Plugging In to the Potential of Electrification

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Electrification
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Global prosperity requires more electricity from cleaner, more sustainable energy sources. At the same time, the proliferation of electrified systems is changing transportation and industrial processes. With its focus on electric vehicles, the automotive industry has been at the forefront of the media coverage of electrification — however, this trend is now impacting every industry. Engineering simulation is playing a critical role in helping engineers understand and capture the benefits of electrification for their own product designs.

To meet the increasing global demand for energy — while also addressing growing concerns about the environment and energy security — new policy and regulatory measures are combining with technology innovations to spark the next electrification revolution.

The auto industry has established itself as a pioneer, capturing both headlines and consumers' attention by making the move from internal combustion engines to new powertrain designs supporting hybrid and fully electric vehicles. But, now electrification is poised to impact every industry. From the more electric aircraft to industrial equipment and distributed power generation plants, the electrification of traditional product designs is creating a major shift, leading to sustainable R&D investments, as well as product improvements and innovations.

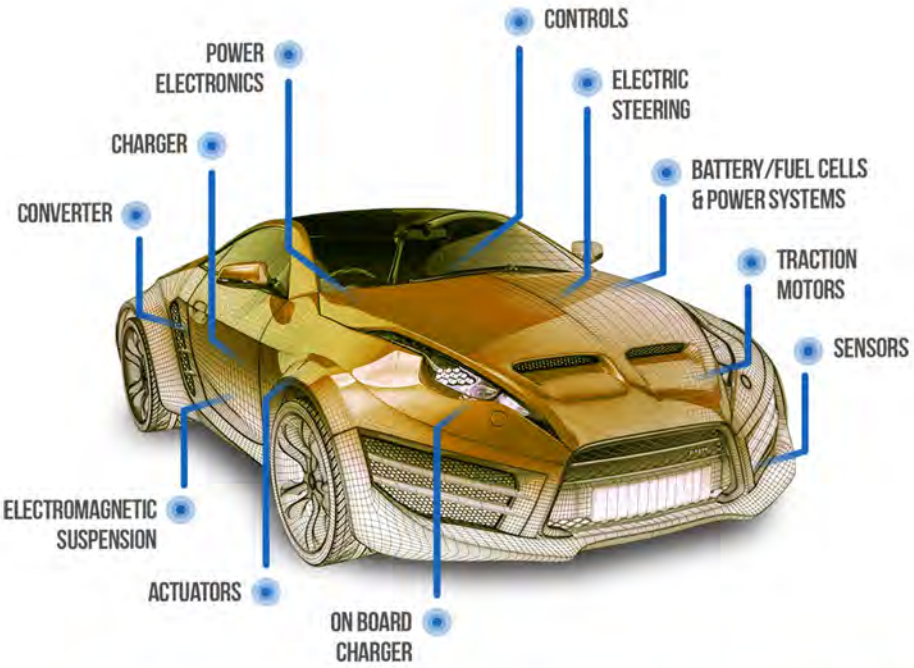
There are several benefits of electrification. Producing electricity from low-carbon sources — including renewables, small-scale nuclear systems, flexible fuels and gas aeroderivatives — enables growing energy demand to be met at a lower cost and with reduced environmental impact. Electrified systems are generally lighter and easier to maintain, while enabling more precise control. They can also be far less expensive. According to Forbes [1], the cost of generating power from offshore wind has fallen by 23 percent since 2010, while the cost of solar photovoltaic electricity has fallen by 73 percent in that time. Likewise, the cost of battery packs, such as those used in electric cars, is continuing to fall.

"Skyrocketing global demand for energy along with environmental and energy security concerns has sparked the next electrification revolution."

However, these benefits are not without challenges. In particular, electrification requires sophisticated new engineering approaches in five key areas related to electrical systems design:

- Power electronics
- Electric machines
- Energy sources such as batteries and fuel cells
- Electromechanical systems integration
- Control software

For each application, the specific engineering problems are different and unique. But electrification teams all share the need to innovate in each of these five areas, quickly and cost-effectively. Companies in every industry feel the pressure to launch groundbreaking new products with electrical components ahead of the competition, and at an attractive price point — and that pressure will only increase.



Enter engineering simulation, which enables a fast, cost-effective, low-risk solution. By leveraging the powerful capabilities of simulation as a routine part of their product development efforts, engineering organizations can affordably solve even the most complex problems related to electrification — and rapidly launch innovations that position their companies for market leadership.

WHERE WE ARE TODAY: ELECTRIFICATION AT A GLANCE

While product electrification will influence every industry, several industries are leading the way and making significant progress.

