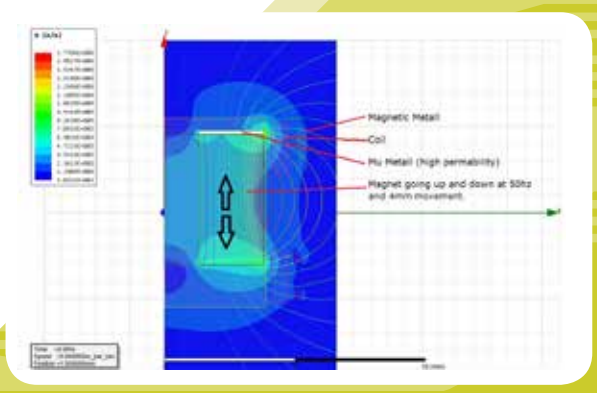
To address these demands, companies need unconventional power sources so that energy harvesting becomes an increasingly viable option. Many very large, global and R&D-heavy companies operating in conventional industries are not yet aware of the numerous locations where smart sensors could be added to their processes to help them realize the power of the IIoT and digital twins. This is where ReVibe Energy comes in. The company is creating a new market and has the speed and flexibility to compete with well-known brands that have 80-plus years of experience but may not innovate quickly with the changing market.

ONE SIZE DOESN'T FIT ALL

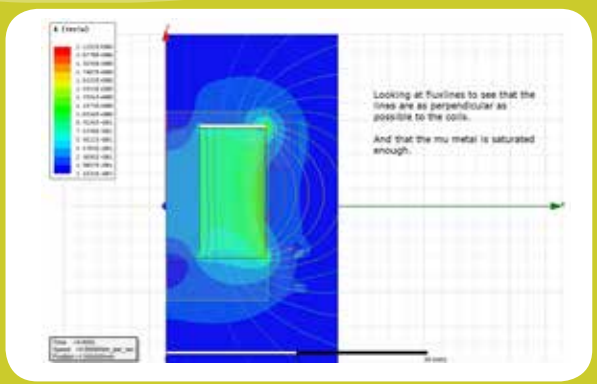
Until recently, vibration energy harvesters were limited in application, as they could not produce sufficient energy to power most wireless devices. Now, with increasingly efficient communication protocols and lower power demands from many electrical components, there are new opportunities for these devices.

There are several technological challenges for vibration energy harvesters. These units are often tuned specifically for the environment in which they are intended to be used. Variations in the frequency and amplitude of the surrounding vibrations negatively affect these units, which produce the most energy at a specific resonant frequency. Even when properly suited for their environment, these energy harvesters only produce enough energy to power the wireless application.

In a recent typical customer case, ReVibe Energy proposed an energy harvesting solution for a railway application. The harvesting device powers a sensor mounted on the railway tracks monitoring remote and off-grid switches. Such a case typically begins with the customer providing information about the vibration environment and specifications about the wireless application. From here, ReVibe Energy needs to quickly estimate the design parameters and the power output from a product that does not yet exist. This calls for very short iterations and testing loops.



ANSYS Maxwell simulation of the magnet and coil



ANSYS Maxwell allows engineers to ensure that flux lines are parallel to the coil and that the Mu-metal is sufficiently saturated for optimal energy generation.

CUSTOMIZING PRODUCTS WITH SIMULATION

ReVibe Energy's patented vibration energy harvesting technology builds upon electromagnetic induction through a system of mechanical springs attached to a magnet oscillating at its resonant frequency.

ReVibe joined the ANSYS Startup Program in 2015 to provide the company's engineers with access to a wide range of ANSYS simulation capabilities and allow them to quickly provide customers with information about the intended solution and reduce development time. They employ ANSYS Mechanical to determine the displacement of the magnet array in relation to the surrounding coils, given a certain vibration frequency and amplitude. It is also used to specify the exact frequencies for all of the system's different resonance modes.

Because product lifetime is crucial when competing with batteries, they also leverage ANSYS Mechanical for structural analysis of the sophisticated spring system. To ensure maximum durability, the simulation model can identify fracture and fatigue points. Based on the displacement information obtained from ANSYS Mechanical, the internal coils can be optimized with regard to geometry.

The engineers apply ANSYS Maxwell to manually optimize several of the unit's parameters related to the magnet, the coil and the amount of Mu-metal (a nickel-iron metal with high permeability for shielding the unit from external magnetic interference) used. The magnet variables include its size and its displacement distance and velocity. Coils are optimized for the number of turns and wire diameter to ensure the right voltage level for rectification electronics. Engineers also employ ANSYS Maxwell to study magnetic flux to properly size the magnet array and to determine the level of magnetization in relation to the oscillating mass. Each parameter change is quickly simulated before modifying the model, with simulations typically taking 10 minutes or less.

