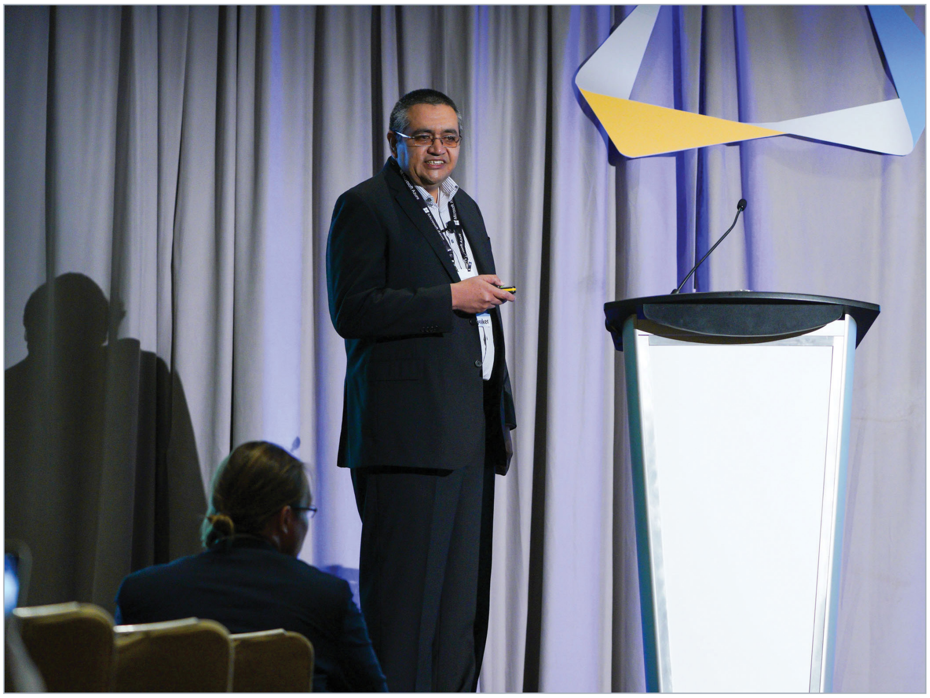
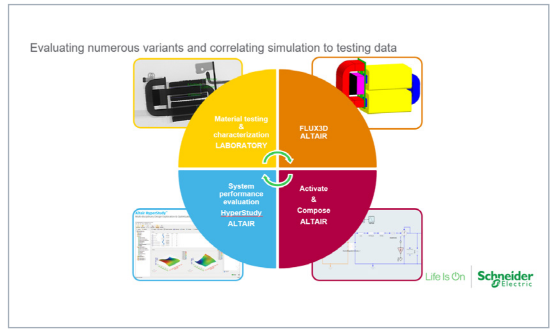
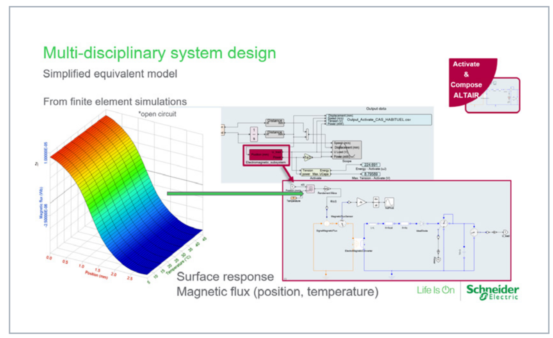
Schneider Electric

ALTAIR

# Optimized Energy Harvesting for Sustainable Smart Lighting Systems






## The Company

Schneider Electric is leading the digital transformation of energy management and automation. In homes, buildings, data centers, infrastructure, and industry, the company's integrated solutions are setting new standards for efficiency and sustainability, which are helping address some of the most profound challenges that society faces. With over 137,000 employees, and a presence in more than 100 countries, Schneider Electric's capabilities embrace a vast portfolio of innovative software, services, and products.

## Their Challenge

In 2019, engineers at Schneider Electric's R&D center in Mexico took on a new project – to study the dynamic performance of a microgenerator, designed to power a wireless communication card for lighting switches by self-harvesting energy. Targeting the European residential market, a self-powered wireless switch offers compelling benefits. In particular, spelling an end to the inconvenience and expense involved in installing traditional light switches. However, to achieve a successful design, particular consideration needed to be given to operating temperature specifications. Differing operating conditions also had to be explored to determine the energy performance of the generator.

The project required a multi-discipline, multi-physics approach. Altair® Flux® was already being used at the R&D center, but the project still needed improvement with simulation and design, and needed to ensure optimization was completed within a tight timeframe.