The auto industry's efforts to develop a broadly adopted electric powertrain design are well-known. Designing a low-cost, lightweight, energy-efficient powertrain system — without sacrificing safety, range, speed, acceleration or passenger comfort — is one of the primary engineering challenges for automakers. Automotive engineers are also investing heavily in new battery and fuel cell designs that exploit novel materials and chemical processes to increase power outputs and storage capacity, while also reducing charging time, size and weight.

In addition to powertrain design, automotive engineers face technical challenges that span the entire vehicle — from heating/cooling and infotainment systems to mission-critical capabilities such as steering and braking. To ensure that all these electrical systems interact seamlessly and safely, engineers must account for every line of control software code and every functional safety system. Only engineering simulation can address multiphysics, multifunctional performance issues quickly enough to meet aggressive development deadlines. Simulation also ensures, from an early design stage, that all components will perform as expected when they are integrated as a complete system.

This issue of *ANSYS Advantage* features several success stories that showcase the contributions of simulation via ANSYS in the global automotive industry. As just one example, ANSYS solutions recently helped Volkswagen Motorsport engineers optimize the battery cooling system for its fully electric race car, leading to a decisive victory — and a new world record for electric vehicle performance — at the 2018 Pikes Peak International Hill Climb (see page 10).

In the aerospace industry, engineers are not only developing technologies that replace existing hydraulic and pneumatic systems with electric equivalents, but

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also fully electric propulsion systems. This promises to revolutionize the entire design of an aircraft and unleash the promise of urban air mobility — via the introduction of small, regional aircraft capable of making short, affordable flights between cities.

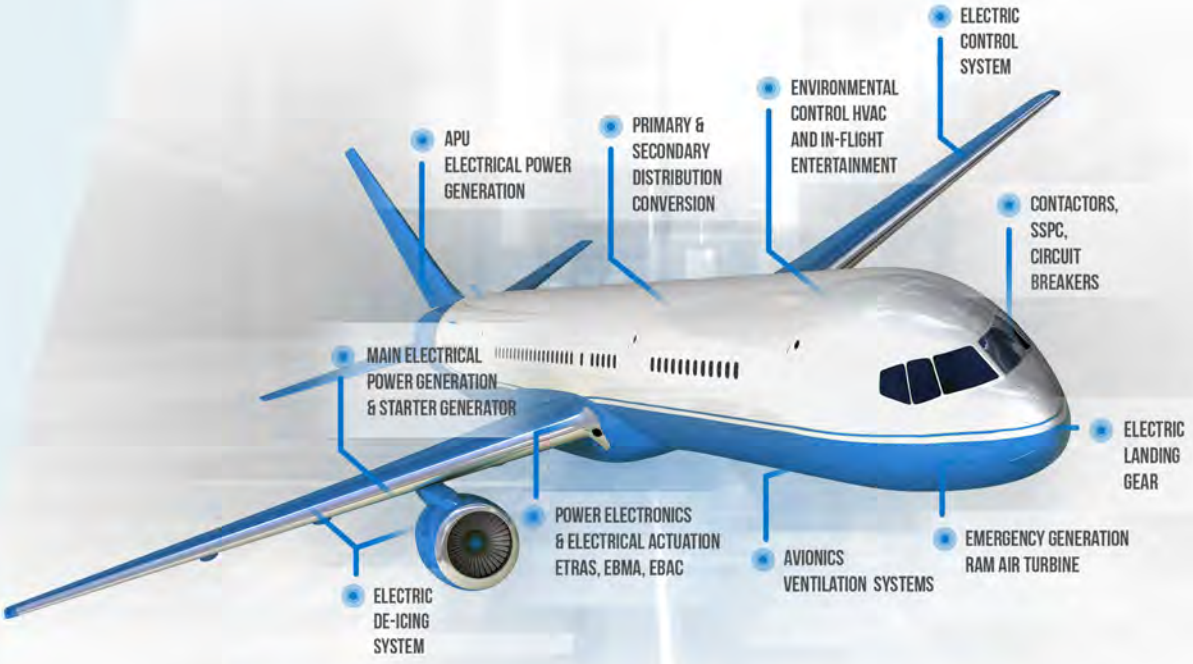
Forget the aircraft as you have always seen it. With electric propulsion, the shape could be completely different. There could be multiple electric motors embedded in the wings; an increased use of lightweight composite materials embedded with antennas and sensors that conduct energy instead of wires; and electric landing and taxiing systems. To make this vision a reality, engineers need to start from scratch and study aerodynamic efficiency, mechanical stresses and electric systems optimization for an entirely new machine design that has never been seen before. They also need to rethink the contribution of control software, which will play a much more significant role in bringing all these systems and components together safely.