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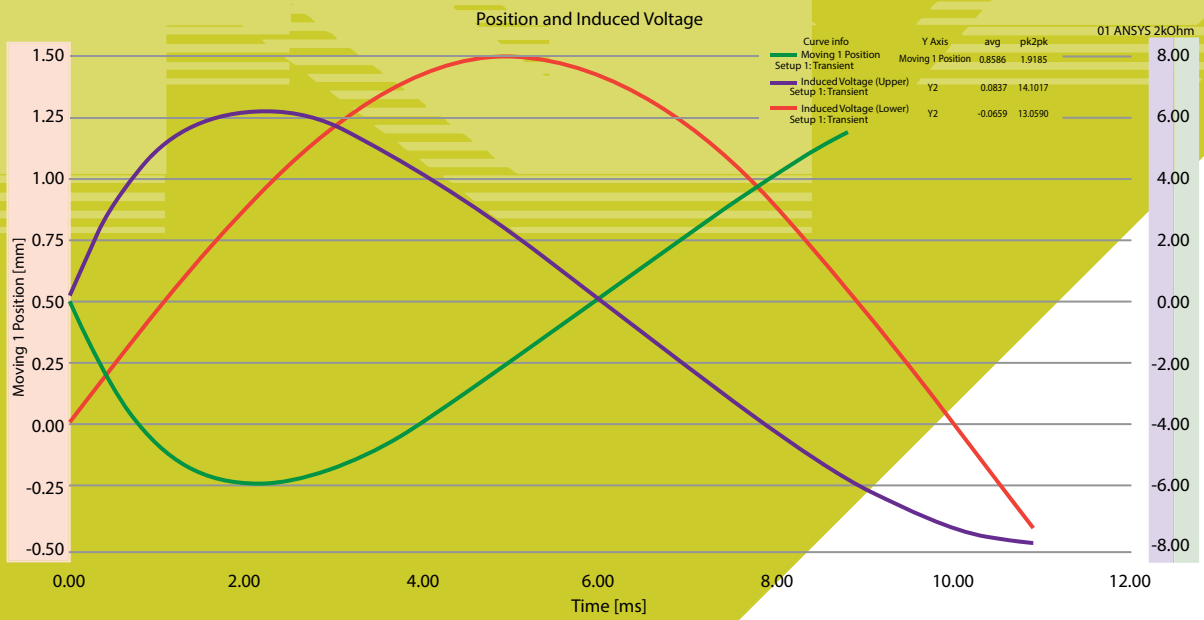
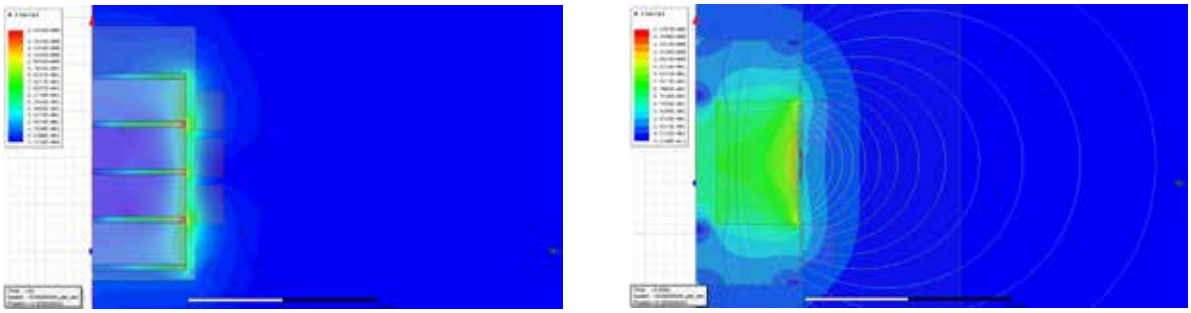


Using ANSYS Maxwell ReVibe can gauge voltage output and determine where to place coils.

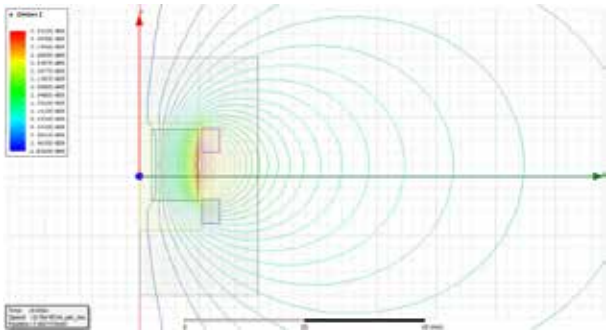


Flux density determined with ANSYS Maxwell

DIGITAL PROTOTYPES

ReVibe Energy leverages ANSYS simulation for digital prototyping to make it easy to develop a new energy harvester for a specific application. Using vibration data from a customer application, simulation is performed with ANSYS Mechanical and Maxwell; engineers then determine design parameters and expected power output for a specific harvester. By using the results of simulation and working with strategic suppliers and additive manufacturing techniques, ReVibe Energy has extremely short product design iteration loops. It usually takes only one to three weeks to produce prototypes that are designed to function and look like the final product. After testing and evaluating one or more units in a relevant environment, the customer will have enough information to make a decision about further development leading to manufacturing. Prior to integrating simulation into the product development cycle, the company required 16 weeks to develop a prototype.

In the case of the railway customer, ReVibe Energy quickly designed and manufactured a vibration energy harvester based on the vibration characteristics of a train passing over the railway switch. Without ANSYS solutions, this would have taken several additional iterations and considerable time and money. As customers and application areas are so diverse, digital prototyping allows ReVibe Energy to quickly adapt to customers' specific requirements, which is vital to the company's business model.



ANSYS Maxwell simulates the magnetic field so that ReVibe can determine the best coil position.

ANSYS simulation software obtained through the ANSYS Startup Program is already a key contributor to ReVibe Energy's value proposition, but ReVibe wants to advance this relationship even further. They are working to develop a black box, which would contain a fully coupled multiphysics simulation model. The black box will include CAD modeling in ANSYS, along with real-time simulations integrating the entire system. Developing this complete solution is a challenge, but the goal is to have a product that begins with an ANSYS CAD model, is tested and simulated in ANSYS software, and is eventually printed as a fully functioning final product via a multimaterial 3-D printer.

Low-Frequency Electromagnetics
ansys.com/low-frequency