Alongside the specific requirements of the microgenerator project, broader issues influenced the choice of software utilized. Notably, Schneider Electric's engineers were keen to adopt a simulation-driven approach, putting it at the very heart of the product design process.

Life Is On | Schneider Electric

## The EMHG Project In Focus

The operating principle of the Electro-Magnetic Harvesting Generator (EMHG) at the heart of this project relies on Faraday's law of induction. It transforms the mechanical input energy of the actuation into electrical energy, which is then used to power an RF card sending a switching signal to a wireless receiver.

In the studied configuration a permanent magnet was placed in a magnetic circuit which is composed of two u-shaped masses separated by an air gap. One of these masses has a set of two electrical coils on its legs and is mechanically fixed. The other is holding the permanent magnet and can move perpendicularly to the length of the coils.

Above all else, they recognized that taking this route would enable them to create more robust, reliable, and better performing products earlier in the development cycle.

Speed was also critical. With an ambitious target set for time to market, simulation tools needed to be as swift as they were accurate.

### The Solution

A fully integrated, multi-physics toolkit was achieved by complementing Altair Flux with three more solutions: Altair Activate™, Altair Compose™, and Altair HyperStudy™. Combined, they provided a highly capable and seamlessly connected platform.

- **Flux** is capable of capturing the electromechanical performance of the equipment Supporting both 2D and 3D modelling, it simulates magnetic state, steady state and transient conditions, along with electrical and thermal properties. Flux computed the magnetic flux through the coils given the position and temperature of the switch.
- **Activate** enables products to be created and simulated as multi-disciplinary systems, in the form of 1D models. These are explored as signal-based or physical block designs, with the option of coupling to 3D models. Through systems simulation, Activate was able to model a fast-to-solve version of the complete switch for time computing efficiency and optimization empowerment, without sacrificing accuracy.
- **Compose** is an environment for performing calculations, manipulating and visualizing data, checking the results of simulation and optimizing designs. With Compose, Schneider replicated the rest of the electromechanical behavior of the switch, driving the 1D solution required for time efficiency.
- **HyperStudy** is a multi-disciplinary design study software that enables exploration and optimization of design performance and robustness; by varying parameters, engineers are better able to understand and improve their designs. HyperStudy was used to generate a response surface of the magnetic flux, coming from Flux simulations, which combined with the electromechanical portion from Compose, delivered the complete and complex multidisciplinary behavior of the switch within Activate.

> "The main impact is the quality of results obtained. Altair's software provided valuable insights into the design parameters and performance of the system."
> - Efraín Gutierrez

### The Results

With support from Altair's local team, the learning curve for the new software was rapid. As a result, Schneider Electric engineers enjoyed extensive opportunities to explore and optimize system design from the outset. Crucially, by combining both 1D and 3D simulation, it was possible to undertake a comprehensive evaluation of all the planned configurations and identify critical issues at an early stage.

The flexibility and capability enabled by Altair had a dramatic effect not only on the performance outcome, but also the speed with which results were achieved. Moreover, robust risk management was assured, with effective simulation and optimization preventing engineers from heading in the wrong direction or building prototypes that did not meet the desired objectives.

"This was the only possible way of completing the project within deadline," said Efraín Gutierrez For Schneider Electric, the project also demonstrates an ambitious, dynamic approach to simulation.

"Simulation has created a world of new product testing that puts products through scenarios that cannot be duplicated by prototypes in the real world. It can test a complex product in its entirety and see how each sub-system performs in conjunction with the overall design. At Schneider Electric, simulation has moved to the center of the process, so a wider range of different digital versions of the product can be created and tested, and performance evaluated while the product is being designed," explains Efraín Gutierrez.

### The EMHG Project In Focus (cont.)

The direction changes of the magnetic field in the coils caused by a sudden movement of the magnet create an electric impulse on the coils through the actuation of the wireless switch module. The electrical energy is temporarily stored by the energy management unit and then converted into a predefined supply voltage by a voltage converter unit. This supply voltage powers an RF card, which sends the radio protocol with all user data via the antenna system to a receiver.

For the project, the kinematics and dynamics of the motion mechanism and generator were considered, including friction. A multi-physics approach was implemented using Flux and Activate, enabling the exploration of different systems architectures. Study of the wireless module was feasible which provided realization of the advantages of whole system simulation.

Study of the dynamic behavior and investigation of the system performance was carried out with the aid of case study simulation. The validation of the models was demonstrated by comparing the simulation results with experimental measurements. To understand the influence of temperature on system performance, a linear thermally-dependent magnetization model was considered. The power generated by the proposed EMHG is sufficient to send data several times per actuation.