Again, simulation provides the means to study all these complex problems and arrive at true innovations. For instance, Seattle-based startup company Zunum Aero was founded to develop an electrically propelled aircraft to connect minor airports using short-haul flights. Simulation enabled Zunum engineers to quickly understand how low-pressure fans, fault-tolerant electric motors and electric controllers work together as a system under real-world conditions. Learn more on page 18.

"Electrification is poised to impact every industry."

As electrification proliferates, the global energy generation industry is also being reinvented. The emergence of distributed power generation through variable and renewable energy sources has introduced a new set of challenges in power generation and distribution.

The proliferation of "microgrids" is a chance for engineers to design extremely innovative new systems for local electricity generation from renewable resources, as well as refine the current technologies for storing and distributing this electric energy. One of the central engineering challenges is optimizing the entire power generation and distribution system, including its physical surroundings — because each system's efficiency depends on the specific weather and geographic conditions around it. In addition to rethinking power generation and distribution grids, there is also a need to modify and optimize components and systems such as wind turbines, turbine blades, converters and generators — as well as downstream equipment such as heat pumps, appliances and industrial machines.



A NEW GENERATION OF MORE ELECTRIC AIRCRAFT

The article "Preserving the Life of Solar Power Inverters," a web exclusive, describes how researchers at the University of Pittsburgh are proving the value of simulation to address the engineering challenges related to localized power generation. They leverage capabilities in ANSYS Twin Builder to study temperature dynamics in solar arrays that occur as environmental conditions change, and how these affect the array's energy outputs. Their goal is to ensure that the product system can maintain consistent performance in the face of inevitable environmental changes.

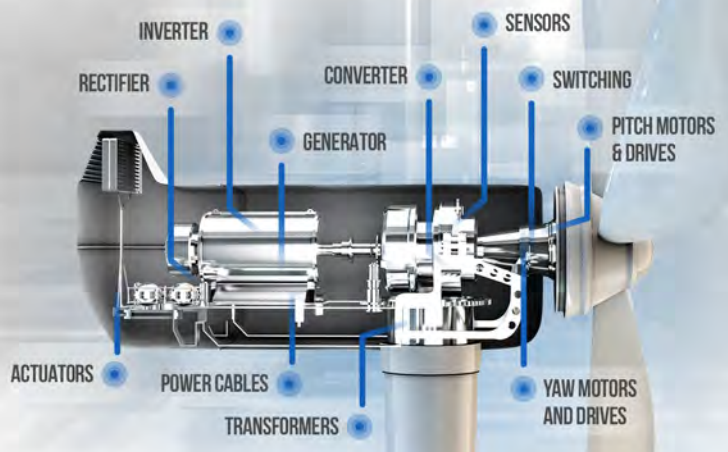
While often overlooked, industrial systems and machines are an enormous source of worldwide power demand. It has been estimated that industrial electric machines, such as pumps, consume over 40 percent of the global electricity produced today. The designs of these products, established for decades in most cases, are the targets for innovation and improvement. Engineers are coming up with new motor designs, electric drives, power electronics, electromechanical drives, cooling systems, user interfaces and embedded software controls that optimize not only these individual components, but the power consumption and energy efficiency of the entire machine.

> ***"Engineering simulation has proven that it can play an important role in securing a new energy future via electrification."***

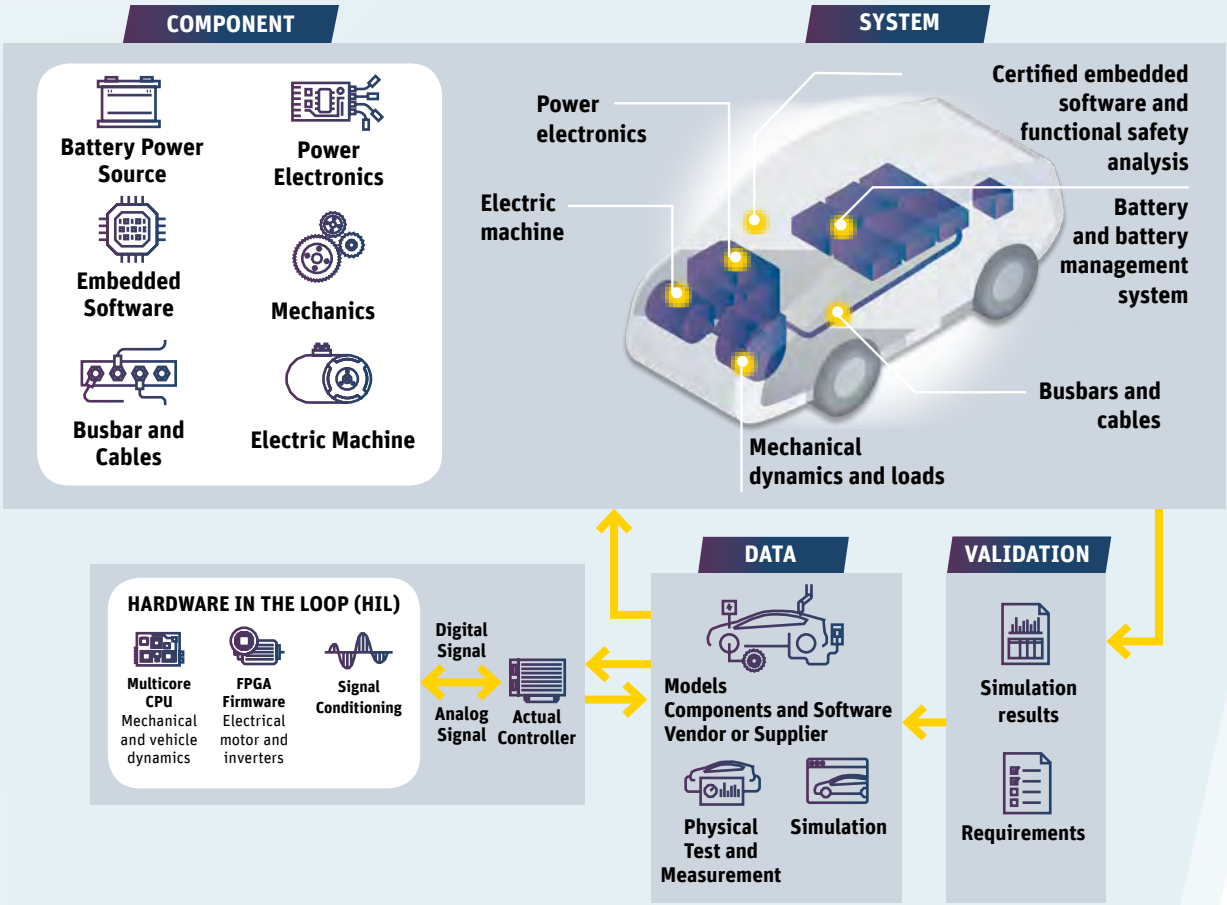
Brazilian company WEG Energy is a leader in developing wind turbines and generators for power plants. WEG engineers use ANSYS solutions to conduct structural, electromagnetic and thermal simulations of these product systems and their individual components. WEG is poised to revolutionize the global market for industrial machinery. Read the full article on page 32.

CHARGING UP ELECTRIFICATION EFFORTS VIA SIMULATION

As electric functionality is added to traditional product designs and as new sources of power become feasible, engineers must solve diverse technical challenges. These include battery management, thermal management, noise reduction, the elimination of electromagnetic interference (EMI), ensuring electromagnetic compatibility (EMC), supporting structural integrity, and minimizing physical damage in real-world operating environments. Engineers must also work to improve performance, increase efficiency, reduce costs and improve safety as they create and investigate entirely new devices, materials and processes for electric machines and power electronics devices.



NEXT GENERATION OF DISTRIBUTED POWER GENERATION



ANSYS ELECTRIFICATION SIMULATION ENVIRONMENT

Given the breadth, depth and technical sophistication of the electrification-related engineering challenges that span so many industries, engineering simulation makes more sense than ever. Today, simulation solutions are available to address tough engineering problems in the five key areas associated with electrification: power electronics, electric machines, energy sources, electromechanical systems integration and control software.

To support our customers as they explore product electrification, ANSYS offers the flagship software solutions in mechanical, fluids and electromagnetic engineering disciplines needed to conduct multiphysics simulations, supported by capabilities for system-level simulation, functional safety analysis, and embedded software development and verification.

Because of the strength of ANSYS solutions, coupled with decades of experience and support for simulation-driven product development teams, it is not surprising that so many of the world's leading engineering teams rely on simulation via ANSYS to fuel their electrification efforts.

As evidenced in this issue of *ANSYS Advantage*, engineering simulation has already proven that it can play an important role in securing a new energy future via electrification. We hope that the customer successes profiled here will inspire you to consider the possibilities of simulation for electrification in your own business.

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Reference

[1] Forbes, Renewable Energy Will Be Consistently Cheaper Than Fossil Fuels By 2020, Report Claims, forbes.com/sites/dominicdudley/2018/01/13/renewable-energy-cost-effective-fossil-fuels-2020/#27d6d1eb4ff2, (12/12/2018)